Candidate Number: POL2244

Paul Ottaro

Fitzwilliam College

Supervisor: Prof. Barak Ariel

Targeting Hot Spots and Harm Spots in a Mass Transit System in Canada: A Tale of the City of Edmonton

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Abstract

While the literature on crime concentration at places is extensive, a limited body of evidence exists on hot spots or harm spots in mass transit settings, and an even more limited line of research focuses on temporal trajectory patterns. The present study is the first to do so in a Canadian context, intending to identify spatial and temporal crime concentrations at Edmonton's Light Rail Transit (LRT) stations for strategic crime prevention initiatives.

This study examined calls-for-service and incident report data spanning six years (2017 – 2022). The Canadian Crime Severity Index (CSI) was applied to convert incident counts to severity scores. Concentration patterns and power-few rankings were calculated for calls-for-service, recorded incidents, and recorded crimes – in terms of counts as well as CSI. K-means clustering technique was used to identify groups of station and offender trajectories by both count and severity. The Pearson correlation coefficient was used to measure the relationship between offender counts and severity.

Both crime incidents and CSI were found to be concentrated in Edmonton's LRT network. Approximately one-fifth of stations accounted for 49% of calls-for-service, 60% of total incident counts, 63% of total incident severity, 53% of criminal code offences counts, and 53% of criminal code offences severity. Three stations – Churchill, Central, and Coliseum – consistently featured as the top three. The trajectory analysis indicated stability in the groups, suggesting that high or low crime counts and crime severity stations remain as such over the study period.

Offender analysis found that 22% of offenders were responsible for 78% of all incidents. There was a statistically significant positive correlation between their offence count and offence severity, suggesting that, in the LRT context, CSI is driven by volume rather than by harm. Temporally, the majority of the offenders belonged to the low crime and low harm severity trajectories.

Practical implications are ubiquitous with the available literature – that concentrating on a small number of places (i.e., stations) – can lead to overall reductions in the entire jurisdiction, as the bulk of crime and harm are spatially concentrated. A place-based approach to crime in Edmonton's LRT stations, can lead to substantial benefits. However, the present study underscores a relatively untapped potential, which calls for an integration of offender data in targeting choices.

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Chapter 1: Introduction

1.1 Crime on Mass Transit

In recent years, more attention has been given to the criminogenic setting of the mass transit system. This scholastic focus mirrors the growing media attention to violent crime and disorder incidents on mass transit systems across Canada (Al Hakim, 2023). These events led to the recent formation of a National Transit Safety Taskforce, comprising major transit agencies, including Metro Vancouver, Toronto, Winnipeg, Calgary, Edmonton, York Region, and Montreal, in an attempt to find solutions to crime and disorder problems (Canadian Urban Transit Association, 2023). Public safety on mass transit is essential, as crime and fear of crime influence the decision to use mass transit (Needle & Cobb, 1997). The risks of deteriorating public safety on mass transit are not only limited to declining ridership and revenue for transit agencies, but also present a burgeoning concern for the safety of passengers and people who work in this environment, hence threatening "the vitality and economic well-being of metropolitan areas" (Clarke, 1996, p.1).

The criminogenic nature of mass transit space is argued to be a function of the confluence of human activity patterns and physical characteristics of the immediate and proximate environments that produce opportunities for crime (Block & Davis, 1996; Brantingham & Brantingham, 1993; La Vigne, 1997; Smith & Cornish, 2012; Ceccato, 2013; Newton, 2014). Nevertheless, as importantly, research on crime and place shows that these factors are not uniform in all places and at all times (Irvin-Erickson & La Vigne, 2015; Ceccato & Uittenbogaard, 2014). There are spatiotemporal variations of crime, given the ubiquitous Pareto curve phenomenon: a clear pattern of crime concentrating in only a few micro-spatial places commonly referred to as hot spots (Sherman et al., 1989). It therefore makes sense for the police to focus their resources efficiently on these hot

spots as it reduces their area of focus while reducing crime citywide (Smith et al., 2024). Focusing police interventions at the hot spots of crime was found to have crime reduction effects, and it did not displace crime but led to a diffusion of benefits to surrounding areas (Sherman & Weisburd, 1995; see meta-analysis of the evidence in Braga et al., 2019). However, the body of evidence on crime concentrations in the mass transit system is limited, and empirical research on the benefits of hot spot policing to prevent crime in this environment is sparse (Ariel et al., 2020).

1.2 The Study's Research Questions

The main objective of this study is to determine the degree of spatial and temporal crime concentration at Edmonton's light rail transit (LRT) stations and identify the power-few stations to inform targeting strategies empirically. The first research question will attempt to address the degree of spatial concentration of crime in the LRT stations using calls-for-service, incident reports, criminal code offences and crime severity as measured by the Canadian Crime Severity Index (CSI). Power-few stations and their rankings will be identified for each dataset.

The following questions take a more surgical approach with the available data. First, a comparison between crime counts and crime severity concentrations will be conducted. Previous studies have shown that crime harm is more heavily concentrated than crime harm, but whether the same is true for the mass transit system is presently unclear. The following research question addresses crime trajectories for transit stations and offenders over the six-year period, using crime counts and severity. A more sophisticated approach is taken here, with a k-means clustering method that groups stations based on volume (either counts or CSI) to identify unique patterns in the data. Next, the temporal distribution of crime counts and crime severity by time-of-day, day-of-week, and month-of-year will be calculated, while the next research sub-question investigates the power-few stations' physical and environmental attributes.

The following questions look at the distribution of offenders in the data, which is an untapped and understudied area in the criminology of places. The offenders' characteristics, incident and severity by offender types, and the correlation between offenders' counts and the severity of offences will be observed.

1.3 The Dissertation's Roadmap

Chapter 2 reviews the existing literature on the criminology of place and highlights some of the areas upon which the present study aims to build. Chapter 3 is the methods chapter, describing the research setting before outlining the data sources, cleaning, limitations, and analytical methods used to answer the research questions. Chapter 4 presents the research findings, while Chapter 5 concludes with a discussion of research, policy, and theoretical implications, as well as the limitations of the research.

Chapter 2. Literature Review

The literature review chapter discusses previous research on the criminology of place. The discussion begins with a comparison of individuals and places as units of analysis, and then traces the historical background of crime and place studies. The chapter will then discuss hot spots of crime, the concept of crime harm, crime on mass transit systems, and concludes with noted research gaps that the present study aims to address.

2.1 Criminology of Place

2.1.1 Individuals versus Places

The field of criminology has traditionally focused more on individuals than places as a unit of analysis (Clarke, 1980; Sherman, 1995). This dominance was evident in the review of 719 empirical articles published in the *Criminology* journal over a period of 25 years from 1990 to 2004, finding 66% of the articles focused on individuals, while only 4% focused on micro-geographic places such as addresses, street segments, and facilities (Weisburd, 2015). Scholars examining individuals as units of analysis rely on the assumption that "crime is a product of human agency" (Weisburd et al., 2012, p.186). As such, they offer criminal justice prescriptions such as rehabilitation programs, that are based on dispositional explanations of individual criminality. However, given the variability in the individual causes of criminality, this approach presents a challenge in predicting criminality and in finding a common crime prevention solution applicable to a wide range of offenders across different settings. Furthermore, as pertains to crime concentration, Wolfgang et al. (1972) finding that 18% of individuals accounted for 50% of all crime compared to the finding by Sherman et al. (1989) that only 3% of places produced 50% of all police calls-for-service, suggest that crime is more concentrated in places. This feature of

concentration makes crime more predictable when the unit of analysis is the place, rather than the offender—and by implication crime at the spatial level is more preventable.

2.1.2 Historical Background of Crime and Place Studies

Whereas studies focused on individuals have been dominant, the interest in the relationship between crime and place is not new, as the earliest studies can be traced back to almost 200 years ago. Ducpetiaux (1827) published crime and suicide statistics of regions in France, Italy, Spain, and England finding differences between the regions and countries. In France, Balbi and Guerry (1829) examined the relationship between education level and crime in large French administrative districts, finding that crime varied across the districts and that areas with high levels of education experienced higher property crime. Quetelet (1831) also examined how crime varied across large administrative areas in France and found that the lowest crime rates were located in the poorest areas of France. Finding similar results was Guerry (1833), who found that the rich north regions of France faced higher property crime rates as compared to the poor regions in the South of France. Parent-Duchatelet (1837) conducted an empirical study and produced maps detailing the distribution of prostitution in the city of Paris from the year 1400 to 1830.

American scholars who pioneered the 'Chicago School' of sociology (Burgess, 1925; Park, 1925; Thrasher, 1927; Shaw,1929; Shaw and McKay, 1942) sought to explain the relationship between the crime problem in cities and characteristics of the urban environment (Weisburd et al., 2009). They relied on the concept of social disorganization and argued that offending occurred in the absence of "structurally located social bonds which encouraged legitimate and discouraged deviant behaviour" (McLaughlin et al., 2004, p.111). However, these early studies of crime and place have been criticized as taking on a macro-level approach by analysing aggregates of places, which may "mask important variation and causal properties within those aggregations" (Sherman et al., 1989,

p. 28). This noted spatial heterogeneity within larger geographical units (Weisburd et al., 2009) has called for a change in the cone of resolution to smaller spatial units of analysis.

2.2 Hot Spots of Crime

2.2.1 Definition of Hot Spots

While there is no universal definition of hot spots (Weisburd et al., 2012), they are defined as "small places in which the occurrence of crime is so frequent that it is highly predictable, at least over a one-year period" (Sherman, 1995, p. 36). Hot spots are also simply defined as places with higher concentrations of crime (Brantingham and Brantingham, 1999; Eck et al., 2005; Pierce et al., 1986; Sherman et al., 1989; Sherman and Weisburd, 1995). Hot spots can be addresses (Eck et al., 2000; Pierce et al., 1986; Sherman et al., 1989); intersections (Taniguchi et al., 2011); street segments (Weisburd et al., 2004); or specific facilities such as transit stations (Ariel, 2011). Regardless of the type of micro-geographic unit, the advantage of hot spots as a unit of analysis is that they provide "a more stable target for police activities; have a stronger evidence base; and raise fewer ethical and legal problems" (Weisburd, 2008, p. 2). Hot spots also provide an opportunity for efficient allocation of policing resources by minimising the geographical focus (Weisburd, 2008) while still achieving total crime reductions citywide (Braga et al., 2019; Lum et al., 2011).

2.2.2 Identification of a Hot Spot

Sherman (1995) points out that there is no universal standard threshold for identifying a hot spot, and he states that the rule of thumb is to identify the top 5% of hot spots that account for 50% of all crimes. To identify hot spots, Spelman (1995) suggests analysing calls-for-service data over a longer period of time, where a place qualifies as a hot spot only if it produces "enough" calls during

a specific time period. It is preferrable to have longer observation periods as predictive accuracy increases with the duration of observation (Spelman, 1995). Since past behaviour is known to be a good predictor of future behaviour (Conner and Armitage, 1998), the habitual offending or recidivism of places provides a strong basis for accurate predictions (Coldren et al., 2013). However, while some hot spots may be permanently and predictably vulnerable, the vulnerability in other places may be temporary or sporadic (Spelman, 1995); hence, targeting decisions should consider the distinction between these types of hot spots.

2.2.3 Statistical versus Clinical Prediction of Hot Spots

Hot Spots can be identified either by data analysis, also known as the statistical method, or by professional judgement, also known as the clinical method (Macbeth and Ariel, 2019). On the one hand, experienced police officers can exercise their professional judgement to identify hot spots, as it is assumed that they have knowledge of problem locations in the areas they police (Wain and Ariel, 2014). On the other hand, the widespread use of information technology systems such as crime mapping and Global Positioning Systems (GPS), has enabled the analysis of large volumes of data to map hot spots (MacBeth and Ariel, 2017). Professional judgement was found to be inaccurate in predicting hot spots compared to statistical forecasting (Macbeth and Ariel, 2019; Sutherland and Mueller-Johnson, 2019). In a Philadelphia case study, Ratcliffe and Kikuchi (2019) found that statistical methods were more accurate in selecting high-harm prolific offenders compared to clinical methods using crime analysts and police detectives. In highlighting the supremacy of statistical methods, Meehl (1954, p. vi) argues that “there is no convincing reason to assume that explicitly formalised mathematical rules and the clinician’s creativity are equally suited for any given kind of task or that their comparative effectiveness is the same for different tasks.” Studies in other fields that employ statistical methods to predict future occurrences have

been found to be more accurate than those relying on clinical methods (Kahneman, 2011; Tversky and Kahneman, 1974). The fact that numerous police agencies have been found to not know where their hot spots are (Sutherland and Mueller-Johnson, 2019) and even allocate police resources in areas they believe to be hot spots but are not actually so (Ariel et al., 2017; Norton et al., 2018; Wain et al., 2017; Weinborn et al., 2017), highlights the importance of adopting statistical methods.

2.2.4 Crime Concentration in Hot Spots

The focus on microspatial and temporal features of crime has come to be known as the criminology of place (Sherman et al., 1989). This renewed focus on the criminology of place arose from empirical observations that crime does not occur randomly, and is not evenly distributed across space (Bruinsma and Weisburd, 2014; Eck et al., 2005); it is highly patterned and predictable (Brantingham and Brantingham, 1993); and it clusters at very small geographic units (Sherman 1995, 2007; Weisburd et al., 2009; 2012). These observations led Weisburd (2015, p. 138) to declare a law of crime concentration that states, "For a defined measure of crime at a specific microgeographic unit, the concentration of crime will fall within a narrow bandwidth of percentages for a defined cumulative proportion of crime." However, Weisburd (2015) cautions that while the evidence of crime concentration at hot spots is robust, drawing similarities from this observation across different cities is problematic given the variety in the units of analysis, data types, and crimes examined. This challenge is further echoed in the systematic review of hot spot studies from 1970 to 2015 that found, for example, that calls-for-service were more concentrated than crime incidents at places; that there was a higher concentration of crime at addresses than at other units of analysis; and that a higher concentration of crime was found in U.S. studies than in non-U.S. studies (Lee et al., 2016). Additionally, in examining the extent to which hot spots of different crime types overlap, Haberman (2017) only found limited spatial overlap among the

crime types. However, Haberman's findings were based on only one year of crime incident data from 2011 from one city, Philadelphia. Thus, only further studies employing different microgeographic units of analysis, data types, crime types, and settings can provide insight as to whether these prior observations are crystallising or not.

2.2.5 Evidence of Crime Concentration in Places

In Minneapolis, Sherman et al. (1989) conducted a spatial analysis of police calls-for-service data over a 1-year period, finding that only 3.3% of addresses accounted for 50.4% of calls. They also concluded that predatory crimes were even more concentrated in place after finding that all robberies were located in 2.2% of addresses, all rapes in 1.2% of addresses, and all motor vehicle thefts in 2.7% of addresses (Sherman et al., 1989). The finding that not only is crime concentrated in a few places, but also that 95% of places in Minneapolis did not experience any predatory crimes (Sherman et al., 1989), is strong evidence that crime does not occur randomly, hence providing a solid basis for targeting police resources at these few high-crime places. Elsewhere in Boston, Pierce et al. (1986) also examined the distribution of police calls-for-service at addresses, finding that 50% of calls to police were produced by a mere 3.6% of addresses. In the Bronx and Baltimore, Eck et al. (2000) found that 10% of addresses experienced 32% of a combination of robberies, assaults, burglaries, thefts, and motor vehicle thefts.

In Jersey City, Weisburd and Mazerolle (2000) examined the distribution of arrests for narcotics using street segments and intersections as their units of analysis, finding that only 4.4% of places accounted for almost half of all arrests. In addition to finding specialisation in the types of drugs sold at certain hot spots, the researchers also found that drug hot spots were more likely to be the sites of crime and disorder than non-drug hot spots (Weisburd and Mazerolle, 2000). In Boston, Braga et al. (2010) examined gun violence over a 29-year period between 1980 and 2008, finding

that only 3% of street segments and intersections accounted for 50% of shootings. Over the same period of time in Boston, they also examined robberies, finding 50% of all robberies were concentrated in 8.1% of street segments and intersections (Braga et al., 2011). The generalisability of the law of crime concentration has been tested outside the United States, finding it to be applicable in numerous settings. In Tel Aviv-Jaffa, Israel, an analysis of 1-year crime incident data in 2010 found that 4.5% of street segments accounted for 50% of crime (Weisburd and Amram, 2014). In Campinas, Brazil, de Melo et al. (2015) found that 50% of crime occurred in only 3.66% of street segments. In a dual city analysis of crime concentration in Canada's two largest cities, Toronto and Montreal, about 4% of all intersections in each city accounted for 50% of all crimes examined (Boivin and de Melo, 2019). Street segments as a unit of analysis, however, suffer limitations such as variable size, as the length of a street segments depends on physical geographical features; and potential for considerable data loss given the practice of omitting crimes occurring at intersections (Harinam et al., 2022).

While studies of crime concentration at street segments have been predominant, other studies have examined the concentration of crime at facilities such as mass transit systems. In England and Wales' mass transit systems, only 5% of stations accounted for 50% of reported crime over a 5-year period (Ariel, 2011). In the South West Trains jurisdiction in England and Wales, analysis of reported crime data for the year 2015 found that out of a total of 206 train stations, only 41 stations (comprising 19.9%) accounted for 80% of all crime (Ariel et al., 2017). In an analysis of the Hong Kong's Mass Transit Railway (MTR) system, which comprises a total of 93 stations, only 8.8% of stations accounted for 50% of all reported crime (Ng et al., 2023). Loukaitou-Sideris (1999) examined crime at bus stops in Los Angeles, finding that out of a total of 19,650 bus stops in the

city, 10 high-crime bus stops, comprising 0.05% of all bus stops, accounted for 18% of total crime at bus stops.

2.2.6 Stability of Hot Spots

The law of crime concentration is further strengthened by the finding that hot spots remain 'hot' over a long period of time (Andresen and Malleson, 2011; Braga et al., 2010; Groff et al., 2010; Walter et al., 2022; Wenger and Lantz, 2022; Weisburd, 2008, 2015), thus providing for reliability and accuracy in the prediction of recidivism in places. In Seattle, an examination of crime incident data over a 14-year period, from 1989 to 2002, found that only 4% of street segments produced 50% of all crime incidents, and that concentrations were generally stable across time (Weisburd et al., 2004). Using a group-based trajectory analysis, Weisburd et al. (2004, p.284) found that "a relatively small proportion of places belong to groups with steeply rising or declining crime trajectories, and that these places are primarily responsible for overall city trends in crime." An analysis of juvenile crime in Seattle over a period of 14 years, from 1989 to 2002, found that less than 1% of street segments accounted for 50% of arrest incidents in any given year during the observation period (Weisburd et al., 2009). However, relying on arrest data has limitations, which include the underreporting of juvenile crime and biases in police enforcement activities in some places (Weisburd et al., 2009). In Vancouver, Canada, Curman et al. (2015) analysed calls-for-service data over a 16-year period from 1991 to 2006, finding that while 7.8% of street segments produced 60% of all calls-for-service, 40% of street segments did not produce any calls to the police throughout the observation period. Also in Vancouver, Canada, Andresen et al. (2017) examined the concentration and stability of disaggregated crime types at street segments and intersections over a period of 16 years, finding that while crime was highly concentrated in place regardless of type, trajectories varied among the crime types. In an earlier study, Andresen and

Linning (2012) argued that aggregations across crime types are only appropriate in microspatial units of analysis based on their finding of empirically distinct spatial patterns of disaggregated crime types.

2.3 The Concept of Crime Harm

2.3.1 Defining Harm

In criminology, harm is defined as "an emotional, psychological, financial, societal, or physical impact" (Bland and Ariel, 2020, p. 63). Most crime analyses rely on counts of crime (Ashby, 2018) and disregard crime severity or fail to apply a measure of weighing crime harm, despite the widely accepted view that "all crimes are not created equal" (Sherman, 2013, p. 422). Some crimes cause significant harm, injury, or damage, whereas others have little to no impact; hence, as Sherman (2013) argues, treating them as equal is misleading. A meaningful measure of harm, therefore, is to assign a weight to each type of crime based on its harmfulness in comparison to all other crime types (Sherman et al., 2016). The renewed focus on harm has been precipitated by a need to better express the harm experienced by victims, limited police budgets necessitating a new method of prioritisation, and the adoption of harm reduction as a policing objective (Sherman et al., 2016). Harm provides a new way of prioritising across crime patterns, such as in places (Weinborn et al., 2017), victims (Dudfield et al., 2017), and offenders (Liggins et al., 2019).

2.3.2 Evidence Supporting the Crime Harm Approach

A focus on harm at places allows for greater precision in targeting, given the finding by Weinborn et al. (2017) that crime harm is more concentrated in places than crime count, with only 1% of places accounting for 50% of harm compared to 3% of places accounting for 50% of crime counts. The crime-harm approach is also likely to result in different maps given that hot spots and harm

spots may not necessarily have the same location, concentration, or dispersion (Weinborn et al., 2017). Considering the differences in concentrations of crime counts and crime harm in places, Weinborn et al. (2017) calculate a patrol cost differential between 100 harm spots and 300 hotspots to be approximately £5.3 million per year. They also make the case that a crime-harm approach presents a greater good to society since prevention of high-harm crimes such as homicides is more beneficial than preventing bicycle thefts (Weinborn et al., 2017). Whereas this study by Weinborn and colleagues provides a good comparison of crime concentration between hot spots and harm spots, it is limited by the lack of longitudinal data to answer the crucial question of the stability of harm spots.

Norton et al. (2018) provide an answer to the question of stability of harm spots in their study, where they found that 70% of harm spots retained their level of harm over the 4-year observation period. However, other studies such as Harinam et al. (2022) did not find harm spots to be stable over time. In the city of Wilmington, Delaware, Ratcliffe (2015) compared traditional hot spots of violence with harm spots, discovering a geographic area that contained substantial crime harm that would not have otherwise been identified through the traditional method. In Suffolk, UK, Bland and Ariel (2020) found that out of the 24,311 couples producing a total of 36,742 callouts for domestic violence over a 5-year period, only 1.77% accounted for 80% of the total crime harm. Given that modern democracies shape their criminal justice and public safety policies based on their citizens general knowledge about crime (Reiss, 1982), a system of harm measurement would play a key role in providing the public with “a reliable and realistic assessment of trends, patterns, and differences in public safety” (Sherman et al., 2020, p. 2).

2.3.3 Criticism of the Crime Harm Approach

Despite the suggestion by Reiss (1982) that legal sanctions are the best way to assess the severity of crime, the seemingly predominant sentence-based harm indices, such as the Cambridge Crime Harm Index (CCHI), are not adequate measures in all circumstances. Sentence-based harm measurement tools fail to capture all forms of harm; hence, defining harm within such narrow limits is faulty. Survey data suggests that citizens are more concerned with low-harm incidents than serious crime (Goldstein, 1977; Webb and Katz, 1997; Kelling and Coles, 1996); hence, a focus on harm risks shifting police attention from matters the citizens consider to be a priority. Bland and Ariel (2020, p. 65) outline the four main categories of crime harm measurement tools as those based on public perception, cost of crime, sentencing weight, and theoretical constructs. While no single harm index captures all these dimensions of harm, sentence-based indices such as the Cambridge Crime Harm Index (CCHI) have gained prominence as they are reliable, inexpensive, and based on sentencing guidelines that reflect the will of the people (Sherman et al., 2016).

2.3.4 The Canadian Crime Severity Index

The Canadian Crime Severity Index (CCSI) was developed in response to the limitations of the traditional crime rate, which was "heavily influenced by fluctuations in high-volume, less serious offences" (Wallace et al., 2009, p. 8). The CCSI relies on sentencing data as a measure of relative severity, given that serious offences will attract more severe sanctions than less serious offences (Wallace et al., 2009). Unlike other sentence-based harm indices such as the Cambridge Crime Harm Index (CCHI) that employ the starting point of sentencing guidelines (Sherman et al., 2016), the CCSI uses the average of actual sentences given for each type of offence. Sherman et al. (2016) therefore argue that the CCHI, unlike the CCSI, reflects pure harm that is devoid of aggravating

and mitigating factors, hence providing a consistent metric of harm. However, the CCSI also provides a consistent metric as the severity weights for each offence are based on five recent years of sentencing data, and the weights are updated every five years "to reflect any changes in sentencing patterns or new legislation" (Wallace et al., 2009, p. 10). Weinborn et al. (2017) point out that the calculation of the CCSI requires access to both police crime data and judicial records of sentences, making it a complex process.

2.4 Crime on Mass Transit

Mass transit crime includes serious crimes and less serious public order offences that can be against the system itself, such as fare evasion and vandalism; or against employees, such as assaults; or against transit users, such as pickpocketing and assault (Ceccato et al., 2022). However, majority of transit crimes are less serious offences as evidenced by a survey of 45 transit agencies which found that only 22% of reported incidents were of a serious nature such as vandalism, public intoxication, and theft (Needle and Cobb, 1997). Crime levels vary across the transit system and are correlated to the crime in the respective neighbourhood (Richards and Hoel, 1980; DeGeneste and Sullivan, 1994). Train stations account for more crime compared to on board trains (DeGeneste and Sullivan, 1994) and bus stops account for more crime compared to on board buses (Loukaitou-Sideris, 1999). Studies on transit crime have found that crime is spatially and temporally concentrated (Pearlstein and Wachs, 1982; Loukaitou-Sideris et al., 2002). Transit stations tend to be conveniently located near residential, employment, commercial and industrial hubs in order to serve as many people as possible, however "this centrality feature of transportation nodes has criminogenic implications" (Ceccato et al., 2022, p.122) as various types of land use affect the routine activities of those places, thereby also shaping their patterns of crime (Ceccato, 2018).

2.5 Research Gaps

While the study of crime hot spots is not new, "its empirical foundation is largely drawn from U.S. studies, and comparatively, little literature is available for other countries, including Canada" (Boivin and de Melo, 2019, p. 46). This disparity is evident in the systematic review by Lee et al. (2016) of hot spot studies, which identified 17 U.S. studies compared to only 9 non-U.S. studies between the years 1970 and 2015. Much of the literature on hot spots in Canada and elsewhere is dominated by studies using street segments as the unit of analysis. The present study not only seeks to contribute local evidence of the law of crime concentration at places (Weisburd, 2015) but also to fill the existing research gap pertaining to hot spot studies on mass transit systems.

While the literature on hotspots of crime employing crime count data is extensive, the literature on harm spots, particularly in Canada, is relatively sparse (Harinam et al., 2022). Application of a harm index would enable a comparative analysis between the spatial concentration of hot spots and harm spots at the aggregate level as well as across different crime types. The developmental trajectories of hot spots have been well studied (Weisburd et al., 2004; Curman et al., 2015; Andresen et al., 2017), compared to those of harm spots; hence, the present study aims to fill this gap.

Chapter 3. Methods

This study incorporates a descriptive analysis of six years' worth of calls-for-service and incident report data to identify transit stations with high concentrations of crime counts and crime severity to inform targeting strategies. This chapter starts with a detailed description of the research setting in the City of Edmonton. It then discusses the unit of analysis for this study, its appropriateness, and similarities with other micro-geographic units of analysis. The chapter then defines the research time and discusses its adequacy in facilitating the research objectives. A detailed characterisation of the data is provided, including its cleaning procedures and limitations. The Canadian Crime Severity Index is then discussed, outlining how it is applied in converting crime counts to severity and its limitations on offences not listed in the Criminal Code of Canada. The chapter then describes the analytic procedures and statistical methods used to answer the research questions.

3.1 Research Setting

The City of Edmonton is located in the western Canadian province of Alberta serving as the provincial capital. Based on 2021 census, Edmonton has a population of 1,010,899, which puts it in second place provincially behind Calgary and fifth place nationally behind Toronto, Montreal, Calgary, and Ottawa (Statistics Canada, 2022). The City of Edmonton covers a land area of 765.61 square kilometres and has a population density of 1320.4 per square kilometre (Statistics Canada, 2022). The City of Edmonton owns and operates the city’s mass transit agency known as Edmonton Transit Service, which consists of a bus network and a light rail transit (LRT) system. Currently, there are two operational lines, Capital Line and Metro Line, with 18 LRT stations. The LRT system is currently undergoing expansion, and while the southeast portion of the new Valley Line

has been completed, it has not yet become operational as of this writing. All stations are at street level except for downtown stations and University LRT station, which are underground stations. The current operational lines consist of 27 kilometres in length of track, and the service has 94 trains. In 2022, Edmonton Transit Service had an annual ridership of 68,829,300, of which the LRT system accounted for 18,996,800 (American Public Transportation Association, 2023). Since the transit service mainly operates within the city limits of Edmonton, it therefore falls under the police jurisdiction of the Edmonton Police Service. However, the Edmonton Transit System is primarily policed by police paraprofessionals known as transit peace officers, who are equivalent to what other provincial jurisdictions call special constables. While transit peace officers have some powers of arrest, they have fewer powers than police officers. They are only granted authority to enforce municipal bylaw offences and provincial statutes such as liquor offences. Police officers, however, are still responsible for responding to criminal matters and high-risk incidents on the transit system.

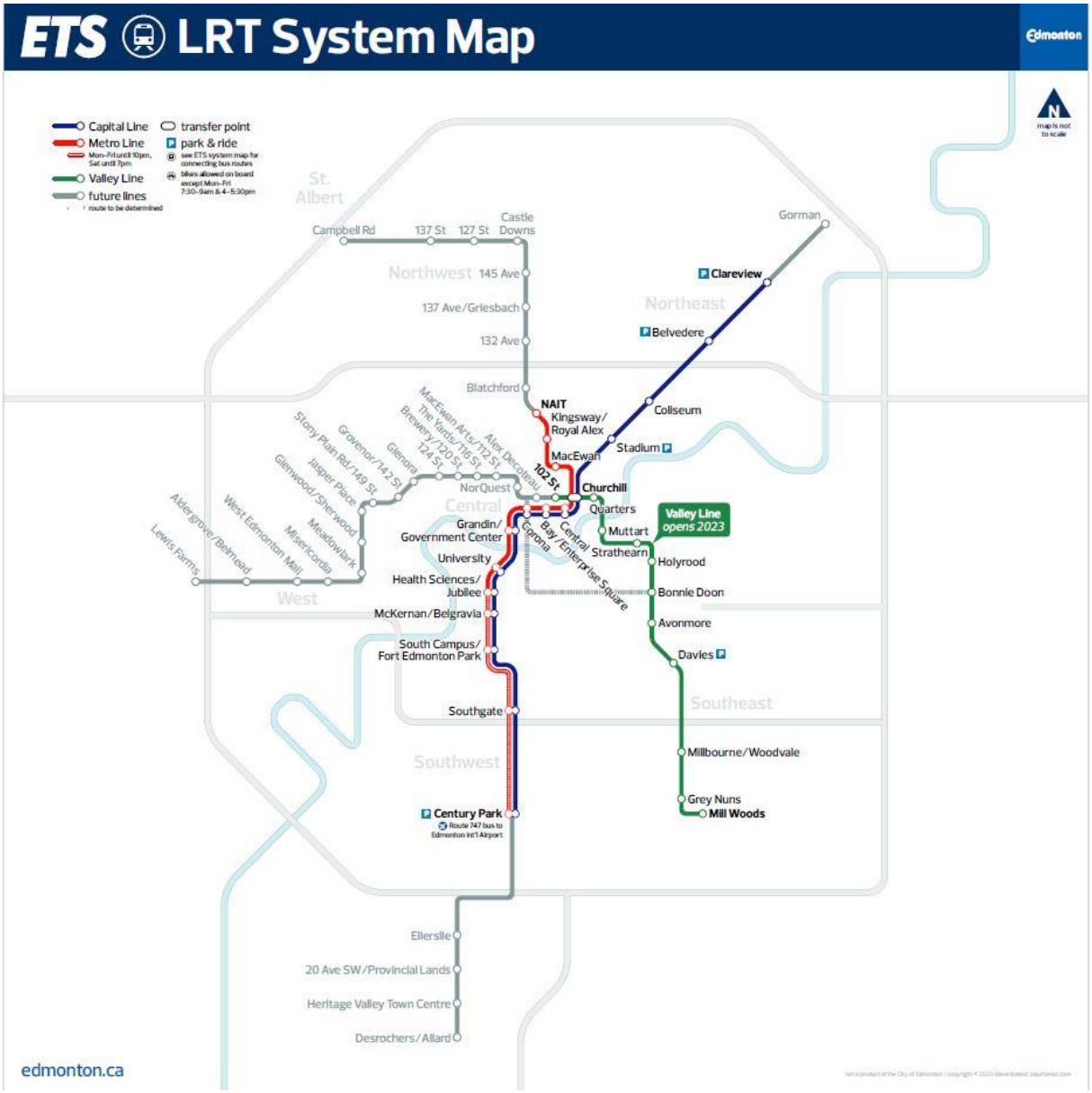

Figure 1: Edmonton Transit LRT System Map (Source: Boland, 2020)

3.2 Unit of Analysis

As this study only focuses on the LRT system, the unit of analysis is the LRT station. Given the objective of this study to inform targeting strategies, the research finding that transit stations account for more crime than onboard trains (DeGeneste & Sullivan, 1994) was a key consideration to focus on stations. Criminology of place calls for smaller units of analysis as larger units include variations that may not be identified at the macro level (Sherman et al., 1989). LRT stations in Edmonton are facilities where each station is assigned a unique street address. While the station sizes vary slightly, most of the stations are no larger than a typical street block, hence their appropriateness as a small geographic unit of analysis. There are similarities between transit stations and other micro-geographic units of analysis, such as street segments, in terms of their social organisation of behaviour. For example, transit stations and street segments each have common standards of acceptable behaviour and shared rhythms of activity that are regular and recurring (Weisburd & Amram, 2014).

3.3 Time Period

The City of Edmonton provided six years of calls-for-service data and incident report data for the period of January 2017 to December 2022. Sherman (1995) suggests an ideal minimum data observation period of 1 year to identify hot spots. Spelman (1995) argues for more extended observation periods in his assertion that predictive accuracy increases with the duration of observation. Thus, six years of calls-for- service and incident report data provided is not only a substantial amount of data for analysis, but the time period is also adequate for identifying consistent patterns and trends. Another consideration was that, given the fluctuations in transit ridership during the COVID-19 pandemic (American Public Transportation Association, 2021;

2022) and the potential effects on crime and disorder, it was necessary to obtain a data period that covered before and after the pandemic. Doing so would enable any discernible patterns during the pandemic to be placed in the context of the general trends.

3.4 Data

As studies suggest differences in crime concentration patterns between calls-for-service and incident reports (Lee et al., 2017), it was necessary to include both data types in the study to investigate whether such differences exist in the case of Edmonton. Calls-for-service data were retrieved from the Computer-Aided Dispatch (CAD) information system maintained by the City of Edmonton. Calls-for-service data includes the following fields: CAD identity number, event identity number, call source, incident type, incident sub-type, call date/time, created time, dispatch time, arrival time, cleared time, incident location name, and Global Positioning System (GPS) coordinates.

Transit crime incident data were retrieved from the incident reporting information system maintained by the City of Edmonton. The transit incident data includes the following fields: case identity number, incident date, incident time, reported date, reported time, incident location (station name), incident type and sub-type, offence type and sub-types, charging section, service outcome type, offender unique identifier, offender's gender, and offender's year of birth.

3.4.1 Data Cleaning

Since this study is focused on crime on LRT stations, non-LRT data, such as incidents on buses, bus stations, bus stops, and other areas, as well as onboard events, were removed. The dataset for calls-for-service had a total of 154,170 records, and upon removing non-LRT records and onboard events, there remained a sample of 102,339 LRT records. For incident report data, there was a total

of 309,509 records, and upon removing non-LRT records and onboard events, there remained a sample of 92,999.

3.4.2 Data Limitations

Both calls-for-service and incident report datasets did not provide location data beyond the station name. While the station name was adequate in attributing incidents and calls-for-service to the relevant station, the analytical capability to identify spatial patterns within each station was lost due to the lack of station sub-location data. Additionally, both calls-for-service and incident report datasets are also limited to occurrences on transit property and, hence, are blind to occurrences near the transit stations. Comparing crime patterns in transit stations with those in their vicinity could explain patterns that may not be apparent by only analysing transit station crime. This point is highlighted by Smith and Clarke (2000, p.169) in their assertion that "Crimes cannot be properly explained, nor effectively prevented, without a thorough understanding of the environment in which they occur. Nowhere is this more apparent than in urban public transport."

Another limitation of the data was the inadequate categorisation of some crime types, which led to inconsistencies with the statute sections in the Criminal Code of Canada. For example, the sub-categories 'Assault ETS Operator' and 'Assault Peace Officer' were not broken down to the three levels of assault in the Criminal Code, namely: Assault – Level 1, Assault with a Weapon and Causing Bodily Harm – Level 2, and Aggravated Assault – Level 3. The implication of this lack of precision in categorising some crime types was the loss of accuracy in assigning severity weights commensurate with the crime sub-type.

While ridership data were available by total annual and monthly figures, it was not broken down by each LRT station, hence the inability to standardise crime counts and crime severity in each

station using station ridership figures. This standardisation, using ridership figures, measures the rate of victimisation by crime counts and severity in each station, and could not be computed due to a lack of station ridership data.

3.5 Analytical Procedures

3.5.1 Distribution of Crime Counts

With the LRT station being the unit of analysis, the number of crime counts per station is computed in two ways by summing up the total calls-for-service per station as well as the total crime incident reports per station. While both calls-for-service and incident reports are crime measures, calls-for-service also indicate the demand for police resources, whereas incident report data is an indicator of actual crime occurrences.

3.5.2 Distribution of CSI

To conduct a severity analysis of each station, crime counts in each station and by each crime type are computed. The resulting crime count total of each crime type is then multiplied by the offence type's respective CSI weight to obtain the total severity of the offence type in each station. The total crime severity in each station is then obtained by summing up all the offence-type severity weight totals within each station.

3.5.3 Identification of the 'Power-Few' Stations

Identification of the 'power-few' stations is conducted in three ways: by crime count, which includes calls-for-service counts and incident report counts, and by crime severity. The 'power-few' approach seeks to find the proportion of a few stations that account for a relatively high level of crime counts and crime severity. To identify 'power-few' stations by crime count and severity,

the stations are first rank-ordered, in descending order, by their respective total crime counts and total crime severity. Then, each station's cumulative percentages of crime counts and crime severity are matched with the cumulative percentages of the rank-ordered stations. Instead of looking at the percentage of stations that account for 50% of crime and harm, a sensitivity analysis uses different percentage thresholds. The identification of the 'power-few' stations is conducted for each year of the data period as well as for the entire six-year data period.

3.5.4 Temporal Distribution of Crime Counts and Crime Severity

To identify the temporal distribution of crime counts, the frequency of occurrences by calls-for-service and incident reports are calculated by counting their respective frequencies for each hour of the day within each transit station. This identifies time periods with the highest frequency of occurrences by calls-for-service and incident reports. To identify the temporal distribution of crime severity, crime counts by incident reports in each hour of the day are converted into severity scores. The total crime severity index for each hour of the day is compared to identify the time periods with the highest levels of crime severity. The same methods are applied for day-of-week and month-of-year to identify days and months with the highest levels of crime counts and crime severity.

3.5.5 Trajectory Analysis – Transit Stations and Offenders

To identify the trajectories of transit station subgroups and offender subgroups based on their crime count and crime severity, a statistical technique known as k-means (Calinski & Harabasz, 1974) is used. K-means is described as a non-parametric method for analysing large and longitudinal data to identify groups of units with similar characteristics (Genolini & Falissard, 2010). K-means is a "hill-climbing" algorithm that falls under the Expectation-Maximisation category of algorithms.

Expectation-Maximisation algorithms work by initially assigning each observation to a cluster, then reaching the optimal clustering by recomputing each cluster and assigning each observation to its 'nearest cluster' (Genolini & Falissard, 2010). This process is repeated until no further changes occur in the clusters.

3.5.6 Analysis of Offenders at Places

To get a picture of the composition of offender participation, proportions of offenders by age and sex are calculated in raw counts and percentages. Offenders' age and sex is also used to calculate the distribution of total crime counts and crime severity. The distribution of crime counts by 'power-few' offenders is obtained by identifying the proportion of 'power-few' offenders from the total number of unique offenders in each station and computing their total crime counts. The result of this calculation is then expressed as a ratio of the total station crime count. To obtain the distribution of crime severity by 'power-few' offenders at stations, the crime counts attributed to 'power-few' offenders at each station are converted using the crime severity index. The result is expressed as a ratio of the total station crime severity. A Pearson correlation coefficient is calculated to establish the relationship between offender crime counts and crime severity.

Chapter 4. Findings

This chapter presents research findings that answer the key critical research question of identifying crime's spatial and temporal distribution in the City of Edmonton's Light Rail Transit (LRT) stations. This research aims to inform the targeting of resources at identified power-few stations to achieve the most significant potential impact on crime count and crime severity.

Given the different approaches to targeting, including crime count or crime severity, the findings present a series of analysis by observing concentrations of crime and power-few stations. Specifically, calls-for-service count, total incident report count, entire incident report severity, criminal code category counts, and severity will be analysed. Research question 1 set out to find, using these different approaches, whether crime concentrates at transit stations, and identifying the power-few stations by each approach. It was found that crime is concentrated at transit stations where 22% of stations accounted for almost 50% of calls-for-service, 60% of total incident reports, 63% of total incident severity, 53% of criminal offence category, and 53% of criminal offence severity. Each approach generated a ranking of the top four power-few stations representing 22% of all stations, where Churchill, Central, and Coliseum Stations consistently featured in the top three in all the rankings. Research question 2 seeks to find out how the concentrations of crime counts and crime severity compare, and the results show an equal concentration of counts and severity.

Research question 3 will utilise the k-means clustering technique to conduct trajectory analysis, to identify groupings of transit stations and offenders with similar degrees of heat stability over the six years. The results indicate that by all crime measurement types, all the station trajectories were increasing whereas for offenders, the low crime and severity level trajectory representing the

largest proportion of offenders was stable under counts and decreasing under severity. The offender groups within the high crime count and severity level had increasing trajectories. Next, research question 4 seeks to conduct temporal analyses of calls-for-service, incident count, and incident severity, using time of day, day of week, and month of year dimensions. The results of the temporal analysis showed highest concentration of crime and severity at 0700 to 0900 hours, 1500 to 1700 hours and 1800 to 2200 hours. This coincides with the morning and evening rush hour periods as well as the late-night period when ridership is relatively lower. It was also found that crime count and severity is higher during the weekdays than the weekends; and higher during the winter months of October to March, while lower during the summer months of April to September.

Research question 5 sets out to address the distribution of crime and disorder, by count and by severity. The results indicate that Loitering, Trespassing, and Fare Evasion account for 83% of all disorder offences count and 92% of all disorder offences severity. For criminal code offences, Drugs, Mischief, Obstruction, Assault, and Weapon offences account for 87% of the total criminal offences' count whereas Drugs, Robbery, and Weapon offences represent 64% of all criminal offences' severity. Research question 6 seeks to address the distribution of offender characteristics, find out whether there is an overlap between power-few offenders and power-few stations, and if there is any relationship between offenders' count and severity. Results show that male offenders comprise of 63% of total offenders, and they also account for 70% of incident count and severity. The distribution of offenders by age found a general decline in crime participation with the advancement of age, consistent with the normal age-crime curve. The Pearson correlation coefficient is calculated, finding a statistically significant positive relationship between offenders' offence count and offence severity, $r = 0.984$, $p < 0.001$.

Research question 7 will compare crime concentration using calls-for-service and incident report data types. It was found that crime was more concentrated by incident reports than by calls-for-service, given that 22% of stations accounted for about 50% of calls-for-service compared to 60% of incident reports. Research question 8 goes a step further to compare crime concentration between people and places. The results obtained in research question 7 are compared with the finding that 22% of offenders were responsible for almost 80% of all incidents, thereby concluding that in Edmonton's mass transit system, crime was more concentrated among people than in places.

Research question 9 will compare the physical attributes of the identified power-few Stations that include Churchill, Central, Coliseum, Southgate and MacEwan. It was found that all these stations share attributes such as a complex design, attachment to multiple pedways, multiple entrances, shared inbound and outbound platform, provision of public washrooms, and lack of fare gates. Finally, this question will also compare the environmental attributes of the identified power-few stations. It was found the some of the power-few stations share attributes such as being located near parking lots, schools, bars, bus stops, liquor stores, homeless shelters, shopping malls, and large event centres. The relevance and implications of these findings will be discussed in the discussion chapter.

4.1 Crime Concentration and Power-few Stations

Research Question 1: What is the spatial concentration of crime counts, by calls-for-service and incident reports, and of crime severity, measured by the Canadian Crime Severity Index (CCSI), and which are the power-few stations that can be targeted for the most potential impact?

4.1.1 Concentration of Crime by Counts Using Calls-For-Service Data

From 2017 to 2022, there were 102,339 calls-for-service (CFS) on the Edmonton LRT Stations. Crime concentration using calls-for-service data was calculated for each year and the entire six-year period. For the whole data period, the top-ranking 22% of stations, (Central, Churchill, Coliseum, and MacEwan LRT stations), were responsible for 49% of all calls-for-service. When analysing individual years, crime concentration for the top 4 stations ranged from a low of 48% in 2021 to a high of 54% in 2020. Figure 2 shows the station power curves by calls-for-service counts and the participating stations are shown in Figure 3.

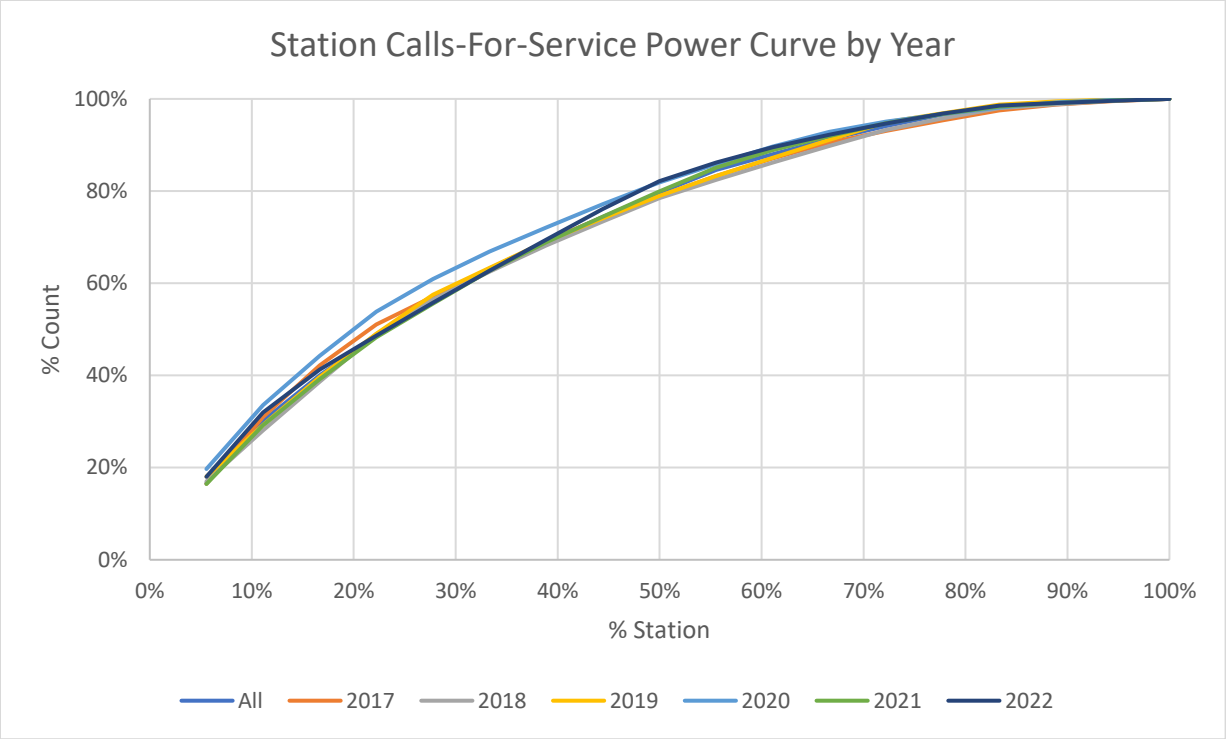

Figure 2: Station power curves by calls-for-service for each year and the entire data period.

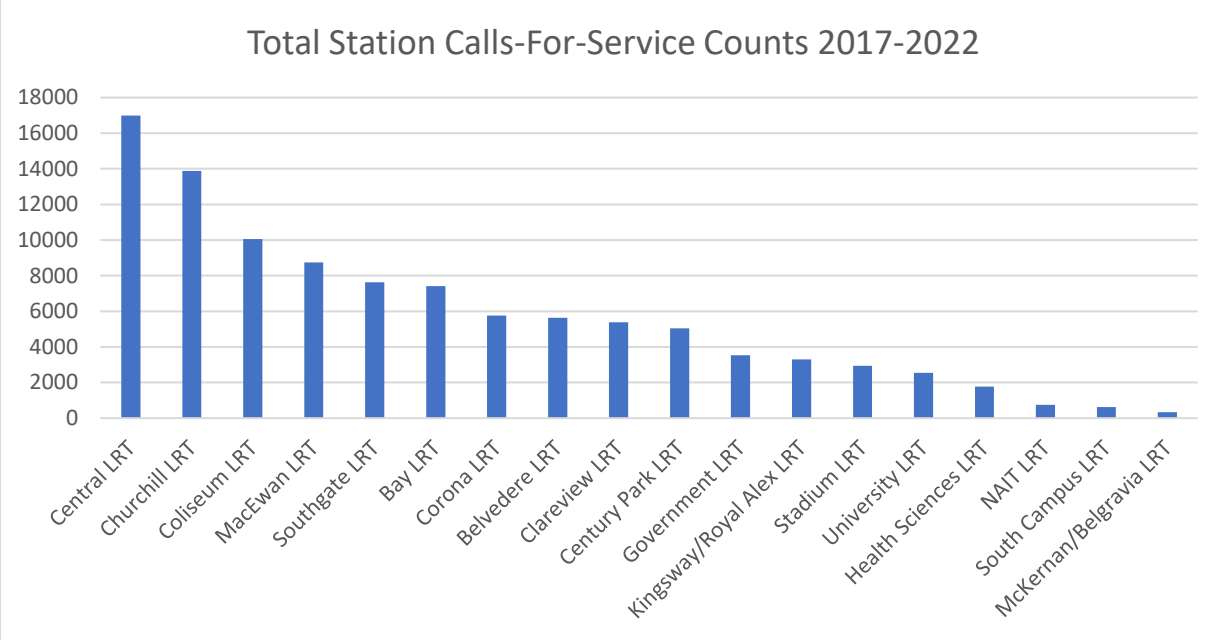

Figure 3: Rank-ordered distribution of calls-for-service by station

4.1.2 Concentration of Total Incident Counts Using Incident Report Data

From 2017 to 2022, there were a total of 92,999 reported incidents on the Edmonton LRT stations. Crime concentration using incident report counts was calculated for each year and the entire six-year data period. Figure 4 shows the station power curves by incident counts. For the whole. data period, the top-ranking 22% of stations, (Central, Churchill, Coliseum and Southgate LRT stations; Figure 5), were responsible for 60% of incident reports. When analysing individual years, crime concentration for the top-ranking 22% of stations ranged from a low of 55% in 2018 to a high of 64% in 2020

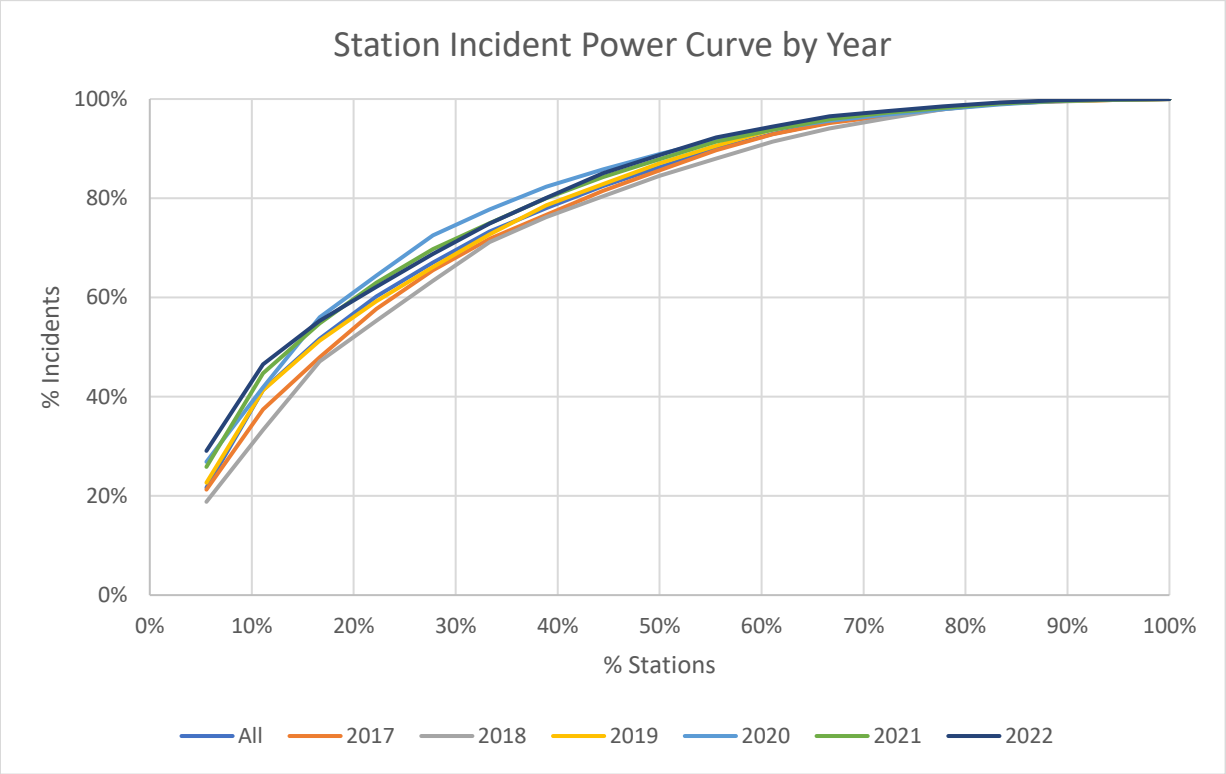

Figure 4:Station power curve by incident counts for each year and the entire data period.

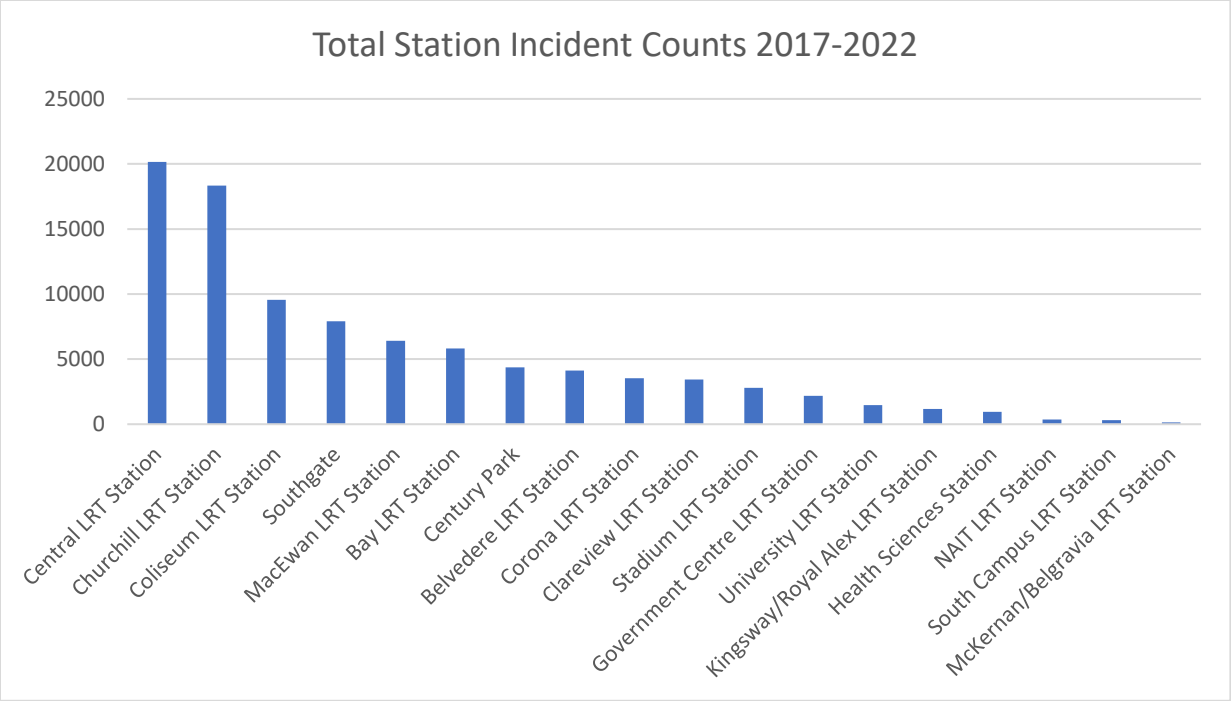

Figure 5: Rank-ordered distribution of incident counts by station

4.1.3 Concentration of Total Incident Severity Using the Crime Severity Index

Total incident counts in each station for the entire data period were converted into severity scores using the Canadian Crime Severity Index. Crime severity concentration was calculated for each year and the entire six-year data period. For the whole data period, the top-ranking 22% of stations, were responsible for 63% of total severity (Churchill, Central, Coliseum, and Southgate LRT stations; Figure 7). When analysing individual years, crime severity concentration for the top-ranking 22% of stations ranged from a low of 59% in 2018 to a high of 67% in 2020. Figure 6 shows the station power curves by total incident severity.

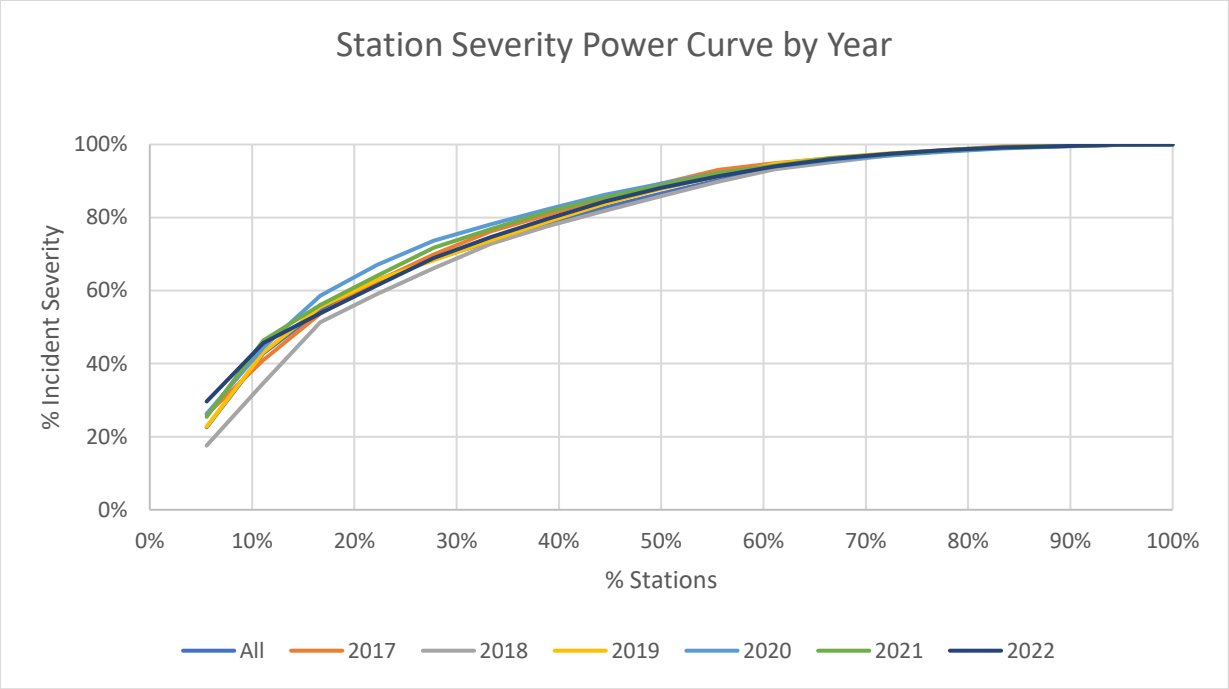

Figure 6: Station power curves by total incident severity for each year and the entire data period

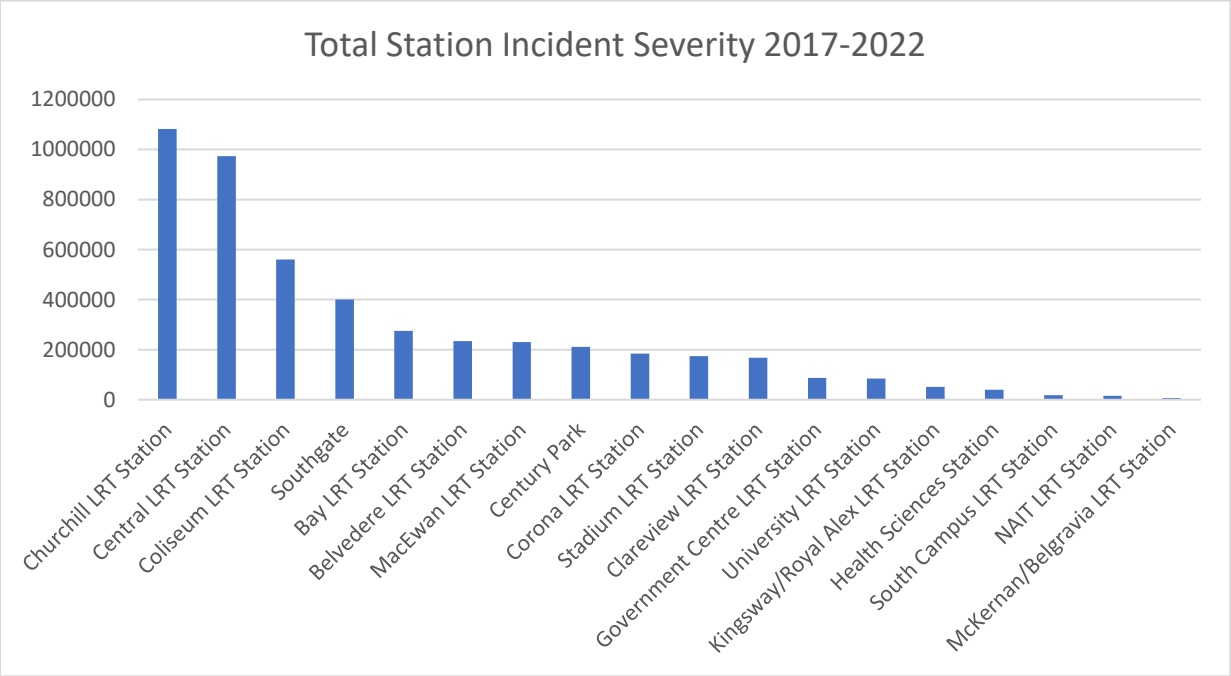

Figure 7: Rank-ordered distribution of total incident severity by stations

4.1.4 Concentration of Crime Incidents Count Using Incident Report Data

From 2017 to 2022, there were 19,809 crime incidents on the LRT stations. For this study, the selected criminal offences include Mischief, Assault, Weapons, Theft, Fraud, Robbery, Sexual Offences, Utter Threats, Break-and-Enter, and Sexual Assault. Figure 8 shows the station power curve of crime incidents. The top-ranking 22% of LRT stations, accounted for 53% of all crime incidents (Churchill, Central, Coliseum, and Southgate LRT Stations; Figure 9).

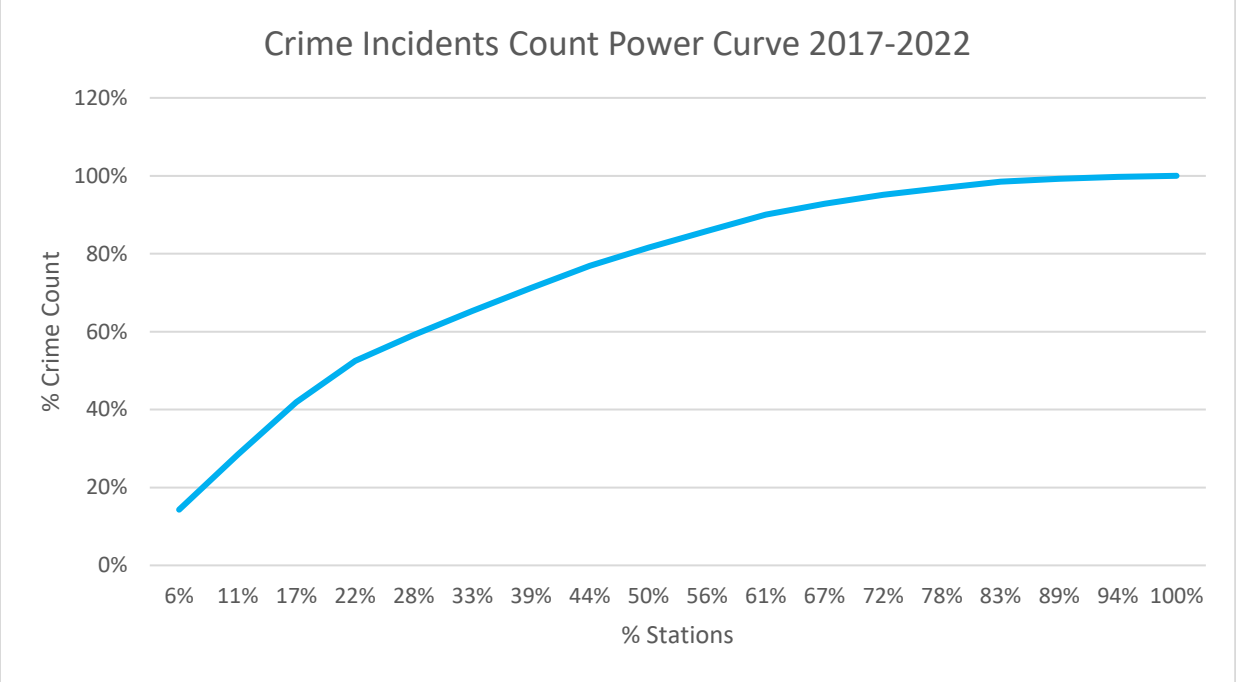

Figure 8: Station power curve of criminal incidents from 2017 to 2022

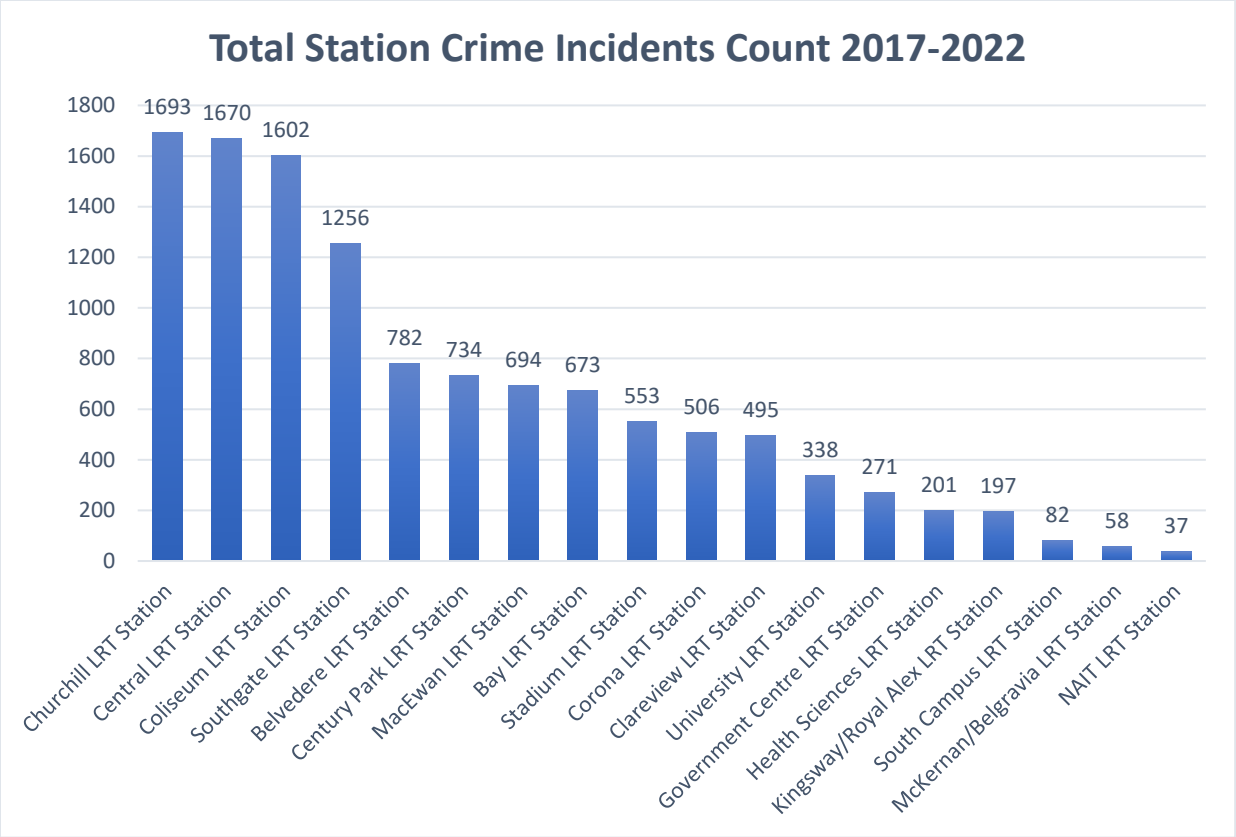

Figure 9: Rank-ordered distribution of total crime incidents count by station

4.1.5 Concentration of Crime Incident Severity Using the Crime Severity Index

From 2017 to 2022, there was a total crime incident crime severity score of 1116048.339. The top-ranking 22% of stations, accounted for 53% of total crime severity. Figure 10 shows the station power curve of criminal incident severity. Figure 11 shows the power-few stations: Coliseum, Churchill, Central, and Southgate LRT stations.

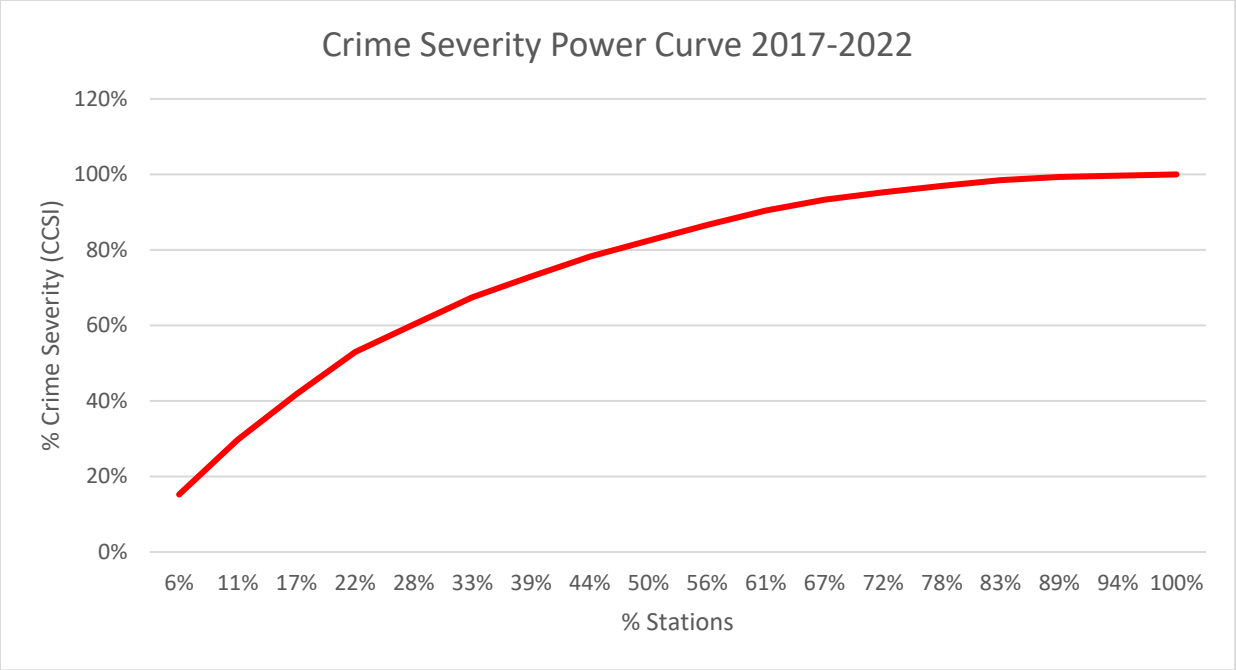

Figure 10: Station power curve of crime incidents severity from 2017 to 2022

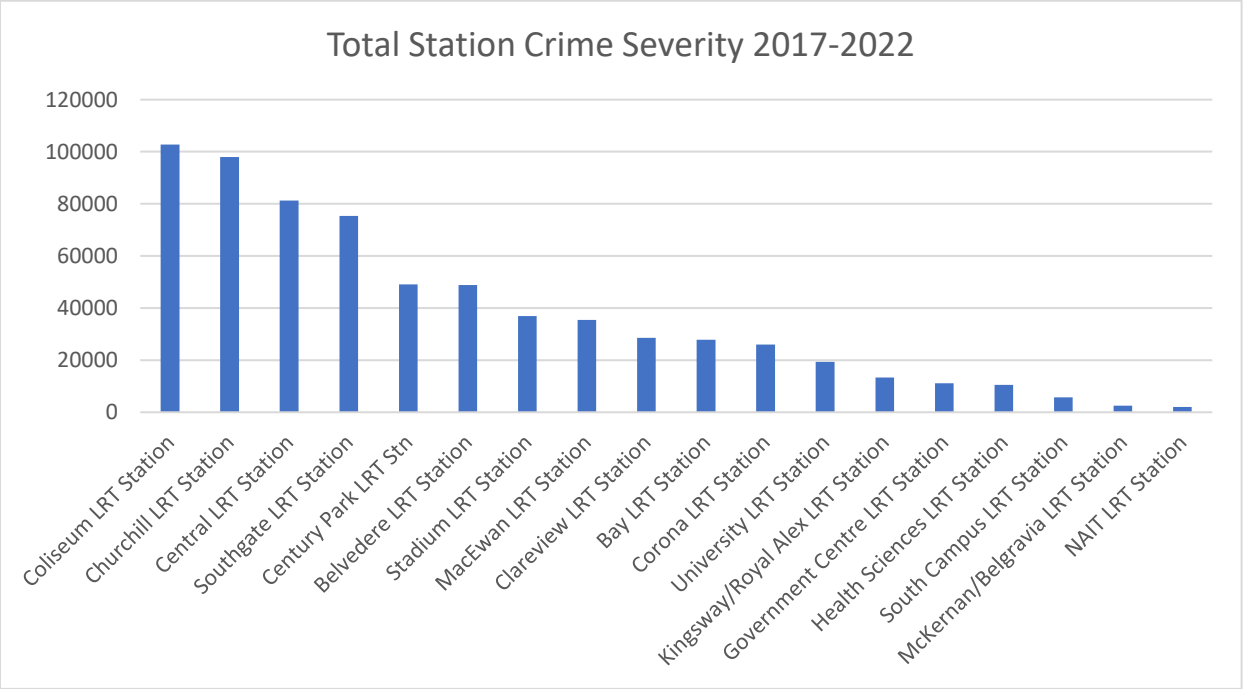

Figure 11: Rank-ordered distribution of total criminal incident severity by station

4.2 Comparison of Concentrations Between Count and Severity

Research Question 2: **How does the concentration of counts compare with that of severity?**

4.2.1 Comparison Between Total Incident Count and Severity Concentrations

From 2017 to 2022, the top-ranking 22% of stations were responsible for 60% of incident counts, whereas 22% were responsible for 63% of incident severity. Thus, in Edmonton, crime severity and count are about equally concentrated. Figure 12 compares the station incident counts and severity power curves for the entire data period.

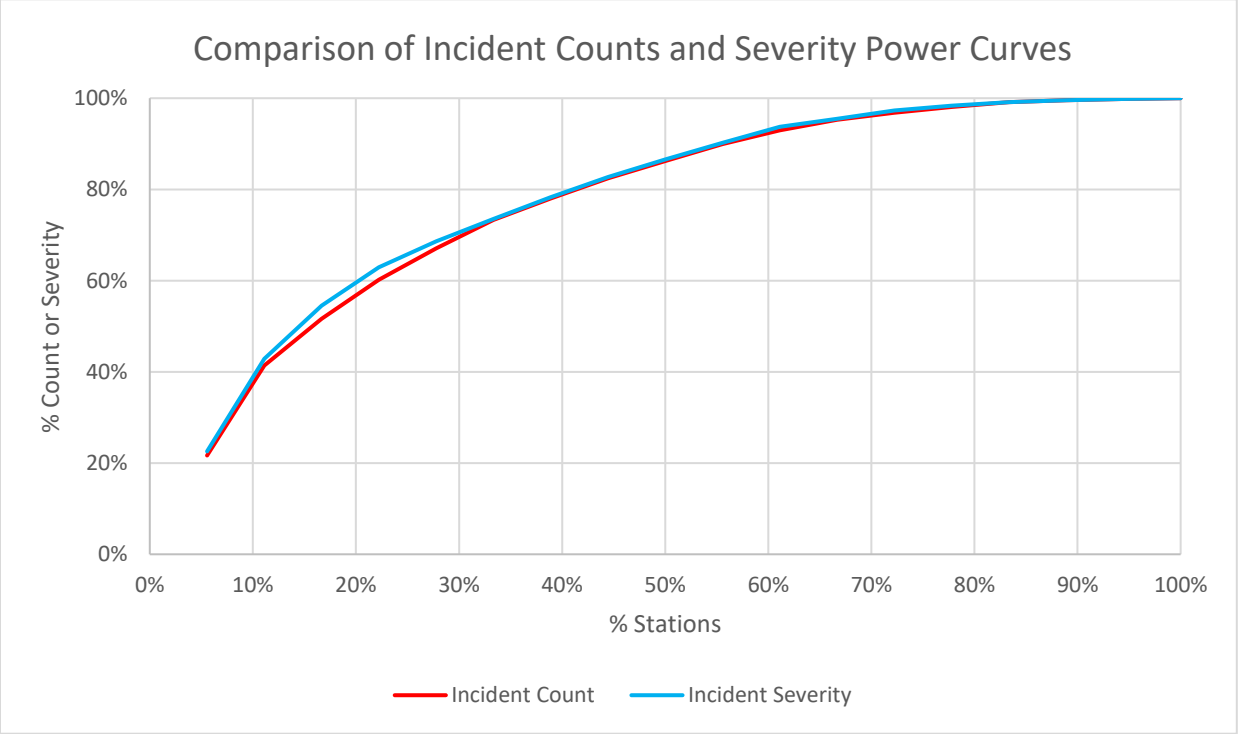

Figure 12: Comparison of incident counts and severity power curves

4.2.2 Comparison Between Crime Count and Severity Concentrations

Analysing the entire data period, 22% of stations were responsible for 53% of crime counts, whereas 22% also accounted for 53% of crime severity. Thus, crime count and severity were equally concentrated. Figure 13 shows a comparison of crime count and severity power curves.

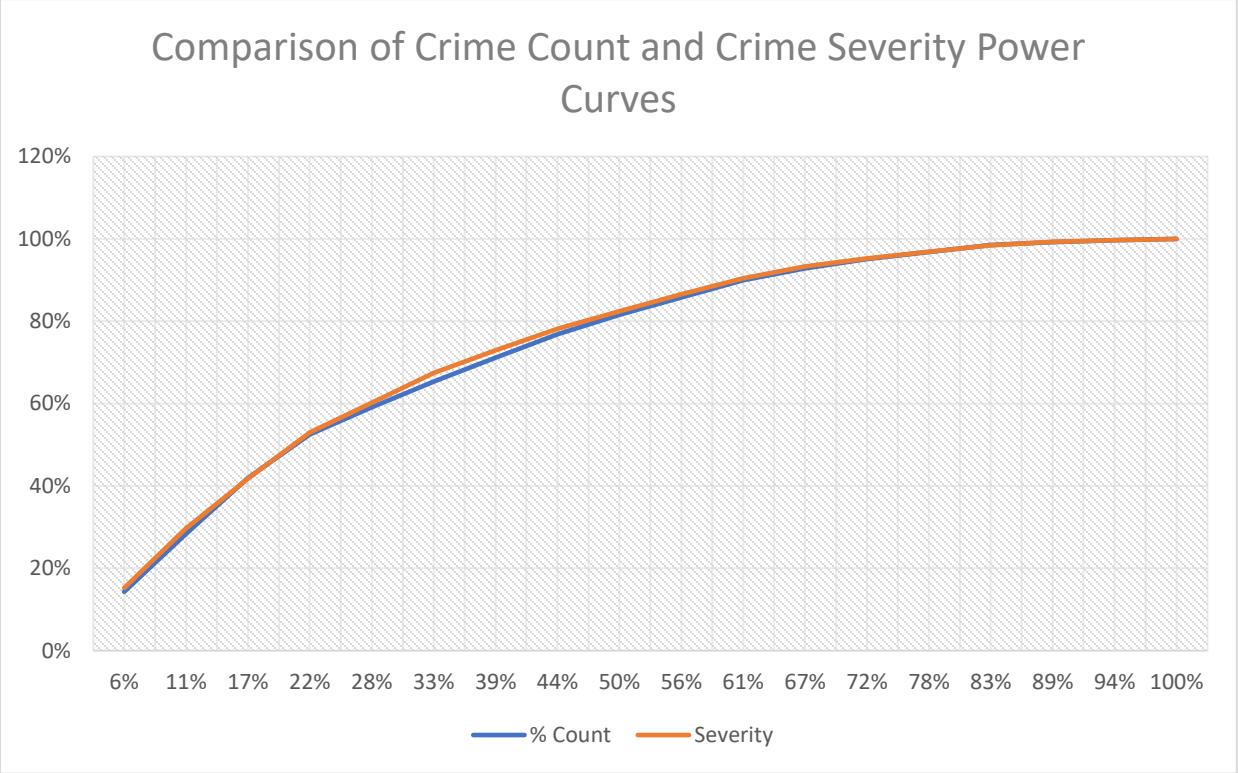

Figure 13: Comparison of crime count and severity power curves

4.3 Crime Trajectories of Stations and Offenders

Research Question 3: **What are the crime trajectories over the six-year data period of stations and offenders, using crime counts and crime severity?**

Table 1 summarises the results from the k-means trajectory analyses. This table shows the different crime measurement types, the number of identified trajectories, the crime counts or severity level in each category, its base crime counts or base severity in 2017, the trend, and the percentage of stations or offenders in each trajectory group.

Table 1: Summary of k-means trajectories

Type	Trajectory	Level	Base, 2017	Trend	Percentage of Stations/Persons
Station CFS Count	A	Moderate	293.625	Increasing	44.00%
	B	Low	111.125	Increasing	44.00%
	C	High	726	Increasing	11.00%
Station Incident Count	A	Low	309	Increasing	66.70%
	B	Moderate	1026.25	Increasing	22.20%
	C	High	2335.5	Increasing	11.10%
Offenders Count	A	Low	0.4861073	Stable (+)	99.30%
	B	Low	6.0082645	Increasing	0.65%
	C	Moderate	11.1111111	Decreasing	0.05%
	D	High	11	Increasing	0.01%
Station Severity	A	Low	15032.01	Increasing	78.00%
	B	High	115171.01	Increasing	11.00%
	C	Moderate	60473.25	Increasing	11.00%
Offenders Severity	A	Low	24.72831	Decreasing	98.9%
	B	Moderate	191.54748	Increasing	1.00%
	C	High	238.74842	Increasing	0.10%

4.3.1 Station Calls-for-Service Trajectories

Figure 14 shows the station calls-for-service trajectories. An optimal k-means partition of three groups was identified, with all groups indicating increasing trajectories.

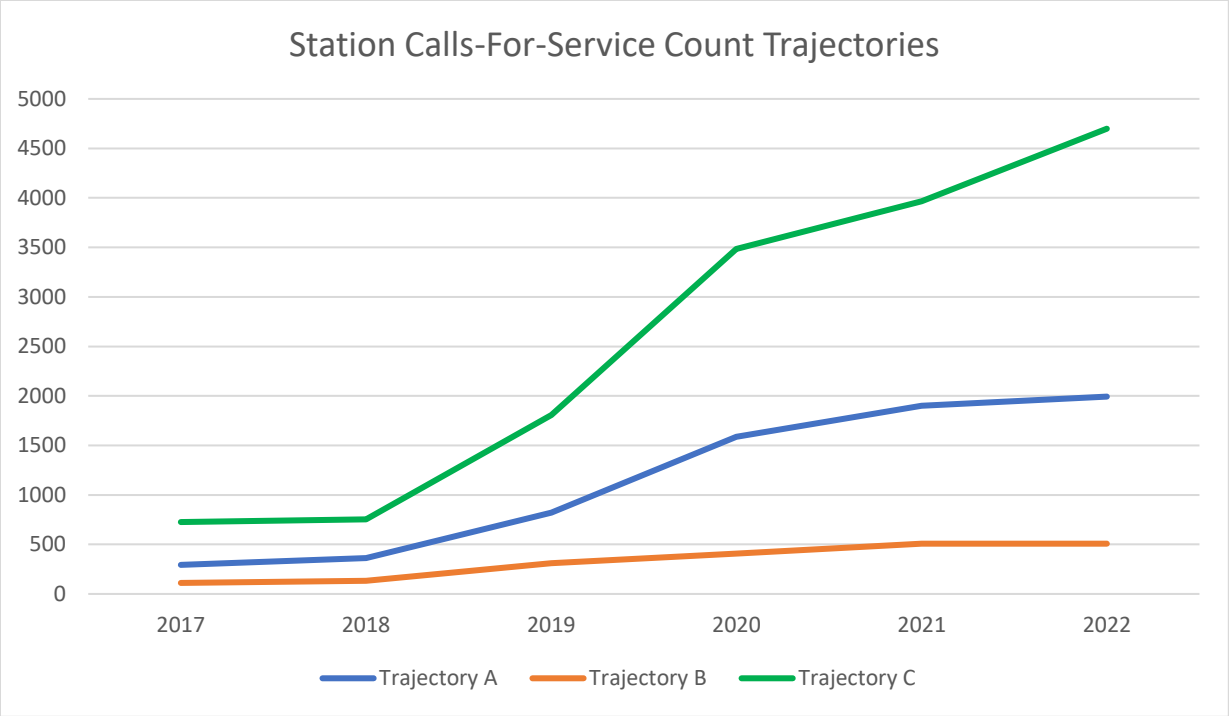

Figure 14: Station calls-for-service count trajectories

4.3.2 Station Incident Count Trajectories

Figure 15 shows the station incident count trajectories. An optimal k-means partition of three groups was identified, with all groups indicating increasing trajectories.

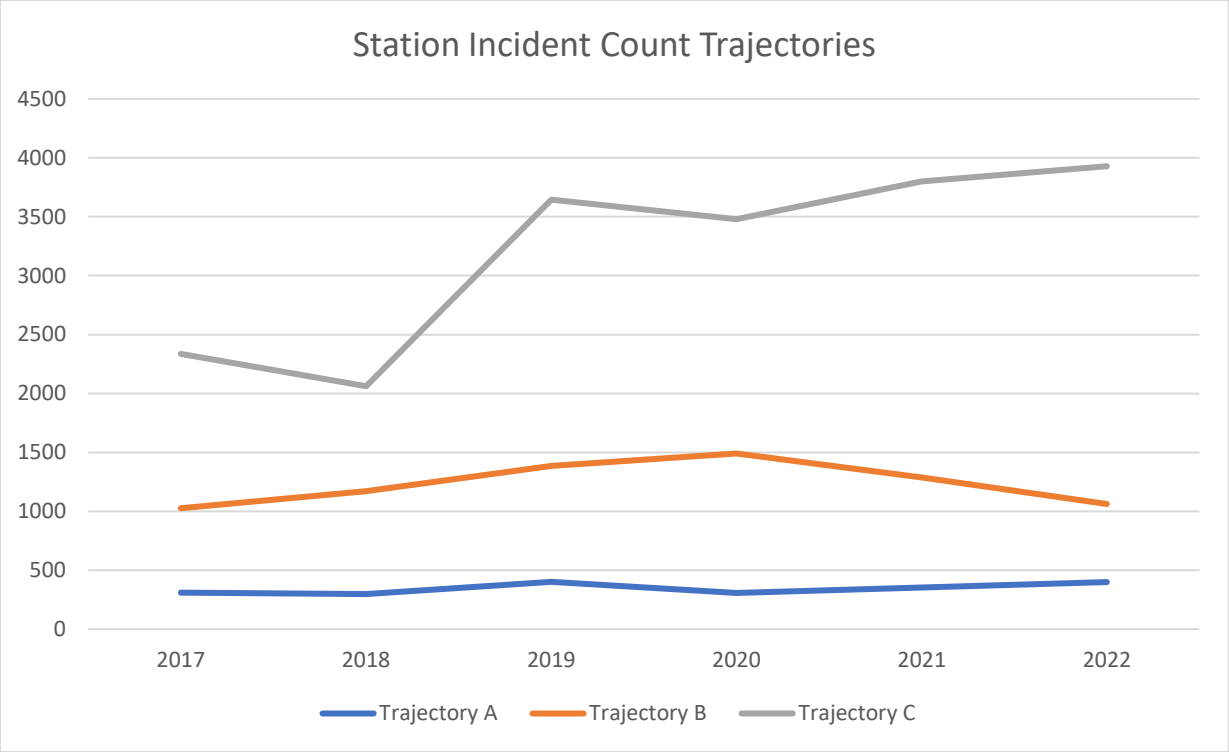

Figure 15: Station incident count trajectories

4.3.3 Offender Incident Count Trajectories

Figure 16 shows the offender incident count trajectories. An optimal k-means partition of four groups comprising two low, one medium, and one high group was identified. 99% of offenders were in the low crime level group and had a stable trajectory. The second group of low crime level and the high crime level group, comprising under 1% of offenders, had increasing trajectories, whereas the medium crime level group had a decreasing trajectory.

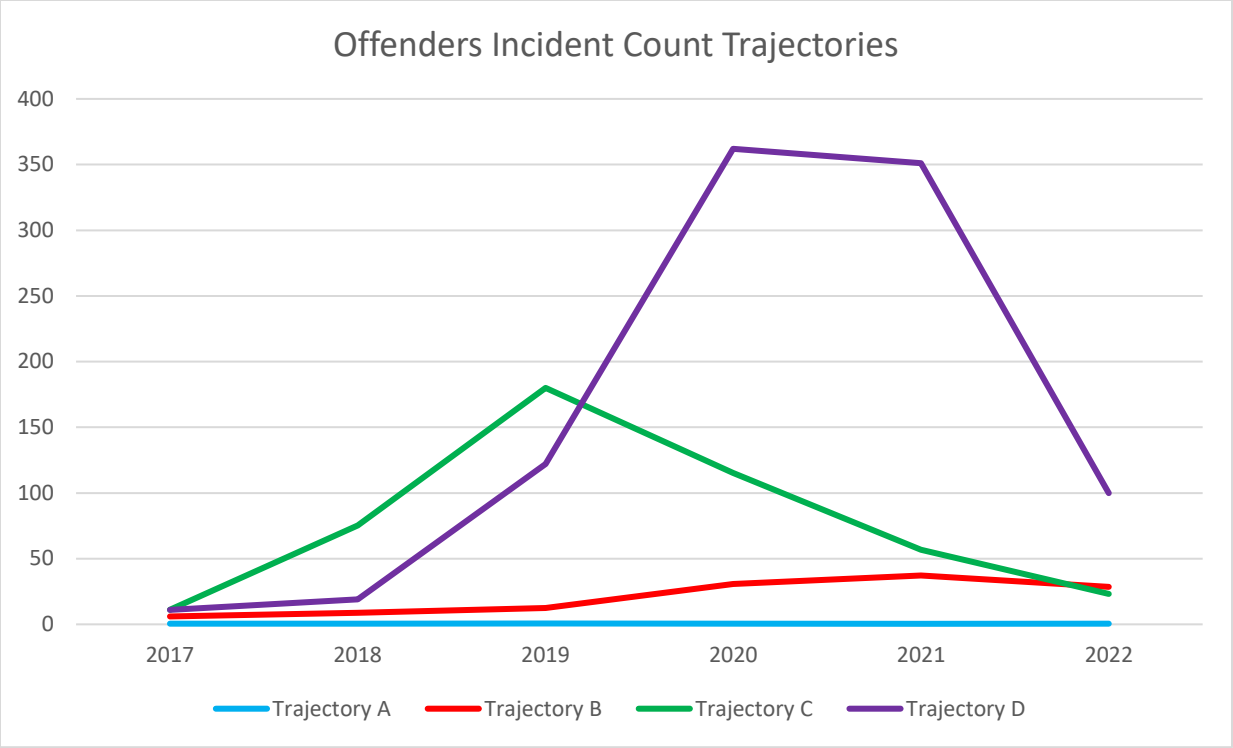

Figure 16: Offender incident count trajectories

4.3.4 Station Incident Severity Trajectories

Figure 17 shows the station incident severity trajectories. An optimal k-means partition of three groups was identified, with all groups showing increasing trajectories.

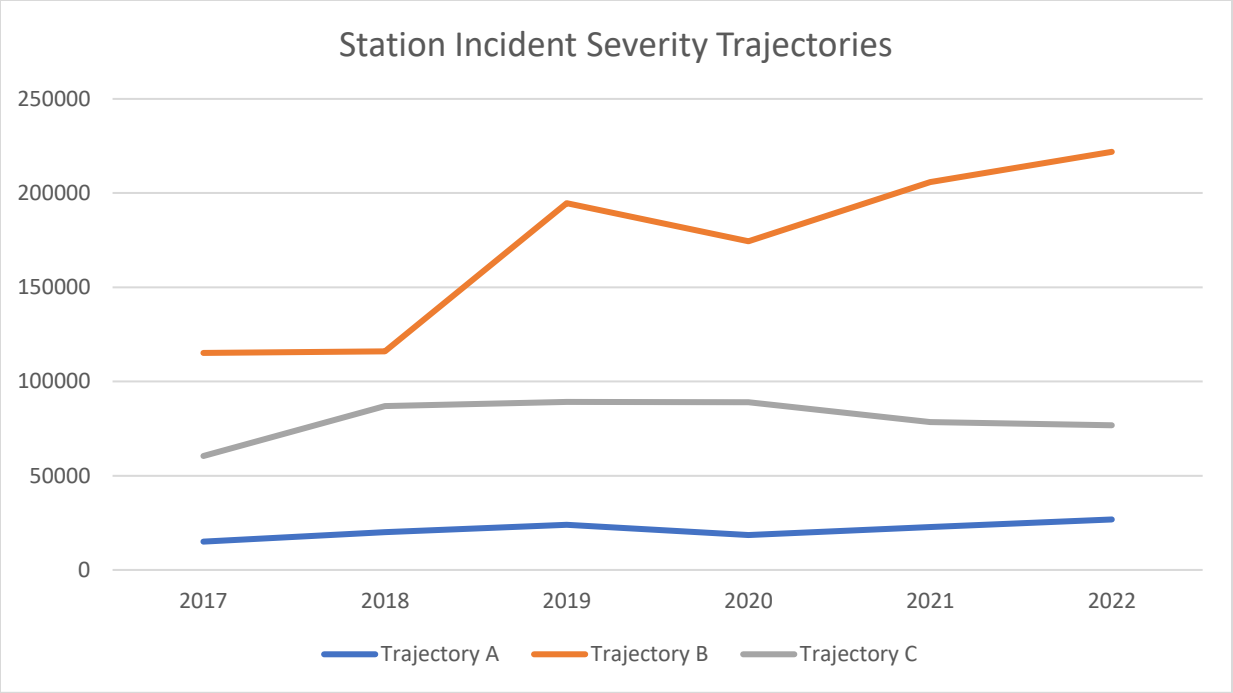

Figure 17: Station incident severity trajectories

4.3.5 Offender Incident Severity Trajectories

Figure 18 shows the offender incident severity trajectories. An optimal k-means partition of three groups was identified where 98% of offenders belonged to the low crime severity level group, which had a decreasing trajectory. The medium and high crime severity groups comprising 1% of offenders had increasing trajectories.

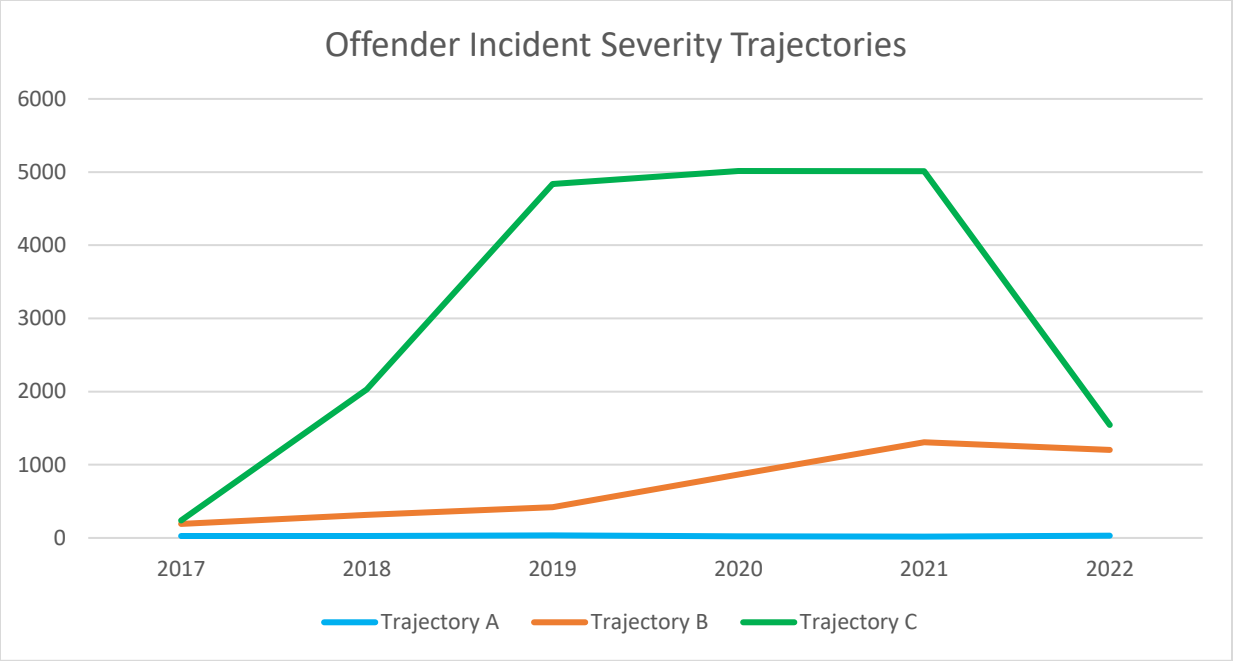

Figure 18: Offender incident severity trajectories

4.4 Temporal Distribution of Crime Counts and Crime Severity

Research Question 4: **What is the temporal distribution of crime counts and severity by hour-of-day, day-of-week, and month-of-year?**

4.4.1 Incident Report Counts by Hour-of-Day

Figure 19 shows the temporal distribution of incident report counts by time-of-day. The hottest times are 2000 to 2300 hours, 0700 to 0900 hours, and 1500 to 1800 hours. These 'hot' times coincide with morning and evening rush hours when more people enter and leave the stations; and late-night hours when fewer people use the transit system.

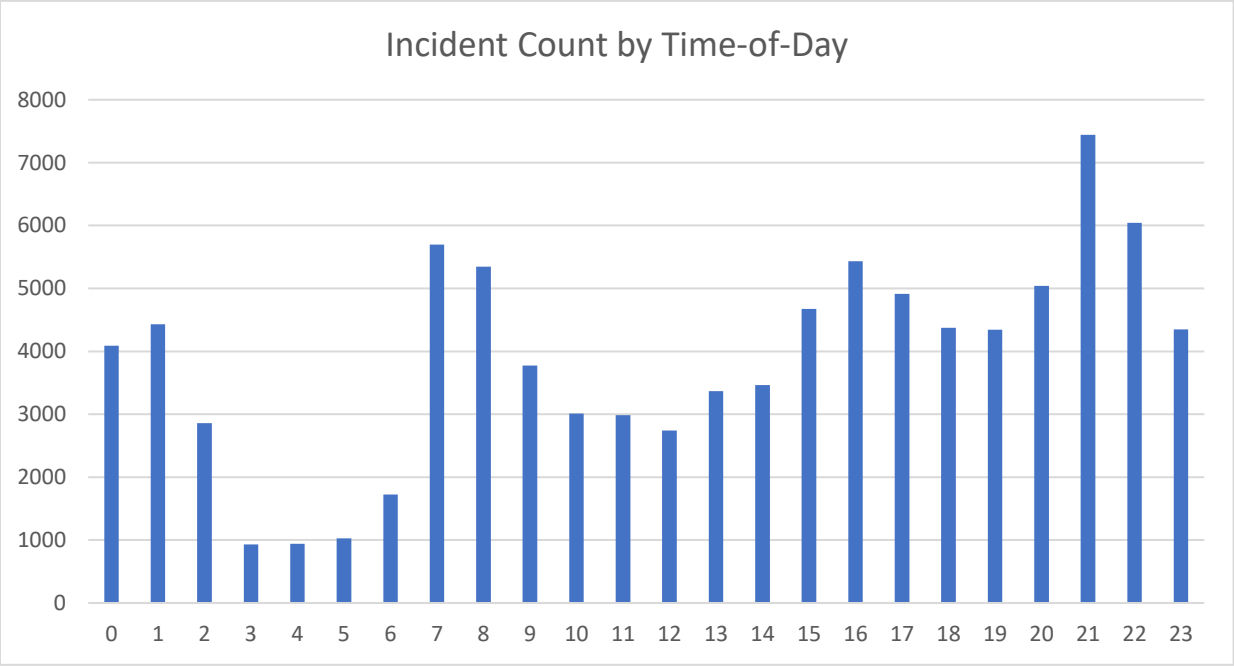

Figure 19:Temporal distribution of incident count by hour-of-day

4.4.2 Incident Severity by Hour-of-Day

Figure 20 shows the temporal distribution of incident severity by hour-of-day. The hottest times are 2000 to 2300 hours, 1500 to 1800 hours, and 0700 to 0900 hours. A general trend appears to be that incident severity increases as the day progresses.

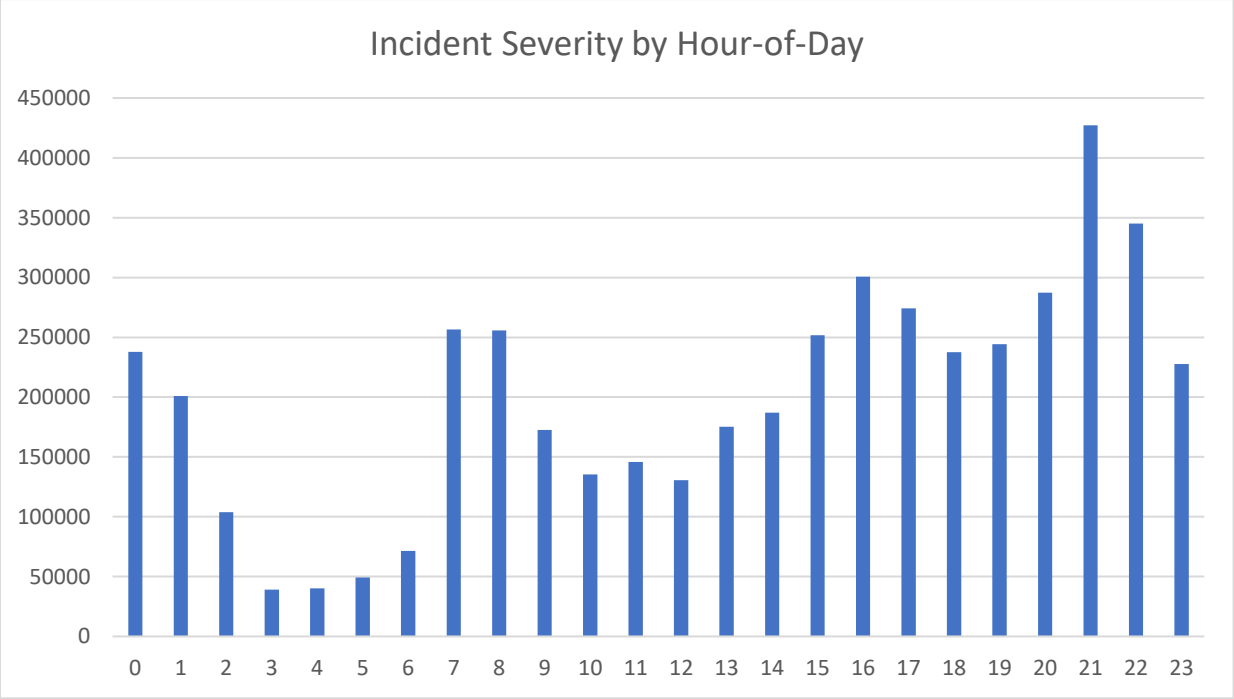

Figure 20:Temporal distribution of incident severity by hour-of-day

4.4.3 Calls-For-Service Counts by Day-of-Week

Figure 21 shows the distribution of calls-for-service counts by day-of-week. Calls-for-service were higher during the weekdays and lowest during the weekends.

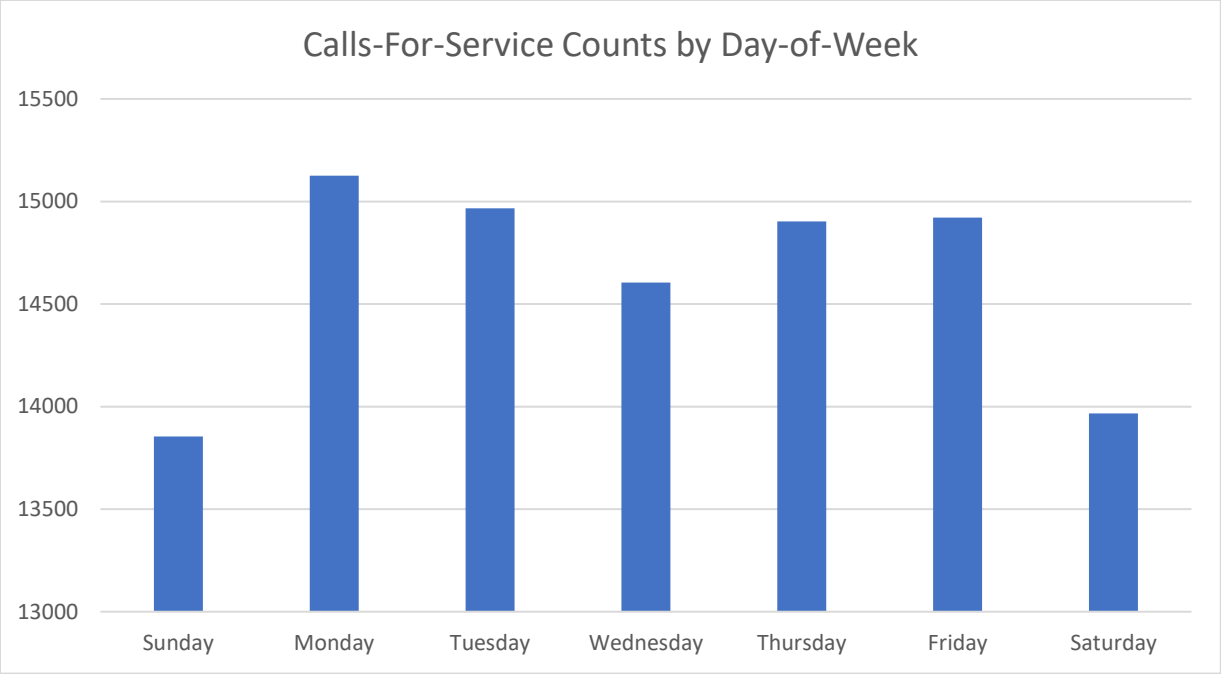

Figure 21: Distribution of call-for-service by day-of-week

4.4.4 Incident Report Counts by Day-of-Week

Figure 22 shows the distribution of incident counts by day-of-week. Incident counts were highest during the weekdays and lowest during the weekends.

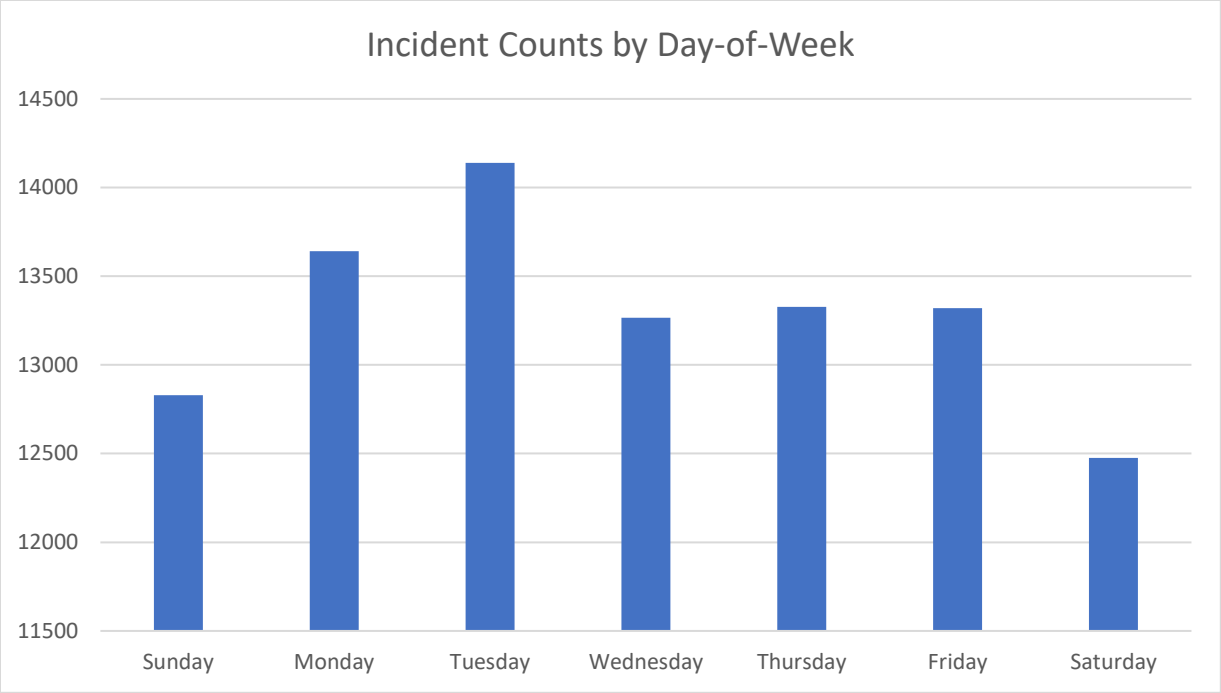

Figure 22: Distribution of incident counts by day-of-week

4.4.5 Incident Severity by Day-of-Week

Figure 23 shows the distribution of incident severity by day-of-week. Similar to distributions for calls-for-service counts and incident counts, the incident severity was highest during the weekdays and lowest during the weekends.

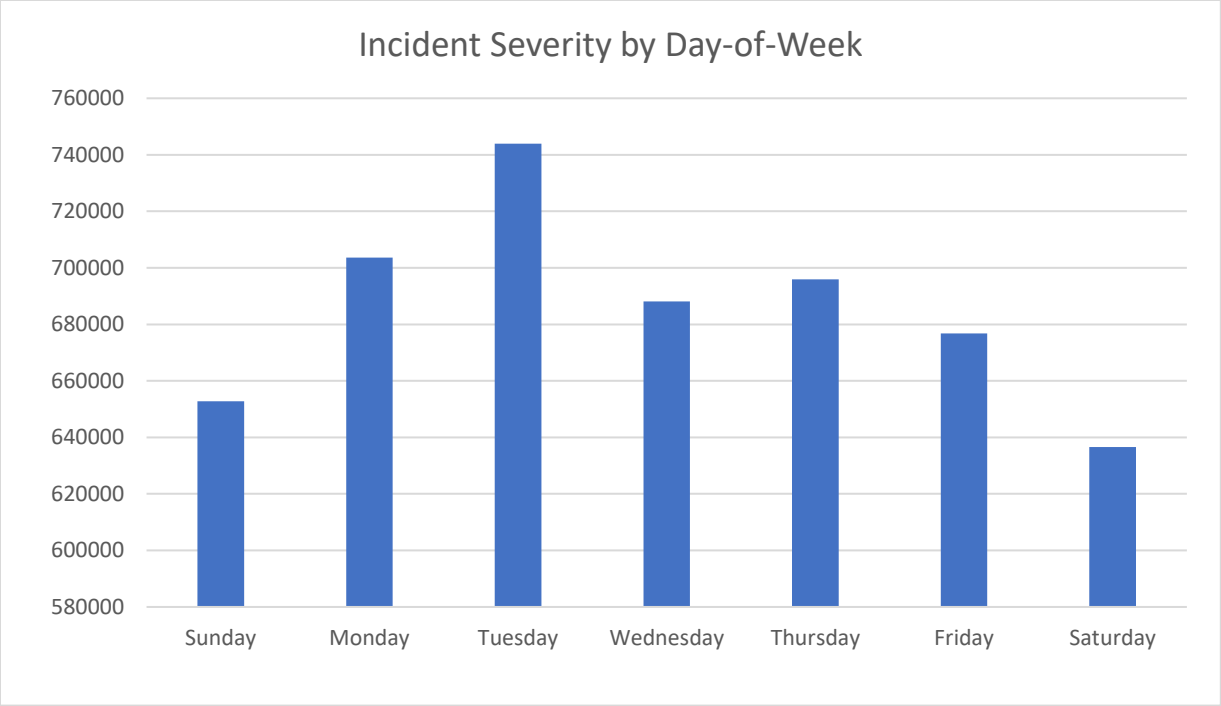

Figure 23: Distribution of incident severity by day-of-week

4.4.6 Calls-For-Service Counts by Month-of-Year

Figure 24 shows the distribution of calls-for-service counts by month-of-year. Calls-for-service are higher in October to March than in April to September. December has the highest calls-for-service, whereas August has the lowest.

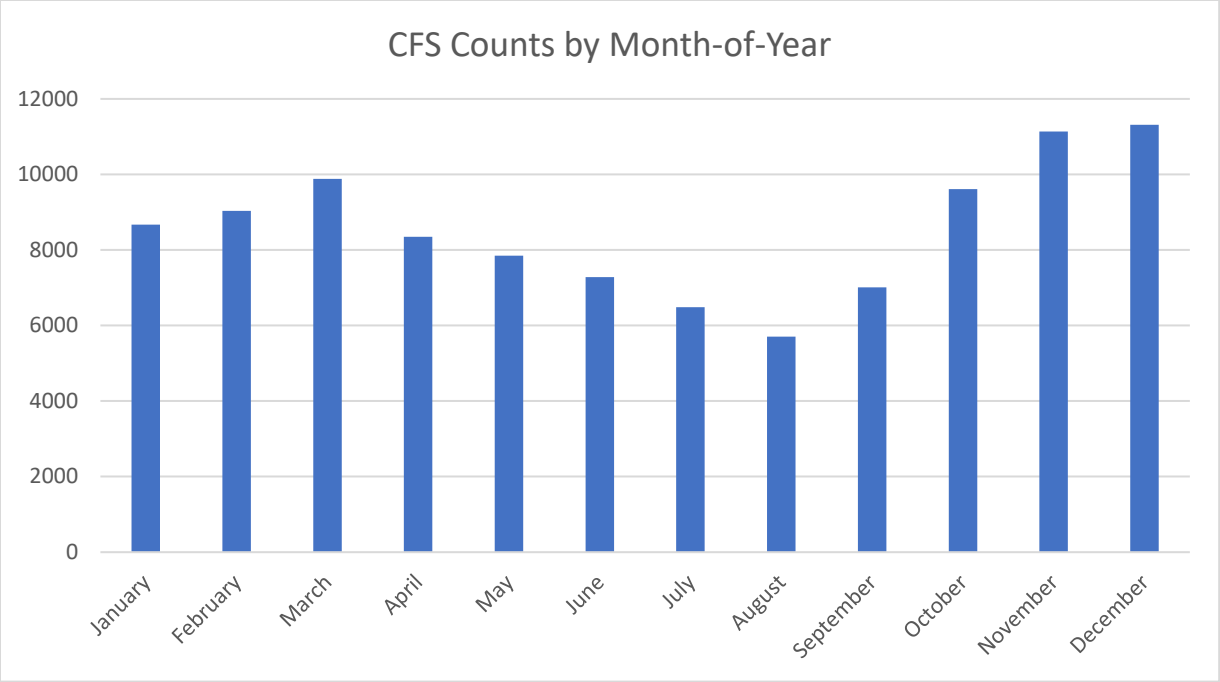

Figure 24: Distribution of calls-for-service by month-of-year

4.4.7 Incident Report Counts by Month-of-Year

Figure 25 shows the distribution of incident report counts by month-of-year. Incident counts are generally higher in the winter months than in the summer months. Incident counts are highest in October and lowest in July.

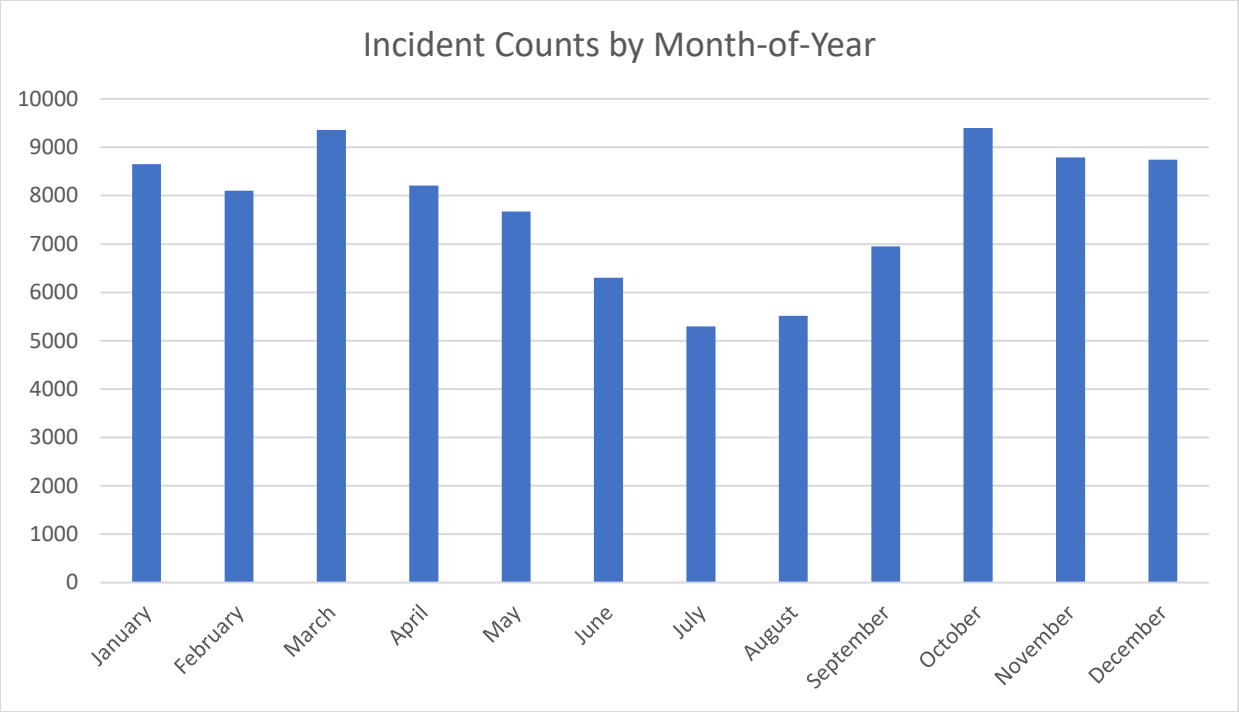

Figure 25: Distribution of incident counts by month-of-year

4.4.8 Incident Severity by Month-of-Year

Figure 26 shows the distribution of incident severity by month-of-year. Incident Severity is highest in October and lowest in July. Severity is lower in the summer months of June to August than in the rest of the year.

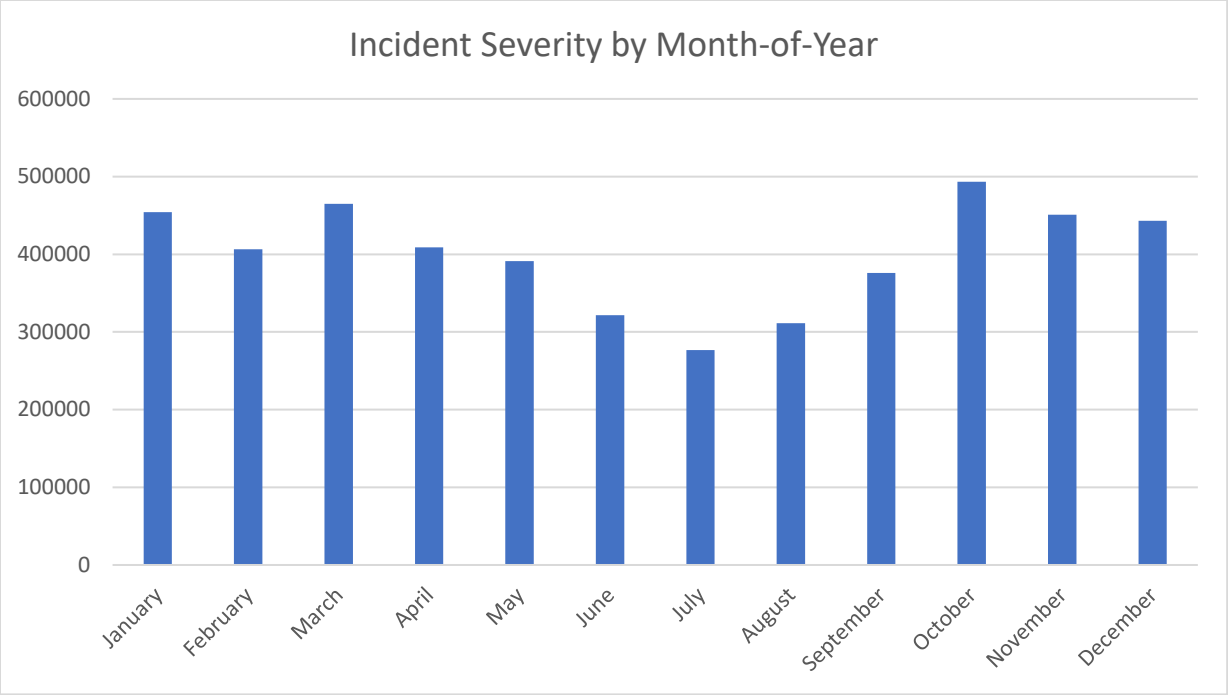

Figure 26: Distribution of incident severity by month-of-year

4.5 Distribution of Crime and Disorder Offences

Research Question 5: **What is the distribution of crime and disorder offences by count and by severity?**

4.5.1 Distribution of Disorder Offences by Count

Figure 27 shows the distribution of disorder offences where loitering, trespassing, and fare evasion collectively account for 83% of all disorder offences' total count.

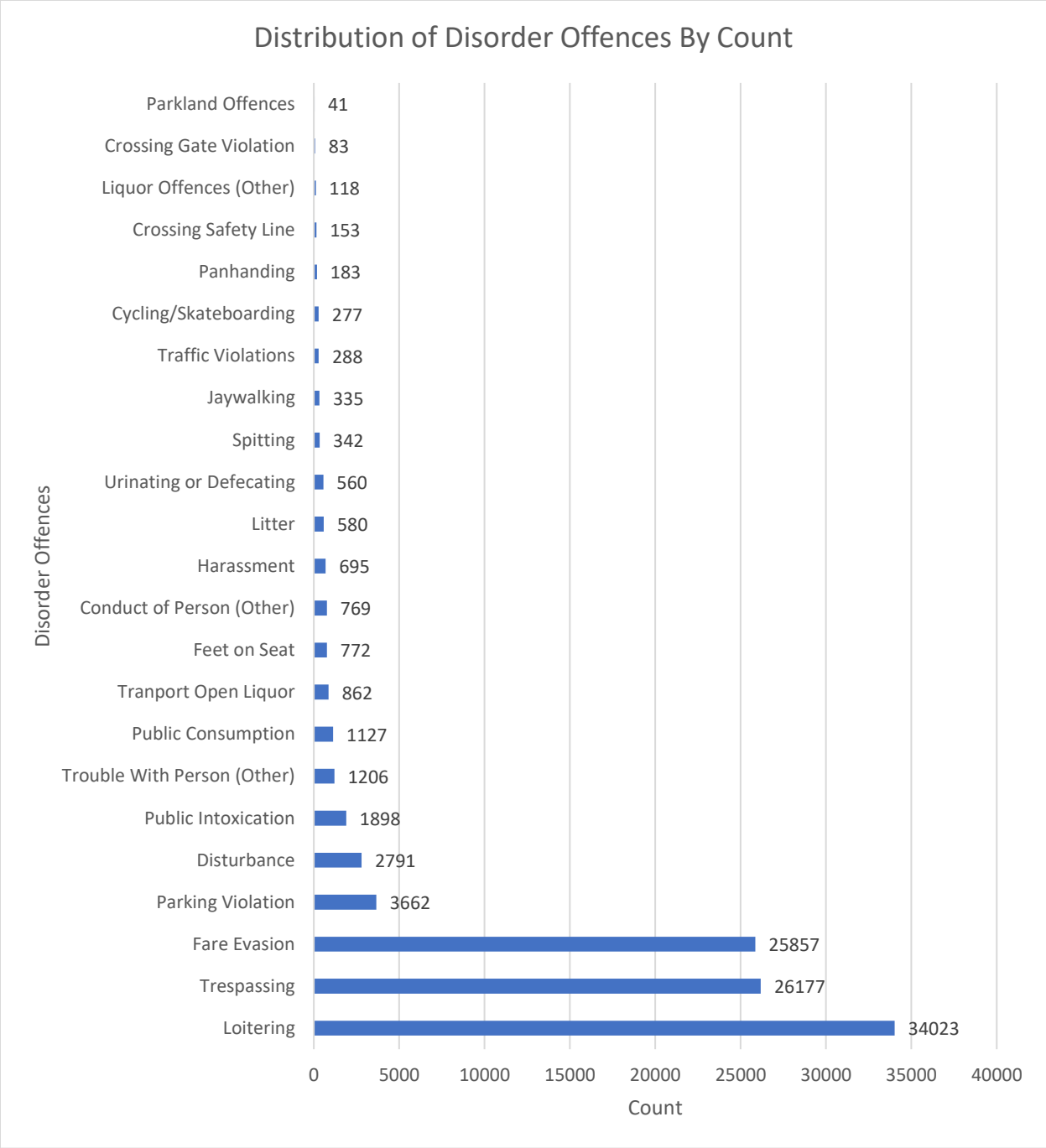

Figure 27: Distribution of disorder offences by count

4.5.2 Distribution of Disorder Offences by Severity

Figure 28 shows the distribution of disorder offences by severity, where fare evasion, trespassing, and loitering collectively represent 92% of disorder offences' total severity. There appears to be only minor differences between the count and severity distributions for disorder offences.

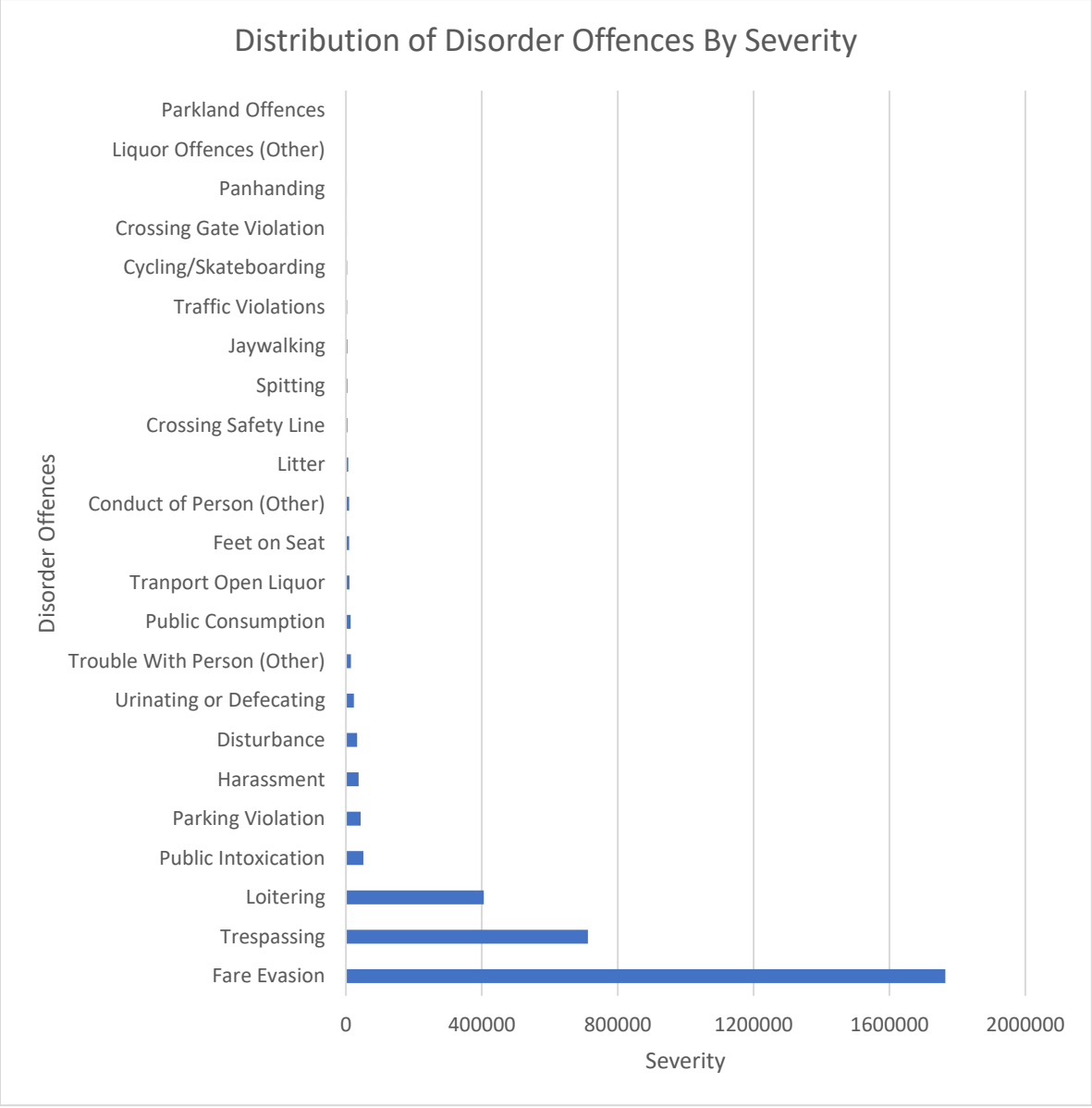

Figure 28: Distribution of disorder offences by severity

4.5.3 Distribution of Criminal Offences by Count

Figure 29 shows the distribution of criminal offences by count, where drugs, mischief, obstruction, assault, and weapon offences account for 87% of the total criminal offences count.

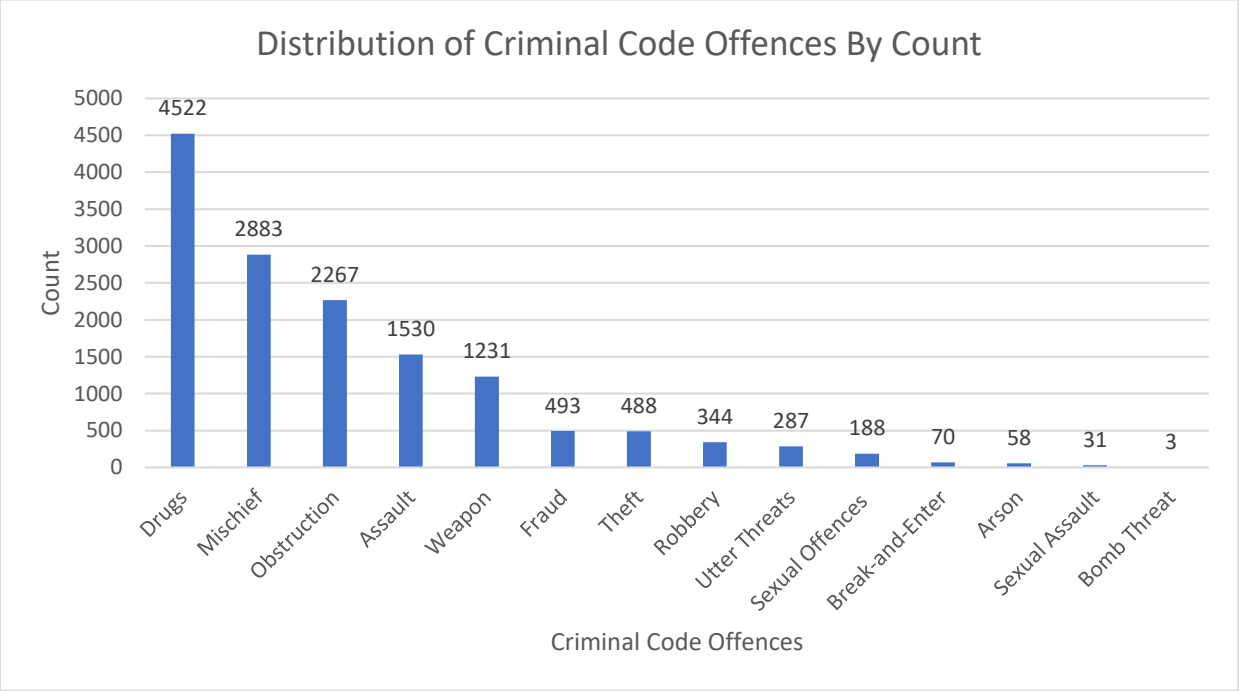

Figure 29: Distribution of criminal offences by count

4.5.4 Distribution of Criminal Offences by Severity

Figure 30 shows the distribution of criminal offences by severity, where drugs, robbery, and weapon offences account for 64% of the total criminal code severity. Significant differences exist in the offences' rankings by count and severity. For example, robbery ranks eighth by count but second by severity; whereas weapon offences rank fifth by count but third by seriousness.

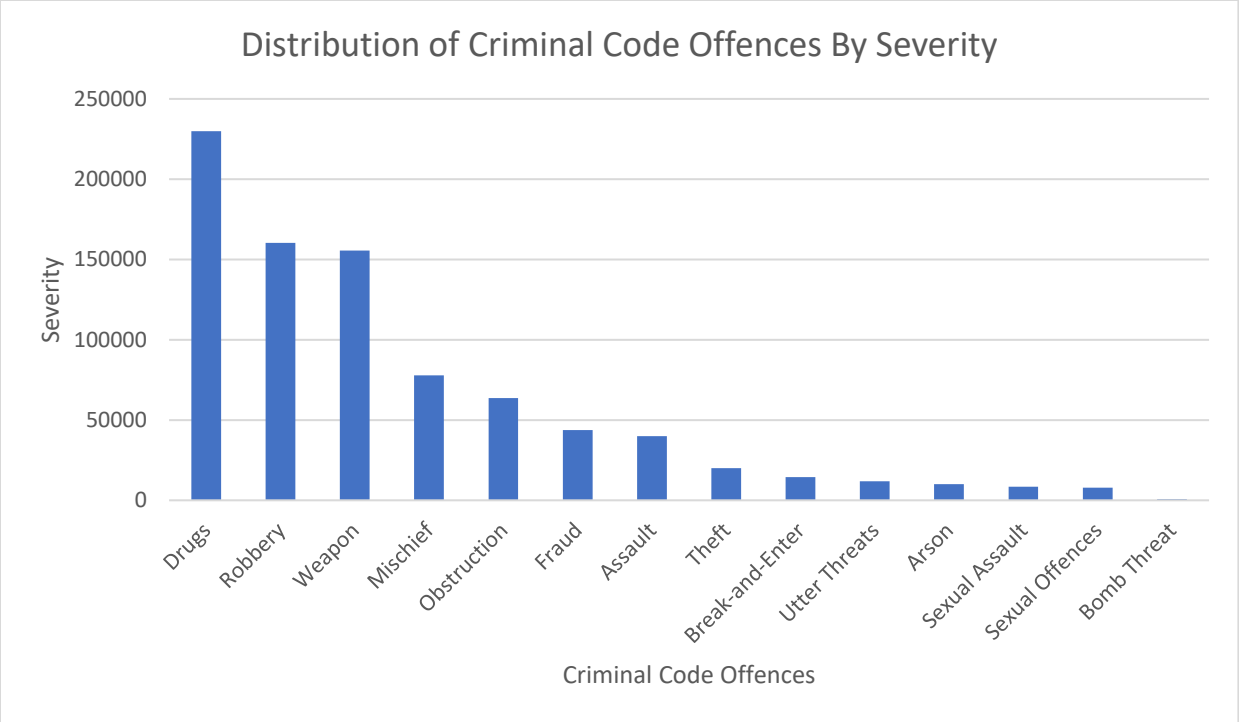

Figure 30: Distribution of criminal offences by Severity

4.6 Distribution of Power-few Offenders and Offender Characteristics at Stations

Research Question 6: **What is the distribution of crime counts and severity by offenders, gender, and age? What is the distribution of station incident count and severity by Power-few and Non-Power-few Offenders? What is the relationship between offenders' count and offenders' severity?**

4.6.1 Distribution of Offenders by Gender

From 2017 to 2022, there was a total of 18,594 unique offenders, where males constituted 11,810 (63%), females constituted 6,446 (35%), and those unidentified constituted 338 (2%). Figure 31 shows the distribution of offenders by gender, using raw counts and percentages.

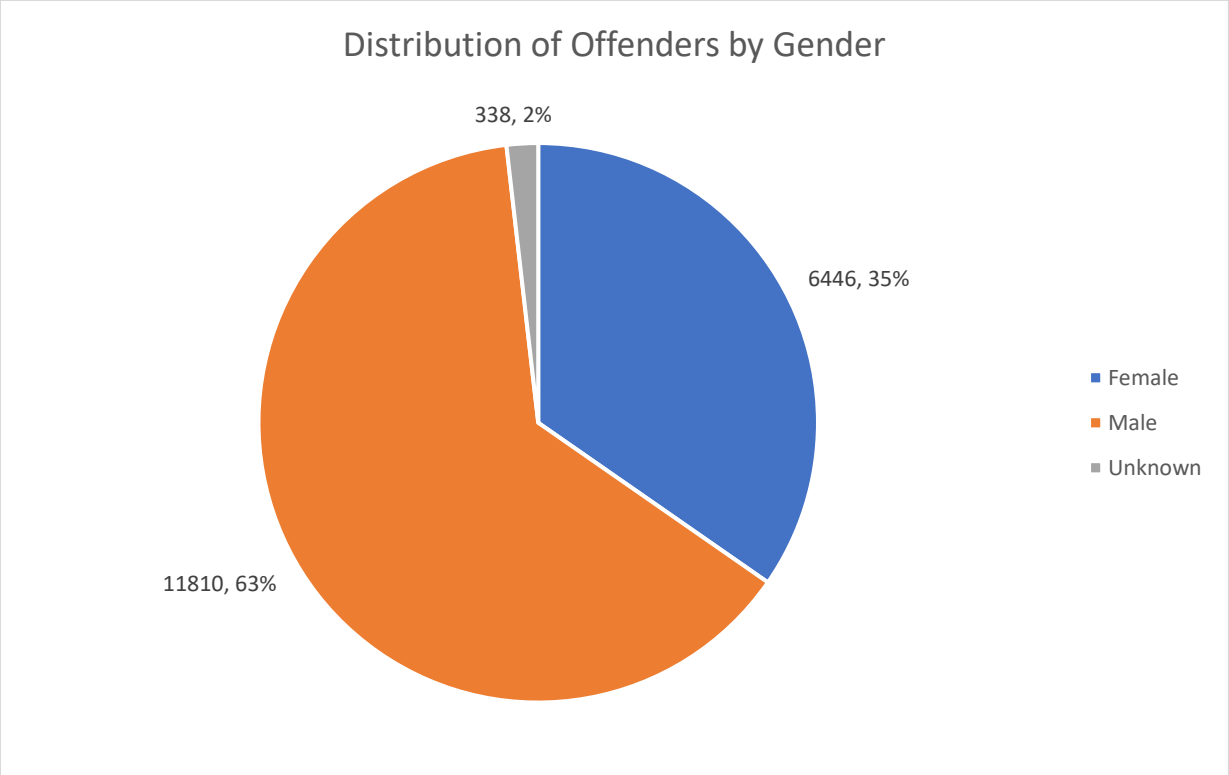

Figure 31: Composition of offenders by gender

4.6.2 Distribution of Offenders by Age

Figure 32 shows the distribution of offenders by age, where most offenders fall between the ages of 17 to 38 years (Mean=32.25, Standard Deviation=12.23). This distribution shows a general decline in crime participation with the advancement of age, consistent with the normal age-crime curve.

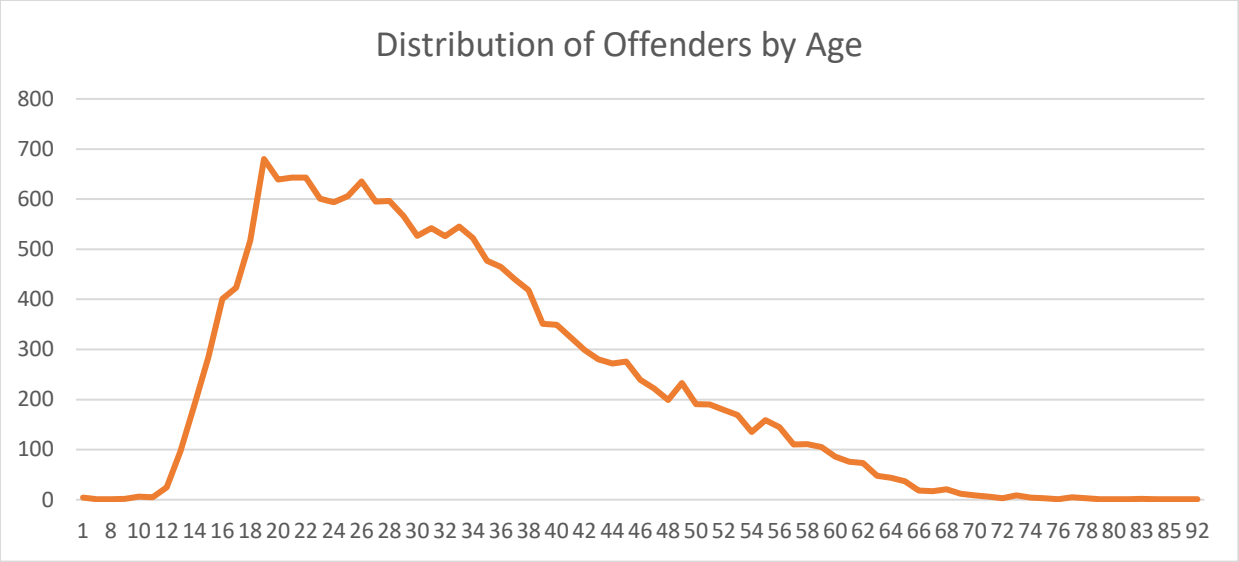

Figure 32: Distribution of offenders by age

4.6.3 Count of Unique Offenders by Year

Figure 33 shows the number of unique offenders each year from 2017 to 2022. The annual change in the count of notable offenders was -3.2% from 2017 to 2018, 33.9% from 2018 to 2019, -46.7% from 2019 to 2020, -15.5% from 2020 to 2021 and 28.4% from 2021 to 2022. The general trend is a decrease in the count of unique offenders from 2017 to 2022.

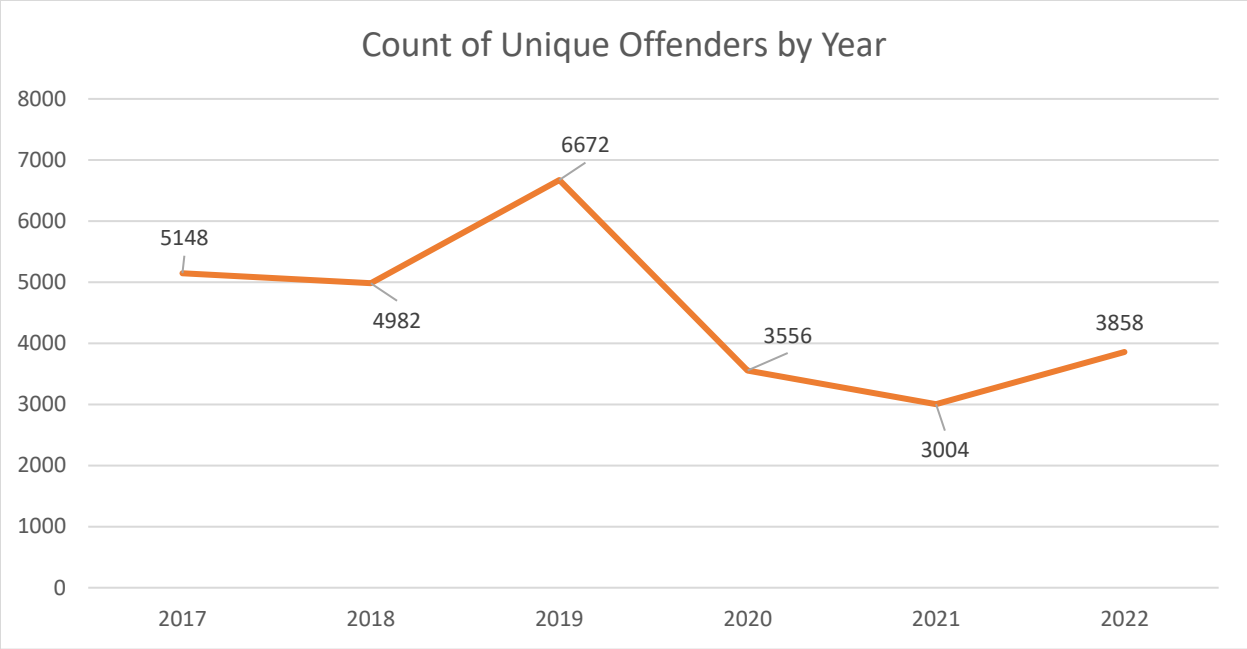

Figure 33: Count of unique offenders by year

4.6.4 Distribution of Incident Count by Offenders' Gender

Figure 34 shows the distribution of incident count by offenders' gender, indicating that males were responsible for more incidents than females. Males accounted for 53364 incidents or 70% (Mean = 4.51, Standard Deviation = 17.98), females accounted for 22257 or 29% (Mean = 3.45, Standard Deviation = 18.45), and those unidentified accounted for 438 or under 1% of all incident count.

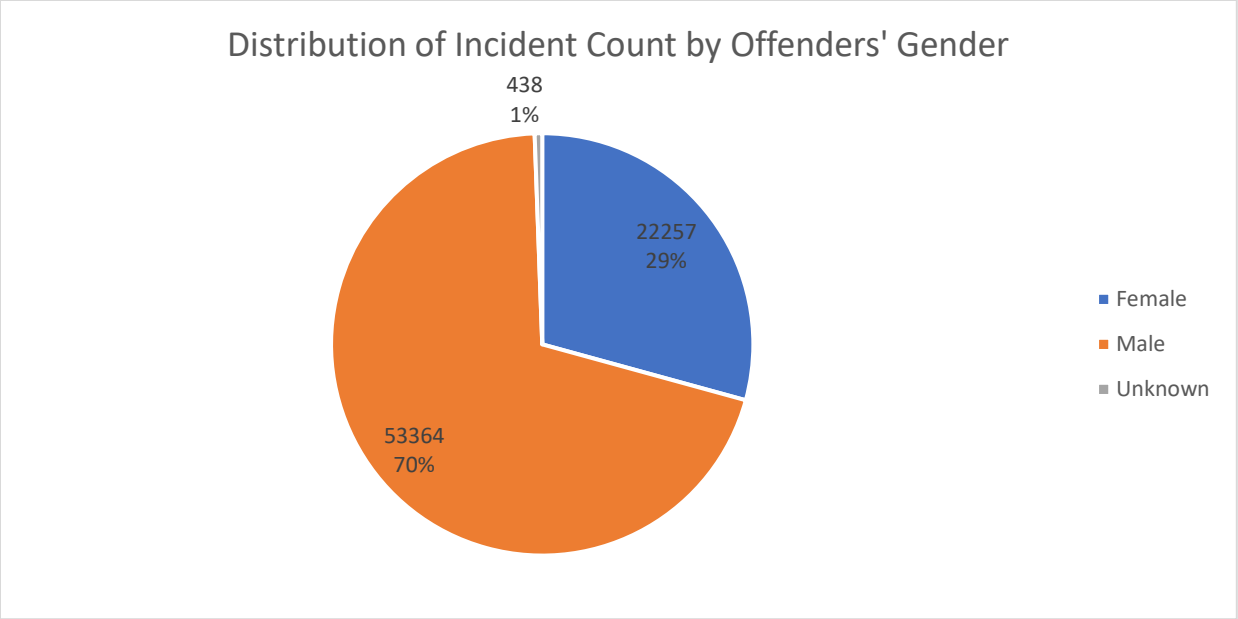

Figure 34: Distribution of incident count by gender

4.6.5 Distribution of Incident Severity by Offenders' Gender

Figure 35 shows the distribution of incident severity by offenders' gender, indicating that males were responsible for a more significant proportion of incident severity than females. Males accounted for a total severity of 2779940.99 or 70% (Mean = 235.38, Standard Deviation = 820.43). Females were responsible for an objective seriousness of 1141030.65 or 29% (Mean = 177.01, Standard Deviation = 792.99). Those unidentified accounted for a total severity of 22739.84 or under 1% of all severity.

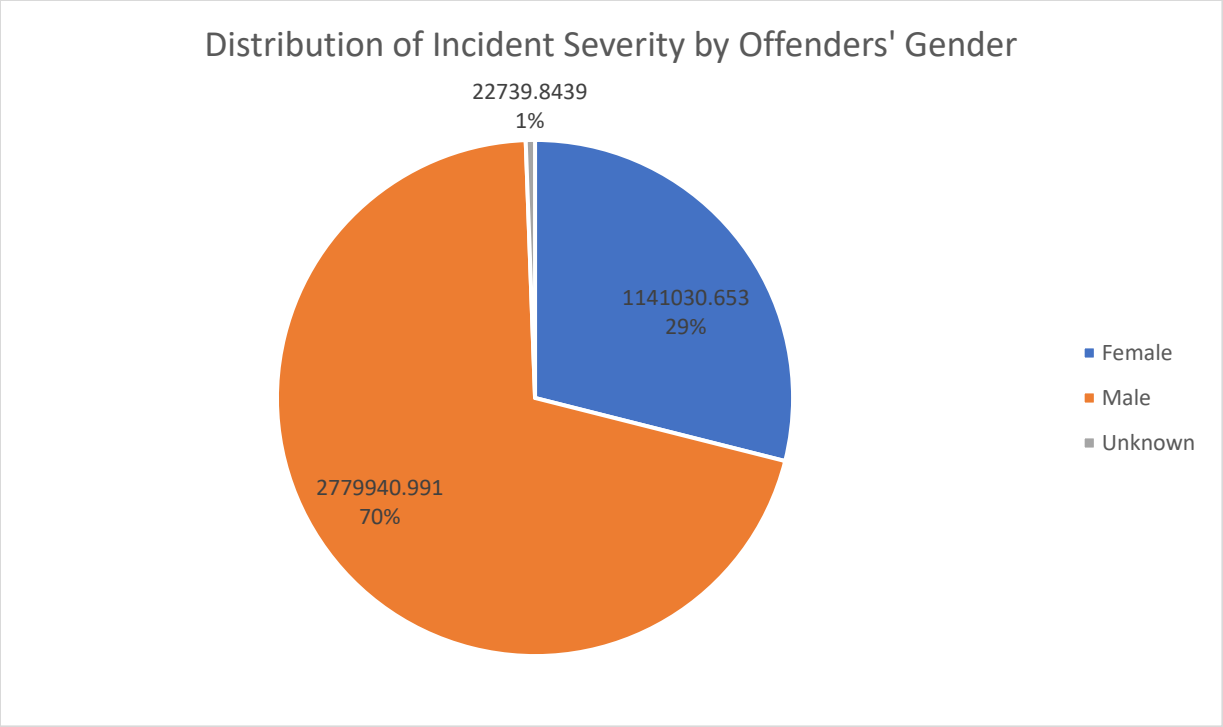

Figure 35: Distribution of incident severity by offenders' gender

4.6.6 Distribution of Incident Count and Severity by Offender Types

This study identified the power-few offenders as those within the top 22% of offenders, accounting for 78% of all incidents. In all stations except Stadium, power-few offenders account for the majority of incident count and severity (See Appendix A). The top stations where the power-few offenders accounted for the most significant proportion of crime count were Central (74.2%), MacEwan (73.6%), Bay (67%), and Government Centre (66.7%). The top stations where the power-few offenders accounted for the most significant proportion of incident severity were Government Centre (69.3%), NAIT (68.9%), Central (68.6%), and MacEwan (65.6%).

4.6.7 Correlation between Offence Counts and Offence Severity Per Offender

The Pearson correlation coefficient is calculated, and the results indicate a statistically significant positive relationship between offenders' offence count and offence severity, $r = 0.984$, $p < 0.001$. Figure 36 shows the distributions of offence count and seriousness for the top 30 offenders, depicting the relationship between the two variables.

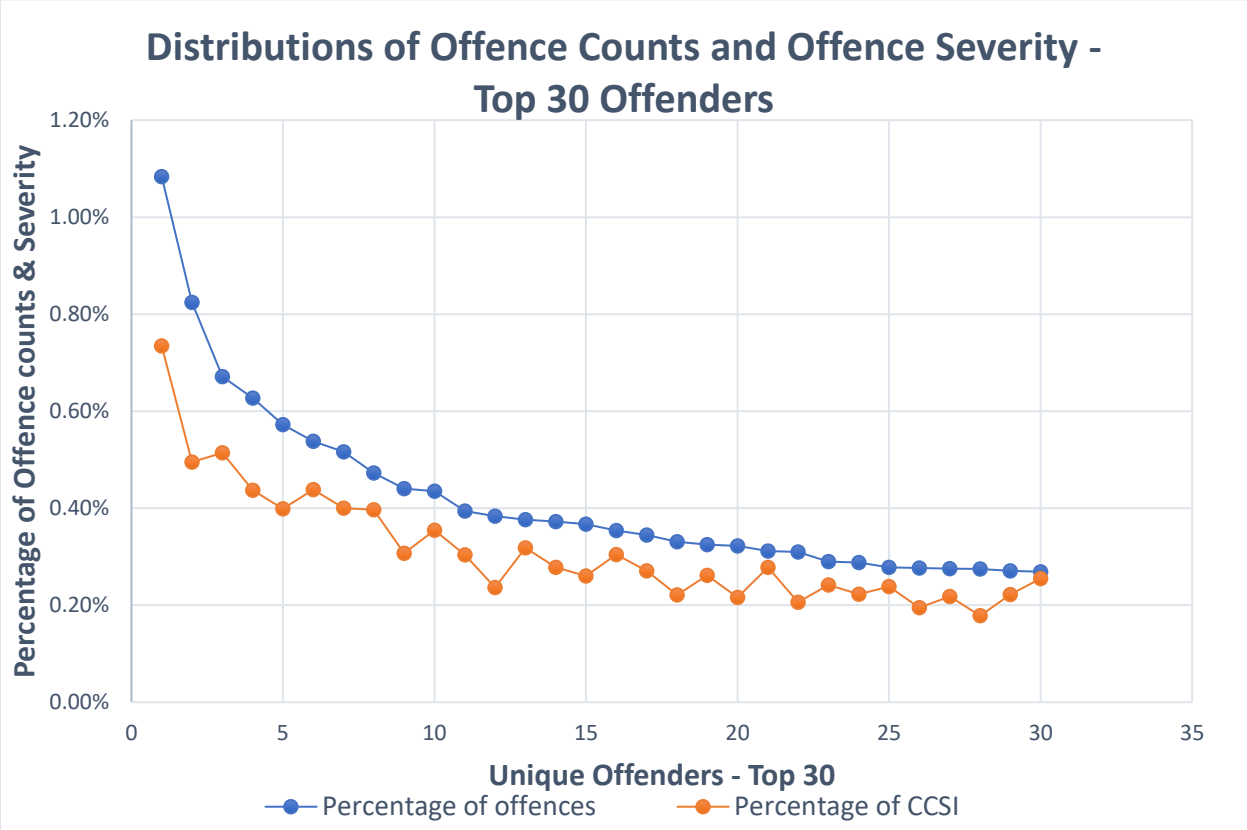

Figure 36: Distributions of offence counts and offence severity

4.7 Comparison of Crime Concentration by Data Types

Research Question 7: **Are there any similarities or differences in crime concentration patterns when using calls-for-service and incident report data types?**

Figure 37 compares the power curves of calls-for-service counts and incident counts by stations. When comparing crime concentration by the two data types, it is clear that incident counts were more concentrated than calls-for-service counts. The top-ranked 22% of stations account for 49% of calls-for-service counts, whereas the top-ranked 22% of stations account for 60% of incident count.

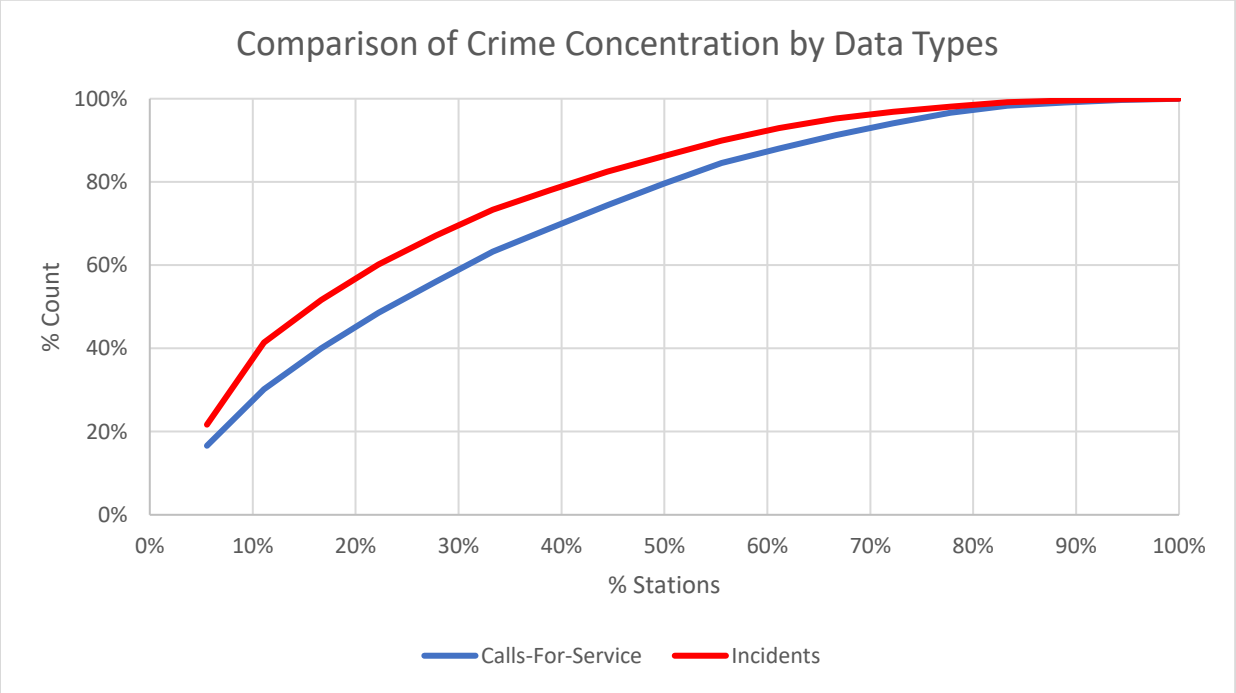

Figure 37: Power curves of calls-for-service and incident report counts by stations

4.8 Comparison of Crime Concentration between Places and People

Research Question 8: **Are there any similarities or differences in crime concentration between places and people?**

Figure 38 compares crime concentration between offenders and stations, showing that crime is more concentrated among offenders than in stations. The top-ranked 22% of stations account for 49% of all calls-for-service and 60% of all incidents, whereas the top-ranked 22% of offenders represent almost 80% of all incidents.

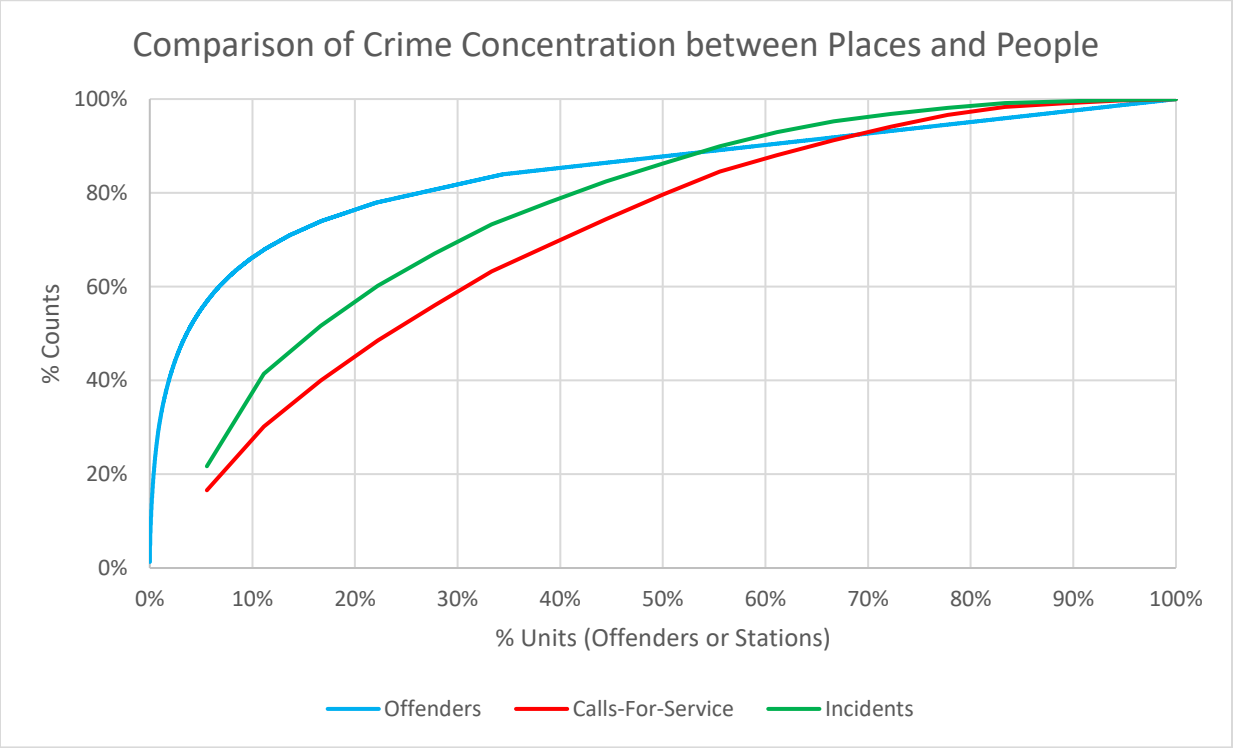

Figure 38: Power curves for offenders, calls-for-service, and incidents

4.9 Comparison of Physical and Environmental Attributes of Power-few Stations

Research Question 9: **What are the similarities or differences in the physical and environmental attributes of Power-few stations?**

Five stations – Central, Churchill, Coliseum, MacEwan, and Southgate LRT Stations – which appear in the power-few rankings, are included in this analysis.

4.9.1 Comparison of Physical Attributes of Power-few Stations

The physical design of these Power-few stations can be described as complex given that these stations include a platform, a concourse, multiple entrances and exits, and are connected to pedways. This contrasts with the simple design, platform-and-shelter-only stations such as NAIT, McKernan/Belgravia, and South Campus, consistently among the lowest-ranked stations. Figure 41 compares the simple design of McKernan/ Belgravia Station with the complex design of Southgate LRT Station. Figures 39 and 40 below show station maps of Churchill and Central LRT Stations, respectively, illustrating the complexity of their station designs. Churchill and Central are underground stations, whereas Coliseum, Southgate, and MacEwan are ground-level stations. Like all other stations in Edmonton, the Power-few stations have a shared platform for both inbound and outbound trains. While the shared platforms allow for a convenient transfer from one train to another, the platforms, particularly in the busier stations, can be crowded, which could have implications for crime opportunities. The power-few stations all have public washrooms, unlike the lowest-ranked stations, such as NAIT and McKernan/Belgravia, which do not have any. The power-few stations, like all other stations in Edmonton, do not have turnstiles or other forms of fare gates at the entrances or to the fare-restricted zones. As a result, fare payment on the LRT system is based on an honour system that requires regular checks and enforcement to maintain the

integrity of the fare system. The lack of fare gates could have implications for fare evasion and other disorders, such as loitering.

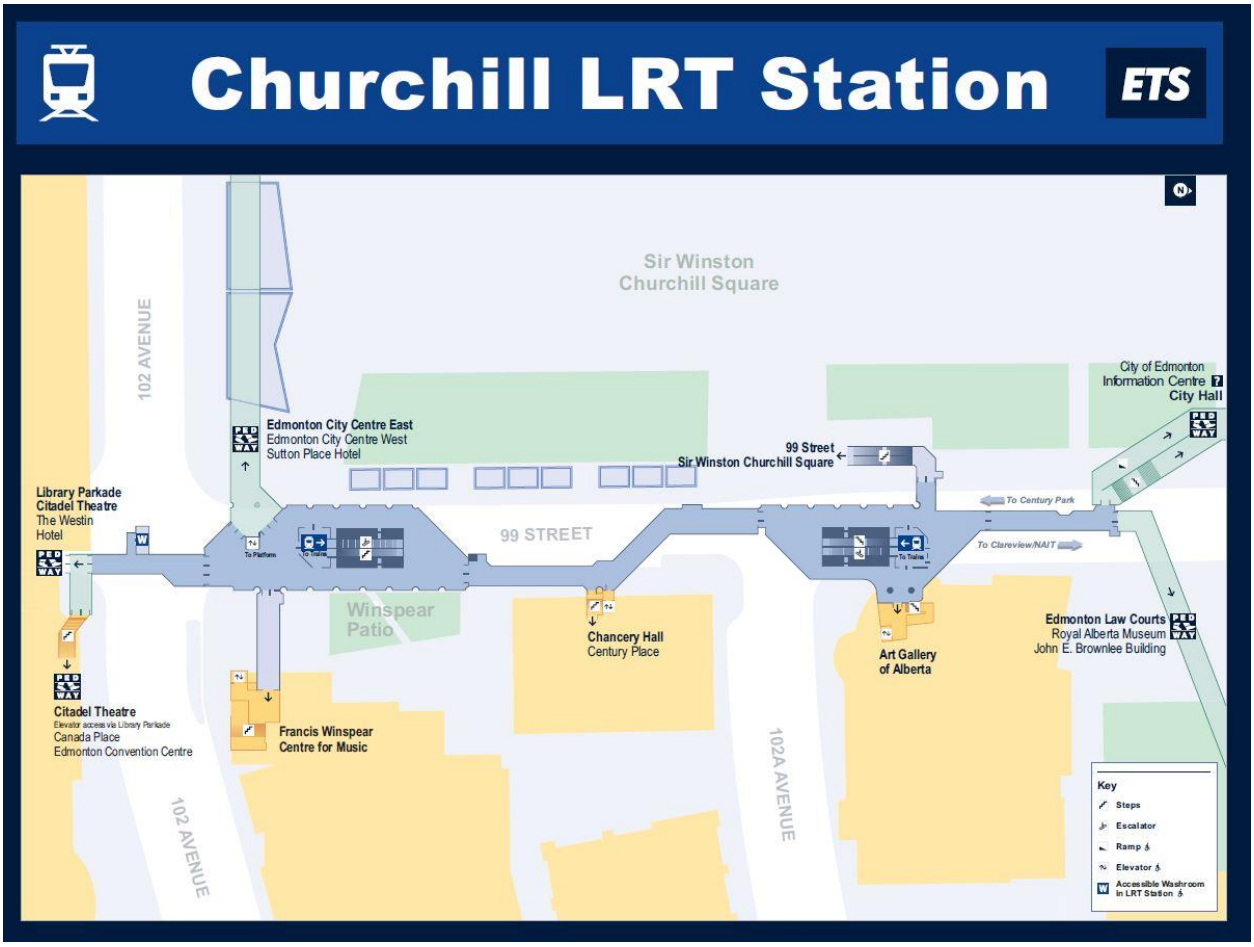

Figure 39: Churchill LRT Station Map (Source: City of Edmonton, 2023)

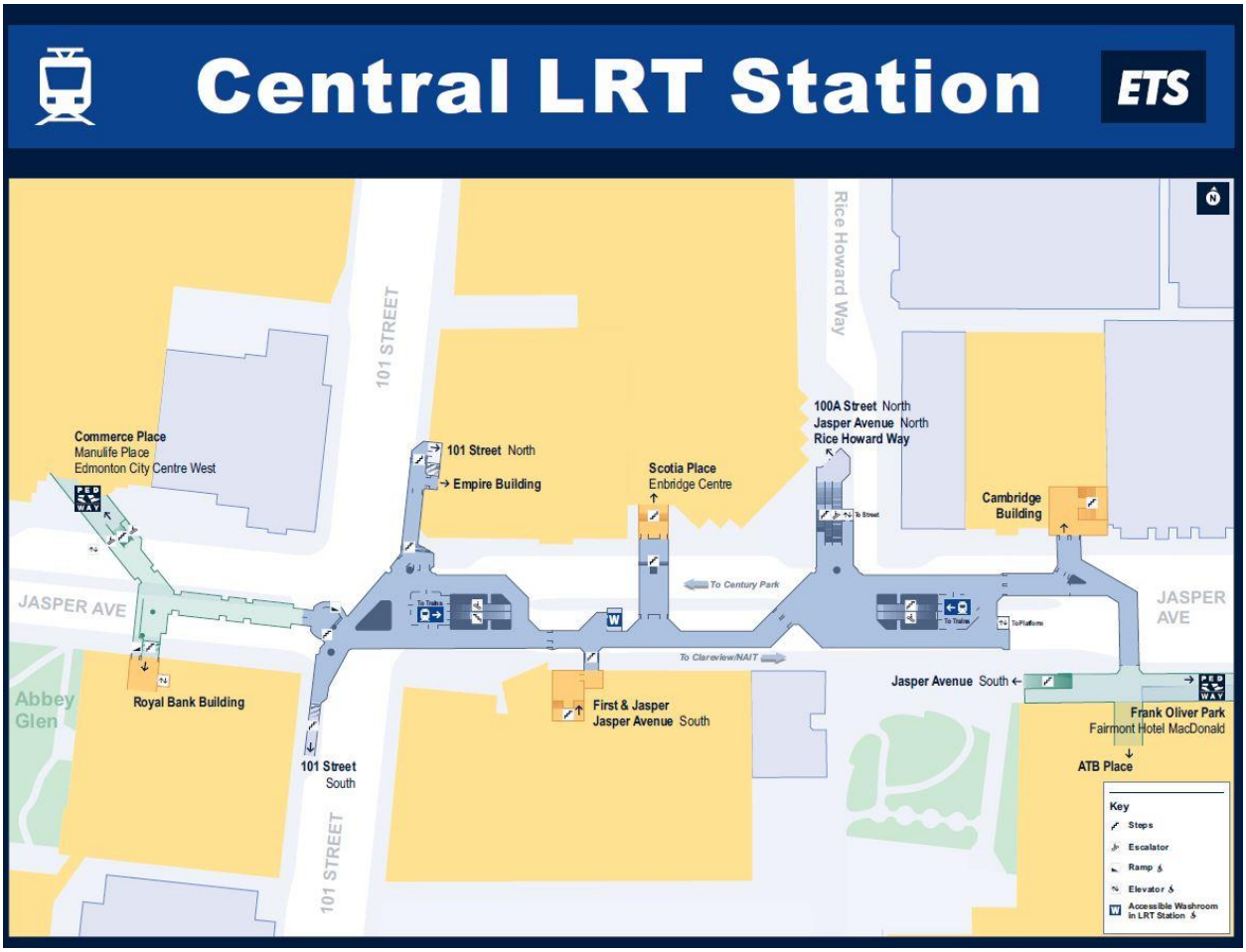

Figure 40: Central LRT Station Map (Source: City of Edmonton, 2023)

Figure 41: McKernan/Belgravia LRT Station (left) and Southgate LRT Station (right)

4.9.2 Comparison of Environmental Attributes of Power-few Stations

Churchill, Central and MacEwan stations are in the city centre, whereas Coliseum and Southgate are in the northeast and south of the city centre, respectively. Churchill, Central, and MacEwan are located near the City Centre Shopping Mall, while Southgate Station is adjacent to the Southgate Shopping Mall. Thus, Coliseum is the only Power-few station not near a shopping mall. Most of the Power-few stations are adjacent to or near major events centres. MacEwan station is adjacent to Rogers Place, a major events centre that includes an ice hockey arena for Edmonton's professional hockey team, the '*Oilers*'. Churchill and Central stations are close to Rogers Place Events Centre and Edmonton Convention Centre. Churchill station is adjacent to Winspear Centre, a performing arts theatre, and Sir Winston Churchill Square, a plaza that hosts festivals and other events. Coliseum is adjacent to the now defunct former ice hockey arena, Rexall Place and is close to Edmonton Expo Centre, a significant events facility. Southgate station is the only power-few station that is not close to any important events centre. Coliseum, MacEwan, and Southgate stations are adjacent to large surface parking lots, whereas Churchill station is adjacent to two underground parkades. Central Station is close to an underground and above-ground parkade.

Churchill, Central, and MacEwan stations are close to homeless shelters and other facilities providing services to the homeless population. Coliseum and Southgate stations are not near any homeless shelters or related facilities. Coliseum and Southgate are adjacent to significant bus terminals, while Churchill, Central, and MacEwan are not. All the power-few stations are close to multiple bus stops in their surrounding area. Most of the power-few stations are close to major commercial streets hosting many businesses such as bars, restaurants, liquor stores, and convenience stores. All the power-few stations are located near high schools. Churchill and Central stations are near Centre High School; MacEwan is near Boyle Street Educational Centre; Coliseum

is near Eastglen High School; and Southgate is near Harry Ainlay High School. Figures 42 to 46 each show a map of the power-few stations and their surrounding areas.

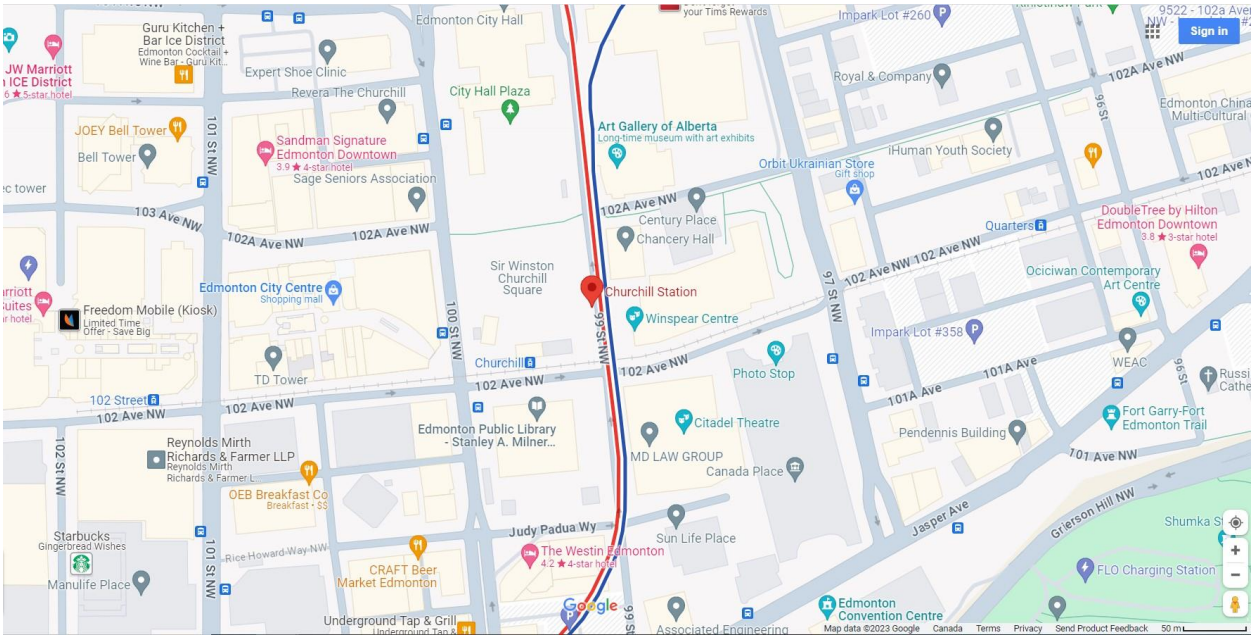

Figure 42: Map showing Churchill LRT Station and surrounding area (Google Maps, 2023)

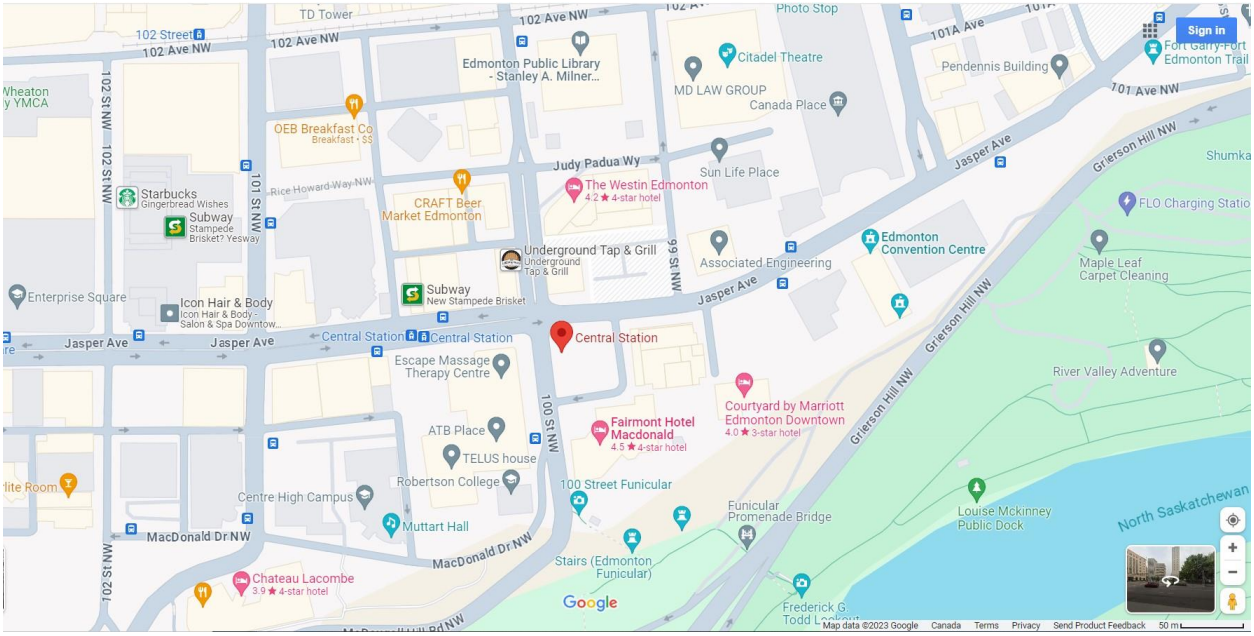

Figure 43: Map showing Central LRT Station and surrounding area (Google Maps, 2023)

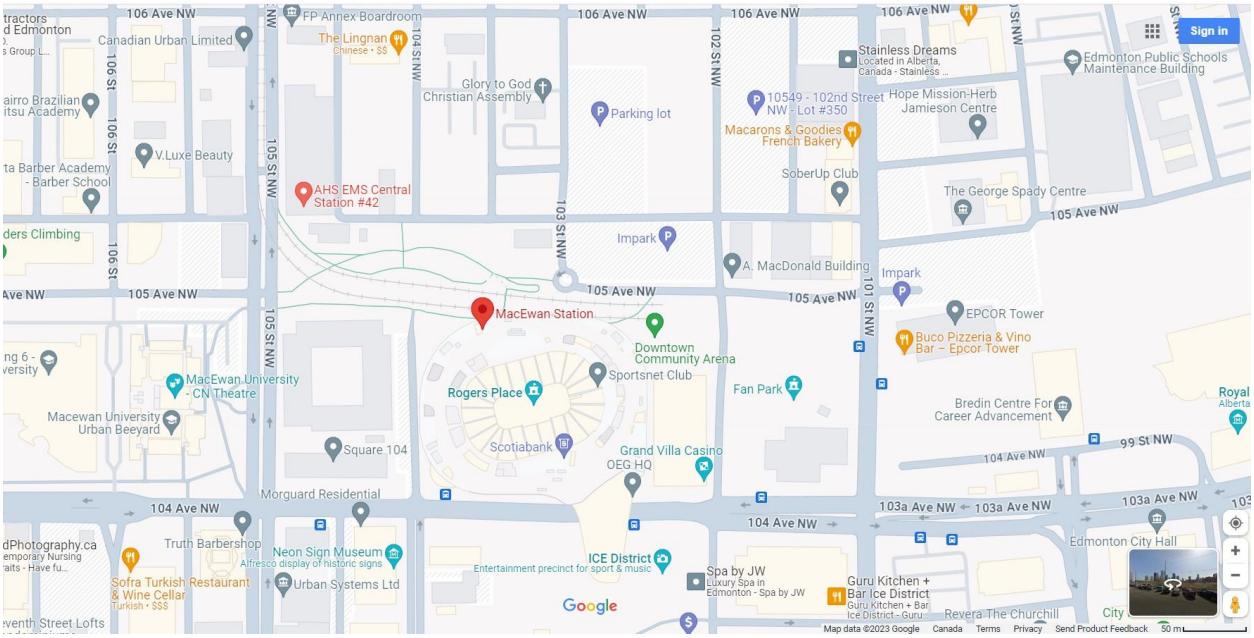

Figure 44: Map showing MacEwan LRT Station and surrounding area (Google Maps, 2023)

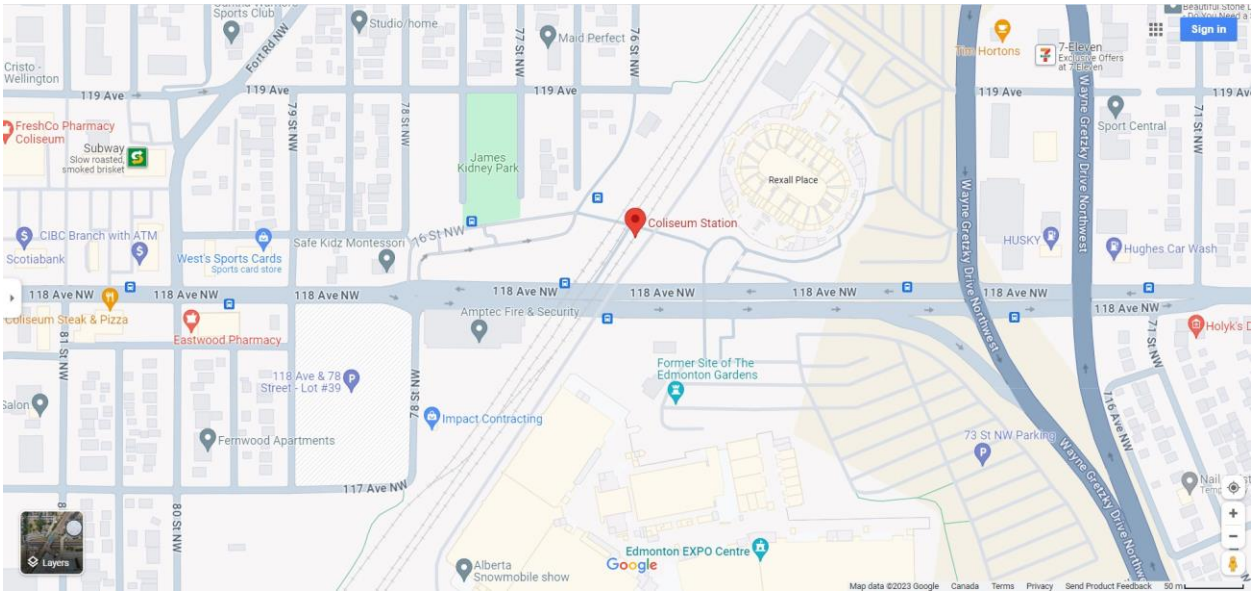

Figure 45: Map showing Coliseum LRT Station and surrounding area (Google Maps, 2023)

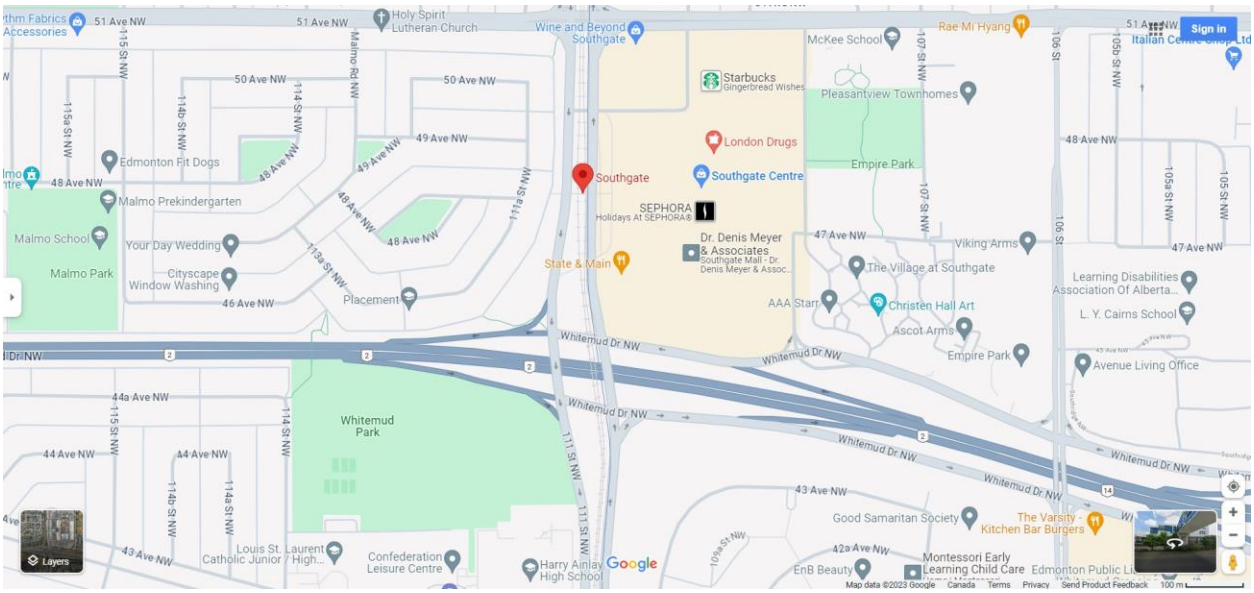

Figure 46: Map showing Southgate LRT Station and surrounding area (Google Maps, 2023)

Table 2: Comparison of Physical Attributes of Power-few Stations

COMPARISON OF PHYSICAL ATTRIBUTES				
CHURCHILL	**CENTRAL**	**MACEWAN**	**COLISEUM**	**SOUTHGATE**
Complex Design	Complex Design	Complex Design	Complex Design	Complex Design
Underground	Underground	Ground-level	Ground-level	Ground-level
Pedways	Pedways	Pedways	Pedways	Pedways
Shared IB/OB Platform	Shared IB/OB Platform	Shared IB/OB Platform	Shared IB/OB Platform	Shared IB/OB Platform
Multiple Entrances/Exits	Multiple Entrances/Exits	Multiple Entrances/Exits	Multiple Entrances/Exits	Multiple Entrances/Exits
Public Washrooms	Public Washrooms	Public Washrooms	Public Washrooms	Public Washrooms
No Turnstiles or Fare Gates	No Turnstiles or Fare Gates	No Turnstiles or Fare Gates	No Turnstiles or Fare Gates	No Turnstiles or Fare Gates

Table 3: Comparison of Environmental Attributes of Power-few Stations

COMPARISON OF ENVIRONMENTAL ATTRIBUTES				
CHURCHILL	**CENTRAL**	**MACEWAN**	**COLISEUM**	**SOUTHGATE**
City Centre	City Centre	City Centre	Northeast	South
Shopping Mall	Shopping Mall	Shopping Mall	None	Shopping Mall
Events Centres	Events Centres	Events Centres	Events Centre	None
Underground Parking lots	Underground & Above-ground Parking Lots	Surface Parking Lots	Surface Parking Lots	Surface Parking Lots
Homeless Shelters	Homeless Shelters	Homeless Shelters	None	None
None	None	None	Bus Terminals	Bus Terminals
Bus Stops	Bus Stops	Bus Stops	Bus Stops	Bus Stops
Convenience Stores	Convenience Stores	Convenience Stores	Convenience Stores	Convenience Stores
Bars	Bars	Bars	Bars	Bars
Liquor Stores	Liquor Stores	Liquor Stores	Liquor Stores	Liquor Stores
School	School	School	School	School

4.10 Chapter Summary

This chapter presented research findings showing that crime is concentrated in a small number of the City of Edmonton's LRT stations. When analysing calls-for-service over six years from 2017 to 2022, 22% of stations, representing only four stations, accounted for close to 50% of all calls-for-service. When analysing incident reports for the same six-year period, 22% of stations were responsible for 60% of all incidents. The Canadian Crime Severity Index was applied to convert all incident counts into severity scores, finding that 22% of stations accounted for 63% of all severity. Thus, while incident counts were more concentrated than calls-for-service counts, incident counts and incident severity were almost equally concentrated. Criminal code offences were analysed separately, finding counts and severity to be equally concentrated, where 22% of stations were responsible for 53% of counts and severity. These various approaches to identifying crime concentrations provided several power-few rankings where three stations, Churchill, Central, and Coliseum, were consistently in the top three, while Southgate was in fourth place in four of the rankings, and MacEwan was in fourth place in one of the rankings.

Table 4: Power-few Stations Rankings

POWER-FEW STATION RANKINGS					
Rank	**Calls-for-Service Counts**	**Total Incident Counts**	**Total Incident Severity**	**Crime Counts**	**Crime Severity**
1.	Central	Central	Churchill	Churchill	Coliseum
2.	Churchill	Churchill	Central	Central	Churchill
3.	Coliseum	Coliseum	Coliseum	Coliseum	Central
4.	MacEwan	Southgate	Southgate	Southgate	Southgate

Table 4 above compares the five different power-few rankings generated in this study. While slight but significant differences across the rankings, they are only noticeable due to the several approaches to targeting employed. Collectively, these approaches provide a more comprehensive method of informing the targeting of police resources, whether the strategy is reducing demand for police services, reducing actual occurrences, or reducing harm.

This study utilised the k-means clustering technique to identify groupings of stations and offenders with similar degrees of heat stability from 2017 to 2022. The results show that by all crime measurement types, all the station trajectories were increasing, while the low crime and severity level trajectory representing a large proportion of offenders was stable under counts and decreasing under severity. Temporal analyses were conducted, finding that crime concentrated during rush hour periods of 0700-0900 hours, 1500-1800 hours, as well as the non-rush hour period of 1800-2300 hours. It was also found that higher levels of crime were experienced during the weekdays than weekends, and during the colder months of October to March than during the warmer months of April to September.

This study also investigated the distribution of crime and disorder offences by count and by severity, finding that Loitering, Trespassing, and Fare Evasion accounted for 83% of total disorder offences count and 92% of total disorder severity. For Criminal offences, Drugs, Mischief, Obstruction, Assault, and Weapon offences accounted for 87% of criminal offences count whereas Drugs, Robbery and Mischief accounted for 64% of criminal offences' severity. The analysis of the distribution of offender characteristics found that while males accounted for 63% of all offenders, they were responsible for 70% of all incident count and severity. The distribution of offenders by age indicated a general decline in crime participation with the advancement of age, consistent with the normal age-crime curve. To find the relationship between offenders' offence

count and severity, a Pearson Correlation Coefficient was calculated, finding a statistically significant positive relationship between offenders' offence count and offence severity, $r = 0.984$, $p < 0.001$.

Comparisons of crime concentrations by data types was conducted finding that crime was more concentration by incident reports than by calls-for-service. 22% of stations accounted for almost 50% of calls-for-service compared to the same proportion of stations accounting for 60% of incidents reports. These results were further compared with the concentration of crime among offenders, where it was found that 22% of offenders accounted for almost 80% of all incidents, thus, supporting the conclusion that crime was more concentrated among people than in places.

Comparison of physical and environment attributes of the Power-few stations were conducted to find out whether there were similarities or differences. For example, complex designs, attachment to multiple pedways, multiple entrances, shared inbound and outbound platform, provision of public washrooms, and lack of fare gates were some of the shared attributes of Power-few stations. Some of the environmental attributes shared by majority of the Power-few stations include proximity to shopping malls, event centres, parking lots, schools, bars, liquor stores, homeless shelters and among others. These physical and environmental characteristics could have implications for crime opportunities at the stations, and those implications will be discussed in the next chapter.

Chapter 5. Discussion

This chapter will discuss the relevance of the findings in the preceding chapter for research, policy, and theory and then address the study's limitations. The chapter will outline research implications from the findings while highlighting the contributions of the current study to the existing evidence base. Future opportunities presented for research will then be discussed. Next, the policy implications of these findings are examined with recommendations on how policing and public safety in mass transit can be improved. Theoretical implications and opportunities to clarify certain theoretical concepts are then discussed. The chapter will conclude with a discussion of the research limitations.

5.1 Research Implications

5.1.1 The Law of Crime Concentration

While the research on the concentration of crime at places is extensive (Lee et al., 2017), the present study contributes evidence supporting the law of crime concentration (Weisburd, 2015) as the first hot spot study of mass transit in Canada. In Edmonton's mass transit system, it was found that 22% of top-ranked stations accounted for 60% of the total incident count. Previous studies have found greater degrees of crime concentration, such as Weisburd and Amram (2014) finding 4.5% of street segments in Tel Aviv-Jaffa accounted for 50% of crime incidents; de Melo et al. (2015) finding that 3.66% of street segments in Campinas, Brazil accounted for 50% of crime; Boivin and de Melo (2019) finding that 4% of street segments in Toronto and Montreal accounted for 50% of crime; and Ariel (2011) finding that 5% of train stations in England and Wales accounted for 50% of crime. However, the present study's degree of crime concentration is more comparable to the findings by Ng, et al. (2023) in Hong Kong's mass transit system, in which

15.2% of top-ranked stations were responsible for 50% of the crime count. Despite the degree of crime concentration, the present study's findings suggest that the law of crime concentration applies in Edmonton's mass transit system as well. This study highlights the need for more research on the concentration of crime, particularly in the mass transit environment.

5.1.2 Application of a Harm Index

The current study contributes to the literature on crime harm as the first to apply a severity index on mass transit crime in Canada. This study found that 22% of stations were responsible for 63% of total severity compared to 60% of the total count. When analysing criminal code offences only, 22% of stations accounted for 53% of severity, similar to the 53% of the count. The present study found that crime count and severity were about equally concentrated. This finding was inconsistent with existing research that found crime harm more concentrated than crime count (Weinborn et al., 2017; Macbeth & Ariel, 2019). However, Fenimore (2019) and Harinam et al. (2022) found equal concentrations regarding counts and harm. Likely, the type of crimes that emerge in mass transit systems are not as harmful as the crimes that takes place 'on the streets', and therefore, the counts and the severity scores are almost synonymous with each other.

5.1.3 Crime Concentration by Different Data Types

Still, the present study adds to the evidence base by finding that incident count was more concentrated than calls-for-service. In Edmonton, 22% of stations were responsible for 49% of all calls-for-service compared to 60% of total incidents. This was inconsistent with the evidence from a systematic review of hot spot studies (Lee et al., 2017) that found calls-for-service more concentrated than crime incidents at places. There are insufficient studies of crime concentration

in mass transit space to determine whether this finding is simply an outlier or part of an emerging pattern specific to mass transit environments.

5.1.4 Temporal Distribution of Crime

The present study conducted a temporal crime analysis, finding consistent peaks across different crime data types. For calls-for-service, incident reports, and incident severity, the highest crime levels occurred between 0700 and 0900 hours, 1500 and 1800 hours, and 2000 and 2300 hours. The hours of 0700 to 0900 and 1500 to 1800 coincide with peak hours when stations are crowded with commuters travelling to or from places of work, whereas 2000 to 2300 hours coincide with a period of lower ridership and less foot traffic into and out of the stations. This is consistent with prior research findings that suggest a correlation between crowded environments and certain types of crime, such as pickpocketing (Ceccato et al., 2015: Newton et al., 2015). In contrast, other types of crimes were more conducive to environments that foster anonymity, such as empty stations (Ceccato et al., 2022). While these studies have provided robust evidence of the temporal concentration of crime during peak and late-night hours, more research is needed on the temporal concentration of specific crime types.

5.1.5 Offender Analysis at Hot Spots

This study contributes to the existing literature on the concentration of crime at places by integrating an analysis of offenders in an effort to understand not only offender characteristics at hot spots but also whether there is any correlation between offenders' crime count and severity. An analysis of offenders should not be misconstrued as a deviation from the subject matter but rather as an integral feature of place that provides a more comprehensive understanding of hotspots. First, the present study found that 22% of the offenders were responsible for 78% of all incidents,

compared to 22% of stations accounting for 60% of all incidents, thereby concluding that in Edmonton, crime was more concentrated among individuals than in places. This finding was inconsistent with prior studies that found crime more concentrated in places (Sherman et al., 1989) than concentration among individuals (Wolfgang et al., 1972). A statistically significant positive relationship was found regarding the relationship between offence count and severity of offenders, with a Pearson Correlation Coefficient of $r = 0.984$, $p < 0.001$. While existing literature on offender patterns primarily exists as stand-alone studies, such as high harm offenders (Liggins et al., 2019) or domestic abuse offenders (Barnham, 2016; Bland & Ariel, 2015), the findings of the present study highlight the importance of including offender analysis as part and parcel of any study of hot spots. Dimensions of offending patterns, such as frequency, intermittency, escalation, and continuity, would be insightful to any study of crime and place. In the same vein and while not addressed in the present study, analysis of victimisation patterns has shown significant promise, as illustrated by the study in Dorset, UK, which found that only 4% of victims accounted for 85% of all crime harm (Dudfield et al., 2017). Thus, a case is being made for more comprehensive research of hot spots that includes thorough analyses of offending and victimisation patterns at places because treating offending and victimisation as a separate silo would only limit the understanding of crime at places.

5.1.6 Station and Offender Trajectories

A k-means longitudinal clustering technique was utilised to identify trajectories of transit stations by calls-for-service, incidents, and severity. An optimal partition of three groups consisting of low, moderate, and high crime levels was identified for each crime data type. The k-means results showed that all station groups had increasing trajectories by all data types. Prior research found stable trajectories of street segments in Seattle, Washington, over 14 years (Weisburd et al., 2004).

Similarly, Curman et al. (2015) found stable trajectories of street segments in Vancouver, Canada, over 16 years. Using hexagonal tessellations in Toronto, Canada, Harinam et al. (2022) found that most hexagons belonged in stable trajectories by total count and severity over six years. Analysis of crime over a two-year period in Hong Kong's mass transit system revealed stable trajectories by crime count and harm (Ng et al., 2023). In addition to station trajectories, the present study identified offender trajectories by count and severity, finding that most offenders had a stable trajectory by count and a decreasing trajectory by severity.

5.1.7 Physical and Environmental Attributes of Mass Transit Hot Spots

In his assertion that "identifying a hot spot is not the same as understanding it", Rosenbaum (2006, p.248) points out that "rarely do we see a detailed analysis of the characteristics of the hot spot and the nature of the problem." The present study attempts to take up this challenge. It goes further than most prior studies of hot spots by comparing the physical and environmental attributes of the identified power-few stations. Some physical similarities all the power-few stations share include a complex station design, lack of turnstiles or fare gates, multiple entrances, connection to pedways, and public washrooms. Some of the environmental attributes shared by most of the power-few stations include proximity to parking lots, convenience stores, liquor stores, schools, homeless shelters, events centres, and shopping malls. Most of these features were in stark contrast to those of non-power-few stations, suggesting a correlation between those attributes and higher crime levels. These findings are consistent with prior research on risky facilities correlating with crime (Clarke & Eck, 2007). The evaluation of the Washington Metro transit system's physical design and finding that the transit system had lower crime levels than the entire city and other subway systems underscores the importance of physical attributes in explaining crime in places

(La Vigne, 1996). Indeed, more research is required to augment these results, particularly from mass transit systems in other cities.

5.2 Policy Implications

5.2.1 Implement Hot Spots Policing as a Standard Strategy

The present study has found that crime in Edmonton's mass transit system concentrates at very few stations, whether by calls-for-service, incident reports, crime type, or harm and that the concentration of crime remains stable over time. A key policy implication is that hot spot policing should be implemented as a standard strategy. There is robust evidence that police intervention at hot spots reduces crime and generates a diffusion of crime reduction benefits to the surrounding areas, rather than displacing crime (Braga et al., 2019). The different approaches to targeting allow for responsiveness to various objectives, such as reducing demand for police services, reducing frequency of occurrences, and reducing harm.

5.2.2 Track Patrol Dosage

In addition to the findings on the spatial concentration of crime at a few stations, crime was also temporally concentrated. This allows for more precision in targeting and a re-design of patrol patterns to optimise the use of resources. A key policy implication is that GPS technology should be used to track patrol dosage more accurately (Wain & Ariel, 2014). The measurement of the intervention would enable the provision of feedback and adjustments to be made. The evidence-based hot spot patrol strategy should specify less frequent and more prolonged visits of 10 to 15 minutes as the optimum (Koper, 1995; Williams & Coupe, 2017). The frequency of patrols should be unpredictable, as Ariel and Partridge (2017) have shown evidence of a backfiring effect of predictable policing. The tracking of patrol would also allow for the maximisation of cumulative

deterrence by measuring the optimum number of consecutive days of patrol required. Bland et al. (2021) found that consecutive patrol days significantly affected crime prevention more than non-consecutive patrol days. The evidence-based patrol strategy aims to prevent crimes and achieve efficiencies by reducing patrol time that does not affect crime. This can be achieved by maximising residual deterrence. For instance, the London Underground experiment highlighted the benefits of residual deterrence, where it was found that 97% of crimes were prevented when the police were not present (Ariel et al., 2020). Barnes et al. (2020) found that four days was the optimum period of patrol absence to maximise residual deterrence. However, given that other studies have found no evidence of residual deterrence (Bland et al., 2021), replications of these studies are needed to obtain local evidence on the optimum number of days without patrol presence. Most importantly, tracking patrols help to avoid the "oscillation between over-policing and under-policing" and ensures the delivery of what Sherman terms as "just right" policing (Sherman, 2020, p.178).

5.2.3 Establish a Dedicated Crime Suppression Team

Studies have suggested that a successful implementation of proactive policing at hot spots is incumbent upon establishing a dedicated, proactive team that does not have the responsibility to respond to calls-for-service (Basford et al., 2021). This ensures the policing intervention is delivered at the prescribed dosage without risking officers being re-directed elsewhere for incident response. While Edmonton has recently established two dedicated crime suppression teams, their daily deployment to hot spots should be based on statistical rather than clinical methods. Prior research has shown that statistical methods are more accurate than clinical methods (Macbeth & Ariel, 2019; Sutherland and Mueller-Johnson, 2019). The work of the dedicated crime suppression teams could be further enhanced by the support of a crime analyst to provide, among many things, updated hot spot and harm spot information and tracking of hot spot interventions.

5.2.4 Outline Evidence-Based Policing Tactics at Mass Transit Hot Spots

As recommendations for hot spot policing often come without specification of what tactics to deploy, a key policy implication is that there should be an outline of what evidence-based tactics should be deployed at hot spots. The selection of a policing tactic at hot spots should be guided by the type of crime problems at hot spots and the effectiveness of the selected tactic against those crime problems. A comprehensive package of tactics should include foot patrols, offender-focused policing, and problem-oriented policing. Foot patrol is effective in preventing crimes (Ratcliffe et al., 2011; Ariel et al., 2016; Ariel et al., 2017), and such visible presence could also have a reassuring effect in improving the citizens' safety perceptions and, by implication, increasing transit ridership.

The rationale for offender-focused policing is supported by the present and prior research (Wolfgang et al., 1972) that found that crime was highly concentrated among very few offenders. Furthermore, offender-focused policing, which integrates crime information with criminal intelligence to proactively target hot spots and prolific offenders (Ratcliffe, 2016), effectively reduces violent crime (Groff et al., 2015). Groff et al. (2015) also argue that because offender-focused policing is targeted at offenders, it is deemed less intrusive for law-abiding citizens and may be favourably viewed as being procedurally just.

Problem-oriented policing is a proactive approach that targets underlying problems that give rise to crime and disorder (Goldstein, 1979). Using the scanning, analysis, response, and assessment (SARA) method, problem-oriented policing requires one to "identify problems, carefully analyse the conditions contributing to the problem, develop a tailored response to these underlying factors, and evaluate outcome effectiveness" (Hinkle et al., 2020, p.1). Systematic review evidence of problem-oriented policing found that it effectively reduced crime and disorder (Hinkle et al.,

2020). A vital advantage of the flexibility offered by all these tactics is the way they could be used with surgical precision to address complex crime problems such as drugs, which is the top offence by count and by harm in Edmonton's mass transit system. For example, high-visibility foot patrols could be used to prevent drug activity inside transit stations. Offender-focused interventions could be used to target drug dealers and, in particular, repeat, or prolific offenders who often have gang affiliations. Problem-oriented policing could be used to target drug users by addressing the underlying factors that resulted in their drug use. While prior research evidence has shown all these tactics to be effective, they must be subjected to further testing to obtain local evidence.

5.2.5 Enhance the Authorities of Peace Officers or Deploy a Dedicated Police Unit

The discussion about policing tactics at hot spots is premature without considering whether those tasked with policing the transit system have the ability, such as legal authorities, training, and resources, to implement the prescribed evidence-based interventions. Canada is a global outlier in its reliance on police paraprofessionals, known as peace officers or special constables, in its policing of urban mass transit systems. Except for Metro Vancouver, all other major Canadian cities, including Calgary, Edmonton, Toronto, Ottawa, and Montreal, rely on peace officers or special constables as the primary law enforcement entity for their mass transit systems. Peace officers have fewer authorities than police officers. In the case of Edmonton, they are only limited to enforcing municipal bylaws and provincial offences, which mostly fall within the disorder category. In addition, peace officers in Edmonton neither have direct access to essential police databases such as the Canadian Police Information Centre (CPIC) nor the authority to execute outstanding warrants and enforce breaches of conditions. The lack of police powers limits the ability of peace officers to implement tactics such as offender-focused policing. Policy options include enhancing the legal authority of peace officers, specifically criminal code authority, to

allow them to investigate criminal offences and execute arrest warrants within the mass transit system. This model is currently in place in other Canadian jurisdictions, such as Toronto and Ottawa. An alternative policy option is to have the police of jurisdiction, the Edmonton Police Service, establish a dedicated transit unit with a permanent presence on the transit system, complementing the peace officers. This model has been adopted in Montreal's mass transit system, where a transit unit of the Montreal Police complements the Montreal transit special constables.

5.2.6 Application of the Crime Severity Index

While this study found that crime count and severity are equally concentrated, the value of severity analysis is that it offers a different method of prioritisation and performance measurement of crime prevention initiatives rather than relying only on crime volumes – hence, the Crime Severity Index should be adopted. A key policy recommendation is to ensure the criminal offence categories and sub-categories within the Record Management Software (RMS) are standardised with the criminal code sections for accurate conversion into severity scores. For example, Assault has three sub-categories in the criminal code: level 1 (simple assault), level 2 (with a weapon or causing bodily harm), and level 3 (aggravated), which have severity scores of 26, 87, and 501, respectively. Thus, if an offence category, such as 'Assault Peace Officer,' does not have options to record either of the three sub-categories, then there could be a significant loss in accuracy given the wide variance of the severity scores.

5.2.7 Capitalise on Situational Crime Prevention

The present study has attempted to describe the physical and environmental attributes of the power-few stations while pointing to similarities that suggest a correlation between the attributes and increased crime levels. Clarke (1983) defines situational crime prevention as measures aimed at

reducing the opportunity of crime through controlling or designing a setting to make crime less rewarding, riskier, or demanding more effort. Prior studies of situational crime prevention measures against specific crime problems, such as post-office robberies (Ekblom, 1987), theft of and from cars (Poyner, 1992), and fare evasion (Clarke, 1993), were shown to be effective. As an example, the City of Edmonton should consider installing fare gates at stations, which would curtail fare evasion and other disorder such as loitering and drug activity. Another recommendation is to establish a policy on station design standards to guide future construction and renovation of transit stations. Such a policy would ensure best practices, such as integrating Crime Prevention Through Environmental Design (CPTED) principles (Jeffery, 1971) at the time of construction. Given the correlation between risky facilities and crime (Clarke & Eck, 2007), this should inform the placement of future transit stations and how to improve the security posture of stations already near other risky facilities.

5.3 Theoretical Implications

The present study's analysis of temporal distributions of crime located three peaks between 0700 and 0900 hours, 1500 to 1800 hours, and 2000 to 2300 hours. Two of these peaks occurred during hours when heavy foot traffic entered and exited transit stations and when people travelled to or from work. These findings were consistent with prior research (Irvin-Erickson & La Vigne, 2015) and have implications for the routine activity theory. In advancing the routine activity theory, Cohen and Felson (1979, p.588) state that for crime to occur, there must be a "convergence in space and time of likely offenders, suitable targets, and the absence of capable guardians." A capable guardian is any person who "serves by simple presence to prevent crime, and by absence to make crime more likely" (Felson, 1995, p.53). Newton et al. (2004, p.303-304) further specify

that “capable guardians are not restricted to police officers or security guards but include anyone whose presence or proximity discourages a crime from happening…”

While the highest crime peak occurred between 2000 to 2300 hours when the stations had fewer people, the other two crime peaks occurred during the peak hours of service, when the stations were crowded. Additionally, during these peak times, there is usually a static presence of highly visible and uniformed security guards, at least in the power-few stations. This calls into question the theory’s claim that anyone can be a capable guardian. Given the finding by Nagin (2013) that certainty of apprehension was the most effective deterrent, it is argued that it is not the mere presence of ‘capable guardians’ that prevents crime but rather what formal or informal signals their presence communicates to likely offenders about certainty of apprehension. It is further argued that such a quality is only associated with those with police powers of arrest. This assertion is supported by research evidence from interviews with 589 arrestees in New York City that pointed to police presence as the most critical factor behind behavioural changes (Golub et al., 2003). Wright and Decker (1994) also found that police presence was a key consideration when deciding to commit robbery, as offenders avoided neighbourhoods with increased police presence. However, studies in the UK have shown crime reduction effects of patrols at hot spots by Police Community Support Officers (PCSOs) who are unarmed and have few police powers (Ariel et al., 2016), as well as by security guards (Ariel et al., 2017), who have no power of arrest. More research is required to clarify the concept of capable guardianship within the routine activity theory.

5.4 Research Limitations

This study was conducted in one city hence, its results can not be generalised to other jurisdictions. More replications would be required in mass transit systems of other jurisdictions to determine the

extent of similarities in findings. This study relies on reported crime data which does not necessarily reflect the entirety of all the crime, given the wide variation in factors such as reporting behaviour, crime recording practices, and changes to crime definition (Ariel and Bland, 2019). Other sources of data such as ambulance data or crime victimisation surveys could be used to complement reported crime data. This was a descriptive study and as such, the policy implications on hot spots policing are speculative hence require conducting randomised controlled trials to test their effect.

While using transit stations as units of analysis allowed for simplicity in comparisons, the variable size of stations was a limitation. This is also a common limitation for studies using street segments, given their variable lengths. Another limitation was the lack of ridership data per station, which impeded crime standardisation by count and harm. The lack of more granular data also limited this study to facilitate a more precise targeting of hot locations within the hot spot stations. The crime data was also limited to the property line of the transit stations; hence, no comparisons could be made between crime in the transit station and the surrounding areas. While excluding crimes on board the trains could be viewed as a limitation, and this study focused on analysing crime at the stations. Furthermore, non-static crimes occurring on trains could occur between stations and, hence, could not be attributed to any station.

5.5 Chapter Summary

This chapter examined the implications of the findings for research, policy, and theory and concluded with a discussion of the limitations. This research found that crime was highly concentrated at a few stations, whether by calls-for-service, incidents, criminal code offences, or severity. While existing literature on the concentration of crime at places is dominated by studies using street segments as the units of analysis, this study contributes to the evidence base by using

transit stations and targeting multiple data types. This chapter outlined policy recommendations, including the adoption of hot spot policing, tracking of patrols, establishing a crime suppression team, outlining what evidence-based policing tactics to use at hot spots, applying harm as a targeting tool, and utilising situational crime prevention techniques. Theoretical implications for the routine activity theory were discussed, highlighting the need to clarify the concept of capable guardianship further within the routine activity theory. Limitations of the study discussed include the variable sizes of stations, lack of ridership data per station, lack of station sub-location data to identify hot locations within stations, lack of crime data of the area surrounding the station to enable comparison to be made, and the exclusion of crimes on board the trains. Despite these limitations, this study achieved what it set out to do in identifying the Power-few stations, using various data types to inform targeting decisions.

Chapter 6. Conclusions

Recognising transit stations as criminogenic hot spots (Irvin-Erickson & La Vigne, 2015), this research aligns with the alarming rise in violent crimes across Canada's mass transit systems (Canadian Urban Transit Association, 2023). The study contributes to the field by identifying key stations for targeted crime prevention, supporting the effectiveness of focused police interventions in such locations (Braga et al., 2019).

The literature review traced an evolution of the criminology of place, shifting focus from individual-based studies to spatial crime concentration. Findings substantiate this shift that a small proportion of places account for a significant share of crime, challenging traditional criminal justice approaches focused on individual rehabilitation (Sherman et al., 1989; Weisburd, 2015; Wolfgang et al., 1972). Hot spots were defined in various forms, and the stability of these hot spots over time was established in the literature (Andresen & Malleson, 2011; Weisburd et al., 2004; Curman et al., 2015). The study shows similar trends.

The study further complicates the available body of research by applying the Canadian Crime Severity Index to evaluate crime severity (Wallace et al., 2009). Our findings reveal a significant concentration of crime at certain stations and times, with a strong correlation between offence count and severity, suggesting that crime count and severity are equally concentrated (Pearson Correlation Coefficient of $r = 0.984$, $p < 0.001$). Thus, while previous studies suggested that harm is more heavily concentrated than crime counts, this is not the case in the mass transit system, suggesting that severity is driven by volume, not harm.

The study's findings suggest the applicability of the law of crime concentration to Edmonton's transit system, advocating for hot spots policing and situational crime prevention as part of the

policy implications. Temporal analysis contradicts some aspects of the routine activity theory, particularly regarding peak crime times and station crowding, indicating the need for a nuanced understanding of capable guardianship in these contexts (Nagin, 2013).

Including offender analysis in this study offers a more holistic view of the crime problem at Edmonton's LRT stations. It highlights the need for tailored strategies that address the locations of high crime concentration and the specific individuals driving these crime rates. This facet of the study complements the spatial analysis of crime concentration by delving into the characteristics and patterns of the offenders themselves. We show that the concentration of crime at specific transit stations is not only a matter of location but also closely linked to the behaviour and activities of a relatively small group of offenders. This revelation is significant as it underscores the role of specific individuals in driving crime rates in these hot spots. The study utilises offender trajectory analysis, employing k-means clustering techniques to categorise offenders based on the frequency and severity of their crimes.

The results indicate distinct offender trajectories, with a notable segment representing a high crime count and severity trajectory. Although small, this group contributes disproportionately to the overall crime statistics at the LRT stations. The trajectory analysis also reveals that while most offenders might display stable or decreasing crime count and severity patterns, this high-risk group shows an increasing trend. In terms of temporal patterns, the analysis shows that the activities of these offenders align with the peak crime times identified in the spatial analysis. This correlation between offender patterns and temporal crime peaks provides valuable insights into the timing and deployment of preventive measures.

From a policy perspective, this research establishes the high concentration of crime at specific Edmonton LRT stations, emphasising the need for targeted resource allocation. However,

addressing crime and disorder challenges in Edmonton and other transit systems requires a comprehensive approach, integrating offender and victim analysis into hot spot strategies. This integrated approach will provide a more complete understanding of the crime problem and enhance the effectiveness of evidence-based policing tactics.

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Appendix A: Crimes at Stations by Offender Types

Stations	% Crimes by Power-few	% Crimes by Non-Power-few	% Crimes by Unknown Offender	% Harm by Power-few	% Harm by Non-Power-few	% Harm Unknown Offender
Bay LRT Station	67.0%	11.3%	21.7%	65.1%	12.9%	22.0%
Belvedere LRT Station	51.6%	25.9%	22.5%	55.2%	26.1%	18.7%
Central LRT Station	74.2%	13.7%	12.2%	68.6%	16.4%	15.0%
Century Park	49.5%	16.9%	33.7%	56.1%	16.4%	27.5%
Churchill LRT Station	63.9%	25.0%	11.1%	63.5%	26.8%	9.7%
Clareview LRT Station	57.8%	13.1%	29.0%	58.1%	13.3%	28.7%
Coliseum LRT Station	57.1%	27.7%	15.2%	57.3%	28.1%	14.6%
Corona LRT Station	56.4%	21.2%	22.4%	57.5%	25.0%	17.5%
Government Centre LRT Station	66.7%	7.8%	25.5%	69.3%	8.4%	22.3%
Health Sciences Station	55.7%	14.1%	30.3%	60.5%	13.2%	26.3%
Kingsway/Royal Alex LRT Station	56.4%	15.3%	28.3%	60.2%	11.4%	28.4%
MacEwan LRT Station	73.6%	8.6%	17.8%	65.6%	7.2%	27.2%
McKernan/Belgravia LRT Station	33.1%	23.0%	43.9%	53.8%	20.5%	25.7%
NAIT LRT Station	56.3%	7.1%	36.6%	68.9%	6.9%	24.1%
South Campus LRT Station	43.4%	33.2%	23.4%	57.7%	21.0%	21.2%
Southgate	55.7%	23.3%	21.0%	54.9%	24.1%	21.0%
Stadium LRT Station	34.6%	35.1%	30.3%	39.5%	33.0%	27.5%
University LRT Station	48.4%	19.8%	31.8%	45.3%	20.1%	34.6%

Appendix B: Canadian Crime Severity Index

CCSI Crime Category	Weight
Murder 1st degree	8273.62
Murder 2nd degree	8273.62
Manslaughter	1916.381
Infanticide	365.625
Criminal negligence causing death	863.6557
Other related violations causing death	656.058
Attempted murder	1961.0375
Conspire to commit murder	2938.7332
Sexual offence which occurred prior to January 4, 1983	361.166
Sexual assault, level 3, aggravated	766.9179
Sexual assault, level 2, weapon or bodily harm	636.7538
Sexual assault, level 1	271.9879
Other sexual violations	704.112
Sexual Interference	369.1297
Invitation to Sexual Touching	439.0413
Sexual Exploitation	629.3987
Sexual Exploitation of a Person with a Disability	478.3806
Incest	1023.4727
Corrupting morals of a child	536.312
Making sexually explicit material available to children	567.6862
Parent or guardian procuring sexual activity	1733.75
Householder permitting sexual activity	188.2222
Luring a Child via a Computer	586.7146
Agreement or Arrangement - sexual offence against child	381.1024
Anal Intercourse	787.8861
Bestiality - Commit or compel person	77.3598
Bestiality in presence of, or incites, a child	461.9329
Voyeurism	100.636
Nonconsensual distribution of intimate images	37.2828
Assault - level 3 - aggravated	501.0619
Assault - level 2 - weapon/bodily harm	87.3625
Assault - level 1	26.1656
Unlawfully causing bodily harm	100.8744
Discharge firearm with intent	953.923
Using firearm in commission of offence	346.1898
Pointing a Firearm	247.3737
Assault peace officer - level 1	39.4785

Assault Against Peace Officer with a weapon or causing bodily harm - level 2	135.0675
Aggravated Assault Against Peace Officer - level 3	501.0619
Criminal negligence causing bodily harm	330.4318
Trap Likely to or Causing Bodily Harm	143.3333
Other assaults	79.2132
Forcible confinement or kidnapping	835.7475
Kidnapping	835.7475
Forcible confinement	273.8152
Hostage-taking	903.8376
Trafficking in persons	864.921
Abduction under 14, not parent/guardian	337.44
Abduction under 16	354.3732
Removal of children from Canada	354.3732
Abduction under 14 contravening a custody order	64.8977
Abduction under 14, by parent/guardian	39.3678
Robbery	465.947
Robbery to steal a firearm	465.947
Extortion	190.0411
Intimidation of a justice system participant or a journalist	161.6299
Intimidation of a non-justice participant	161.6299
Criminal harassment	53.1132
Indecent/Harassing Communications	23.8072
Uttering threats	41.2405
Explosives causing death/bodily harm	350.9037
Arson - disregard for human life	396.4654
Other violent violations	146.9478
Failure to comply with mandatory safeguards in relation to medical assistance in dying	41.5722
Forging or destroying documents related to assistance requests with criminal intent	41.5722
Causing or Providing Conversion Therapy	41.5722
Material Benefit from Conversion Therapy	23.8072
Intimidation of a person to impede them from obtaining health services	161.6299
Intimidation of a health professional to impede their duties	161.6299
Intimidation of a person assisting in the performance of the health services to impede in those functions	161.6299
Obstruction or interference with access to heath services	161.6299
Failure to Provide Necessaries	79.2869
Impeding Attempt to Save Life	326.396
Obtaining sexual services for consideration	32.2803
Obtaining sexual services for consideration from person under 18 yrs.	193.8482
Material benefit from sexual services	337.3125
Material benefit from sexual services provided by person under 18 yrs.	550.2482
Procuring	490.5534
Procuring - person under 18 yrs.	733.2363

Advertising sexual services	191.2196
Arson	173.5699
Breaking and entering	205.3029
Breaking and entering to steal firearm	360.2483
Break and enter to steal a firearm from a motor vehicle	360.2483
Theft over $5,000	134.1332
Theft of motor vehicle over $5,000	77.7238
Theft over $5,000 from a motor vehicle	134.1332
Shoplifting over $5,000	134.1332
Motor Vehicle Theft	77.7238
Theft $5,000 or under	29.3403
Theft of motor vehicle $5,000 or under	77.7238
Theft $5,000 or under from a motor vehicle	29.3403
Shoplifting $5,000 or under	29.3403
Possess stolen property	118.0366
Traffic stolen goods over $5000 (incl intent)	106.6514
Possession of Stolen Goods over $5 000	118.0366
Traffic stolen goods under $5000 (incl intent)	82.0836
Possession of Stolen Goods $5 000 or under	63.0934
Fraud	88.5554
Identity Theft	81.5979
Identity Fraud	68.3273
Mischief	26.999
Mischief in relation to cultural property	97.169
Hate-motivated mischief relating to property used by identifiable group	97.169
Mischief relating to war memorials	97.169
Altering/Removing/Destroying Vehicle Identification Number (VIN)	112.2106
Bawdy house	23.8072
Living off the avails of prostitution of a person under 18	469.5185
Procuring	535.589
Obtains or communicates with a person under 18 for purpose of sex	510.822
Other prostitution	23.8072
Public Communication to Sell Sexual Services	46.6071
Offences Related to Impeding Traffic to Buy or Sell Sexual Services	46.6071
Betting house	22.0466
Gaming house	22.0466
Other violations related to gaming and betting	22.0466
Common Bawdy House (to keep, to transport a person to)	54.697
Offensive weapons: explosives	203.7381
Offensive weapons: prohibited	81.717
Offensive weapons: restricted	81.717
Firearm transfers or serial numbers	81.717
Other offensive weapons	81.717

Weapons trafficking	664.2714
Weapons possession contrary to order	168.2389
Possession of weapons	126.3506
Unauthorized importing or exporting of weapons	434.0109
Firearms documentation or administration	254.987
Unsafe storage of firearms	73.6208
Fail to comply with order	23.562
Counterfeiting	68.2359
Disturb the peace	11.9285
Escape or helps to escape from lawful custody	55.1281
Indecent acts	41.4465
Child Pornography (Possessing or Accessing)	326.2419
Making, or distribution of child pornography	519.4267
Corrupting morals	142.9077
Obstruct public/peace officer	28.0887
Prisoner unlawfully at large	24.5394
Trespass at night	27.2018
Fail to appear	12.6328
Breach of probation	32.6829
Utter threats to Property/Animal	38.1664
Advocating genocide	118.9781
Public incitement of hatred	48.72
Promoting or Advertising Conversion Therapy	14.3962
Unauthorized recording of a movie	52.2746
Offences against public order (Part II CC)	48.0022
Property or service for terrorist activity	1124.75
Freezing of property, disclosure, audit	1124.75
Participate in activity of terrorist group	1124.75
Facilitate terrorist activity	1124.75
Commission or instructing to carry out terrorist activity	1124.75
Harbour or conceal terrorist	1124.75
Hoax terrorism	118.9781
Advocating/Promoting Terrorism Offence	118.9781
Firearms and other offensive weapons (Part III CC)	73.6208
Leaving Canada to participate in activity of terrorist group	1124.75
Leaving Canada to facilitate terrorist activity	1124.75
Leaving Canada to commit offence for terrorist group	1124.75
Leaving Canada to commit offence that is terrorist activity	1124.75
Concealing person who carried out terrorist activity that is a terrorism offence for which that person is liable to imprisonment for life	1124.75
Concealing person who carried out terrorist activity that is a terrorism offence for which that person is liable to any punishment other than life	1124.75
Concealing person who is likely to carry out terrorist activity	1124.75

Other offences against the administration of law and justice (Part IV CC)	51.8809
Sexual offences, public morals and disorderly conduct (Part V CC)	131.8569
Invasion of privacy (Part VI CC)	72.4167
Disorderly houses, gaming and betting	23.8072
Offences against the person and reputation (Part VIII CC)	154.4479
Failure to comply with the regulations/obligations for medical assistance in dying	154.4479
Other Offences Against the Person and Reputation	45.3261
Offences against rights of property (Part IX CC)	179.7422
Fraudulent transactions relating to contracts and trade (Part X CC)	130.4762
Wilful and forbidden acts in respect of certain property (Part XI CC)	30.206
Wilful and Forbidden Acts in Respect of Certain Material Property	16.5108
Injuring or endangering Animals	44.1207
Killing or injuring Law Enforcement or Military Animals	78.8005
Causing unnecessary suffering to Animals	35.1211
Causing damage or injury due to a failure to exercise reasonable care - animals or birds	17.7013
Arena for animal fighting	36.3213
Offences relating to currency (Part XII CC)	202.7562
Proceeds of crime (Part XII.2 CC)	284.3968
Attempts, conspiracies, accessories (Part XIII CC)	266.5061
Instruct offence for criminal organization	1124.75
Commit offence for criminal organization	519.8645
Participate in activities of criminal organization	407.4909
Recruitment of members by a criminal organization	407.4909
All other Criminal Code (includes Part XII.1 CC)	104.6207
Heroin - possession	36.636
Possession - cocaine	27.9696
Other Controlled Drugs and Substances Act - possession	50.8251
Possession - cannabis (pre-legalization)	29.825
Possession- Methamphetamines (Crystal meth)	33.0629
Possession- Methylenedioxyamphetamine (Ecstasy)	35.3921
Possession - Opioid (other than heroin)	19.9123
Heroin - trafficking	427.5347
Cocaine - trafficking	288.568
Other Controlled Drugs and Substances Act - trafficking	228.8703
Cannabis - trafficking (pre-legalization)	94.1693
Methamphetamines (Crystal meth) - trafficking	303.9908
Methylenedioxyamphetamine (Ecstasy) - trafficking	207.6532
Trafficking - Opioid (other than heroin)	533.9148
Heroin - importation and exportation	1190.6
Cocaine - importation and exportation	1226.0248
Other Controlled Drugs and Substances Act - importation and exportation	150.1364
Cannabis - importation and exportation (pre-legalization)	150.4855

Methamphetamines (Crystal meth) - importation and exportation	192.4667
Methylenedioxyamphetamine (Ecstasy) - importation and exportation	1327.8
Importation and Exportation - Opioid (other than heroin)	1122.23
Heroin - production	157.9369
Cocaine - production	175.0514
Other Controlled Drugs and Substances Act - production	195.2485
Cannabis - production (pre-legalization)	150.6176
Methamphetamines (Crystal meth) - production	510.2915
Methylenedioxyamphetamine (Ecstasy) - production	693.5
Production - Opioid (other than heroin)	131.1585
Possession, sale, etc., for use in production of or trafficking in substance	142.9333
Possession of illicit or over 30g dried cannabis (or equivalent) by adult	22.2152
Possession of over 5g dried cannabis (or equivalent) by youth	3.3333
Possession of budding or flowering plants, or more than four cannabis plants	7.3846
Possession of cannabis by organization	46.2305
Distribution to an organization, illicit or over 30g dried cannabis (or equivalent) by adult	141.7683
Distribution of cannabis to youth by adult	131.237
Distribution to an organization or over 5g dried cannabis (or equivalent) by youth	131.237
Distribution of budding or flowering plants, or more than four cannabis plants	131.237
Distribution of cannabis by organization	131.237
Possession of cannabis for purpose of distributing	74.7344
Sale of cannabis to adult	139.65
Sale of cannabis to youth	166.8445
Sale of cannabis to an organization	166.8445
Possession of cannabis for purpose of selling	106.1915
Importation and exportation of cannabis	150.4855
Possession of cannabis for purpose of exportation	150.4855
Obtain, offer to obtain, alter or offer to alter cannabis	143.4
Cultivate, propagate or harvest cannabis by adult	173.2245
Cultivate, propagate or harvest cannabis by youth or organization	132.4362
Possess, produce, sell, distribute or import anything for use in production or distribution of illicit cannabis	46.2305
Use of young person in the commission of a cannabis offence	288
Other Cannabis Act	44.5172
Bankruptcy Act	5.4062
Income Tax Act	5.4062
Canada Shipping Act	3.9608
Canada Health Act	28.6705
Customs Act	21.0627
Competition Act	220.7292
Excise Act	110.0104
Youth Criminal Justice Act	21.9313
Immigration and Refugee Protection Act	81.46

Human Trafficking	864.921
Human Smuggling fewer than 10 persons	92.2642
Human Smuggling 10 persons or more	224.337
Firearms Act	3.9608
National Defence Act	81.46
Emergencies Act	71.0393
Quarantine Act	25.3917
Other federal statutes	28.6705
Dangerous operation - causing death	740.4733
Dangerous operation - causing bodily harm	244.739
Dangerous operation of motor vehicle, vessel or aircraft	73.8985
Dangerous operation evading police - causing death	1045.8164
Dangerous operation evading police - causing bodily harm	629.22
Dangerous operation of motor vehicle evading police	116.3478
Operation - low blood drug concentration	10
Impaired operation - causing death	1045.8164
Operation while impaired causing death (alcohol and drugs)	1045.8164
Impaired operation (drugs) - causing death	1045.8164
Operation while impaired causing death (unspecified)	1045.8164
Impaired operation - causing bodily harm	230.3902
Operation while impaired causing bodily harm (alcohol and drugs)	230.3902
Impaired operation (drugs) - causing bodily harm	230.3902
Operation while impaired causing bodily harm (unspecified)	211.0408
Impaired operation of motor vehicle, vessel or aircraft	11.6805
Operation while impaired (alcohol and drugs)	12.5
Imp operation (drugs) vehicle, vessel, aircraft	25.7
Operation while impaired (unspecified)	11.1752
Impaired operation - failure to provide breath sample	18.5959
Failure to comply or refusal (drugs)	18.5959
Impaired operation - failure to provide blood sample	18.5959
Failure to provide blood sample (drugs)	18.5959
Failure or refusal to comply with demand (alcohol)	15.7594
Failure or refusal to comply with demand (alcohol and drugs)	15.7594
Failure or refusal to comply with demand (drugs)	15.7594
Failure or refusal to comply with demand (unspecified)	15.7594
Failure or refusal to comply with demand, accident resulting in bodily harm (alcohol)	229.2788
Failure or refusal to comply with demand, accident resulting in bodily harm (alcohol and drugs)	229.2788
Failure or refusal to comply with demand, accident resulting in bodily harm (drugs)	229.2788

Failure or refusal to comply with demand, accident resulting in bodily harm (unspecified)	229.2788
Failure or refusal to comply with demand, accident resulting in death (alcohol)	1045.8164
Failure or refusal to comply with demand, accident resulting in death (alcohol and drugs)	1045.8164
Failure or refusal to comply with demand, accident resulting in death (drugs)	1045.8164
Failure or refusal to comply with demand, accident resulting in death (unspecified)	1045.8164
Failure to stop or remain (unspecified- exp 2011)	67.6997
Fail to stop causing death	733.3333
Fail to stop causing bodily harm	153.4139
Fail to stop or remain	60.2011
Driving while prohibited	59.0141
Other Criminal Code traffic violations	108
Causing death by criminal negligence while street racing	1045.8164
Causing bodily harm by criminal negligence while street racing	80
Dangerous operation causing death while street racing	1045.8164
Dangerous operation causing bodily harm while street racing	316.8889
Dangerous operation of motor vehicle while street racing	108.0556