Where and When Do Bicycles Disappear the Most in Toronto?

Unveiling the Pattern and Potential Factors of Bike Theft

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Introduction

Cycling is not only an environmentally friendly mode of transportation, but has also become an important part of urban transportation. At the same time, increased bicycle use has been accompanied by an increase in bicycle theft, a problem that has become a thorny issue in many cities around the world, including Toronto. Bicycle theft not only brings economic losses to citizens, but also directly affects their transportation choices and even affects the safety and quality of life. Hence, we are looking to analyse the data to understand patterns and trends in bike theft in Toronto so we can identify high-risk areas and make recommendations to help address bike theft.

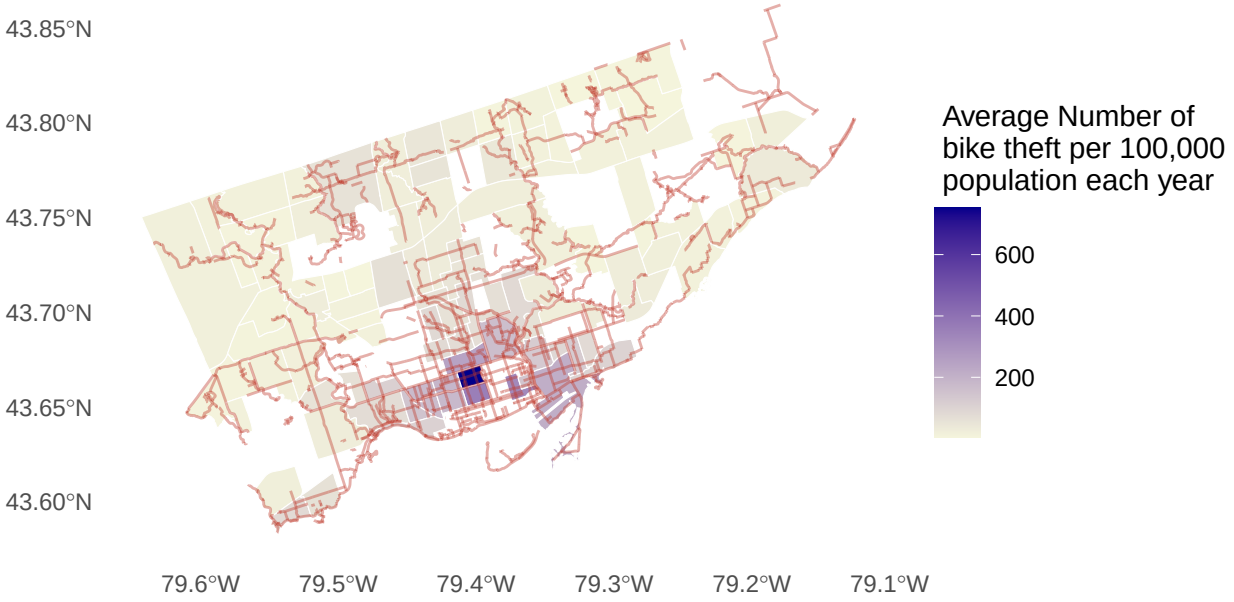
This study conducts a visualisation analysis of bicycle theft data within Toronto from 2014 to 2023, and uses the data to obtain the geographical distribution, time dynamic trends of theft cases, and their correlation with location types and bicycle types. By exploring how different factors influence the occurrence of bicycle theft using five sub-questions, we hope to provide bicycle owners with reliable data analysis and practical prevention tips. We also hope to provide data support to urban planners and policymakers to assist them in designing safer cities, environment, thus achieving the purpose of reducing the occurrence of bicycle theft. The following visualisations are built on two datasets: Bike Theft in Toronto ("Bicycle Thefts Open Data," n.d.) and Neighbourhood Crime Rates ("Neighbourhood Crime Rates Open Data," n.d.) which are collected and generated by Toronto Police.

Interesting Findings

Sub-question 1: Where do the highest numbers of bike thefts occur in Toronto?

To better understand the landscape of theft in Toronto, we conducted a data analysis of bike thefts in various areas of Toronto, focusing on where these incidents occur and how they impact our communities. These neighbourhoods were defined based on Statistics Canada census tracts. Figure 1 has two layers, one is the Toronto 158 neighbourhood ("Toronto Neighbourhoods," n.d.) and the other is the bike lane views ("Cycling Network Data," n.d.). From the dataset provided by Toronto Police ("Neighbourhood Crime Rates Open Data," n.d.), we mapped bicycle theft crime rates per 100,000 people in different neighbourhoods in Toronto from 2014 to 2023.

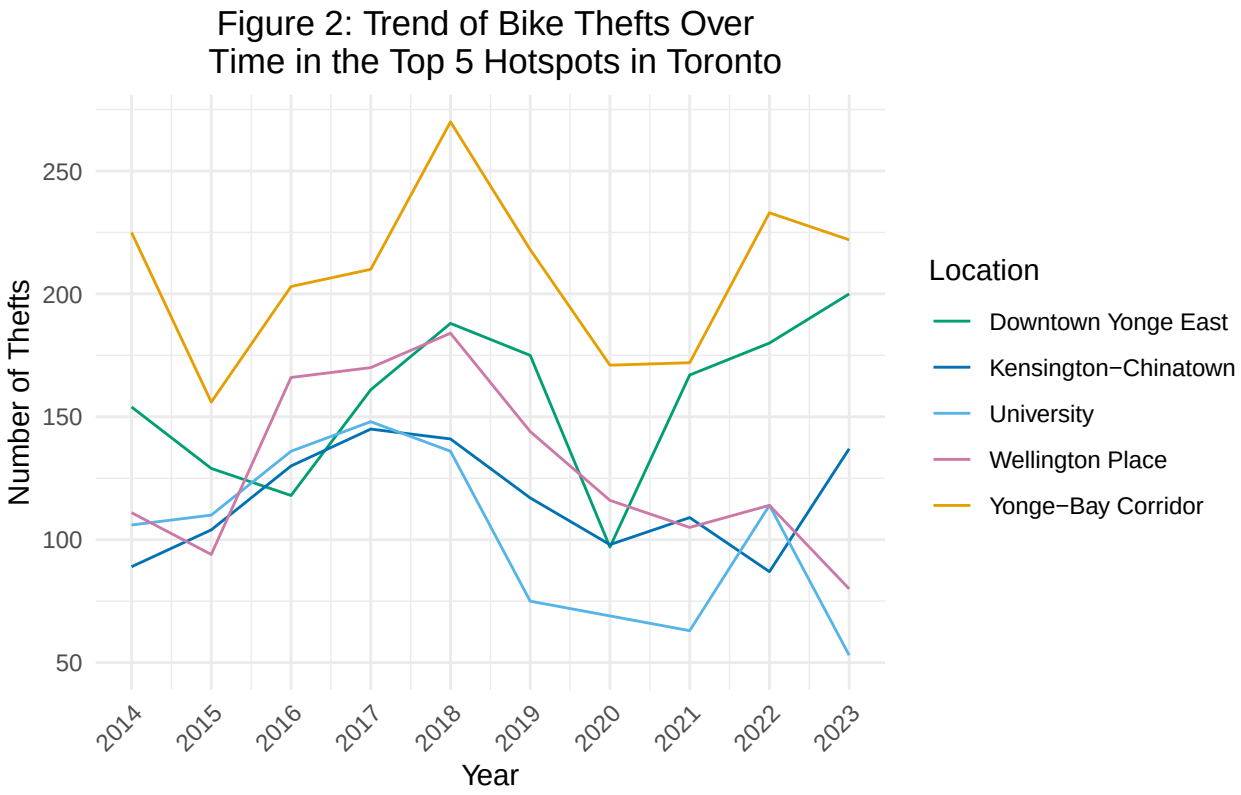
Figure 1: Bike Thefts Crime Rate and Bike Lanes in Toronto by Neighborhood



It is clear to see that in the image the shading on the map ranges from light to dark, with blue representing neighbourhoods with a higher rate of bike theft per 100,000 people, while lighter colours represent neighbourhoods with a lower rate of theft. It can be clearly seen that the closer to the lake, the higher the theft rate, especially in the city centre, which also shows that the centre of the city has the highest bicycle lanes (in red lines). Having more lanes in the downtown area indicates a push towards encouraging cycling, but it also inadvertently raises the risk of bike thefts due to the higher concentration of bicycles in these regions. This image highlights that central city areas (downtown region) are particularly vulnerable and therefore the may urgent need for targeted prevention measures in these communities. We want to dive in deeper in those area with dark shades from trends, time, premises type and bike features in the following four sub-questions.

Sub-question 2: Are there any time trends in bike thefts in these high-risk areas in Toronto?

After analysing geographic factors, we began to wonder if there were other factors that affected bicycle theft, especially in those area with higher bike theft rate. Hence, we included the time factor in Figure 2, and we drew a line chart that focus only on the top 5 high-risk areas to get a more complete understanding of the issue.



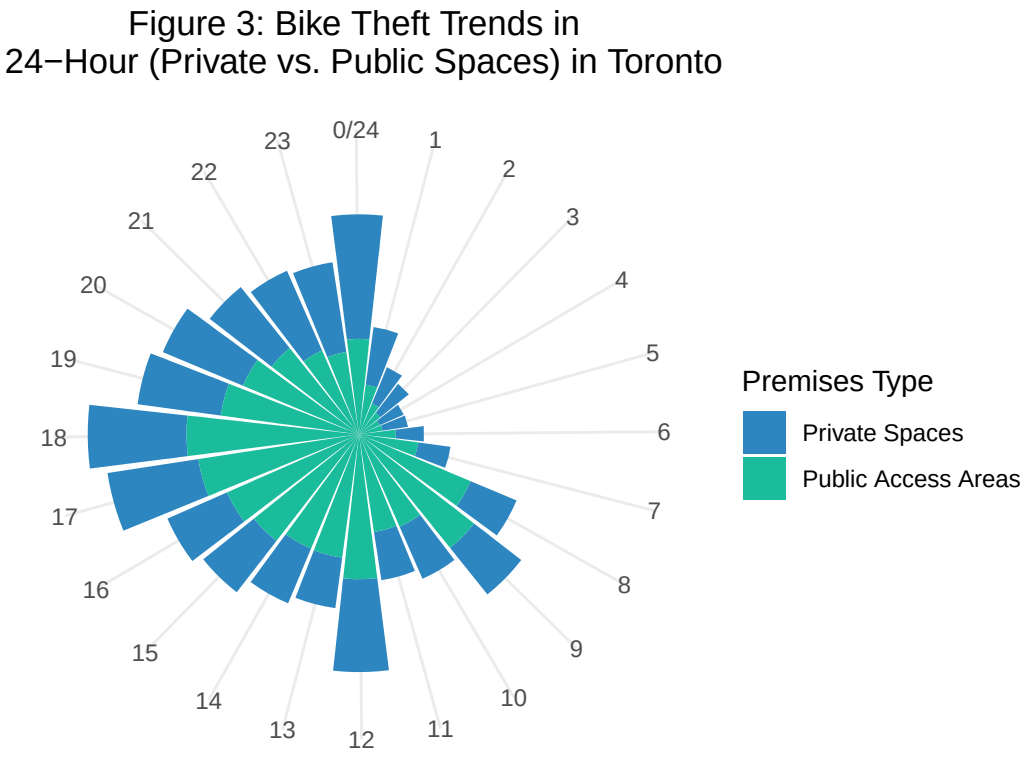
This map includes the locations of thefts, as well as when they are most likely to occur. We filtered out the top five hotspot locations with the highest crime rates from the first hotspot map, and then used a line chart to show trends over time for the top five bike theft hotspots in Toronto from 2014 to 2023. Each line represents one of the top 5 hotspots for bike theft: Downtown Yonge East, Kensington-Chinatown, University, Wellington Place and Yonge – the Bay Corridor, all areas with dense bike lanes and heavy traffic. Now, the graph also shows time trends for each location from 2014 to 2023. Although there are obvious peaks and troughs, the overall pattern is similar. What makes us curious is that there seems to be a general decline in thefts in all locations around 2020. So we thought this might be related to the global COVID-19 pandemic, when lockdowns and outdoor activities were reduced, so the drop in theft rates across neighbourhoods suggests that bike theft, regardless of location, is changing with society. After that, it can be seen that the theft rate has rebounded somewhat after 2020, which also represents the opening of the city and the restoration of normal activities, and the theft pattern has returned to the previous pattern. University areas in particular have seen a sharp increase in theft rates, possibly due to a resurgence in campus activity.

Sub-question 3: How do patterns of bike thefts in Toronto vary between Private Spaces and Public Access Areas throughout the day in Toronto?

After a visualisation regarding the yearly trend, we would like to further refine factors and dive deeper in the time variable. Therefore, we break down bike theft incidents into 24-hour periods in time in Figure 3, which allows us to observe the frequency of incidents at different times. At the same time, we further divide places into two types: private areas and public areas.

This clock-like graph represents the number of occurrences of bike thefts for each hour of the day, with the length of each segment representing the number of thefts that occurred during that hour. The graph uses two contrasting colours to differentiate between private spaces (e.g.blue) and publicly accessible areas

(e.g.green).



The chart distinctly showcases that both private and public spaces follow a similar trend over a 24-hour period, suggesting synchronicity in theft incidents throughout the day and night. From the late night hours of 1 AM to the early morning at 7 AM, there's a notable downturn in bike thefts, which is particularly pronounced in private spaces. This observation aligns with the expectation that most individuals would be at home during these hours, leading to a higher concentration of unattended bikes in residential settings.

As the morning progresses, starting around 8 AM, which corresponds with the commencement of typical work and school hours, there is an observable uptick in thefts, peaking sharply at noon. This midday high point could be attributed to bikes being left in public spaces as their owners engage in daily activities. The frequency of thefts then tapers off toward 6 PM, coinciding with the end of the workday, when people typically return home, possibly deterring theft in public spaces due to decreased opportunities. In summary, the peak hours are at 12 AM, 12 PM and 6 PM.

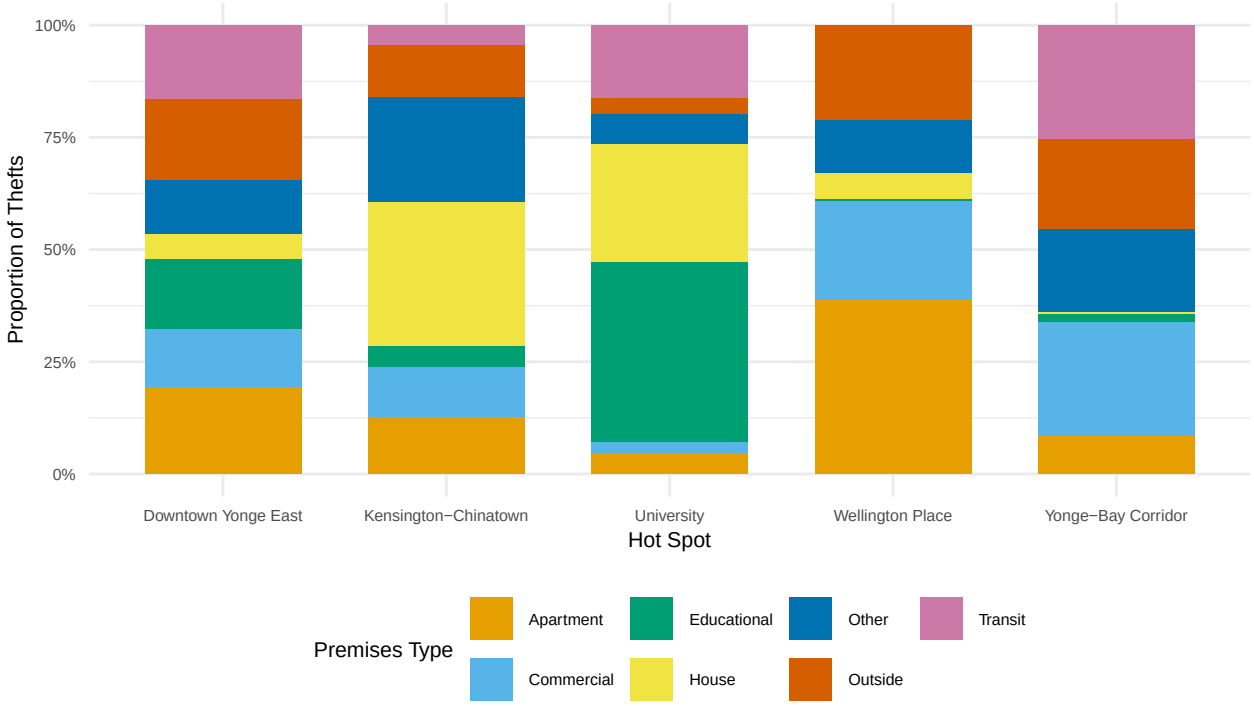
Taking a closer examination of the midnight hour reveals that thefts in private spaces constitute a significant proportion of the incidents, suggesting that bikes are more vulnerable to theft in residential areas during the late hours when owners are likely to be at home. Throughout the day, the incidence of thefts in public spaces is more prominent, especially during working hours from 9 AM to 6 PM, indicating that unattended bikes in public areas are prime targets during these periods. This plots reveal the pattern of bike theft and may have some implication in the future, which will also be carefully discussed in the conclusion section.

Sub-question 4: How does the type of area (residential, commercial, industrial) influence bike theft ratesm in Toronto?

We now know the trend of bike thefts in private and public spaces. It would be interesting to refine and focus on various specific premise types. Therefore, Figure 4 demonstrates a distribution of the proportion of

bicycle thefts in each type of premises within the main theft hotspots being plotted based on bicycle theft data within the top 5 areas of a specific premises type. These top five locations represent the neighbourhoods experiencing the highest number of bike thefts per 100,000 people.Therefore, we further divided the premise types into seven different categories. This stacked bar chart depicts the proportion and structure of thefts within each category to provide a comparative perspective of the most prevalent instances of bicycle theft.

Figure 4: Proportional Distribution of Bike Thefts Across Premises Types in Toronto Top 5 Hotspots



In Toronto's top five hotspots for bike theft, the premise type in Yonge East seems to be dominated by 'Transit', 'Outside' and 'Apartment'. Whereas Yonge Bay Corridor is mostly in 'Transit' and 'Commercial'. In Kensington–Chinatown, 'House' spaces lead in theft proportion, closely followed by 'Other' spaces. For Wellington Place, 'Apartments' have the highest theft proportion, with 'Commercial' areas again being a significant concern. The University area is predominantly affected by thefts in 'Educational' premises, with 'House' spaces as the second most common location for thefts. These insights suggest the necessity for security strategies that are finely tuned to each area's specific risk profile, focusing not just on the highest proportion but also on the other category to comprehensively safeguard against theft.

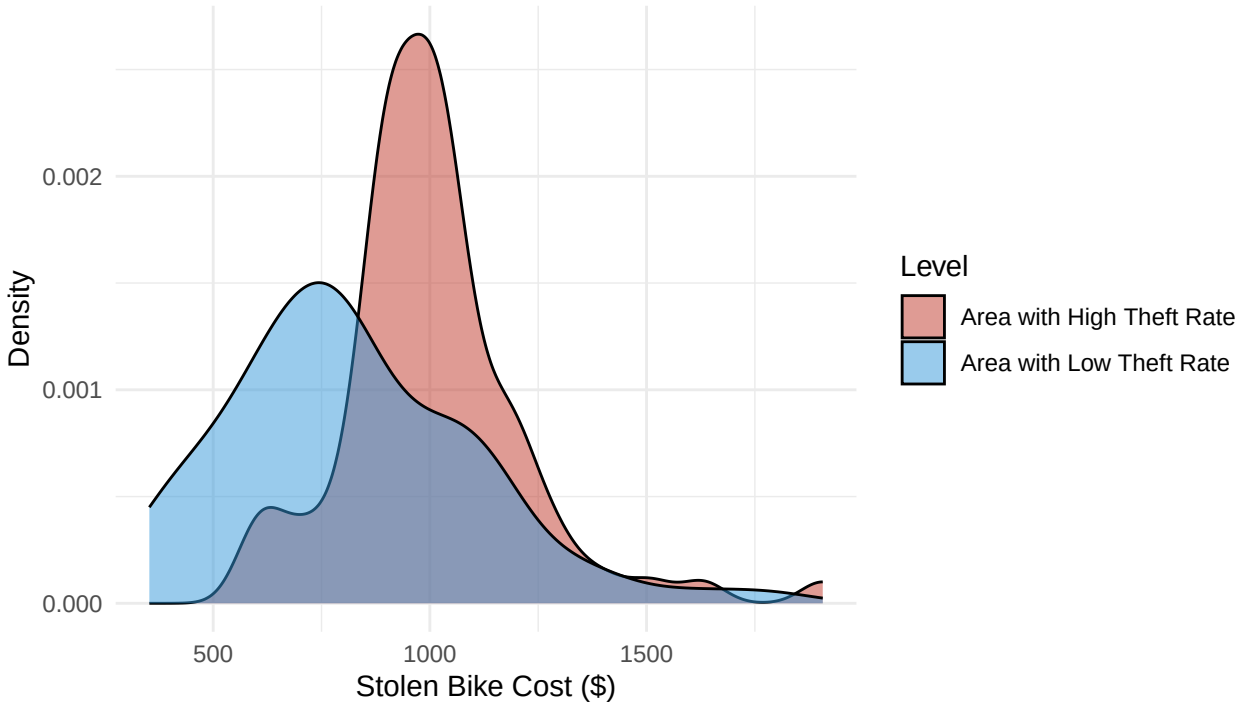
The plot reveals a unique distribution of premise types across each hotspot, with no single category prevailing everywhere. "Commercial" spaces are prominent in Wellington Place and Yonge-Bay Corridor, while "House" is significant in Kensington–Chinatown and the University area. "Outside" areas are critical in Downtown Yonge East, Wellington Place, and Yonge–Bay Corridor.

The complexity of these plots, stemming from the varied premise types across regions, highlights the necessity for an in-depth analysis to grasp the subtleties. This understanding is crucial for communities to effectively customize their security strategies based on the dominant premise types within their areas.

Sub-question 5: What are the cost profiles of bicycles stolen in Toronto?

After analysing objective factors such as geographic and temporal aspects, we began to consider whether the feature of the bicycle itself might also act as another factor influencing theft incidents, especially in the high bike theft rate regions. We decided to focus on the cost of the bike and connect this hypothesis with the results of previous visualisations in Figure 5.

Figure 5: Comparative Density of Stolen Bike Costs in Areas with High and Low Theft Rates in Toronto



In Figure 5, we first find the median of the crime rates in the neighbourhood, then those with a rate greater than the median is grouped as "Areas with High Crime Rate Area" and others are "Areas with Low Crime Rate". The purpose of this chart is to analyse the correlation between the value of a bicycle and its likelihood of being stolen, by charting the relative density of bicycle costs in areas with high and low theft rates. We can see that the density plot has two overlapping distributions: one is a red areas with a high theft rate that peaks at about $1,000; the other is a blue areas with a low theft rate that peaks at about $750. Therefore, this plot may suggest that on average, areas with higher theft rates will steal more expensive bikes, and thieves will be attracted to higher-value items for high returns.

Limitations

Our study, focusing on bicycle thefts between 2014 and 2023, faces challenges that impact the comprehensiveness and accuracy of our conclusions. The main one is the restricted time frame of the dataset, as well as the lack of consistent population data for Toronto's neighbourhoods in these years. Additionally, data like passenger flow in the public area (i.e., Transit and Outside) and daytime passenger flow versus night time are not included in the analysis. Access to this information is important since it will help us confirm whether bike theft rates published by Toronto Police each year are accurate and also improve the visuals we create for more lucidity and insight.

Moreover, some charts also have their own limitation. For example, in Figure 4, limitation lies in its inability to reflect the varying densities of premise types across different locations, such as some areas inherently having more apartments, which could distort the perceived theft risk. The proportions do not account for the absolute number of thefts or the density of bikes, which are crucial for a complete understanding of theft likelihood.

Furthermore, despite our efforts to consider population density, there are numerous other complex demographic details missing in those communities. These demographic data (income levels, percentage of bike ownership and/or efficiency of local law enforcement) may contribute towards the topic thereby yielding a more accurate relationship/ pattern concerning bike thefts within Toronto.

In addition, there is also an issue with the reliance on crime data, which likely underestimates the true scale of bike thefts happening in Toronto. Some victims might not report such incidents due to possible perceptions of police receptivity or the belief that the monetary worth of their stolen property is too low to warrant official reporting. This kind of self-reporting bias significantly distorts our knowledge about the actual crime rate.

Future Steps

How can we overcome these challenges? First, alternative data sources or statistical models that estimate population and demographic change, and also extend the time frame of the dataset, which may add more insight and boost robustness to our analysis. In order to make the data set better reflect the reality of bike theft in Toronto it would be useful to have initiatives targeted at theft reporting and public awareness-raising campaigns to help to reduce the bias of the data. Also, we could expand our study by looking at more neighbourhoods or even doing a comparative study with other cities within Canada so that we give a richer context. This will enable us to confirm if any similar patterns are observed elsewhere outside Toronto while ensuring that our findings are generalizable. Overcoming these limitations can help with accuracy, generalizability, and credibility, as well as deepening insights for future investigations.

Conclusion

Throughout this study, we combined geographic, temporal, and characteristic aspects with data and graphics to examine bicycle theft in Toronto. According to the data, there was a constant greater incidence of bike theft in neighbourhoods with lots of bike lanes and significant traffic. The results of a multiple-factor analysis demonstrated that these occurrences had a time, place, and type relationship and were not random. Moreover, the distribution plot reveals that expensive bikes were most likely to be taken from high-crime locations, suggesting that cyclists may want to consider travelling with less expensive bikes in these regions.

Some Implications

From those interesting findings, it is obvious that bike thefts are worryingly common in places with lots of bike lanes in downtown Toronto. This indicates that we need to do more to keep bikes safe and prevent such things. For urban planners, this could mean the integration of bike theft data into city planning processes to ensure that new bike lanes and cycling facilities are accompanied by adequate security features. It might be also a good idea to have law enforcement agencies targeting initiatives in identified hotspots, potentially utilising predictive analytics to preempt theft occurrences before they happen, such as adding more patrols at peak hour and at those high-risk regions. As for the cyclists, they should also be aware that more expensive bikes are more likely to be stolen, so they should think carefully about how they secure their bikes, especially when parking in busy downtown areas and near some public spaces. Ultimately, understanding the patterns of bike theft creates a safe and secure urban environment. Expect a collaborative effort between community members, city planners and law enforcement to develop different ways to reduce the bike theft problem in Toronto.

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