Crime concentration in Oslo

An explorative analysis of the spatial distribution of burglary and vehicle theft

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Abstract

Title: Crime Concentration in Oslo – an explorative analysis of the spatial distribution of burglary and vehicle theft.
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The last decades we have seen a large preventive move in western policing with a use of place-based policing. In Norway too, greater pressure has been put on the police force to prevent and reduce crime at places – but to execute this work successfully, any actor would require knowledge about if, where and why crime cluster at certain locations.

This thesis analyses the spatial concentration and distribution of commercial- and residential burglaries and motor vehicle theft in Oslo, Norway using quantitative methods, including GIS-technology. Drawing on central theoretical perspectives and previous empirical work in the field of environmental criminology it aims at investigating to what degree these crimes are spatially concentrated at a relatively small number of places in the city of Oslo, what characterize these hot spots, and what environmental characteristics highlighted in previous research seem to generate the crimes.

The analysis shows crime is an opportunistic by-product of routine activities in people’s lives, and that risk and effort are important factors in offenders’ contextual calculation about whether commit crime. This gives a strong implication of crime prevention through securitization by altering or controlling physical environments, or peoples’ perceptions of these. Environmental criminology thus brings great potential for this “new” police task of crime prevention. Yet, although spatial concentration is found for all crimes a main finding is some are not concentrated as tightly as expected from central assumptions in this field, such as the application of the 80/20 rule to crimes ecological concentration and the following “law of crime concentration at places”. Therefore, these should not be taken at face value in future research or policy discussions and we need more contextual information of crimes spatial distribution in Norway to most efficiently reduce or prevent crime at hot spots.
Preface

As a criminology student and research assistant in a small country as Norway, I early noticed how some research fields and methodological approximations was completely or partly missing from the available courses or was largely dependent of a single or a few researchers across Scandinavia. After a theoretical under degree focused on white collar crime, which is one of these scarce fields, I decided I wanted to break with the strong tradition of qualitative research in Scandinavian criminology and use my master’s degree as an opportunity to learn quantitative methods barely used here, yet highly important as we move further into the digital age and western police services are pushed toward intelligence led policing.

In an initial meeting with Torbjørn Skardhamar¹, who has a long experience of statistical work and crime mapping, I was introduced to the idea of a thesis in environmental criminology with the use of GIS technology. Soon I learned a great risk in quantitative work is how time consuming the process of acquire data specific enough for the desirable analysis might be. My work had to be put on hold because of a 17-month long wait for the approval of the crime data by different institutions, but I am glad I decided to wait and that I still managed to finish my work with only a 12-month postponing in total.

Special thanks goes to Torbjørn, who not only gave me the idea for this work but also showed patience and was an important linkage between me and the different institutions needed to be contacted several times for the acquiring of crime data, as well as functioning as my supervisor who helped me overcome many significant barriers methodologically during my learning process. I am also very grateful for the support from my other supervisor Helene O. I. Gundhus², who also engaged enthusiastically throughout the process and came with many fruitful suggestions for literature and important feedback on my writing.

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1 Introduction

Crime is a complex event, and in addition to understand the problematic behavior itself it is important to understand the mechanisms and opportunities that allow or encourage the problematic activity if one wants to hinder or reduce it. Traditionally, what has been the primarily focus in criminology and responses to crime is the criminal, even if the study of the spatial aspects of crime is far from new (Andresen, 2014). Crime prevention practitioners long focused almost exclusively on the developing of policies that would rehabilitate, change or deter offenders. But crime prediction and empirical evaluation of correctional policy- and preventive programs directed towards offenders have had mixed results (Weisburd et al., 2012) and longitudinal offender-research on crime concentration at an individual level have exposed strong evidence of people “aging out of crime” displaying less stability in offending over the life course than previously assumed over peoples’ life course (Sampson and Laub, 2003). Reactive models of policing have started to lose creditability (Weisburd and Eck, 2004, Reiner, 2010). During the same time that police forces worldwide have met severe constraint on spending next to an increasing pressure of efficiency and a huge amount of new duties has followed both from new technology and a greater focus on crime prevention (Mohler et al., 2015, Ferguson, 2017, Tilley and Laycock, 2018). Greater concerns and efforts are now put into equip the police with the information and tools needed for them to accomplish both new and old tasks, and newer criminological research have switched focus from the offender to how crime opportunities are specifically dependent of environmental circumstances since these regulates targets available, activities people can engage in and who controls the location. Some of todays’ criminologist argue that the strongest physical characteristic of crime is that the sites where crimes occur are concentrated (Brantingham, 2010) and only a few narrowly defined “hot spots” in cities amount for the vast majority of the criminal activity (Santos, 2016).

Hot spots of crime at places is something that indicate a large potential for crime reduction and prevention using a focused geographical approach and gathering contextual environmental knowledge for crime preventive purposes has lately caught on in law enforcement, research, government officials, politics and the media (Wang, 2012, Perry et al., 2013, Ferguson, 2017). Today, situational crime prevention is argued to be one of the most promising forms of crime control (Clarke, 2010) and this line of work is consistently growing. In Scandinavia too, a dominating trend have lately been on professionalization and research
that consider “what works” with a clear connection to evidence-based policing (Granér, 2014) and Norway specifically met the new challenges and the increased pressure on the police force with a huge reform (Høigård, 2005, Sørli and Larsson, 2018). Officials push for evidence-based crime preventive measures and a better use of technology for this purpose (NOU, 2013:9) and the Norwegian Board of Technology (2015) explicit recommends the Norwegian police to follow other countries use of predictive data-analyses in their daily operational work to calculate risk associated with specific areas and introduce place-based work. But, the fruitfulness of these techniques depends on the possibility of predicting where a criminal act is likely to occur, thus on the ecological concentration of crime. The (social) ecology of crime is the study of the social and behavioral consequences of interactions between human beings and their environment, and the term of ecological concentration here points to the underlying assumptions of these preventive techniques that criminal activity is concentrated at certain areas. At the core of the process is tactical crime analysis that explore where and why this criminal behavior is concentrated (Clarke and Eck, 2005, Santos, 2016). This thesis explores property crimes spatial distribution and concentration and specific environmental crime generating factors to provide a descriptive compilation and evaluate the fruitfulness of this approach in a new context.

**Research question**

The aim of this thesis is twofold. It is first and foremost an explorative analysis that aims to map and evaluate the ecological distribution and concentration of burglaries and motor vehicle theft in a new context. It also investigates what environmental characteristics seem to correlate with high criminal victimization to understand what might generate a higher volume of these crimes at places. More specifically, the research question is;

*To what degree are burglaries and motor vehicle theft spatially concentrated at a relatively small number of places in the city of Oslo? What characterize these hot spots and what environmental characteristics seem to generate the crimes?*
1.1 Theoretical perspective

Different explanations or theories about crime and the criminal resolves in different measurement for fighting crime or prevent it, and fundamentally, whether responsibility is put on the individual or the environment will have consequences in a wider sense (Lomell and Skilbrei, 2017). For a long time, researchers have seen spatial differences in criminal activity and understood that there is no coincidence where and when crime occurs. Nevertheless, it is only during recent years criminology and crime prevention moved further away from the main focus on the offender, and the field of what is today known as “environmental criminology” became a staple theoretical framework in criminological theory (Andresen, 2014).

One important difference between the newer compared to previous criminological and spatial studies is how researchers now began including geographical concepts in social sciences and focus on how the physical space shape practices and behavior pattern (Harvey, 2010), also criminal activity (Andresen, 2014). The framework of environmental criminology includes a set of theories which most importantly claims crime occurs only when the opportunity exists for that crime, and seek to understand how these opportunities are created and subsequently cluster together in space (Santos, 2016). When developed, the field was viewed as a radical reconceptualization of the crime problem that reoriented criminology away from the individual towards the environment surrounding him. But to clarify: highlighting the environmental side of criminal events is not to refuse seeing it as a problem at the individual level too. Criminals, of course, play a role in environmental criminology, but here as one of the components of the crime problem rather than the point of departure (Weisburd et al., 2012).

Environmental criminology was developed to embrace characteristics and explanations of criminal behavior that could complement the older, already well established, empirical insights by incorporate the spatial-temporal investigation of crime events. It embraces that learning how and where offenders (can) commit crimes is as important as learning why they commit them. The field includes a very useful practical set of theories that shows us that crime will most often occur in particular places (Andresen, 2014) and different environmental factors is generating the crimes (Brantingham and Brantingham, 1993, Felson and Clarke, 1998, Bernasco et al., 2011).
1.2 Methods

Regardless of the type of crime preventive intervention and who’s carrying it out, contextual information is required to execute this successfully (Perry et al., 2013). The first step is logically to investigate if and where crime cluster. Measurements must also be specifically designed for the crime and situation at hand (Andresen, 2014), and understanding why an area is highly exposed to crime helps tailor intervention strategies to the problem (Payne, 2013).

The literature about crime and place are missing a standardized methodological approach for the calculation and analysis of crime concentration (Bernasco and Steenbeek, 2016), but technical developments have widened the possibilities and interest of analytical tools that draw on very large data sets to prevent crime (Ferguson, 2017). The science of crime mapping with geographical information techniques (GIS) is a collection of computer hardware and software designed to create, manipulate, analyze and display geographic data and is commonly used to geo-code information to identify and analyze areas highly exposed to crime. Tracing crime patterns with GIS-technology provides insight into activity-patterns not otherwise apparent, and the manual “eyeballing”-of-maps-method is the most straightforward way of determining problem areas. It is the most often used method in crime analysis and policing (Wang, 2012, Santos, 2016) and will be used here together with a calculation of the proportion of crime in hot spots to describe crimes spatial distribution and concentration. Multiple regression models are used to evaluate the impact of specific crime generating features to identify place characteristics contributing to this crime pattern.

With appropriate theory and data, crime maps can communicate vital information – especially to the police for an allocation of scarce resources (Santos, 2016). But to map the frequency of crimes with historical crime data to prevent further unwanted activity is built on an underlying assumption that “the past is prologue”. Environmental criminologist have contributed with convincing evidence of a stability of crime concentration at places across many cities in both North America and Europe (Weisburd and Amram, 2014, e.g. Weisburd, 2015) and there is, as we will see, a very strong collective empirical base showing a high effectiveness of focusing on hot spots by these methods. Today, crime analysis (understood as both a profession and a set of crime mapping techniques) is a field recognized as highly important by government, policing and academic communities (Braga et al., 2014, Santos, 2016, Weisburd et al., 2016, Wortley and Townsley, 2017).
1.3 Thesis structure

This introduction has provided a contextualization of my environmentally focused approach to crime prevention and a short outline of the framework and methods relevant for an examination of the spatial distribution of crime. Next, we turn to a more thorough investigation of the theoretical perspectives of environmental criminology. Since this is the main perspective that underlie the assumptions which this thesis is based upon it is essential to start the dissertation by describing the origins, historical development and core assumptions in the primary theoretical frameworks included in this field of research.

The third chapter present empirical data that have reinforced the interest of this type of research and strengthened theoretical assumption. Scholars have mapped both crime distributions and investigated correlations between crime clusters and additional environmental factors. The findings of this empirical work, most specifically about burglary and motor vehicle theft, are highly relevant as a point of departure for specific methodological choices. Consulting this literature thus provide a scientific base for selecting input parameters and show what research is missing in the field. Together with theoretical insights from the second chapter, the third chapter also lays ground for further discussion of the crime distribution in Oslo by highlighting contextual knowledge and limitations of this study.

With the rise and widened use of large data sets with a goal to reveal hidden patterns or provide insights for crime prevention (Ferguson, 2017), transparency is more important than ever before (Kaufmann et al., 2018). The data science of the crime mapping process can be broken down in three important and essential steps; data- collection, processing and visualization. The fourth chapter goes more into technical detail of these parts to understand the procedures used to answer my research question. The empirical results from this quantitative analysis is presented in the fifth chapter, before the validity and reliability of these findings are discussed in the sixth. Here, a deeper analysis of the empirical results is provided too with the use of knowledge gained from both theoretical work, contextual knowledge and previous empirical findings. A critical consideration in predicting hot spots is how to act on this information (Perry et al., 2013) and some theoretical and practical implications of my findings are stated before I consider some recommendations for researchers and practitioners of crime prevention.
2 Theory

As mentioned in the introduction chapter, the theoretical framework commonly used to study the geographical distribution of crime, and chosen to do so also in this study, is a set of theories today broadly referred to as environmental criminology. The goal of this field is not to explain why a specific offender commits a specific crime, but to complement this by understanding other factors that could explain the prevalence of a criminal events by identify patterns of behavior and environmental factors that create opportunities for crime (Smith et. al, in: Weisburd et al., 2009, Santos, 2016). This chapter begins with an examination of the roots of this framework. We then review the two main theoretical perspectives within environmental criminology that are concerned with the establishing of crime distribution patterns: routine activity theory and the geometric theory of crime. Next, we turn to the underlying assumption about the human nature in this tradition: rational choice theory. Together, these theories provide an understanding of core assumptions in crime pattern theory: a theory that tries to synthesize these environmental criminological theories and is important for my own approach to crime and crime control. The more practical approached theory of situational crime prevention will be emphasized in the last part, before I summarize the chapters key points.

2.1 Towards environmental criminology

Even if the offender has largely been the focus of both crime prevention and criminological research during history, and the application of the theories we today know as environmental criminology began first in the early 1970s, one may argue the roots of these theories is found in earlier work of “spatial criminology”. Often, social disorganization theory, that originated from America scholars in the beginning of the 20th century, is framed as the starting point of this spatial criminology – but it actually dates back even longer (Andresen, 2014) to the very beginning of empirical informed social science. City walls from many hundred years back witness about a way of thinking about crime prevention by environmental modification already during this time (Hauge, 1996), and the early work of Guerry and Quetelet in the beginning of the 1800’s contributed significantly to the development of the spatial focus in criminology (Andresen, 2014). These European scholars were probably the first who scientifically analyzed crime at place (Weisburd et al., 2009) and this pioneering work on the
ecological approach to the crime problem had an overall focus on larger macro units at a highly aggregated level, which was used for systemic comparisons of crime figures. From this research came the first recognizable examples of crime maps which inspired many other European researchers (Wortley and Townsley, 2017). Europe was by this time not only the leading initiative taker when it comes to the ecological theory of crime (Andresen, 2014) but also a major contributor to the development of the social science in general (Akvaag, 2008).

During the interwar period the field of social science struggled in Europe. From this time until the 1970s it was the United States who had the leading theoretical hegemony (Akvaag, 2008) and began directing focus to human ecology. In 1915, Burgess (1915) was one of the Americans who focused on geographical factors of crime, and he changed the level of analysis from large macro units to a more careful comparison within cities. This researched found the home location of juvenile delinquents to be more important for criminal activity than individual factors such as gender or ethnic group, and urban environment and proximity to the business district to be interrelated (Andresen, 2014). Burgess became very important for spatial criminology because social disorganization theory got developed from his concentric zone model, a model that divides the city in to five different zones based on land use and assumes a radical expansion of city growth (Burgess, 1925). This was a feature very prominent to American cities at this point in history (Weisburd et al., 2009), also of Chicago where the study was conducted. The rapid growth of the city is expected to make zones invade into the zones surrounding them, which forces a generation of great population turn over and results in a huge withdrawing from the community. Parts of the city are therefore becoming social disorganized and more disposed for criminal activity. From 1929 this model was extensively tested in the context of criminal activity by other sociologists at the Chicago school (Shaw et al., 1929, Shaw and Moore, 1931, Shaw and McKay, 1942) and social disorganization theory was here further developed with new units of analysis (Weisburd et al., 2009) and became prominent in criminological thought during the 1930s and 1940s (Andresen, 2014).

After showing how ethnic groups that moved adapted to their new environment and changed behavior and how similar patterns of the concentration of crime could be found in different cities with different units of analysis Shaw and McKay (1942) stated that it wasn’t the individual that was the main reason for delinquency to occur, but the neighborhood. In general, the social disorganization theory argue that characteristics of the individuals’ social
situation make them more or less likely to conduct delinquent activities, and this is still a vital factor in environmental criminology.

The ecological approach to the crime problem and the city as the level of analysis was popular for a few decades, during a time were functionalistic perspectives that focused on how the structure impacted on the individual gained ground and community-level variables such as relative deprivation, low socioeconomic status and cultural goals might effect behavior by putting pressure on individuals to consider use of socially unaccepted means to reach these goals (Ohlin, 1960, Merton and Merton, 1968). However, a disciplinary shift back to the emphasis of the individual occurred and has been seen as one main reason for social disorganization theory falling out of favor after being a dominant theory in the 1950s and 1960s (Bursik, 1988). Empirical and methodological critics of the approach emerged (Weisburd et al., 2009) and researchers in spatial criminology started to use cross-sectional data instead of longitudinal – something that made it hard to make any claims about the stable ecological structures assumed in social disorganization theory (Andresen, 2014).

The fall of the rehabilitation programs in the 60’s and the fact that crime rates were continuously hitting new heights resulted in a wide spread understanding in western countries that “nothing works” (Garland, 2001). This led to an ongoing search for new solutions to the crime problem and the interest of the place of crimes re-emerged. As social science started building bridges between individual and structural perspectives (Akvaag, 2008) and social and geographic work was tried to be combined (Harvey, 2010), the requirements of new theories that could explain the current environments influence on behavior (Cornish and Clarke, 2008) led to a shifting focus towards even smaller micro units of analysis in the field (Weisburd et al., 2009). The new era of spatial criminology can by general agreement be dated to 1971 (Wortley and Townsley, 2017). This was the time of the publishing of the book *crime prevention through environmental design* (Jeffery, 1971), in which the author examined the immediate environments role in crime and coined the term “environmental criminology”. Alongside Newman’s’ (1972) work on crime prevention through urban design by the creation of *defensible spaces*, this study has been seen as one of the two streams that led environmental criminology forward in the years that came (Andresen, 2014).

Social disorganization has during this time been less neglected and criticized but in general, newer research does not incorporate direct measures of the mediating factors of social disorganization. It is more typically applied in conjunction with other theories and continually
used for creating hypothesizes (Andresen, 2014). Instead of being concerned about how individuals are impacted by the sociological conditions of the neighborhood, several studies were now published during a short period of time were researchers possessed the new geographical imagination that they used to see how individuals moved through the environment instead (Brantingham and Brantingham, 1993) to identify the relationship between specific aspects of the urban architecture and crime (for an overview see: Weisburd et al., 2012). The thought about designing out crime by altering situations also expanded to other areas than the build environment (Wortley and Townsley, 2017) like an alteration in security of certain “hot products” most likely stolen by thieves (Clarke and Webb, 1999). Today, environmental criminology is used as an umbrella term to describe several theoretical frameworks developed and used in these studies (Andresen, 2014). They all share quite a low level of analysis unit, and most importantly; they focus on the opportunity for crime in the very context it occurs in, and the situational decision individuals make to (not) commit crimes with an aim of prevent or reduce undesirable acts. I will briefly summarize the theories in this field that focus particularly on the spatial distribution of crime, before moving on to environmental criminology’s understanding of human nature and on how this situational crime prevention can be achieved.

2.2 Crime distribution at places

2.2.1 Routine activity theory

It is appropriate to begin the examination of crime patterns with the routine activity theory – an approach said to be at the heart of almost all subsequent explanations of offender mobility and the patterning of crime (Wortley and Townsley, 2017).

The routine activity theory was developed in 1979 and sets up a simple explanation of the appearances of crime events based on a focus of how crime opportunities shift with changes in behavior on an individual and societal level. Cohen and Felson (1979) here shifted the orientation of the conventional criminology of the time, from the criminals and their motive over to the crime event, and built upon the earlier work of human ecology from the Chicago school. The aim was to explain the massive increase in crime rates that was seen alongside social and economic improvements in society.
The pattern of high crime rates beside improved conditions for citizens didn’t fit into the
theories which stood strong by the time which were predicting a decrease in crime when
social ills and poverty was alleviated. Instead of placing emphasis on offenders motive the
routine activity theory assumes, without really focusing on why, that there is a ready supply
of people who are likely offenders and explains the big variations of criminal behavior and
risk across different time and places by stressing spatial and temporal factors of human
behavior (Chamard, 2010, Andresen, 2014).

The theory also assumes most crime feeds off by opportunities emerging during the activity of
ordinary routines. Therefore, analysts in this tradition looks at how these general behavioral
patterns impact the opportunities that makes a crime event more likely to occur (Santos,
2016). More specifically, the routine activities refer to day-to-day things such as going to
work, school, socializing and playing (Chamard, 2010) and are defined as “any recurrent and
prevalent activities which provide for basic population and individual needs, whatever their
biological or cultural origins” (Cohen and Felson, 1979). During the 60s’, big social and
cultural dimensions of Western societies changed which resulted in a huge shift in the routine
activities for a large number of people in the American society – and this was something that
Cohen and Felson (1979) recognized as impacting the crime pattern. From surveys they’d
seen that crime events were closely linked to conventional legal activities, that primary
control of ordinary citizens seemed to be important for supervision of people and that the
technical changes made products lighter and easier to steal and thus more suitable to likely
offenders (Chamard, 2010).

The focus on this socio-physical elements resulted in their three-component approach to crime
analysis that states that each crime event requires a physical convergence of the three
elements: a likely offender, a suitable target and the absence of a capable guardian against
crime (Cohen and Felson, 1979). This wasn’t meant as a coherent general theory of crime but
sought to explain criminal events referred to as “direct-contact predatory violations”, which
involve at least one offender, one personal or property target, and the absence of a guardian
that could prevent such a violation (Andresen, 2014). Cohen and Felson (1979) illustrated
how an alternation of any part of this crime equation would impact the level of crime in
society, and the physical space where these three components interact in became the main
focus of study.
2.2.2 Some elaborations of routine activity theory

The fundamentals of the routine activity approach, and the expectations it brings, have generally been confirmed empirically and remain strong today (Andresen, 2014) but the theory has also developed both in the sense of specific micro- or macro levels of components during the years and been broadened through a merging with other theories (Chamard, 2010).

In the primary version, Cohen and Felson (1979) created the acronym VIVA to simplify why some targets are more suitable for offenders than others, pointing towards the value, inertia, visibility and the access of the targeted person or object (Chamard, 2010, Andresen, 2014) – a model that Clarke and Webb (1999) a few years later revised and specifically designed for theft of what they called “hot products”. This revised model, which was named CRAVED, encompasses six properties that make targets especially attractive for thieves, namely concealable, removable, available, valuable, enjoyable, and disposable. It overcomes some of the shortcomings pointed out about the VIVA model, such as considering more of what impact offenders’ motivation.

Eck (2005) also expanded the routine activity approach by develop the ‘crime triangle’, to elaborate the relationship between different elements that create crime opportunities and is necessary for crime to even occur. The theory is illustrated by two triangles compound together; the one inside of the other contains three elements: a potential offender, a crime target and a place for the occurrence of the event. The outside one depicts three types of supervisors: the handler who supervises the offender, the guardian who supervises the target and the manager who supervises the crime setting. The crime triangle theory states that for a crime to occur a potential offender need to escape the handler and find a target free from guardians in a suitable place with less management. Crime does not occur every time these factors coincide, but the probability for a crime is high when this favorable opportunity emerge (Santos, 2016), and the theory thus highlights securitization by different types of guardianship to reduce crime.

2.2.3 The geometric theory of crime

Brantingham and Brantingham (1981) developed the geometric theory of crime based on the thoughts of routine activity perspective and the crime triangle, and added on a fourth dimension; the law. By adding this upon three main components already mentioned in
environmental criminology: the offender, the target and the spatial-temporal aspect (Andresen, 2014), they limit the research to criminal events and exclude all other norm-breaking activity. But it is their emphasis of the spatial-temporal dimension that is most vital for my study and what makes this an historically important development of environmental criminology.

The geometric theory of crime investigates, generally speaking, how the spatial-temporal dimension of a criminal event interacts with the other dimensions. It states, in the same way as the routine activity theory, that people are usually living a life as law-abiding citizens but are all potential offenders. The assumption is that the basic pattern of crime is a consequence of crime opportunities available in people’s regular activity pattern, and in this way governed by the major spatial nodes in a person’s life. The theory considers the movement of people by including peoples’ pathways between their activity nodes and how people reflect differently about places at different times because of their different perceptions of spaces they move through. The Brantinghams (1981) here define space in a cartographic sense like objective geographical dimensions, separated from the more place: a more subjective concept used to describe particular coordinates with cartographic space (Andresen, 2014).

“The environmental backcloth” is a concept evoked to emphasize the dynamic dimension of a place and explains how the static context like road network, buildings, signs etc. can remain, but the temporal component can modify our perceptions of the place making us reflect in a different way about it. The place can completely transform, but this can be done so slowly that it appears to be static (Andresen, 2014). The authors show how people develop a sense of places, or “awareness spaces”, of the discrete locations and pathways they regularly use. Knowledge and attachment can make people comfortable in an area or make them develop a fear of place and this theory states people construct a crime template, like a checklist, that they use to “read” the environment and find suitable targets in their awareness space. This crime template is relatively fixed when first established, but also dynamic since people can change their perceptions of a place and learn which environmental cues are good or bad in different situation from other people or their own experience (Andresen, 2014).

Because of planned physical structures of modern environments most areas within a municipality have one dominant land use which results in many areas being designed as mass activity nodes (Andresen, 2014). This means some environments are richer in possible targets for certain crimes and will at the same time be common places for many potential offenders.
who will have some commonalities in their crime templates (Andresen, 2014). This should not come as a surprise if one considers the routine activities shared by most people in a city.

Concentration of routine activities, land use and offenders target selection in their shared awareness space has one major consequence: Crime tends to cluster in or near major pathways or mass activity nodes, which implicate crime analysts should focus on patterns that emerge here.

Brantingham and Brantingham (1993) developed two concepts highly valuable for any analyst that tries to look at clusters of criminal acts at major pathways and nodes, called crime generators and crime attractors. *Crime generators* are places that generate a lot of criminal events because of characteristics that makes a large number of potential offenders and targets converge in time and space. *Crime attractors* on the other hand, attract motivated offenders because of known criminal opportunities in the area.

These two concepts embody the consequences of overlapping awareness spaces and the social learning that can impact potential offenders’ crime template and, in this way, turn a place into a crime attractor for more motivated offenders. Bearing this in mind, we can examine the spatial dimension of crime to get information that might help us understand what increase the risk of crime and predict the possibility for the appearance of future criminal acts to hinder them. The geometric theory of crime assumes crimes are to be hindered by different physical, social and cognitive environmental barriers (Andresen, 2014), which thus become vital for crime prevention.

### 2.3 Criminal activity: The contextual rational choice

Environmental criminology is said to be concerned only with crime events and the place they occur, not the root causes to crime or the criminal per se (Wortley and Townsley, 2017). The theories do not ignore the criminal, since the understanding of the crime events is necessarily based on some ground assumptions about agents and the fundamental role the environment has on their behavior. This could in a sense be said to concern why crime events occur in the first place and traits about the criminal, but might more accurately be described as theories about *how* the crime event happen, not who commits it and why (Kinney, 2010).
2.3.1 Rational choice theory

The basic understanding of the human agent working in the background within the field of environmental criminology is the rational choice theory (Wortley and Townsley, 2017).

This is a utilitarian economical model used by many different disciplines. In criminology it occurred already in the eighteenth and nineteenth century by Beccaria (1764) and Bentham (1887) that applied an economic calculus to front control of illegal behavior by severe punishment. This approach lost favor in criminology for a long time but was resurrected and modernized by Becker (1968) in the 60’s when individual perspective gained new ground and has been standing even stronger since Clarke and Cornish (1985) used it to explain why the rehabilitation environment had effect only on some offenders, but not all (Andresen, 2014). The underlying premise of this theory is that individuals are taking active choices about their actions based on a utilitarian calculation of potential costs and benefits by their action (Clarke and Cornish, 1985). It could be said to derive from a Hobbesian view of human nature as presented in the Leviathan (Hobbes, 1980[1651]); that people would commit deviant or illegal/unwanted acts without any social contracts or agreements. This thought rests on an assumption of an underlying motivation for acting out of self-interest (Kinney, 2010) and the rational choice theory suggests that if given the right opportunity any person is a potential offender (Santos, 2016). This also align with social control theory too, that understands humans as in need of a socialization to gain self-control by internalization of moral values or norms to reduce their inclination to indulge in behavior recognized as antisocial or criminal (Gottfredson and Hirschi, 1990).

Behavior is in the rational choice theory seen as a representation of the effect of individuals’ strategy to achieve a desired end, and even if the theory includes many personal, social or environmental factors that impact individuals and lead them to conduct a criminal act, crime simply comes down to a result of agents’ decision-making process previous to, and within, the specific crime situation (Hauge, 2001) about being involved and what act to commit (Clarke and Cornish, 1985).

Researchers have supplemented the original theory by describing how the situation itself and the social setting have a role of creating or intensifying the motivations (Wortley and Townsley, 2017) by altering the crime template discussed in the geometric theory of crime. It has also been shown that the rationality of different reasons can be limited or bounded, and
that it is subjective (Andresen, 2014). Of big importance in the rational choice theory is this environmental and subjective situational specificity. With this aspect, the theory serves as a link between the environmental levels of analysis and the individual by highlighting the immediate environments (direct or indirect) impact on the decision-making process (Wortley and Townsley, 2017) which sets out the basic push and pulls factors that are thought to be of central importance to the crime occurrence (Kinney, 2010).

The Chicago School early made us aware of that the same people in different environments can results in different levels of criminal involvement, but unlike this neighborhood-focus that actually don’t consider exactly where people are located at different times, rational choice theory (and thus also environmental criminology in general) place a micro focus on peoples’ actual location to understand individual choices in this particular situation. As seen in routine activity theory and the geometric theory of crime: the spatial-temporal dimension is vital (Andresen, 2014). Where people are at – and the different situational factors at this place at this certain time – matter for their involvement in criminal acts. Mapping behavioral patterning to understand environmental factors of people’s opportunistic choices to commit crime is therefore an important part for the understanding of crime events, and for reduction or prevention of these.

### 2.4 Crime pattern and prevention

These previous mentioned main assumptions shared within theories in environmental criminology contributed to a comprehensive theory that connects these traits and aims to enhance our understanding about crime clusters at places and in time, called crime pattern theory (Brantingham and Brantingham, 1993). This part looks closer at this theory as well as the more practical approached prominent in environmental criminology; the theory of situational crime prevention.

#### 2.4.1 Crime pattern theory

Crime pattern theory states that criminal events occur only where the activity space of potential offenders overlaps with the activity space of victims or targets (Santos, 2016) since this intersection create the opportunity for the action. Not only is the space important because it is logically required for this overlap to happen, but also their characteristics are seen to
influence the likelihood of crimes to occur and for a place to become a crime hot spot (Weisburd et al., 2012). As shown in Figure 1 below, the metaphysical aspects of rational choice-, and routine activity theory and geometric theory of crime are incorporated in to the synthesizing metatheory of crime patterns which uses flowcharts like this figure to make a general representation of a criminal event (Brantingham and Brantingham, 1993).

Figure 1: The criminal process, activities and motivation
Source: Adaption of Brantingham and Brantingham (1993, p.275)

Routine activity theory here represents the source of an individuals’ action and is tied to their backcloths (on the left side in the flow chart) and the geometric theory of crime through the concepts of activity space and awareness space (on the top right side), because these are part and parcel of our routine activities which makes us spend a lot of time at certain places (Andresen, 2014). When an individual is simply doing something (the current action), legal or illegal, a triggering event occurs. This triggering event can be simple or complex and the effect is highly situational and subjective because of individuals readiness/willingness and crime template (Andresen, 2014).
The three circles to the left in figure 1 also show how the motivation for committing crime is affected by the different backcloths. Theoretically, the choice the individual make is a result of the utilitarian calculation affected by opportunities and cues available in the structural environmental backcloth and the readiness is affected by the psychological, economic and legal backcloth incorporated in the crime template (Andresen, 2014). The result of the criminal opportunity and the crime event itself will reinforce or modify the individuals’ crime template (to the right in figure 1) and might also affect the routine activities in the future.

It is essential to mention that rational choice theory, that underpin environmental criminology in general, suggests that individuals will not commit crimes when the right opportunity is missing, the risk or effort are too high, or the anticipated rewards are not adequate (Clarke and Felson, 1993, Cornish and Clarke, 2008). A direct consequence of this understanding is place-based criminology emphasize police agencies and communities to take measures or develop strategies with the aim of prevent crimes by altering opportunities or individuals’ perceptions about them to deter potential offenders or reduce the actual opportunity for committing crime at all. To suggest, evaluate and develop different means of this sort to reduce or eliminate criminal activities is the scope of the theory of situational crime prevention (Cornish and Clarke, 2003) which is largely used in many countries to prevent both burglaries and vehicle theft.

### 2.4.2 Situational crime prevention

Based in the theoretical concepts discussed so far, the field of situational crime prevention was initiated in England during the 1980’s (Santos, 2016). Fundamentally, this field recognize how the opportunities that facilitates crime may be unique and directly related to the immediate environmental setting and seeks to provide measurements to counter crime that are too (Santos, 2016). Situational crime prevention thus has the objective of creating unfavorable circumstances and is said to be the “science of reducing opportunities for crime” (Clarke, 2010). Schemes has been developed and different strategies has been promoted that aims to alter the situational determinants in the physical and social environment to effect individuals’ behavior to make crime less likely to happen (Clarke, 2010).

The theory of situational crime prevention is often criticized for being simplistic, but it has support from all theories in environmental criminology discussed in this chapter – routine activity theory, geometric theory of crime, the rational choice perspective, and thus also the
metatheory crime pattern theory. More recently it has also made use of social and environmental psychological theory to further understand the interplay between people and their environments (Clarke, 2010). It has been showed that an understanding of how the crimes are committed can be a very useful knowledge to develop many effective and highly practical prevention strategies, but knowing why they are committed is not necessarily worth considering if the objective is to reduce the occurrence of a specific crime, then using a more action-focused research is enough (Clarke, 2010). This is done in a more pragmatic way by developing hypotheses of the main determinants, identify and study a range of solutions, put the measurement in to place and evaluate the results.

Dispositional scholars often criticize this by saying crime can only be truly prevented by removing the root cause of crime, highlighting factors such as poverty, inequalities, discrimination, individual- family- or other social issues (Wortley, 2010). But pragmatic situational research has showed that it is often enough to remove just one small, key ingredient of the crime opportunity that changes peoples’ crime templates to prevent crime (Clarke, 2010). They argue situational changes are more likely to be effective because they are directed to near to the performance of the behavior, rather than to distant causes of crime that might be less amenable to intervention (Clarke, 2010, Wortley, 2010). The opportunity itself is also seen by some in this tradition as the actual root cause of criminal acts – because of the necessity of an opportunity to be present for a potential offender to act out the crime (Felson and Clarke, 1998).

Success of prevention measures used is most likely if the focus of preventive tactics is very specific; which could refer both to a specific crime type, location, time of event or the nature of the target. Crime analysis play an important part of this very pragmatic way of fighting crime, both in analysis for recommendation of programs and in evaluations of implemented ones (Santos, 2016) and we can use insight from specific burglary or vehicle theft-preventive analyses to understand hot spots of these crimes or what might generate these crime in specific local environments.

2.5 Summary

Crime is known to be a highly complex and contextual event and different theories consider different aspects of criminal events and criminals, leaving criminologists with numerous of
factors for their analysis of criminal acts in a society. Environmental criminology first and foremost adds on the spatial-temporal dimension, which has usually been missing in traditional criminology.

To summarize the main points in this theoretical approach, environmental criminological theories try to make sense of the crime events as they happen in everyday life by focusing on the various aspects of the settings in which crime opportunities occurs. The rational choice theory is the basic human model for these criminological theories. Instead of investigating the root causes of the crime or the offenders’ motivation per se, environmental criminologists use this human model as their starting point assuming all people potential offenders under the “right” circumstances. They focus on how actors are strategically calculating situational aspects and base their decision to (not) commit crimes on their perceptions of the specific opportunities. Scholars of this tradition therefore look at the immediate environment and how it affects peoples’ utilitarian calculation to understand the role of place in crime events.

Routine activity theory and its elaborations sets out some basic ideas of how the nodes in people’s lives comes into being, and how opportunities for crime are influenced and available for different individuals at different times through their daily activities. The geometric theory of crime is useful when we wish to understand how victims and offenders come together at particular places and how crime cluster at different mass activity nodes and pathways between these. It also gives a deeper understanding for how people make their situational choices, by bringing up the use of their adopted “crime template” to evaluate the crime opportunities given in different environments.

On their own, these theories are all significantly adding to our understanding of crime and the criminal event, but collectively they can provide a representation of the whole environment of which the crime occurs within (Andresen, 2014). Together, they give us information about the social environment (routine activity theory), the built environment (geometric theory of crime) and the cognitive environment (rational choice theory). The metatheory “crime pattern theory” that binds all these theories together, thus adds a lot of value in showing how the environmental theories are connected and is a good point of departure for my explorative analysis of the spatial distribution of burglary and vehicle theft in Oslo, Norway.

Studies like this has big practical implications (Weisburd et al., 2012) since they suggest that one can identify and understand patterns of events and use this to address crime and disorder in local settings (Santos, 2016). This is what the theory of situational crime prevention
embrace when considering what contextual factors could be altered, to reduce or prevent undesirable acts (Cornish and Clarke, 2003). The classification of specific situational preventive techniques have been developed alongside programs and evaluation of these, empirical research on determinants of a variety of crimes, critique and examination of opportunity factors that within the crime setting itself may prompt, provoke, pressure or permit individuals to offend (Cornish and Clarke, 2003). Before my analysis of burglary and vehicle theft is presented and discussed, we will look closer at this particular previous research and practical application of the theories to see how environmental criminology stand empirically, and what conclusions or key insight that have been provided about mass activity nodes and major routine activities that seem to impact the crime distribution, especially what is seen as main crime generating factors and crime attractors for the crimes analyzed later in this thesis.
3 Previous research

Theories focused on environmental influences on criminal actions have been around long enough to be well developed, but it is especially since the 70s' a small number of spatial criminologists have operationalized the theories and empirically tested them (Andresen, 2014). This chapter will map some of their empirical findings. I begin with important studies of crime concentration – since any claim about the fruitfulness of using findings about crime locations for preventive purposes are depending on a reasonable level of stability in these patterns (Andresen, 2014). Findings about distance to crime and the directionality bias of offenders’ pathway to the crime location is investigated in the next section to point out different environmental factors that are said to impact peoples’ daily movement pattern (and consequently the general crime pattern). I then turn to research on target suitability to understand how a target and environmental attributes of its’ location can function as crime attractors. Burglary and vehicle theft are highlighted throughout this chapter, especially in the last part where practical applications of specific situational crime prevention measures are presented. Nordic research, especially Norwegian, is emphasized here because of the contextual importance and to be able to later in this thesis discuss prevention of the crimes in focus. I summarize this chapter with some expectation for my exploratory investigation of the spatial concentration and ecological characteristics of burglary and vehicle theft in Oslo.

3.1 Spatial crime concentration

That a few places account for most crimes in the city is not a new insight. Already in the earliest spatial studies of crime this was evident, and scholars have continuously linked this variation to physical and social characteristics of the environment (Braga et al., 2014). Theories within environmental criminology all embrace the fact that crime is neither randomly nor uniformly distributed across space and claim there will be certain places that have disproportionate volumes of criminal events, creating "hot spots of crime" and leaving other places "cold". There is no consensus of the size of a hot spot but they are commonly understood as "an area that has greater than average number of criminal or disorder events, or an area where people have higher than average risk of victimization" (Eck, 2005).

The phenomena of the 80-20 rule (also known as the Pareto Principle) is a theory founded in the late 19th century by the economist Vilfredo Pareto who noticed 80 percent of the wealth
was concentrated in 20 percent of a population (Sanders, 1987). It has since been thought of as a universal rule that 20 percent of something are responsible for 80 percent of the outcome and applied to several aspects of social life and nature, also to describe the crime distribution. In practice this is seldom exactly 80-20 – but always a small percentage involved in large outcomes (Clarke and Eck, 2005). In criminology, it has been used to explain phenomena such as repeat criminals, repeat victims and hot spots – and in spatial criminology today it is considered a fact that a large percentage of the crimes happen in a small part of a given jurisdictions area (e.g. Weisburd, 2015).

In line with the Chicago school, earlier empirical studies about crime concentration focused on bigger “hot” areas, looking at land use variables that contributed to a disproportionate amount of crime in different neighborhoods (MacDonald, 2015). Urbanization and the population density was found to impact neighborhoods crime rate, and after empirically confirmation the central districts as well as deprived or disorganized neighborhoods were considered as being criminogenic (for a review of this literature see: Weisburd et al., 2012). However, already in the 50’s it was showed how correlations for the same variables can be different at an individual and ecologic level, leading to an “ecological fallacy” (Robinson, 1950) – meaning that the researcher might miss underlying variability within larger units that might be vital for the understanding of crime patterns.

Improved availability of data, technology and new empirical findings have since pushed the interest to a smaller level of analysis and brought forward a large amount on empirical data (Weisburd et al., 2009) and a large variation in smaller areas within the larger high crime ones has been found (Weisburd et al., 2012, Frogner et al., 2013, Weisburd, 2015). For example, in Minneapolis, Minnesota, Sherman et al. (1989) saw that even in neighborhoods with the highest crime rates criminal events clustered at only a few locations within these, and that 50 percent of the calls for service to the police were generated from only 3 percent of the street segment in the city. Others have correspondingly seen a very small percentage of street segments account for most of the crimes in other cities like Boston, Seattle, Bronx, Baltimore and Jersey City, USA (Eck et al., 2000, Weisburd and Mazerolle, 2000, Weisburd et al., 2004, Weisburd et al., 2009, Groff et al., 2010, Braga et al., 2010, Weisburd et al., 2016) Ottawa and Vancouver, Canada (Andresen and Malleson, 2011, Andresen and Linning, 2012, Curman et al., 2015), Tel Aviv-Jaffa, Israel (Weisburd and Amram, 2014) and Campinas, Brazil (de Melo et al., 2015).
That the crime patterns have been seen to be interspersed throughout the city and that a hot spot does not have to be an “area” in terms of a neighborhood as it was thought of earlier is a vital finding. The results of this micro-level variability showed that the term “hot spot” could actually refer to a very specific location (a hot point, like a specific address), a pathway (like a street or an alley) or even a hot target (a person or a thing) (Eck, 2005). This calls into question the labeling of neighborhood as either “good” or “bad” usually inspired by social organization theory and other macro theories that use larger areas as the analysis unit (Shaw et al., 1929, Sampson and Groves, 1989, Steenbeek et al., 2015). The clustering of crime on smaller geographical units rather implicate there might be unsafe places in a generally assumed, safe neighborhood, and safe places in what is usually seen as an unsafe area (Sherman et al., 1989). By highlighting this, I certainly do not implicate that macro level studies won’t provide vital insight about what causes crimes but the micro-variability seen advocates that whatever influences are brought by larger geographical units such as community or neighborhoods, local influences are producing strong variations too (Weisburd et al., 2012).

Many of these spatial crime cluster-studies is however not longitudinal ones and don't really prove, but rather assume, the crime pattern found remains ecological stable over time. This is especially important because if the spatial aspect of crime hot spots were a concentration that was constantly shifting location, it would make little sense to focus resources on specific locations in these studies, or even investigate their characteristics (Spelman, 1995).

To answer this critique, Weisburd and colleagues (2004) used longer time series and more dynamic statistical modeling than earlier studies and observed the crime distribution at a street-level in Seattle over a 14 years period of time. The statistical technique used identified eighteen different trajectories to investigate if the hot spots could be considered stable over the years and found that eight of the 18 trajectories showed no statistically significant change appeared during the years. These eight stable trajectories evidenced low levels of criminal events and represented 84 percent of all street segments in Seattle and the study found all criminal events were to be found in between 48-53 percent of the street segments (Weisburd et al., 2004). The authors concluded a high amount of stability was present at this micro-level of analysis, and that only 14 percent of the street segments in Seattle accounted for the big crime drop seen in Seattle during the 90s’. Other street segments had during this period of time no change in crime rates and some experienced even higher amount of crime than usual.
Additionally, the overall distribution of crime in Seattle was fairly similar year to year, and the vast majority of the street segments was in this sense to be considered as stable (Weisburd et al., 2004). In Vancouver too, the crime drop has been shown to be driven only by a few trajectories while the majority of street segment in the city did not actually follow this decreasing trend (Curman et al., 2015). Street segments in Seattle have also been defined as “chronic” in later studies (e.g. Groff et al., 2010) and after a replication of the 2004-study, Weisburd and his collages (2012) put forth the “law of crime concentration of places” that means that “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”. They advocate this as applicable across different cities as well as within them. This is a geographical twist on the known behavior of a few chronic offenders who commit most of the crimes (Wolfgang, Figlio and Sellin, 1972 in: de Melo et al., 2015). Instead of offenders, this points at how the same number of street segments produce about the same proportion of crime at places over time, even though the level of total crime during the same years might change (Weisburd et al., 2012). This is basically an application of the 80/20-rule on a microgeographic level of analysis that highlights a validation of its temporal stability.

3.2 Distance and direction to crime generators

Three interrelated elements within the spatial analysis of crime is place, distance and direction (Frank et al., 2012) and even if this thesis focus on the first of these, a brief incorporation of the other elements is important for a wider understanding of both the place and the crime event itself. Distance and direction are researched with measuring the journey to crime, usually from the home location of offenders. This will not be a possible measurement in this thesis, since there is no information in my data about the offender or their location. Nevertheless, findings in this literature are important in this study since they strengthen theoretical assumptions in environmental criminology; like the awareness space, routine activities and the calculation of pros and cons assumed undertaken by potential offenders and can be used to understand why some areas are more heavily exposed to crime than others and what environmental characteristics seem to generate higher crime rates.

A quite logical assumption following the thought of a calculating actor, is that people don’t travel any longer than they have to when completing their daily tasks or crime (Andresen,
2014). This is because it takes time and money, in other words; effort, to overcome distance – something a utilitarian actor would try to avoid (Clarke and Cornish, 1985).

*The distance to crime* is seen to vary between offender traits, target location and the type of crime committed. Concerning the crimes of this thesis, the frequency of burglaries correspondingly with the assumption usually decrease with the distance of the target from the burglars’ own home (Ye et al., 2015). Some studies have seen the distance might increase with the value of stolen goods (Boggs, 1965, Bernasco and Luykx, 2003), suggesting that burglars do in some way weight the profitability with the crime up against effort or risk to travel to distant or unfamiliar areas. Yet, residential burglars generally seem to choose residences in areas with familiar social and physical infrastructure, and Wiles and Costello (2000) states most offenders tend to commit crime in local areas where they live or spend leisure time. Bernasco correspondingly found that offenders of both burglary and theft from auto are more than 22 times more likely to commit crimes in an area they currently live or formerly lived in (Santos, 2016). That higher risk and effort-related attributes of burgled houses seem to weigh heavier in offenders calculation then the value of stolen property, does imply a distance decay in burglaries towards areas close to offenders routine activities (Vandeviver et al., 2015). That the frequency of offending decreases with the distance to the offenders home is an hypothesis supported in a number of empirical studies in both United States and Europe (Frank et al., 2012).

*The directional bias* of offenses (that people move in certain directions from their home when committing a crime) is less researched than distance decay in spatial analyses of crime (Frank et al., 2012). In the 80s’ Rengert and Wasilchick (1985, in: Andresen, 2014) undertook the first empirically investigation of the strength of directional bias on criminal behavior, specifically burglary. After this initial study showed a direct relationship between target choice and offenders’ journey to work, a few empirical studies with small sample sizes was conducted that confirmed an existence of a directionality bias for different crime types (for an overview see: Frank et al., 2012). These makes it hard to propose any general claims because of this methodological limitation and their size, but two larger studies were undertaken showing a directional bias is present and matters (Wiles and Costello, 2000, Frank et al., 2012). The validity of these result is questionable since it cannot be assumed all property offenders have a job or even a home address. Put simply, it might be other places than the home or work location where the decision-making process to commit a crime begins.
(Townsley et al., 2015). Missing data on these alternatives lower the validity of the results, and studies like these can be said to be biased towards reported and solved burglaries committed by people that have a home or a workplace, and were the information is available. Bernasco and Luykx (2003) found that offenders become familiar with activity nodes during their legal or illegal routine activities, and these nodes may serve as alternative anchor points for their journey to crime. However, different empirical work consistently display that even if the distance or the nodes vary, the journey to crime is generally short (for an overview see: Andresen, 2014, or: Weisburd et al., 2009) and peoples’ general movement patterns don’t seem to differ based on whether they are offending or not (e.g. Wiles and Costello, 2000). This imply that whether or not it is between home, work or other places where people spend their time, crime seem to be an opportunistic by-product of other activities in people’s lives.

Consequential, nodes and paths with crime opportunities available that are shared between many people, mass activity nodes, would logically result in a large volume of crime. That there are greater number of criminal events where there are numerous of people are not an innovative statement; we have known this for at least fifty years (Weisburd and Braga, 2006), but this newer insight from environmental criminology will help us analyze this correlation further. Since many people for different reasons share the same nodes or paths, mainly because of land use impacting their movement, there are general flows of potential offenders and victims toward some parts of a city and away from others along predictable paths at predictable times (Brantingham, 2010) creating patterns fruitful for examination.

Recall the concept of crime generators from the geometric theory of crime (Brantingham and Brantingham, 1993). These places generate many criminal events simply because they bring together a big volume of potential victims and offenders, they contain mass activity nodes. A deeper understanding of these will extend our understanding about different aspects in crime opportunities and help us take informed choices about how to prevent or reduce crime in hot spots. Weisburd and his colleagues’ (2009) used this framework to examine chronic street segments characteristics to understand what generated crimes. The authors found several important variables that seemed to increase the probability for a clustering of crime at street segments. Statistically significant was the presence of motivated offenders (measured in high-risk juveniles), the presence of a public facility, a larger resident population, bus stops, or indicators of the street segment to be inside an industrial business area (Weisburd et al., 2009). All of these factors are somehow connected to the volume of people in an area, and
hence connected to the crime generator term. Other important indicators of where people actually spend a lot of time is transportation networks, particularly road density (Andresen, 2014). If a street segment is part of an arterial road has been seen to affect the probability for crime (Weisburd et al., 2009, Curman et al., 2015) and viewed in the aggregate it has been showed clearly that many property crimes occur on or near main roads and near major public transit stops (Brantingham 2010). Also land use like entertainment districts, commercial areas or educational facilities concentrate the population for different reasons, which also, as expected, have been seen to concentrate property crimes (Beconytė et al., 2012, Andresen, 2014). For example, the central district usually contains a much higher concentration of high-crime segments, and this is a logically common area for peoples activity nodes to gather (Townsley et al., 2015) through bus stops, retail-sales, public facilities, businesses and the like (Weisburd et al., 2012).

3.3 Suitable targets as crime attractors

To analyze what (mass) activity nodes function as crime generators helps us understand crime concentration at places to some degree but the large micro-variability seen in spatial crime studies makes it important to look closer at what can make crime patterns show differences in local settings too. The assumption that the 80-20 rule will be applicable on a micro-level of analysis (Weisburd et al., 2009) means we could expect a relatively large percentage of criminal victimization upon a relatively small percentage of targets in generally hot areas, and this is exactly what the criminological literature of (near) repeat victimization has found to be evident.

*Repeat victimization* is a name on the phenomena of a place or a person repeatedly being a victim of the same crime or of more than one crime type. The more specific hypothesis of *near repeat victimization* states that similar targets, or targets physical close to a recent victimized person or property, temporarily increases the risk of victimization (Andresen, 2014). The percentage of (near) repeat victimization has shown to vary among crime types and across regions of the world (van Dijk, 2001) but most of this research has been conducted for residential burglary and theft from vehicle crimes (Santos, 2016) which have direct relevance for this thesis. They have showed particularly evidence for burglaries (Mohler et al., 2011 in: Perry et al., 2013) and when offenders return to for example a previously targeted home, this property can be understood with the concept of crime attractors; it attracts
motivated offenders because of known criminal opportunities. Researching micro-variability, Johnson et al. (1997) found the proportion of households suffering from repeated targeting were fifteen times more densely packed than the number of victimized households for the entire study area, demonstrating how some targets within high crime areas seems to be “hotter” than others (Johnson et al., 1997). So, what makes targets hot or more suitable for victimization?

Numerous studies worldwide with incarcerated and active burglars indicate superior recognition of cues signifying the relative affluence of a property (e.g. Nee, 2015) and the demand of a particular type of automobile on the market (e.g. Clarke and Mayhew, 1994). Earlier ethnographic research and offender interviews also suggest burglars are driven by monetary gain and favor wealthiest targets over poorer ones for better financial profit (for an overview see: Vandeouver et al., 2015) showing that reward is, not very surprisingly, an attribute of importance when offenders choose their targets. One would then maybe expect a general property crime traction toward wealthier parts of the city, and as mentioned earlier, there might be some distance increase because of value of possible targets (Bernasco and Luykx, 2003). Still, a lot of research on the distance decay implied a decrease in crime with the distance to home stating effort is more important than reward in this regard (see part 3.2), but maybe value is more important than effort on a micro level? Research show goods are usually identified by burglars before the actual crime appears and do impact the crime decision. Yet, similar to the macro-studies showing a traction to areas with higher accessibility for offenders, empirical insights on a micro-level too reveal risk- and effort attributes to be more important than affluency (Vandeouver et al., 2015).

In theory, guardianship and securitization is important attributes that increases risk and effort of a crime opportunity. Newman's (1972) early theorized about prevention through the creation of “defensible spaces”, which embraced this element of offenders calculation of risk and effort. Here, informal guardianship is expected to have large impact on deterrence of property crimes, and residential areas are utilized and physically manipulated in ways that maximize their security and protection (Reynald, 2010) and they are maintained to create a perception of that people care about and control the area. Both physical and symbolic barriers or zones are defined to limit the volume of users of a space and the framework is highly depending on capable guardians and justify measurements like gated communities and neighbors watch. It share a lot of elements with Jeffery’s (1971) model about crime
prevention through environmental design (CPTED) which is built on the same primary idea of designing the environment as a tool for discouraging crime and impact potential offenders calculation of crime opportunities (Reynald, 2010, Andresen, 2014). Mechanical surveillance replaces the natural guardians if needed, and target hardening are used not only to restrict the area, but also accessibility of the actual target (Jeffery, 1971), lowering the crime attractive attribute of low effort and risk.

Guardianship is still frequently endorsed as an important preventive measure for burglaries, and empirical research constantly show that potential visibility from capable human guardians are usually monitored by burglars and taken into account throughout the target choice process to lower risk (Nee, 2015). Research on burglaries temporal patterning of have found a general peak of crime at times when buildings are most likely unoccupied (e.g. Jenion, 2003) and this is logically explained by burglars taking advantage of this lowered risk because of the absence of guardians (Clarke and Eck, 2005). Routine activity theory is even built from empirical work showing this pattern of burglary rates increasing when people for different reasons started to spend more time away from their homes (Cohen and Felson, 1979) and that offenders wish to minimize the probability to get caught is also a conclusion drawn in studies of other crime types that have seen that less street lighting correlates with higher crime levels too – since darkness equal a large decreased exposure-risk for the offender (e.g. Coupe and Blake, 2006, Weisburd et al., 2012). This might be very important for burglaries and car theft, especially in Scandinavia that experience lower level of daylight during large parts of the year which makes offenders move around unnoticed to a larger extent.

Spatial studies have shown how especially cues rendering the property easier to access are used to make the more specific situational decision to actually undertake a burglary (Nee, 2015) and automobiles parked at a public parking spot has showed to be four time as vulnerable than the ones parked outside the home or work of the owner, and 200 times more vulnerable than those parked in the owners’ garage (Mayhew and Braun, 2004 in: Andresen, 2014) showing easy access influence the offenders’ target choice also for this type of crime. Using the security hypothesis and incorporated conjectures of routine activity and opportunity theory, Farrell and his colleagues (2011) explained how security improvements played a major part in driving big crime falls for car theft, and present confirmatory evidence of the validity of the indicator of protection in the actual target, and security in the surface lots automobiles are parked have also efficiently lowered car thefts (Clarke and Goldstein, 2003).
Increased household security has in the same way been seen to deter burglars and produced declining burglary rates (Tilley et al., 2011, Nee, 2015, Vandeviver et al., 2015, Tseloni et al., 2017). These results imply that high reward is an attribute that to some degree attract potential offenders to possible targets, but even more important is an evaluation of low risk and/or effort for the person to commit the crime. Less protected (valuable) targets are clearly more suitable for burglary and theft than other (valuable) targets in the same area. But, newer practical research embrace a focus shift from quantity to quality of the securitization and other implemented target hardening quantities (Tilley et al., 2011). This makes it vital for us to look closer at insight from these and other evaluation studies of practical application of specific prevention techniques to understand even more specifically what generate or attract crime, and what type of implementation seems most fruitful for a prevention of the crimes of this thesis.

3.4 Practical applications of situational crime prevention

Part 2.4 showed how the theory of situational crime prevention embraces the insight from crime pattern theory that some (mass) activity nodes and pathways in between these are more affected of crimes than others. Previous research has also given us insights about how some targets seem to and attract potential offenders than others. Researchers in the tradition of situational prevention concentrate on what factors could be used or altered to reduce crime in these hot areas or for these hot targets that are reportingly victimized. The techniques incorporated are primarily built on a rational choice framework and attempt to disrupt instrumental aspects of the crime-commission process; that is, those that increase perceived effort and risks, reduce anticipated rewards or provocations, and remove excuses. They are thus aiming toward both the crime opportunity itself, and the motivated offenders calculation (Cornish and Clarke, 2003).

Specific quality measurements have proven to be efficient in many contexts if implemented correctly, especially in certain time frames (Clarke and Eck, 2005). Of most importance for evaluating my research will be what have been found to be efficient techniques for a reduction and/or prevention of burglaries and car theft.
Historically, responses to property crime patterns usually focus on deterring offenders and encouraging victims to protect their property through informal strategies (Santos, 2016), justified by using a neo-liberal rhetoric for individual responsibility over their own safety (Wallace, 2009). This rhetoric is common in today’s security- and risk-oriented society (Beck, 1992, Zedner, 2007) which is also evident in Norway (Larsson et al., 2016), but have been criticized for reducing security to a privilege for the ones that can afford it (Aas, 2013).

Much of this informal target hardening measurements suggested is built in security that is supposed to reduce (perceived) effort for the offender. Recommendations for buildings to be built with double-glazed windows and meet strict forced-entry standards are emphasized, as well as an upgrade to this by residents or store owners to prevent break ins (Weisel Lamm, 2002, Clarke, 2002). Additional external security measurements are suggested too; for example burglar alarms, security chains, videotaping, security lightings that react on movements, and different CPTED initiatives (Clarke, 2002, Weisel Lamm, 2002).

Combinations of external security have conferred at least 20 times greater protection against burglary with entry than no security (Tseloni et al., 2017). To decrease car theft, advances in car security such as central locking, electric immobilizers, alarms and tracking advice have been effective (Kriven and Ziersch, 2007, Farrell et al., 2011). Altering the targets environmental surrounding to increase a possibility for, or perceptions of, guardianship has also shown good results. For example increased security in parking lots through better lightning, fencing, electric access, more attendants or CCTV (Tilley, 1993, Clarke and Goldstein, 2003, Welsh and Farrington, 2009, Fujita and Maxfield, 2012). For burglaries these include for example more supervision through trimmed bushes, gatekeepers, neighbors watch, property security marking or CCTV (e.g. Bowers and Johnson, 2005, Townsley et al., 2015, Tseloni et al., 2017).

Additionally, studies have focused on the most formal way of guardianships for residents, stores and automobiles; different policing strategies. The assumption that the police provide a deterrence function is what this institution is built upon (Ratcliffe et al., 2011) and can be traced back to the early writings of both Beccaria (1764) and Bentham (1887) who argued for the need to influence the calculus of would-be-criminals and for society to ensure that the cost of committing a crime would be outweighed by any potential benefits to prevent crime. Evidence of the actual deterrence from increasing the costs of offending is however low, and the biggest issue is how deterrence stems from a tangible and direct prospect of detection (e.g.
Beccaria, 1764, Ratcliffe et al., 2011), and that police could prevent crime was later claimed to be a myth (Bayley, 1996, Reiner, 2010).

As criminologist gained a more nuanced understanding of criminal behavior, they understood the certainty of apprehension plays a stronger role than severity of punishment as a mechanism of general deterrence (Sutherland, 1940, Durlauf and Nagin, 2010) and with environmental criminology’s identification of place as a fundamental component of the crime equation, location-specific prospects gave new hope for the police potential to reach deterrence and crime prevention (Clarke, 2010). To the extent that crime is concentrated among a small amount of targets and places, the efficiency of crime prevention by policing strategies by the state can also be maximized (Weisburd et al., 2012) and geo-coding software and mapping techniques like the ones used in this thesis have lately enabled and extended the ability to pinpoint high crime areas, which could help official services to make informed choices.

Directed patrol based on crime mapping is the prominent tactic of what is today known as a hot spot policing. This can beside increased presence of different uniforms, like police or security guards, also include place managing, traffic stops and raids (Frogner et al., 2013) and have the capacity to be an efficient way of preventing crime (Weisburd et al., 2012). The appeal of focusing limited resources on a small number of high-activity crime places is straight forward, and research show somewhat small but statistically significant and noteworthy crime reduction gains (Braga et al., 2014). Both general and specific deterrence may occur if the presence of a police officer is sufficient to increase offenders’ perceived risk of apprehension (Durlauf and Nagin, 2010). But the results are mixed (Frogner et al., 2013) and when studying burglaries, long-term effect for hot spot policing have also been hard to produce. Another place focused and intelligence led policing strategy is predictive policing that also identify small geographic areas based on a higher likelihood of crime happening there, but concentrate not on patrolling these areas, but on predicting the next offence with algorithms and put officers at the crime scene at a specific time to take offenders red-handed (Perry et al., 2013, Kaufmann, 2018). It is although commonly acknowledged that both hot spot policing and predictive policing work best as a part of a comprehensive crime prevention strategy (Santos, 2016). In a recent example of hot spot policing from Newport News, Virginia regular enforcement methods in these areas obtained some short-term results, but the high burglary rate surged as the police left. Only after involving other actors and more
specific interventions than traditional policing inside the hot spots, burglaries where substantially reduced (Braga et al., 2014) and it also generated higher positive community perceptions of the police relatively to arresting more offenders as predictive policing focus on (Santos, 2016). This many-sided focus on a specific place, crime and evaluation of specific responses is called problem-oriented policing (POP). Here, one focus on the substance of policing in a more analytic way than what’s traditionally done (Goldstein, 1979) and with the technical developments and availability of new big detailed data sets possibilities and interest for this type of evidence-based policing is widened (Ferguson, 2017). The center for POP has since its beginning in 2002 documented hundreds of successful cases of crime reduction for different crimes through this method (Clarke and Eck, 2014) and today, problem-oriented policing is argued to be the most promising police strategies for property crimes (Santos, 2016). The term is translated also into Scandinavian languages (e.g. Knutsson and Søvik, 2005) and in many countries, focused geographical approaches and gathering of contextual environmental knowledge for crime preventive purposes are endorsed by law enforcement, research, government officials, politics and the media (Perry et al., 2013, Ferguson, 2017, Wang, 2012). Problem-specific best-practice guides with summarized knowledge from research and reported police practice generally suggest a mixture between focused formal policing, informal control from other actors such as security guards or shop staff, updated securitization/target hardening, CPTED and city planning all together (Clarke and Eck, 2014). Important to mention is that, generally, it has been shown to make a major difference using some of the predictive technique – even simple hot spot mapping – than doing nothing (Santos, 2016). Temporal studies also show how most repeat victimization occur close in time (Johnson et al., 1997) and near repeats usually within the first coming hours or up to a week after the initial burglary (Santos, 2016). This means the risk decline quickly both in time and distance (Ye et al., 2015) after a burglary, and prevention initiatives should probably be implemented sooner rather than later to avoid further crimes in an area.

Even if evaluations of situational prevention show positive results critics argue crime rates might not necessarily decrease in total despite lower results in the intervention area, and have long focused on the risk of “displacement of crime” – the phenomena of when offenders adapt and the securitization or intervention only lead to that crime shift target, form, place or time instead of being eliminated (Reppetto, 1976). Still, some are eager to notify us about the possibility of offenders to adjust in undesirable ways to preventive measures and this is usually what’s used as the major feature for discarding place based studies in general and
probably the biggest issue when considering the effectiveness of evidence based policing initiatives based on crime location (Weisburd et al., 2012). Certainly, it is methodologically challenging, and maybe even impossible, to account for all sorts of displacement. Even if a shift to other parts of the city might not be seen in a spatial evaluation of crime intervention, we can imagine with the increased mobility in contemporary society that a long-distant movement out of the city or even to another country is possible. Theoretically though, most crime are not functionally equivalent (Clarke and Cornish, 1985) and if motivated offenders will seize the best opportunities they meet in their everyday activity, the “second best” may simply not be worth the effort. This critique thus neglects the important role of opportunity-specific temptation for offenders, assuming motivated offenders are so compelled to commit a crime they will try to even if they are pushed to less optimal sites (Ratcliffe et al., 2011).

Comprehensive reviews of crime reduction studies that look for a displacement of different crime types also show very few empirical evidences of this feature (Guerette and Bowers, 2009, Santos, 2016). If found, rarely all crime moves to new locations and decreasing crime rates are often still evident. Some studies show a low quantitative reduction but that a qualitative reduction was present, showing offenders committed less serious crime after the implementation of crime prevention (Jørgensen, 2010) which is also a very positive change.

Reinforcing theoretical suggestions in the tradition of environmental criminology, empirical data thus show offenders’ costs of displacing their actions to other areas outweigh benefits of the action, and displacement of crime seldom fully offset the prevention benefits these methods have. Many studies are actually pointing towards a complete opposite result of intervention; instead of a displacement of crime there have been supporting findings on the hypothesis on “diffusion of crime control benefits” (Clarke and Weisburd, 1994) for both problem-oriented policing and hot spot policing in areas immediately surrounding targeted high-activity crime places (Braga et al., 2014). This means that when some crime activity is successfully eliminated (either partially or fully) the crime preventive action can affect other types of crime or nearby places, leading to other problems being eliminated or reduced as well (Santos, 2016). This can be a result of changes in opportunities for crime, or of potential offenders’ perceptions of other places or targets as well. Relevant for this thesis, empirical data have shown for example how tracking systems for vehicles made car theft decline also for car owners that didn’t buy the device, and similarly, securitization of repeatedly burgled homes and stores reduce the risk of burglaries also for other places (Clarke, 2010). Hence,
both theory and practical applications of these thought show that altering the (perceptions) of effort and risk of committing these crimes seems promising for crime reduction.

3.4.1 Nordic findings

The ecologic crime research from the last 30 years conclude systematic policing approaches could be effective if they are specifically focused (Santos, 2016) which makes contextual findings vital. Unfortunately, there are not many proper effect evaluations of intervention for hot spot policing outside of America, which limit the knowledge of how effective these policing technique is, and if it will work, in smaller cities or rural areas (Frogner et al., 2013, Weisburd and Telep, 2014).

In the Nordic countries, crime prevention and security-technical approaches in general have had a strong position since the 1970s’ when the National Council for Crime Prevention (BRÅ) was constituted in Sweden, and already in the 80’s Norwegian researchers highlighted the importance of a more thorough evaluation of preventive measures and warned about too general and unspecific measurements without clearly defined targets to be the most efficient (Larsen 1988 in: Hauge, 1996). It has since then been a steady increase of more tactical investigation and a clear turn toward evidence-based policy across Scandinavia and today both official document and research suggest that in Norway, it is a desire for a holistic and long-term commitment to prevention that dominates (Runhovde and Skjevrak, 2018). During the last two decades the Norwegian state has incorporated this, and an overall strategy has been problem-oriented policing (Gundhus, 2018).

A few Nordic examples of place-based policing implementations are to be found, but mostly they consider street violence (Jørgensen, 2010, Skardhamar et al., 2016) or investigation techniques (Dahl and Mork Lomell, 2016, Myhrer, 2019). Some focus on situational crime prevention (Knutsson and Clarke, 2006, Knutsson and Tilley, 2009) and more specifically CCTV (Lomell, 2007, e.g. Dahl and Mork Lomell, 2019), the time of crime (Olseryd, 2014), data reliability (Gerell, 2018), collective efficacy (Gerell, 2015, Gerell and Kronkvist, 2016) and how the weather effects crime distributions (Hart et al., 2019), but generally, crime and place studies in Scandinavia are scarce. In a review of Nordic policing research between 2004-2009, pro-active policing strategies based on crime mapping is not mentioned once (Valland, 2011) and in the comprehensive meta-study of crime prevention initiatives in Norway during later years by Runhovde and Skjevrak (2018), spatial mapping of crime at
places is not in focus either, but rather the debate about police armament and prevention of violence, radicalization, juvenile- and economic crime. One specific spatial evaluation study of a very successful program for the reduction of alcohol-related violence that was implemented in Stockholm, Sweden, and replicated in Oslo, Norway, found no statistically significant effect in the latter context (Skardhamar et al., 2016). This points to the very important detail that the same prevention technique is not necessarily successful in another city and it is important to base intervention on mapping and knowledge of contextual mechanisms.

3.5 Expectations in my research area

That people usually make a rational calculation about (not) committing offences have gained a reliable empirical ground across many countries. Whether this choice is strictly about not using unnecessary effort to get to the location or inside a building, about people choosing to commit crimes in their awareness space because of the knowledge of the area, or if it is an absence of (in)formal guardianship that is most important, the implications of these theory-strengthening findings are the same; crime is a byproduct of everyday activity, and therefore anchored to persistent personal activity nodes and travel paths in between these. Research state this makes crime tightly coupled at places and that prevention of crime can be reached through CTPED-techniques, city planning, target hardening and/or different kinds of guardianship at high crime places. Positive results from prevention through these place-based techniques and empirical research of crime clusters bodes well for a generalizability of a spatial version of the 80-20 rule, with strong verification through Northern American cities, but and also in Tel Aviv-Jaffa in Israel (Weisburd and Amram, 2014) and in a Latin American context (de Melo et al., 2015).

Yet, even if Weisburd’s “law of crime concentration” seemed generalizable to Brazil the similarity of spatial crime patterns across crime types, and thus the ability to aggregate similar crime in to broader categorizes, was not (de Melo et al., 2015) and generalizability is always important to consider for anyone that aims at implementing place-based policy prescriptions in a totally different country. Almost all theoretical and empirical work of ecological characteristics of crime is still very dominated by insights from countries outside of Scandinavia, and even outside of Europe. If place-based strategies will be fruitful for a prevention of burglary and vehicle theft in Oslo depends on the spatial clustering and
patterned of these crimes in this city and specifically what preventive strategies seems most eligible for these crimes depends on what seems to generate or attract them.

A general expectation is that (property) crimes will be concentrated around accessible areas – mass activity nodes that function as crime generators. The central district is expected to be heavily exposed to crime in Oslo, as in other cities, because of its function as a mass activity node with many crime generating features such as for example public facilities, businesses and a big volume of people are concentrated here. Since a larger amount of motivated offenders in an area is seen as generating more crime, the presence of schools and drug addiction facilities are used as possible crime generating variables in my regression, as juveniles and drug addicts are often represented as property crime offender (Weisburd et al., 2009) and educational facilities are shown in many studies to be connected to higher crime rates (Andresen, 2014), for example because of a peak in criminal activity is seen during adolescent when most youth should be still enrolled in school (Sampson and Laub, 2003).

For an attraction of burglars and thieves, research show effort and risk seem to play a larger role than potential rewards of the offence. For accessibility (less effort), transportations network variables such as major roads, railways and public transportation stops are used. Even if rewards might be higher in an area does not make houses in it automatically a victim of burglars, in the same way as not just the most valuable cars get stolen. Target hardening (increased risk) lower the probability of property crimes, and since areas with more highly secured targets can be expected to cluster in wealthier part of the city, we expect less crimes in affluent areas of Oslo and a higher coupling in more accessible or disadvantaged locations. I do not have a specific variable to measure affluency and security in different areas in Oslo, but some background information about the city characteristics makes a visual interpretation of the crime mapping possible in this aspect and deepen our understanding of the spatial patterning of crimes.

Crimes is also thought of as being highly associated with specific land use in the tradition of environmental criminology because of a higher amount of opportunities for certain crimes at different places. Therefore, I also include variables of commercial-, residential land use, parks and green areas in my regression analysis. Population count by place is included in the regression too, since a large residential population is also claimed as a crime generating feature because of the volume of people in an area, and all above features should be controlled for this.
3.5.1 Oslo, Norway

This study draws from a dataset of all registered criminal activity and environmental characteristics in one jurisdiction; Oslo, Norway. This is both a municipality, a county and the capital of Norway. The city is the largest in Norway with a population size of 681,071 (SSB, 2019) and the amount of reported crime, both absolute numbers and controlled for population, is higher in Oslo than in any other Norwegian county (Lomell and Skilbrei, 2017). This city I consider small enough for evaluate conclusions about crime concentration at places in a new context, with a totally different city size than done before (see chapter 3), but it is at the same time big enough to have an adequate number of crime to undertake such a study, which is a particularly important issue for quantitative studies of crime and place (Weisburd et al., 2012).

Oslo is surrounded by natural barriers made of forests and water, in addition to this, a big river runs through the city – dividing it in a noticeable characteristic of a west- and an east side that historically has been not only a physical, but also social barrier between classes (Ljunggren, 2017). This river is possible to cross at many places by foot, car or any public transit option, and the class-division might be less noticeable today. The west is nevertheless still commonly associated with affluency and it is a larger amount of low employment and residents receiving welfare assistance on the east side, which results in disparate living conditions and different challenges in different parts of the city even if Oslo, compared to international standards, has a high degree of social equality, inclusion and political stability and the population in general has a high level of employment (Oslo, 2018). The city center is located at the south part of this river by the harbor and this is the largest commercial area and without doubt a mass activity node. Since 1999 there have been surveillance in this area to deter potential offenders and guide police patrols and CCTV cover areas surrounding the central station, shopping centers and hotels nearby and the lower part of the main shopping and restaurant street in Oslo; Karl Johans gate (Lomell, 2007). Tolls have been put out for vehicle passage at several locations to avoid heavy traffic down town and as a new environmental measure, the Oslo City Government have decided to reduce private car use in the central area, resulting in, per today, a removal of 1050 parking spots down town and several traffic restrictions since 2017 (Oslo, 2019).

The population growth has during the years of this study been on average 1.3 percent per year (SSB, 2019) and this is met with comprehensive urban planning measures with major housing
projects launched with a wish of growing the city from the inside by prioritizing urban and commercial densification in areas which are centrally located along existing or new public transport hubs (Oslo, 2018).

3.5.2 Limitations

Within the broad research literature outlined above, my current study of burglary and motor vehicle theft in Oslo can be characterized as an exploratory study of both spatial concentration and environmental characteristics of these crimes, which is missing from the Nordic field. One should notice that the time of crime and offender characteristics are beyond the reach of this study. In theory, time gives a directional bias and creates an ebb and flow of people or vehicle in certain areas at certain times which changes the number of potential offenders, guardians and targets in places – affecting when thefts and break-ins are most frequent and when the quality in prevention techniques might be the highest (Clarke and Eck, 2005). But unattended property theft, such as the crimes of this thesis, are especially hard to pin down to reasonable exact times and therefore often lack precise time information which renders the analysis more difficult (Boldt and Borg, 2016), and additionally, the offender is very seldom known (Clarke and Eck, 2005). In my data, knowledge of the offenders is not provided and the time of crimes I consider too unreliable for analysis. This consideration is further explained in my methodological chapter, which we now turn to.
4 Methods

The aim of this study is to use explorative mapping to evaluate crimes geographical distribution across Oslo to investigate to what degree different types of burglaries and vehicle theft are spatially concentrated at a relatively small number of places in the city. It also evaluates what environmental characteristics highlighted in previous research seem to correlate with high criminal victimization in Oslo to understand what might generate a higher volume of these crimes at different places.

To sum up my expectations following from my two last chapters: Crimes will be spatially concentrated, especially around accessible areas or mass activity nodes containing many crime generators or in more disadvantaged locations that might have lower securitization than the wealthier parts of the city. The presence of schools, drug addiction facilities, main roads, railways, public transit stops are thought of as likely crime generators or crime attractors that could help us understand the spatial pattern and clustering of crime. The amount of crime specific opportunities because of different kind of land use should theoretically also have a large impact too and is investigated with the use of information about where residential or commercial area, greens and parks are located.

The variables of land use and possible crime generators will be included in a multiple regression model to evaluate their impact on the probability of crime at places. Crimes spatial concentration and distribution will be mapped by GIS-technology and interpreted visually, as well as with a calculation of crime proportionate clustering in smaller geographical areas.

Since the data used and the way we process, manipulate and present them can have significant impact on subsequent interpretation of the results it is important with transparency. This chapter will concentrate on methodological choices made. First, the data collection and what the different data sets include are described. Second, an explanation of statistical tools used and more technical details about the processing of the raw data is given, as well as information about the unit of analysis. In the last part of this chapter, specific choices of how crime concentration, -generators and -distributions are analyzed is presented, as well as how the results will be visually communicated.
4.1 Data collection

4.1.1 Crime data

The tabular database of reported crime incidents was obtained from the crime registry of Oslo Police District (STRASAK). The police crime registry is historically the most common dataset used in crime analysis even if the difficulties of acquiring data from police agencies is known from many countries (Weisburd et al., 2012). This was undeniably the biggest obstacle to overcome in this project too. In Norway, the Data Protection Services (NSD) is an important actor of the ethical aspects of academic research and needs to be notified whenever personal data is processed, even if only anonymous data is to be published. Since my requested dataset included all registered crime from the police department linked to specific geographical coordinates, it is a very sensible dataset that needed to go through the procedure of notification at this institution. At first, the request was denied. The data does not include any information about offenders, but the possibility one could link certain public known crimes to offenders or potentially identify victims’ residents by a visual plotting on exact locations in a small city like Oslo was considered a risk too high. An anonymization was needed, and it was decided the analysis should be provided through geocoding the crime coordinates into grid-cells á 100m² instead of individual addresses, and a new request was sent in. The anonymization by the use of grid cells and the fact that only property crimes with a higher crime rate was to be used in this thesis solved the problem of any risk of identification. Nevertheless, NSD decided the project needed a license from The Data Protection Authority (Datatilsynet) and the Attorney General of Norway (Riksadvokaten) too, and the fact that this was during a time of changing procedures in between the NSD and The Data Protection Authority it delayed the process even more.

The importance of official police data in this type of analysis and the importance of these studies to be conducted are recognized widely in both literature and by officials in Norway (see chapter 1 and 3) and with a large methodological interest and a support from the police early on in this process I decided to put my thesis on hold and wait for the procedure to go through. After a 17-month long wait the dataset was given a green light from NSD, The Data Protection Authority, the Attorney General of Norway and the Police ICT Services – and my study could finally continue.
The dataset obtained included 505,164 observations. This is all reported property crimes since the year of 2000 up until 24th of August 2018 when the data was subtracted from the police records. No observation had missing coordinate-values in this original data which means no exclusion was necessary for this reason and they could all be used for my purposes. Every observation of a reported crime incident had 16 supplementary variables including details about crime group, crime type and municipality by both name and code, date and time of occurrence and registration, neighborhood, geographical coordinates in longitude and latitude. This was complemented also with distinct information of the year, month, weekday and hour (1-24) of the occurrence of each reported crime.

4.1.2 Geographic data

The geographic data that will be used to plot and describe hot spots of crime in Oslo and their characteristics is put together with the use of many different sources. Maps is extracted for the visualization of the city with Google Maps through Google API\(^3\), and more detailed map data from The Norwegian Mapping Authority (Kartverket)\(^4\) are used to produce a grid net of Oslo with cells á 100x100 meters to layer on top of this for plotting and regression purposes. This is a very reliable source for research on geographical aspects in Norway both nationwide and on a district-level as used here. The geographic variable data used to test the hypothesizes with regression analysis between the crime data and the anticipated crime generators are collected from diverse sources. Information about bus stops and train-, subway and tram line maps are collected from the national hub for public transportation information, Entur\(^5\). They also provide route planners for the Public Transport Authority in Oslo (Ruter, 2019) and is the most reliable source for this type of information. Data of main roads and the location of parks,

\(^3\) Google API is a set of application programming interfaces (APIs) developed by Google which allow communication with Google Services, as well as their integrated services. DEVELOPERS, G. 2019. https://developers.google.com/maps/documentation/geocoding/start. [Accessed 20/05/2019].

\(^4\) The Norwegian Mapping Authority is a public agency under the Norwegian Ministry of Local Government and Modernisation. They bear nationwide responsibility for geographical information, operates the national property registry and undertakes all property registration in Norway. They produce and manage national digital map series (land maps and nautical charts) and play an important role as the nationwide coordinator of geodata, which involves establishing and coordinating work with the national geographical infrastructure within Norway. This means working closely with municipalities, other public sector suppliers and users of geographical information via Norway Digital which makes their data highly reliable at the district-level too. The map data sets are released in a form as close to the original as possible and with boundaries, road data and place names. KARTVERKET. 2019. Available: https://www.kartverket.no/en [Accessed 19/03/2019].

\(^5\) Entur is owned by The National Ministry of Transport and Communications and operate the national registry for all public transports in Norway as well as provides data and APIs for routes and real-time of public transports ENTUR. 2019. https://www.entur.org/about-entur/. [Accessed 19/03/2019].
green areas (forest, grass, cemeteries etc.), schools, residential- and commercial areas are obtained from OpenStreetMap via Geofabrik⁶. Additionally, addresses for all drug abuse institutions were gathered by searching at the website register of Oslo municipality, then geocoded manually and validated by cross checking the geocoded addresses on the map data obtained. Population data is gathered from Norwegian population register. These data were created at grid-level by my supervisor Torbjørn Skardhamar as part of the project ‘Ethnic segregation in schools and neighborhoods: consequences and dynamics’ (UiO, 2017). In keeping with confidentiality regulations, the data made available to me was anonymized by setting all values in individual grid cells that were less than five to five.

All of these sources are collected in 2018 from open sources, thus no additional approval was needed to use this material. For the possibility to highlight other constant environmental characteristics on the map, such as rivers, different shape files of Oslo were also obtained through OpenStreetMap.

### 4.2 Data processing

When data is collected, the second step of any data analysis is the processing of these data. A manipulation of the data is needed to explore and tidy the raw crime data to gain a wider understanding of the structure and its content, and to turn the dataset of registered crime into a useful structured single table that one could perform additional analysis on and add the external variables to. This exploring tidying process is important for any robust analysis (Wickham, 2016) and is a cleaning of records that includes the selection of what variables to include or exclude, and a filtering or grouping of observation to make suitable aggregations. This cleaning process also makes it possible to identify initial patterns in the data to further analyze and before describing the more technical choices made to select time span, crime type and the spatial unit of analysis for my plots and regressions, the statistical tools learned to be able to perform these procedures are presented.

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⁶ OpenStreetMap (OSM) is a collaborative project motivated by restrictions on use or availability of map information across the globe that creates and distribute free, editable geographic map data of the whole world and release it with an open-content license. OSLOSTREETMAP. 2019. https://www.openstreetmap.org. [Accessed 20/05/2019]. Geofabrik GmbH is a member of the OSM Foundation that extract, select and process free geodata and offers fragmented datasets in the format of ‘shape files’ which is handled in regular GIS software. GEOFABRIK. 2018. http://download.geofabrik.de/europe/norway.html. [Accessed 20/05/2019].
4.2.1 Statistical tool: RStudio

To get started on my data processing, I used the interactive learning tool Datacamp and articles and forums at R-bloggers to learn the statistical software RStudio – which is a great program for geographic analysis due to its wide-ranging data visualization capabilities. RStudio is an open-source and freely distributed analytic tool that provide access to very powerful techniques were analysis can be easily reproduced and verified. In technical terms, it is a cross-platform software with integrated development environment (IDE) for the R statistical language with a large and growing number of different data packages. Packages are basically bundles of code, data, documentation and tests that are easy to share with others, and an interactive web-community surrounding R makes the learning process quicker, but also provides continuous improvements of the program in general by package development by users.

There is always more than one way to do certain tasks in RStudio, and a few different packages was researched and learned to tidy, analyze and visualize my data. For the cleaning and aggregation, I mostly used the package tidyverse (Wickham, 2018) which provides a collection of packages that are used for fast and simple handling of large data. The geocode-function in the ggmap package (Kahle and Wickham, 2013) that makes use of maps from Google was used for the geocoding process, and the sp package (Pebesma et al., 2013) for most of my geographical manipulation. Additional packages used for crime mapping functions is geosphere (Hijmans et al., 2017) and maptools (Bivand and Lewin-Koh, 2013), and the ggplot2 package (Wickham, 2016) for graphical visualization.

These packages can control all details of the graphic systems in R and allows you to produce a wide variety of visualizations virtually according to any purpose, and is a tool that combine spatial information of static maps from for example Google Maps and OpenStreetMap. The ggplot2 package is based on the language "the grammar of graphics" that embodies a deep philosophy of visualization and is a very useful tool for creating graphics with the mapping of different variables to the aesthetics (e.g. size, shape and color) of geometric objects (points and lines etc.) (Wickham, 2016). Just like maps, ggplot2 is built with layers as its key feature which makes it easy to combine different elements on plots as an overlay of areal data with the use of a coordinate reference system – something that makes ggplot2 the typical first choice for high-quality mapping in R.
The exploration of statistical relationship between crime data and explanatory variables was done using the R Base package which contain basic functionalities and is loaded by default in RStudio to let R run as a language (RDocumentation, 2019). Additionally, the packages spdep (Bivand and Piras, 2015) and stargazer (Hlavac, 2018) was used to produce regression models and print outputs of these.

4.2.2 Data aggregation and filtering

The whole crime dataset provided by the police department included all reported crime during an eight-year period starting from year 2000. Notably, the new criminal justice law that was implemented October 1st 2015 was different from the earlier one both in structure, language and content (Lomell and Skilbrei, 2017) which led to a significant change in the definitions and codes of criminal acts in this police register. This makes longitudinal studies much more challenging, especially when it comes to trend analysis or comparisons of the years before and after the change. Even if traditional property crimes\(^7\) are not the most altered group of crimes (Lomell and Skilbrei, 2017) this could limit the research vastly and I have therefore chosen to study only the most recent years. I include crimes that happened after the change of codes in 2015 until the of May 2018. The cut to exclude the last 85 days of registered crime data is due to a delay in registration practice of criminal events\(^8\). The time span is still long enough to provide a vital long-term trend analysis of crime concentration (Perry et al., 2013). Another positive outcome of placing more weight on the most recent data is that Oslo is one of the fastest growing and developing cities in Europe (Oslo, 2018) and using only the latest years of reported crime gives the result from my regression analysis with exploratory geographical variables collected in 2018 higher reliability.

The choice of using traditional property crime in this thesis was driven first by what crime incidents constitutes a big enough amount to provide a useful quantitative geographic analysis and avoid sensitivity-issues, as mentioned earlier. Burglary and vehicle theft represent as

\(^7\) Criminology differentiate between ‘traditional theft’ such as residential or commercial burglary, pick pocketing, theft from individuals and vehicle theft, and more modern property crimes are usually called ‘economic crimes’ in Norway LOMELL, H. M. & SKILBREI, M.-L. 2017. Kriminologi, Oslo, Universitetsforlaget.

\(^8\) A statistical analysis of the difference between date and hour of the crime events and when this was registered by the police was conducted, first for all crime, and then for only the crimes of relevance for this thesis and after the change in registration routines. The analysis showed that 75\% of these crimes where registered after 39 days, 90\% was registered after 76 days. It is therefore safe to assume my analysis that cut out the last three months (a total of 85 days because of data provided only up until 24\(^{th}\) August) does not exclude a significant amount of crimes because of late reporting or delays in the registration praxis.
much as a third of all crime reported each year in Norway but is still one of the crime groups with the lowest clearance rate and one of the fields that have gotten maybe least attention from criminological research (Lomell and Skilbrei, 2017). Especially today, when the focus has turned toward prevention of different cyber-crimes and other relatively new types of crime they get even less attention (Sætre, 2018). Once one considers the importance of opportunity, it is also in theory essentially self-evident that the spatial patterns and environmental criminogenic factors might vary by crime type and that we should explore the distribution of crime types as specific as possible. From traditional property crime, pickpocketing and theft from individuals were excluded because of the possibility of these to occur both indoors and outdoors and the big methodological challenge to differ this substantial place characteristic in my dataset – something that is fundamental for any environmental analysis of crime opportunities. The remaining observations were categorized into four exclusionary main categories for comparing analysis purposes: Residential burglary, commercial burglary, motor vehicle theft or others by using active registration codes after October 2015 and an evaluation and small alteration of the classifications used by Statistics Norway (SSB, 2017)⁹. The observations sorted as “Other” crime was used only for exploratory plotting, and it is the spatial plotting of the three more specific crime groups that will be presented and analyzed in this thesis.

4.2.3 Unit of analysis

The unit of analysis is rarely a problem when one studies individuals or their actions but gets more complex when the environmental influences of these actions are introduced. There is no ideal level of the geographical unit for analysis, yet a growing consensus among scholars in this research area that the unit should be small (Weisburd et al., 2009, Vandeviver et al., 2015). Theoretically, environmental criminology naturally pushes the cone of geographic resolution to a low level of analysis for the understanding of the interaction between crime and place, and the recognition of the importance of micro-units is also a result of many

critical evaluations of empirical research since the very beginning of spatial studies showing that whatever macro level effect influences crime across geography, there are strong local level trends (See chapter 2 and 3). As discussed earlier, there is a risk that a small number of particularly crime active places in a larger geographical area gives the impression of the whole area to be overall crime-prone, even when this is not the case. This ecological fallacy can make us draw misleading conclusions about local variables that might impact individual behavior which might wrongfully guide crime prevention initiatives (Weisburd et al., 2012). Similar aggregation-errors is not unique to, or only emphasized in, crime studies. It is also imaginable this fallacy could be reversed too; that a micro unit focus might result in larger community or neighborhood effects are missed. Starting with a micro level approach allows the researcher to examine the influences of the local and then see how these relate to larger influences. It is known that data collection on higher levels might not allow for this sort of conversion into smaller units (Weisburd et al., 2009), thus the best way to avoid these challenges seems to be by starting the data collection from the lowest geographical level possible and aggregate upwards (Eck, 2005, Weisburd et al., 2012). The smallest possible level of analysis in this thesis is a grid-analysis based on 100m² because of earlier mentioned confidentiality aspects. Mapping is usually a method to resolve an unequal area into standard-sized grids used for analysis by placing an artificial grid (which is equally sized square cells arranged in rows and columns generated by a GIS-operation) on top of the area of interest, and the crime addresses in the original dataset is rounded down to be placed in the closest grid. By doing this, we avoid the generally termed “modifiable area unit problem” (MAUP) (Openshaw, 1984), which is a potential source of error that can affect the outcome of any geographic data analysis, consisting of the possible problems of both using different scale size in the units and spatial shift in the existing boundaries used. The risk of boundaries used in analysis for larger units (such as police beats or neighborhoods) that are created for other administrative purposes mislead our analysis (Weisburd et al., 2009) is thus evaded. Grid cells are also generally more reliable than the use of street addresses in a rapidly growing city where these might change (Weisburd et al 2014). The aggregation of crimes on grid cells also prevent the exclusion of areas of interest because of too small amount of crime at an address/street level (Perry et al., 2013) or errors due to coding errors from wrongly entered or missing housing number, or problems occurring from registration on the closest available street address from where the incident happened (Weisburd et al., 2012). With grid mapping, crimes will most likely end up in the correct grid or the neighbor-cell – and potential
neighborhood effects will be controlled for with an additional regression analysis that we will come back to later on. The grid mapping is also a method suitable for the handling of large data and it gives us a small enough unit of analysis to evaluate environmental variables close to high level of crime occurrence, and to be a manageable size for police response or other situational preventive initiatives (Weisburd et al., 2009).

The total amount of grid cells in Oslo used in this study is 16 248. These are also used for the calculation of the crime concentration of places according to the 80/20-rule by evaluating if a few of these cells contain a large amount of the crimes.

### 4.2.4 Geocoding

A geographic coordinate system (CS) enables every location on earth to be specified with a set of numbers, letters or symbols and thus allows us to locate data on maps as a layer and coordinates is what is used to link data together based on the unit of analysis. The geographic coordinates of the registered incidents were provided in the police data set and most of the cartographic variables. Here, an extraction and adjustment of the registered CS into the same projection string had to be proceeded to be able to accurately layer crime data on top of data from Google Maps. The CS of crime data was altered from the locally used universal transverse mercator (UTM)\(^{10}\) into the projection of longitude and latitude before linking crime observation and geographic data to specific grid cells. This binding of dataset makes it possible to plot a heat map of crimes aggregated on each cell, but also makes it possible to test the strength in relation between the crime data and specific geographic variables in a regression model.

The drug addiction facilities I had to manually geocode, which is a vectorized function which accepts character strings like addresses and returns a data frame of the geographic information of this place by assigning corresponding x- and y- coordinates. The ability to move from an address to coordinates is virtually a must for any visualization of spatial data, and this was

\(^{10}\) Setting the same projection across data is done by using the generic coordinate transformation software PROJ to get an overview of what parameters is used and then overwrite the existing coordinate values associated with spatial objects to a different CS. Longitude and latitude is the most commonly used spherical reference system for locating positions on earth with angles measured from the equator and the prime meridian. UTM is not a single map projection like this, but a cylindrical grid-projection where the globe is divided into 60 north and south zones, each spanning 6° of longitude based on a specifically defined secant transverse mercator projection which minimize the error and distortion of distance within each zone. GEOKOV. 2014. *UTM - Universal Transverse Mercator* [Online]. Geokov Education. Available: http://geokov.com/education/utm.aspx [Accessed 20/03/2019]. The city of Oslo is inside the 32V zone of UTM.
done here by adding information of each drug addict facility’s street addresses and house number registered at the website of Oslo municipality in a tabular file. This file was imported to RStudio, and the address strings where standardized into English letters and converted into lower case letters to avoid any missing values. Geocoding preferences was, as mentioned, specified and run with the geocode function in the ggmap package (Kahle and Wickham, 2013). In this process, the CS was changed from longitude/latitude into UTM to add the addresses on the correct grid cell in Oslo, then converted back to longitude/latitude to plot this to the Google Maps image that are used in the spatial visualization functions used in R.

Geocoding has the potential to introduce error into the analysis which would automatically lead to a spatial measurement error. Usually this issue is solved by using a minimum acceptable match rate (of addresses and geographic coordinates) of 85 percent (Ratcliffe, 2004). The geocoding procedure used for this additional data does not suffer from this error since all the involved addresses contained a specific street and house number, and exact coordinates can thus be returned in this process for all of them. In addition to this, I could easily control manually for mistakes made in this process by mapping the results in a scatterplot layered on top of a map of Oslo and cross checking them by searching for the addresses online, since they were quite few in total.

4.3 Data visualization

Data visualization is a type of scientific communication of statistics and geometry design combined in useful ways, and the way patterns manifest themselves and how we interpret the results of criminal analysis is strongly dependent on the way this visualization is made (Andresen, 2014). Less visual noise is vital to prevent misinterpretation since overly complex figures usually end up very confusing. This is in part why the cleaning of the data to remove unnecessary information and keep the most important one is so important: To end up with the most accurate description of our data in the visualizations (Wickham, 2014).

4.3.1 Crime mapping

Mapping crime with GIS allows for the analysts to overlay different datasets such as reported crime and census demographics on maps to identify crime hot spots, along with other trends and patterns. Tactical crime mapping is today a key component of both crime analysis and
policing strategies (Santos, 2016). For a communication of knowledge to others, it is important that the plots are as self-exploratory as possible, and for the spatial distribution of burglaries and vehicle theft in Oslo, a spatiotemporal analysis and a visualization through heat mapping is chosen. This type of density mapping does not limit the analysis to predetermined areas (e.g. polygons or points), rather it shows how incidents cluster across space (Santos, 2016). This control for the drawback in more simple point mapping (e.g. crime incidents placed on top of each other might not be differentiated by looking at the map even with use of transparency, and mapping with graduated size of symbols might lead to problems distinguish the actual value of a point). Heat mapping is a two-dimensional representation with values represented by graduated colors and provides an immediate visual summary of information (Wilkinson and Friendly, 2009). More specifically, this type of concentration map uses a range of colors to indicate a progression of numeric values by aggregating data into groupings (here number of crimes per grid cell) and displaying the data through color intensity and altering to reflect the value. This allows for examination of more data. The grid-shading in my visualization range from white (no crime) to red (high crime) and since crime groups are displayed individually this grading scale is relative to the amount of each specific crime in the whole city.

Just as more specific geographic areas is more likely to improve results, so could smaller temporal windows (Boldt and Borg, 2016). Larger aggregation over time might mask trends on shorter time spans and vice versa. The accumulation of crime incidents over too long time interval can indicate the presence of a hot spot when one does not really exist, and to make sure our analysis does not suffer from any deceptive hot spots of this reason, additional explorative maps were created and displayed sequentially for all crime types together and individually by weekdays, seasons and years11. This chronological visualization of data can make hot spot movements and stability visible (Weisburd et al., 2012) even if shorter time spans could also show results that could be due to statistical noise. The results are excluded from the thesis because of size limitations but to sum up the findings; the placement of hot spots appears stable over time for the different crime types in my analysis – hence the maps later analyzed based on the aggregation of crime for the whole time period seem reliable.

11 For the analysis of seasons and years, only data from 2016 and 2017 were included because these are the only full years of registration after the change of the criminal law in 2015 and the extraction of the register in 2018. For weekdays-pattern, all observations between October 2015 and 2018 are included. Months as a unit of analysis was avoided because of their unequal amount of days.
4.3.2 Regression analysis

The crime concentration at places will be analyzed in this thesis by an investigation of proportion of reported crimes in each grid cell according to the 80-20 rule.

To further analyze why crime as a phenomenon is spatially associated with the spatial arrangement of another phenomenon, a focused examination of the correlation between the crime count and additional ecological variables in grid cells will be provided, using a multiple linear regression analysis. A linear trend line is created by a statistical equation which estimates the relationship between variables, and a multiple linear analysis is a technique that extends simple linear regression so that more than one independent variable (environmental characteristics) can be considered and used to predict the value of a dependent variable (crime).

A risk in multiple regression models is that too many variables are put into a single model and the resulting formulas then merely reflects random noise in the input data rather than a true relationship between input and output variables (Perry et al., 2013). This was controlled for by a stepwise selection of variables that can spot this effect by adding one variable at a time in the fitting of the linear model to the observed data and run these models individually until all variables are included.

Another methodological issue in regression analysis is the possible spurious relation between input and output variables, which means independent variable we haven’t accounted for could create the correlation we see in the results. For spatial studies, a failure to control for the confining influence of population usually lead to a spurious correlation, which is why the residential population in each grid cell is added as a variable here.

A second regression model for all variables was created to control for any spatial autocorrelation and neighborhood effects in the regression analysis. This is important since an inference from regression models with spatial data can be suspect and individual cases might not be independent because nearby things are similar – thus we need to control for any misleading correlation because of their spatial location. It is plausible crimes are impacted by crime generators but cluster further than a few meters away from it, in neighboring grid-cells. A regular regression model will only show a variable as significant if it is correlated with higher crime count in the same grid cell – but it might be that, for example, the presence of a school doesn’t impact the crime count in the cell where the school is located, but potential
offenders move from this facility and commit crime in areas (grid-cells) close to it. The second regression model controls for this neighborhood-effects according to a ‘queen case’ as seen in figure 2. This second model gives us values for all variables both at the level of grid-cells and neighboring grid-cells to so that we can spot if some variables generate higher amount of crime in any of the neighboring areas.

![Queen case model for neighborhood effects.](image)

Both regression models are run for each crime individually, and the output of both models with all variables included will be displayed in its whole in a correlation matrix. The models are placed in the same output for easier comparison between values of both individual cells and neighbor-cells for the different variables. Some geographic variables that showed a significant relation with crime in the regression analysis were also plotted as an additional layer for exploratory purposes on top of the crime maps to easier interpret some of these results, but these maps are excluded from the thesis because of size limitations. The interpretation of both regression models is presented in the next chapter together with the concentration count-analysis of the 80/20 rule and the visual analysis of the ordinary heat maps. All results are further discussed in the last chapter.
5 Results

International research that has considered the spatial distribution of crimes have established a solid empirical base for us to assume there will be found a spatial clustering of crimes at certain places in Oslo, and that the distribution patterning will show a tight coupling in some crime prone areas that thus are accountable for a large amount of all the crimes across the city. This will be driven by certain crime generating features in the environment making targets more accessible for more potential offenders and require less effort or risk for them.

Frequency tables, scatterplots, line graphs, regression models and heat maps with different data sets and for different time spans was used to understand the spatial distribution of residential- and commercial burglary and motor vehicle theft in Oslo to evaluate these assumptions, and limitation of what results to present visually in the thesis was required.

This chapter is divided in to two main parts. Results from the evaluation of spatial crime distribution and the tightness of the crime concentration relative to the 80/20-rule is presented first. In the second part, the heat maps and regression models for each specific crime group is presented to evaluate specific crime patterns and crime generating factors. A short summary of the result brings this chapter to an end before we turn to a further discussion of my empirical results in the next.

5.1 Spatial crime concentration in Oslo

At first, the data analysis of all the 74 992 property crimes registered from 1 October 2015 until 31 May 2018 in Oslo made property crime appear as highly concentrated at places. This heat map visualization is excluded here but displayed a huge concentration of crimes in the central area of Oslo compared to other parts of the city, with the highest density surrounding the central station and the busiest streets downtown. Different scaling of the map or diverse time spans did not change the prominence of this hot spot and made it hard to draw any other conclusion from this than that property crimes are spatially concentrated in Oslo’s central area.

It is of course possible that property crime is concentrated almost exclusively in the central area of Oslo, but these initial results could also be caused of an ecological fallacy following an aggregation of all property crimes. More specific variable input might be necessary to
show underlying variability in the spatial crime distribution, and therefore all other property crimes than the three of interest here (residential- and commercial burglary and motor vehicle theft) where excluded. This left only a third of all crimes, but once again the mapping showed a sharp concentration surrounding the central area. A possible skewing of result caused by extreme values for one or two of the crimes could be present. Feasible reasons could for example be that commercial stores and/or parking spots for motor vehicles are concentrated downtown and gather these crimes here, or that some of the crimes were of high proportion compared to the others. Capping extreme values did not make the result very different but examine the total amount of each crime and plotting them separately confirmed these suspicions of a methodological fallacy; commercial burglary had a crime count twice as big as the other two crime groups and was the most concentrated. This made all other areas outside of downtown look like cold spots because of a low density in relation to the rate of commercial burglary here, shadowing the other crimes real distribution patterns.

![Commercial burglary: Residential burglary: Motor vehicle theft:](image)

**Figure 3**: Spatial crime distribution in Oslo 01.10.2015-31.05.2018.

As seen in Figure 3, the three crimes had very different spread across the city, with commercial burglary being the most concentrated in the central area. Whether or not different time spans, map scales, extreme value corrections and summarizations were used, plots of the three crimes together and showed the need to separate them. It is thus clear that any beneficial hot spot analysis of crime in the city must be specific enough to not suffer from ecological fallacies, spurious relations and a consequential low validity.
5.1.1 The 80-20 rule in Oslo

For commercial burglary, there is a clear spatial concentration in the empirical data in a small part of Oslo. The central area is where most of these crimes are committed, and a summarization and arrangement of all these crimes per grid cell (high → low) tells us that only 2.14% of the cells that experienced commercial burglaries between October 2015 and May 2018 amount for half of all these crimes during this time. We find as much as 80% of all commercial burglaries reported in only 11.7% of the grids – a strong validation of the 80/20 rule. But, as we can see in Figure 3, the spatial distribution of residential burglary and motor vehicle theft show a larger spread throughout the city and it is less clear whether the rule of a tight spatial concentration holds for these crimes too.

Of the total amount of 16,248 grid cells covering the area of Oslo, only 701 cells even experienced any reports of commercial burglaries between October 2015 and May 2018, and the crimes are tightly coupled inside these few grid cells too. But the spread of reported crime was wider for the other types of property crimes. Residential burglaries where reported across a total of 2690 grid cells during the time of study, and motor vehicle theft across 2902 grids. Although there is some degree of concentration in the spatial distribution for these crimes too, an 80/20 analysis shows 80% of these crimes does not fall within a very small percentages of the grid cells that reported crime experience. Eighty percent of the residential burglaries are found only if we look at 53% of the 2690 grid cells that experienced this type of crime. For the 80/20 rule to apply for residential burglaries one has to include at least 4445 more (crime free) cells in the calculation. Similarly, we must look at as much as over 60% of the 2902 grid cells that reported motor vehicle theft experience to perceive 80% of these crimes. If one includes an extra 5868 cells that has no reported vehicle theft, 80% of these crimes is to be found in only 20% of the grid cells. This means we have to more than double the amount of grid cell to reach this result for these crimes.

Crime concentration and the tightness in the spatial clustering thus seems very crime specific and when using only grid cells that have experienced crime, a very tight coupling of crime according to the 80/20 rule was only found for commercial burglaries. Even if some areas of Oslo also have a higher amount of residential burglaries and motor vehicle theft too and the maps therefore show hot spots of crime in some areas, the 80/20 rule does not apply unless we include a large amount of grid cells that has no reported crime between October 2015 and May 2018.
5.2 Spatial patterns and crime generators

Both theory, previous research and the initial empirical results of crime concentration in this thesis speak for a crime specific analysis to fully understand crime distribution patterns and crime generators, thus results from the mapping and regression analysis of each crime groups will further on be presented individually.

5.2.1 Commercial burglaries

As declared above, the crime distribution for all three selected crime groups aggregated were skewed by a high proportion of commercial burglaries clustered in downtown Oslo. Since this could be an extreme value placed here, with one or a few very crime prominent cells that shadowed other hot spots of commercial burglaries other places, the dataset was initially arranged to check the number of commercial burglaries in the most crime prominent cells and be able to exclude extreme values if necessary. The spatial distribution of commercial burglary was plotted with three different datasets keeping, excluding or lowering these extreme values. Since none of these alterations of the data changed the result dramatically, it is safe to say that most of the commercial burglaries are in fact concentrated in a few cells in this central area, and no other very strong hot spots are present. The regular dataset with all observation could therefore be kept for further analysis.

The visualization of commercial burglaries in Oslo (Figure 4) shows this large centralization of these crimes with a strong hot spot located in the biggest main activity node in the city; the central area. The crimes are concentrated where the largest commercial areas are to be found, as well as the highest volume of people, most public transit stops and major entertainment districts. The outskirt of the hot spot stretches out towards shopping streets connected to the central area, going up to Majorstuen on the west, and Grünerløkka in the north.

By using a map with a larger scale (Figure 5) we get a closer view of this highly crime prone spot downtown and how the highest amount of crime is found in the same places as shopping malls and shopping streets are located, surrounding the central station.
Figure 4:
Spatial distribution of commercial burglary in Oslo 01.10.2015-31.05.2018.

Figure 5:
Spatial distribution of commercial burglary in Oslo central area 01.10.2015-31.05.2018.
Table 1: Regression output for commercial burglary

<table>
<thead>
<tr>
<th>Variables at the level of grid-cells</th>
<th>Regular OLS Model</th>
<th>OLS incl. Spatial lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>-0.01 (0.5)</td>
<td>0.5 (0.7)</td>
</tr>
<tr>
<td>Major Road</td>
<td>-0.2** (0.1)</td>
<td>-0.2*** (0.1)</td>
</tr>
<tr>
<td>Railway</td>
<td>0.9*** (0.1)</td>
<td>0.8*** (0.1)</td>
</tr>
<tr>
<td>Park</td>
<td>-0.4 (0.4)</td>
<td>-0.2 (0.5)</td>
</tr>
<tr>
<td>Commercial area</td>
<td>6.5*** (0.4)</td>
<td>-3.8*** (0.8)</td>
</tr>
<tr>
<td>Green area</td>
<td>-0.1 (0.1)</td>
<td>-0.1 (0.2)</td>
</tr>
<tr>
<td>Residential area</td>
<td>-0.6*** (0.2)</td>
<td>-0.1 (0.3)</td>
</tr>
<tr>
<td>Public transit stops</td>
<td>1.5*** (0.2)</td>
<td>1.4*** (0.2)</td>
</tr>
<tr>
<td>Drug addiction facility</td>
<td>3.3 (3.2)</td>
<td>1.1 (3.2)</td>
</tr>
<tr>
<td>Population count</td>
<td>0.01*** (0.002)</td>
<td>0.001 (0.003)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables at the level of neighboring grid-cells</th>
<th>Regular OLS Model</th>
<th>OLS incl. Spatial lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>-0.2* (0.1)</td>
<td></td>
</tr>
<tr>
<td>Major Road</td>
<td>-0.1*** (0.02)</td>
<td></td>
</tr>
<tr>
<td>Railway</td>
<td>0.01 (0.02)</td>
<td></td>
</tr>
<tr>
<td>Park</td>
<td>-0.1 (0.1)</td>
<td></td>
</tr>
<tr>
<td>Commercial area</td>
<td>1.7*** (0.1)</td>
<td></td>
</tr>
<tr>
<td>Green area</td>
<td>0.001 (0.03)</td>
<td></td>
</tr>
<tr>
<td>Residential area</td>
<td>-0.1** (0.1)</td>
<td></td>
</tr>
<tr>
<td>Public transit stops</td>
<td>0.6*** (0.1)</td>
<td></td>
</tr>
<tr>
<td>Drug addiction facility</td>
<td>4.3*** (1.1)</td>
<td></td>
</tr>
<tr>
<td>Population count</td>
<td>0.001 (0.001)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.1 (0.2)</td>
<td>-0.2 (0.3)</td>
</tr>
<tr>
<td>Observations</td>
<td>16,248</td>
<td>16,248</td>
</tr>
<tr>
<td>R2</td>
<td>0.04</td>
<td>0.1</td>
</tr>
<tr>
<td>Adjusted R2</td>
<td>0.04</td>
<td>0.1</td>
</tr>
<tr>
<td>Residual Std. Error</td>
<td>15.6 (df=16237)</td>
<td>15.4 (df=16227)</td>
</tr>
<tr>
<td>F Statistic</td>
<td>69.3*** (df=10;16237)</td>
<td>51.3*** (df=20;16227)</td>
</tr>
</tbody>
</table>

Note: *p<0.1; **p<0.05; ***p<0.01
The regression analysis of commercial burglaries’ crime generators (Table 1) confirms the visual interpretation of the maps: There is a very high correlation between commercial burglaries and commercial areas. The regular regression model tells us the probability of commercial crime increase with as much as 6.5 crimes in grid cells registered as commercial areas, and a strong significant, positive relation is also found for the variables of railways and public transit stops. This means there is a higher probability for a higher amount of commercial burglaries in grid cells where these variables are located.

The variables of schools, parks and green areas are not statistically significant for the probability of commercial burglaries, while there is an actual lower risk of this crime if a grid-cell is defined as residential areas or that contain a major road. The second regression model, that control for neighborhood- and spatial lag effects, show how the probability of commercial burglaries are also lower in grid cells that are located in proximity of residential- and commercial areas. Drug addiction facilities does not have a significant effect on the probability for commercial burglary in the grid-cell these are located, but the second regression model shows the probability of commercial burglaries raise significantly if commercial stores are located close to these facilities or public transit stops.

The controlling of population count in each grid-cell is significant even if the impact is small, but altogether, these results show a higher probability of commercial burglary in areas with a lot of people – especially with an easy access to stores and commute alternatives or located close to drug addiction facilities.

5.2.2 Residential burglaries

In the case of residential burglary, the reported crime is much wider spread throughout the city. This made it less beneficial with a scaling of the map window and only the small-scale map was used for visualization. It is also important to mention that no grid cell in this dataset consisted of extreme values and it was therefore not necessary with any exclusion or lowering of values to evaluate skewing or hiding of hot spots because of this.

In general, the density map of residential burglaries (Figure 6) displays what the 80/20-analysis also showed; a bigger part of Oslo is troubled with this type of burglary than of commercial burglary. The concentration is spread, but some hot spots are visible. At first sight we notice a higher concentration in areas where many people travel through or spend
their leisure time, like Majorstuen, the central station and residential areas closer to the city centrum, while the suburbs and the more rural areas are less exposed to residential burglaries.

This match the expectations about more residential burglaries in more disadvantage and accessible areas, and a closer look at the hot spot-locations strengthen this initial finding. Most striking with the visualization of residential burglary in Oslo, is the location of the hot spots inside the urban area. It is easily noticeable how the highest concentration or residential burglaries is located to the east of Akerselva, a river long known for dividing the city – not only into the western and eastern district, but also known as an old border between the wealthy and the poor (see chapter 3). The river is highlighted on the map to simplify the readers interpretation of this pattern. At the lower part of Akerselva, there is several affluent residential areas on the west that is as close to the central area as the residential areas on the east side. But still, the concentration is much lower in affluent areas to the west, such as Frogner, Ullevål and Vika. One exception is by the big commute intersection Majorstuen which is slightly higher exposed to this crime than the rest of the western wealthier parts of town. On the east side, Grünerløkka, Tøyen and Grønland – all apartment-areas along the river with a higher degree of lower income residents – is most hit by burglary.
Table 2: Regression output for residential burglary

<table>
<thead>
<tr>
<th>Variables at the level of grid-cells</th>
<th>Regular OLS Model</th>
<th>OLS incl. Spatial lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>0.02 (0.03)</td>
<td>0.1 (0.05)</td>
</tr>
<tr>
<td>Major Road</td>
<td>0.04*** (0.01)</td>
<td>0.01 (0.01)</td>
</tr>
<tr>
<td>Railway</td>
<td>0.01** (0.005)</td>
<td>-0.03*** (0.01)</td>
</tr>
<tr>
<td>Park</td>
<td>0.1*** (0.03)</td>
<td>-0.02 (0.04)</td>
</tr>
<tr>
<td>Commercial area</td>
<td>0.04 (0.03)</td>
<td>0.04 (0.1)</td>
</tr>
<tr>
<td>Green area</td>
<td>-0.01* (0.01)</td>
<td>0.03** (0.01)</td>
</tr>
<tr>
<td>Residential area</td>
<td>-0.1*** (0.01)</td>
<td>-0.02 (0.02)</td>
</tr>
<tr>
<td>Public transit stops</td>
<td>0.01 (0.01)</td>
<td>0.001 (0.01)</td>
</tr>
<tr>
<td>Drug addiction facility</td>
<td>0.3 (0.2)</td>
<td>0.1 (0.2)</td>
</tr>
<tr>
<td>Population count</td>
<td>0.01*** (0.000)</td>
<td>0.01*** (0.000)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables at the level of neighboring grid-cells</th>
<th>Regular OLS Model</th>
<th>OLS incl. Spatial lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>-0.02* (0.01)</td>
<td></td>
</tr>
<tr>
<td>Major Road</td>
<td>0.01*** (0.002)</td>
<td></td>
</tr>
<tr>
<td>Railway</td>
<td>0.01*** (0.001)</td>
<td></td>
</tr>
<tr>
<td>Park</td>
<td>0.02*** (0.01)</td>
<td></td>
</tr>
<tr>
<td>Commercial area</td>
<td>-0.001 (0.01)</td>
<td></td>
</tr>
<tr>
<td>Green area</td>
<td>-0.01*** (0.002)</td>
<td></td>
</tr>
<tr>
<td>Residential area</td>
<td>-0.02*** (0.004)</td>
<td></td>
</tr>
<tr>
<td>Public transit stops</td>
<td>-0.002 (0.004)</td>
<td></td>
</tr>
<tr>
<td>Drug addiction facility</td>
<td>0.5*** (0.1)</td>
<td></td>
</tr>
<tr>
<td>Population count</td>
<td>0.001*** (0.000)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.1*** (0.02)</td>
<td>-0.1*** (0.02)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Regular OLS Model</th>
<th>OLS incl. Spatial lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>16,248</td>
<td>16,248</td>
</tr>
<tr>
<td>R2</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Adjusted R2</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Residual Std. Error</td>
<td>1.1 (df=16237)</td>
<td>1.1 (df=16227)</td>
</tr>
<tr>
<td>F Statistic</td>
<td>919.1*** (df=10;16237)</td>
<td>493.6*** (df=20;16227)</td>
</tr>
</tbody>
</table>

Note: *p<0.1; **p<0.05; ***p<0.01
The regression analysis of (Table 2) gives us some expected and some less expected significant relations between residential burglary and the additional ecological variables used. A significant, but somewhat unexpectedly negative relation is shown between the presence of residential burglary and residential areas in the same grid cells or nearby. This might look strange at first, since any residential burglary needs a residential building to burgle. However, housing do vary significantly between areas and the question is how the term “residential area” is used. An exploratory plot of all residential areas in my dataset (excluded here because of space limitations) showed that a large part of central Oslo is not registered as a residential area even if a lot of multi-family houses and apartments are located here. Especially this use of the definition and the fact that subdivisions with only a few single-family per cell take up a large amount of the area in the outskirts of town, might be what makes the residential area-variable negative in the regression models. We do control for the population count in each grid cell, and this variable shows it is a higher probability for residential burglary in cells where more people live. This confirms the heat map interpretations; residential burglary is lower in affluent areas and higher in busy areas or where more people live.

Public transit stops show no significant relation to the amount of residential burglaries, but major roads do. Parks, greens and railways seem to have a (small) impact on the probability of these crimes, while the variable of commercial areas and the presence of a school does not correlate with residential burglaries.

Just as in the case of other burglaries, the presence of a drug addiction facility have no significant effect on the probability for commercial burglary in the grid-cell they are located, but the controlling of spatial lag and an effect on neighboring grid-cells shows how the probability of crime raises significantly in areas close to drug addiction facilities.

**5.2.3 Motor vehicle theft**

As for residential burglaries, no extreme values were present in the dataset of motor vehicle thefts and no alterations had to be done to dodge skewing or hiding of hot spots in the density mapping of this crime group either.
The spatial distribution of motor vehicle theft (Figure 7) visualize a wide spread of these crimes across the city, and a prominent hot spot is seen in the central area and stretches up towards the busy areas of Majorstuen and Grünerløkka.

The shape of the total colored area on this heat map is similar to the one of residential burglary but the strong west- and east side characteristic is gone. Theft of motor vehicle looks more evenly spread throughout all the most central neighborhoods where many people live, travel through and spend a large amount of their time. Less motor vehicle crimes are reported in areas where we could assume there are more single-family houses with their own parking spot and/or garage. As can be seen in the results from the regression analysis below (Table 3) it is a significant negative relation between motor vehicle theft and residential areas, and positive for population count in each grid cell, which can confirm that this is probably the case.
Table 3: Regression output for motor vehicle theft

<table>
<thead>
<tr>
<th>Variables at the level of grid-cells</th>
<th>Regular OLS Model</th>
<th>OLS incl. Spatial lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>0.04 (0.03)</td>
<td>0.1* (0.04)</td>
</tr>
<tr>
<td>Major Road</td>
<td>0.04*** (0.005)</td>
<td>-0.002 (0.01)</td>
</tr>
<tr>
<td>Railway</td>
<td>0.01 (0.004)</td>
<td>-0.02*** (0.01)</td>
</tr>
<tr>
<td>Park</td>
<td>0.1*** (0.02)</td>
<td>-0.1* (0.03)</td>
</tr>
<tr>
<td>Commercial area</td>
<td>0.2*** (0.02)</td>
<td>0.1** (0.1)</td>
</tr>
<tr>
<td>Green area</td>
<td>-0.03*** (0.02)</td>
<td>0.000 (0.01)</td>
</tr>
<tr>
<td>Residential area</td>
<td>-0.1*** (0.01)</td>
<td>0.01 (0.02)</td>
</tr>
<tr>
<td>Public transit stops</td>
<td>0.1*** (0.01)</td>
<td>0.04*** (0.01)</td>
</tr>
<tr>
<td>Drug addiction facility</td>
<td>0.8*** (0.2)</td>
<td>0.6*** (0.2)</td>
</tr>
<tr>
<td>Population count</td>
<td>0.01*** (0.000)</td>
<td>0.01*** (0.000)</td>
</tr>
</tbody>
</table>

| Variables at the level of neighboring grid-cells | | |
|--------------------------------------------------|--|
| School                                           | -0.02* (0.01) |
| Major Road                                       | 0.01*** (0.001) |
| Railway                                          | 0.003*** (0.001) |
| Park                                             | 0.02*** (0.01) |
| Commercial area                                  | 0.02** (0.01) |
| Green area                                       | -0.004** (0.002) |
| Residential area                                 | -0.03*** (0.003) |
| Public transit stops                             | 0.01** (0.004) |
| Drug addiction facility                          | 0.6*** (0.1) |
| Population count                                 | 0.000*** (0.000) |
| Constant                                         | 0.1*** (0.01) |

| Observations                                     | 16,248 | 16,248 |
| R2                                               | 0.2    | 0.2    |
| Adjusted R2                                      | 0.2    | 0.2    |
| Residual Std. Error                              | 1.0 (df=16237) | 1.0 (df=16227) |
| F Statistic                                      | 382.6*** (df=10;16237) | 223.4*** (df=20;16227) |

Note: *p<0.1; **p<0.05; ***p<0.01
There is also a little lower risk for motor vehicle theft in cells with green areas, most likely because of a small number of vehicles and/or potential offenders here. The presence of railways or a school in a grid cell does not have a significant impact of the probability of motor vehicle theft, but there is a (small) change in the probability in neighboring grid-cells, negative for schools and positive for railways.

A (small) positive correlation is found between motor vehicle theft and public transit stops, major roads, commercial areas and parks in both the actual cell these variables are located, and close to them.

The largest coefficient for the significant variables in these two regression models is found for drug addiction facilities. In the grid cell where these facilities are located the probability raises with 0.8 crime, and for the neighboring grid-cells with 0.6.

### 5.3 Summary

Environmental criminology provides both theoretically and empirically a strong expectation about crime to be spatially concentrated (see chapter 2 and 3) and this is something my empirical findings show too. However, the analysis of burglaries and motor vehicle thefts in Oslo do not confirm that all crimes are necessarily spatially concentrated at only a few places in a city, and it highlight an importance of crime specific analysis and evaluation. Commercial burglary is tightly coupled and concentrated at very few grid cells, while residential burglary and motor vehicle theft is not – they are more spread across the whole city even if some hot spots are visible.

The expectation about crime to be most concentrated around accessible areas or mass activity nodes containing many crime generators, or in more disadvantaged locations are met to some degree. All crimes are higher in the central area, but crime generators also seem quite crime specific. The presence of schools, drug addiction facilities, main roads, railways, public transit stops and some variables of land use (greens, parks, commercial- and residential areas) were used in the regression analysis, since earlier research pointed towards these as likely to generate or attract crime. My empirical findings show commercial burglaries are most concentrated in (central) commercial areas and occur more often by railways or other public transit stops – while reports of residential burglaries are most prominent in central
disadvantage areas and/or close to major roads and parks. There is a higher probability for motor vehicle theft in grid cells with drug addiction facilities, public transit stops, major roads, commercial areas, parks – but especially prominent in the busy downtown area.

An interesting finding is how drug addiction facilities was only a significant variable in the regular OLS regression model for motor vehicle crime, but the second regression model controlling for a queen’s case (figure 2) showed how it was strongly significant for neighboring grid-cells for all different crime types. The presence of a school showed no significant relation to any of these crimes, which is also interesting since it is often assumed to impact crime rates (see part 3.5).
6 Discussion

For environmental criminologists, “opportunity makes the thief” is more than just a popular saying – it’s the cornerstone of their approach (Cornish and Clarke, 2003). As seen in the second and third chapter of this thesis, scholars in this tradition highlight how the environment regulate not only targets available but also the possible activities people can engage in people’s perception about effort, risks and benefits of the opportunities they are provided. Offenders are thought of as making their choices to engage in and commit crime based on these perceptions of opportunities, thus, prevention and reduction of crime would in theory be easily achieved by changing the environment and/or the potential offenders’ perceptions of the crime opportunities within it. For this to be even a reasonable way to prevent criminal activity one must assume that what’s “past is prologue” – that we can use past experiences of crime to understand where crime will happen in the future. Environmental criminologists and policy makers adopt this way of thinking when they argue one can identify and understand spatial patterns of unwanted acts to address crime and disorder in at places (Clarke and Eck, 2014, Andresen, 2014, Weisburd et al., 2016, Santos, 2016, Ferguson, 2017).

The aim of this thesis was to explore this thoughts by using theories and previous insights provided in this field to investigate if property crimes are clustered and tightly coupled at certain places in Oslo, Norway, and if specific environmental characteristics highlighted in earlier studies seem to contribute to a higher amount of crime at places. Before I deliberate on my empirical findings about burglaries and vehicle thefts spatial patterning, important ecological variables and these findings practical, theoretical and methodological implications, the validity and reliability of my research is evaluated which is vital to be able to consider any prevention tactics and suggest future research.

6.1 Validity and reliability

Validity refers to whether data accurately reflects the concept they are intended to measure, and for any crime analyst, the methods and results are only as good as the data used (Santos 2016). Since I examine data of registered crimes my results are subject to the standard limitations of these kind of data. One of the biggest concerns regarding the use of any official crime data is that it may reflect merely “what is known to the police” or be a better
measurement of police activity than represent the actual crime in a society. The total amount of actual crime is unknown, and the spatial distribution mapped here is of crimes reported to, or initiated by, law enforcement. Other similar issues with this data is that some reported crimes might get a new definition after investigation, and knowledge about time, date and place for the occurrence might to some point be uncertain. However, property crimes have in general a much greater level of reporting to the police than other crime types, and given victims need for documentation for insurance purposes it is likely that incident details of burglary and auto theft is reported fairly accurately (Clarke and Eck, 2005) and it is therefore reasonable to assume the analysis is representative for the actual patterning of these crimes. Registered crime data is the most complete data available and a very popular dataset in the spatial criminology literature because of the details provided. It has also proven to be incredible instructive for hot spot analysis and preventive purposes (Andresen, 2014), which also indicate accuracy.

Reliability is also extremely important for data analysis and refers to whether data measures the same in repeated observations. Policy and law changes could result in a sharp increase of decrease in the empirical examination because the data does no longer represent the same phenomenon. This would of course significantly affect the reliability of the analysis result, and therefore data of all reported crime before the big change in the criminal law and registration practice in October 2015 in Norway is excluded. For more on different effort made to ensure the quality of the crime data see chapter four.

The additional environmental variables used are collected in 2018, and the exclusion of older crime data is also important to minimize this time differences between criminal event data and census data (Andresen, 2014). My additional data is biased towards variables already found to be important crime generators and crime attractors in previous research and what is available for researchers, which implies that other reasonable criminogenic variables might be excluded that could give further understanding of spatial crime patterns. This is usually called “the issue of unknown unknowns” (Logan, 2009); there is always a possibility of new variables that have not been considered or even defined is critical to the outcome. A limitation is nevertheless always necessary, and my choices is both theoretically and empirically driven (see chapter 2 and 3), and the data is collected from reliable sources (chapter 4).

Limitations mentioned above have been kept in mind during this whole project and will be remembered throughout the discussion of my results.
6.2 Empirical findings

During the last decades, environmental criminology has showed both theoretically and empirically that place matters for the crime equation (e.g. Sherman et al., 1989, Weisburd et al., 2016, see also chapter 2 and 3 of this thesis). The mapping done in this study also visualized that, clearly, some areas are more exposed to crime and confirms this statement; place do matter. But many questions remain; does a few places matter the most? and if so; why do these places experience more crime than others?

6.2.1 Concentration tightness vary

Crime mapping studies have previously revealed how crime clusters vary in both its form and size, and if events are tightly grouped or more dispersed within hot areas. Even so, central environmental criminologists today conclude that the 80/20-rule will apply for spatial crime distributions, and Weisburd and his colleges (2012, 2015) goes as far as claiming that “the concentration of crime will fall within a narrow bandwidth of percentages for a defined cumulative proportion of crime” is a general law of crime concentration at places – implying crime in smaller cities in other countries than where these studies were undertaken, will follow this pattern too.

When investigating the spatial distribution of property crimes in Oslo one could quickly make a seemingly accurate interpretation of the initial maps that crime here does follow this law. The mapping of all reported property crimes between October 2015 and May 2018 showed a spatial distribution pattern that was easily recognizable as a small elevated dot in the downtown district. Even when other crime than commercial- and residential burglary and motor vehicle theft was excluded in the plot and only these three plotted together, the same pattern appeared. Mapping of different time spans or capping of extreme values did not change the strong concentration of crime downtown. Nevertheless, one of the main methodological issues of density mapping and other quantitative work in this tradition is the ecological fallacy and how a strong visual relation could easily be caused by spurious correlation, aggregation choices or the unit of analysis. When this was considered and the three crime types were plotted individually, it was clear that differences in the spatial distribution between these crimes had in fact been shadowed in these initial plots by a very much higher amount and tighter spatial clustering of commercial burglaries.
Residential burglary and motor vehicle theft showed a much larger spread throughout the city, and the examination of the 80/20-rule for each crime individually demonstrated that what we could visually interpret was true; a tight spatial concentration of crimes according to the 80/20-rule was only evident for commercial burglaries. For these, 11.7% of the grid cells accounted for 80% of the reported crimes between October 2015 and May 2018. Even if some areas of Oslo also have a higher amount of residential burglaries and motor vehicle theft too, this rule did not apply unless a large amount of grid cells that had no reported crime during this period was included. We had to more than double the amount of grid cells in the analysis (use 7135 cells instead of the initial 2690 for residential burglary and 8770 cells instead of the initial 2902 for motor vehicle theft) to reach a result of 20% of the cells to account for 80% of these crimes. If we use only grid cells that experiences at least one of these crimes during the 2.5 years evaluated, we must look at a between 53-60% of the grids to find 80% of the reported residential burglaries and motor vehicle theft. Of course, if all 16248 cells (covering the total area of Oslo) are included in the calculation, a very small amount of these cells will account for 80% of the crime – but that one need to use goodwill and include grid cells with no experience of crime to validate the 80/20-rule and Weisburd’s law of crime concentration at places raises some questions.

When Weisburd and his coworkers (2012) argue for a clear concentration of crime that confirms a few places account for most of the crimes in a city, they also aim at confirming these patterns are stable over time. When evaluating this stability, it is however noticeable that the eight of the 18 trajectories that show highest degree of stability in this study evidence low levels of criminal events. It is suggested these trajectories might have some sort of characteristics that discourage crime that we should identify for prevention benefits. This might be true, and if so, it is vital information for crime prevention. Nevertheless, the scholars do not investigate this further, and most importantly; they do not discuss whether it could be a result of an actual lack of crime opportunities in these areas. If environment control both the presence of targets, offenders, activity – thus crime opportunities – it could be argued places with very few people or where crime might not even possibly happen should not be included in the analysis at all because it might produce exaggerated and misleading results. Since Weisburd’s unit of analysis is street segments, it is very possible there won’t be opportunities for all crimes at all streets in a city.
It has been stated by other scholars that ‘removing zero value spatial units of analysis is a critical step in the analysis to ensure improper inference is not being made, especially in the context of spatially-specific crime prevention interventions’ (de Melo et al., 2015). By using only places where at least one crime has been reported during the time period one investigate, we can be sure some sort of crime opportunity is apparent here, which gives the analysis much higher validity.

When all grid-cells without any reported crime experience is excluded in the analysis of burglaries and vehicle theft in Oslo, Norway, we do not find a clustering according to the 80/20-rule for all crime types. The “law of crime concentration at places” is built upon the tenet that a few places account for most of the crime in a city and claims stability in this pattern. It is suggested as a ‘general law’ and consequently transferable to other cities and countries as well (Weisburd et al., 2004, Weisburd et al., 2012, Weisburd and Amram, 2014, Weisburd, 2015, Weisburd et al., 2016). Yet, the main finding in this empirical study in Norway is that although there clearly are some degree of concentration of property crimes in Oslo, the 80/20 rule does not really hold.

What is also surprising is the use of aggregated crime types in studies where Weisburd and his colleagues research crime concentration (Weisburd et al., 2012, Weisburd and Amram, 2014) It is widely acknowledged that in general, crime specific research is fundamentally important to determine which type of hot spot method should be used (Eck, 2005) and even crime that share many traits such as different types of burglary logically occur at different environments. Lately is has been highlighted that we should therefore avoid aggregated crime group categories such as ‘property crime’ or ‘violent crime’ (Andresen and Linning, 2012, de Melo et al., 2015). These studies and the empirical analysis of this thesis clearly shows crimes should therefore be examined separately if environmental factors are of interests. Most spatial research and experiences from preventive work show exactly how different types of crimes have different spatial relationships, dependencies, structures and distributions – which are the result of different social and spatial processes over an area because of places unique characteristics (Eck, 2005). Already in their early work that was important to the very funding of modern environmental criminology, Brantingham and Brantingham (1993) stated each crime type must have different flowcharts dealing with the specific nature of that crime. It is therefore surprising how central academics in this very tradition creates a law of crime concentration at places without being specific enough in their crime aggregating choices.
As seen, crimes spatial distribution and the level of concentration could be misinterpreted both by this type of crime aggregation and the choice of including places that might not even include actual crime opportunities. Missing important differences in the spatial patterns could have consequences for situational crime prevention measurements, that we have seen is dependent on a very detailed knowledge about specific crime opportunities (e.g. Sherman et al., 1989, Clarke and Eck, 2005, Knutsson and Clarke, 2006, Clarke, 2010, MacDonald, 2015, Eck and Spelman, 2016).

Even if the different crimes in Oslo are not as tightly concentrated at places as the 80/20-rule implies, there is some visual hot spots in the city experiencing higher crime rates than other places. Some degree of concentration is thus visible, and some places are “hotter” than others – but what environmental factors contribute more specifically to a higher amount of crime in these areas?

6.2.2 Environmental characteristics of hot spots

As noticed in the second and third chapter of this thesis, criminologists have been rattled with the question of what makes some places seem more criminogenic than others for decades and in the tradition of environmental criminology, shared pathways and nodes are one of the ways in how environmental criminologists make sense of how the urban form and structure plays a role in the shaping of (criminal) activity patterns (e.g. Brantingham and Brantingham, 1981). To sum up some important theoretical standpoints of this tradition, and specifically the crime pattern theory, hot spots are said to occur because places function as crime generators (makes a large number of potential offenders and targets converging in time and space) and crime attractors (attract motivated offenders because of known criminal opportunities in the area) (Brantingham and Brantingham, 1993).

Generators for commercial burglary

The expectation from the crime pattern theory (Brantingham and Brantingham, 1993) that crime would be most clustered around crime generators where confirmed in this study. Especially for commercial burglaries, the concentration was higher in the downtown area where many shared activity nodes are present that creates a large flow of people and the largest commercial areas are to be found that logically creates a high amount of crime opportunities for this kind of burglary. The cluster is strongest at the central district
characterized with many factors that is usually thought of as crime generating are gathered (such as shopping malls, public facilities, public transportation networks), and the hot spot stretches out toward shopping streets connected to this central district.

Quite logically, “commercial area” is the most significant environmental variable for a higher probability of commercial burglaries in Oslo, which make sense because of the high number of targets here. Yet – an exploratory plot (excluded here because of space limitations) showed other areas in Oslo where many opportunities for commercial burglary gathered did not experience as high amount of crime compared to the areas downtown. Even with a lowering of extreme values in the central area, bigger shopping malls in the outskirt of town did not distinguish them self as hot spots in the heat mapping. This indicate that not only a concentration of crime opportunities is driving up crime rates, but it is the combination of a high volume of people in places that contains many crime opportunities is what generates the largest amount of commercial burglaries. This strengthen the journey to crime-literatures claim and the importance of the accessibility of crime opportunities (chapter 3). People don’t make the extra effort and travel far to look for, or commit, crimes. Rather, as the routine activity perspective and environmental criminology in general states; crime is a by-product of law-abiding activity and happens when people notice crime opportunities at places where they spend their leisure time or travel by on their way to their daily routines (chapter 2). It seems like it is because of these malls’ location further out from many people’s daily pathways and main activity nodes they don’t generate as much crime even if the opportunities are present.

The crime triangle (Eck, 2005) states that a convergence of a motivated offender, a target and the absence of guardianship is what creates a high risk of crime. Another possible explanation could then be that motivated offenders commit more commercial burglaries downtown because the guardianship of targets and general security is lower be less here, but in Oslo central area it is large amount of surveillance, and commercial stores and malls here also have burglar alarms, guards and many other security measurements just as shopping malls outside of this district. It thus seems more likely it is the offender-part of the triangle that differ between these locations and that the probability for commercial burglaries seems highly impacted by the volume of people in an area. The population count in each grid cell is highly significant, and as mentioned, also a large public transportation network generates a high volume of people at the largest hot spot downtown. A correlation between commercial burglaries and the existence of railways and public transit stops in the same grid cell is found,
and the probability for commercial burglaries is also larger in areas close to public transit stops. These variables are used to look closer at the importance of accessibility to crime opportunities, which thus seems vital. However, major roads that could also indicate accessibility show a negative effect on this type of crime. One could interpreted this finding as if potential offenders use public transit alternatives more than their own vehicles for this type of crime, since offenders might not require a vehicle for the escape or to move stolen items. It could also be that public transit stops and railways raise the probability of commercial burglaries because they function as shared activity nodes and their most significant attribute are that they are usually gathered or more common in central district and by shopping streets where we have seen crime cluster, while major roads are more common in the outskirt of, or around Oslo. Commercial areas, public transit stops and railways thus function as important crime generators by bringing together a high amount of people and targets in space and time.

Previous research has in addition to crime generators as these highlighted both drug addiction facilities and schools as an indicator of more potential motivated property offenders in an area (e.g. Weisburd et al., 2009), but the regular OLS model of commercial burglaries in Oslo (table 1) showed no significant effect of the presence of either of them. Importantly, just because a variable does not show up in a particular model does not mean that the variable is not an important factor for the crime (Perry et al., 2013). If a variable impact the probability of crime in areas further away from the variable’s location than in a radius of a 100 meter, the first regression model used here that measure only the grid-cell might miss this relationship. To control for any spatial lag effect and impact on neighborhood grid-cells, the spatial lag regression analysis was added for all three crimes. This regression model showed that for the presence of a drug addiction facility has a positive significant effect on neighboring grid-cells, which means that it is a higher probability for commercial burglaries in areas close to a drug addiction facility, but not in the actual cell these are located in. This could indicate these facilities creates a flow of more potential offenders to or through neighborhoods nearby, or that they are located close to areas that in some other way generate crime or attract offenders.

To summarize, the analysis shows, as expected, a higher probability of commercial burglary in central areas with a converging of many targets and a high volume of people, especially areas that are easily accessible by public transportation and/or close to drug addiction facilities.
Generators for residential burglary

Residential burglary and motor vehicle theft too, showed some expected results of a higher clustering in more central areas and places that most certainly creates a high and constant flow of people, even if the spread in these crimes spatial distribution was larger in general. Noticeably, it is also a larger spread of crime opportunities for these crimes, since residents and vehicles are spread all over the city.

The heat map for residential burglaries visualized how more affluent areas experience less residential burglaries, and that the suburbs and more rural areas in the outskirt of town are less exposed to residential burglaries illustrate how people don’t travel an extra distance to commit crime even if the reward might be higher here. Fundamentally, the downtown area has more crime opportunities in a small area too since it consists of more multi-family houses and apartments, which also might be a reason for a higher number of residential burglaries here. Yet, the difference in crime concentration in the downtown area makes this conclusion seem a bit too simple. The heat mapping shows how affluent areas to the west of Akerselva experience less residential burglaries. Both the west and east areas have many apartments and therefore many crime opportunities, and are both as close in distance and as accessible for people through major roads, public transportation etc. The fact that the eastern areas suffer more from crime could therefore not be explained by accessibility of crime opportunities, but the pattern is possibly also a confirmation of the above discussion of the offender’s crime calculation of rewards and the effort of travelling. If one assumes more potential burglars live and spend their time at less affluent part of Oslo, the higher concentration of crimes on the less affluent side of the river might simply be a spatial distribution that shows how they don’t travel out of their awareness space. People then rather commit crime close to their home or during daily routines as previous research suggests. This can’t be controlled in my analysis because of the limitations caused by missing offender data, but theoretically this would be a result of people’s perception of a higher effort and risk of committing crime at unfamiliar places. It could also be that they simply take advantage of crime opportunities they stumble upon during their routine activities instead of actively seeking to commit a crime or look for burglary opportunities that gives a higher reward. Earlier work on offender choice that had more available data on offenders’ home location, routine activities and their own description of the crimes could analyze this further and have highlighted how familiarity of an area or specific targets is more important than the actual reward (e.g. Vandeviver et al., 2015) and
that many commit crimes because they pass by an opportunity or a perceived suitable target (see part 3.2 and 3.3).

If a “hot target” is not necessarily based only on the potential offenders perceptions of the reward of the crime, but more so the effort of traveling to the residents or the risk of committing it, a higher security in wealthier parts of the city might also contribute to an avoidance of these areas and targets – which is the general finding of the testing of the security hypothesis (Farrell et al., 2011, Tilley et al., 2011, Tseloni et al., 2017). Newman (1972) showed in his early spatial study of crime how taller tower block generally has a higher crime rate, and said these blocks invited to crime because residents did not know their neighbors and the design of the buildings did not make it easy to exercise any efficient supervision of your neighbors’ apartments. Christie (1975) showed how social closeness and dependency between people in a “tightly knit” society could have an important crime preventive effect and raise primary control in an area. If the design of apartments does not allow for an overview by residents of their neighbors’ properties, primary control might not be possible, and this could explain why suburbs experience less residential burglary than central apartment areas. But what it does not explain is the differences between crime rates between downtown areas. Christie (1975) claims primary control is more effective than secondary control because it arrives early, often spontaneous, while the secondary is re-active and more time-consuming. However, critical voices have highlighted how Christies typology might not fit the order of modern cities (Johansen, 2000) and at least the downtown area could most likely be characterized as a “loosely knit” society today, where primary control might not be a very imaginable option. Secondary control is usually established as an answer on problems where primary control is not possible (Olaussen, 2007) and it is reasonable to believe apartment buildings in more well-off central areas have more static surveillance and secondary control. Noticeable, these secondary control techniques are highly developed, more pro-active and less time-consuming since Christies (1975) theory was written, and today this type of (preventive) secondary control seems efficient – as the security hypothesis assumes (Farrell et al., 2011, Tilley et al., 2011, Tseloni et al., 2017), especially for burglary (e.g. Nee, 2015, Vandeviver et al., 2015, Tseloni et al., 2017, Sidebottom et al., 2018).

That the regression analysis show a higher probability of residential burglaries where major roads and parks are found could indicate that burglary is an opportunistic crime that are more likely to happen when the opportunity arise as people pass by during their daily activity or see
a chance of entering a building without breaking in to the main entrance. Since there is no significant outcome of public transportation in the regression analysis for residential burglaries, it could be major roads also indicate easy escape roads and that offenders usually use a vehicle to get away with bigger items or without getting seen. If one uses vehicles more than public transportation, parks would also be an easy and accessible place to park while committing the burglary. It thus seems like the accessibility, but rather by car than public transport, is important for residential burglary. The volume of people and the number of residents is vital, and just as in the case of commercial burglaries, the probability of residential burglary raises significantly in areas close to drug addiction facilities, but schools show no correlation.

**Generators for motor vehicle theft**

As mentioned in the last section, the spread of motor vehicle thefts across larger parts of Oslo could be explained by a large spread of crime opportunities for this crime. Vehicle theft are more evenly distributed in all central areas than residential burglary, and considering earlier research findings highlighting open parking lots and parking places with less security as most crime prone (Tilley, 1993, Clarke and Goldstein, 2003, Welsh and Farrington, 2009, Fujita and Maxfield, 2012), this might be a result of the city’s very limited amount of off-street parking and the fact that it is always many cars parked out on the open streets across all urban neighborhoods.

The most prominent hot spot of vehicle theft in Oslo is seen in the central area and stretches up towards other busy central areas, Majorstuen and Grünerløkka, and the west-east side characteristic seen for residential burglaries is gone. The accessible central areas are all hit by vehicle theft which could be interpreted as the security of affluent resident don’t have as large impact on this crime. This might be because unprotected vehicles in the streets are a prominent characteristic of both east and west areas of central Oslo. The pattern here instead show less vehicle crime is reported where less people travel through daily, and where single-family houses with their own parking spot and/or garage are located which significantly raises the effort and risk for the offender since also the car is secured at these residents. Residential areas did show a negative relation with the crime rate of vehicle theft which indicates a strong opportunistic character, and a higher significance of the effort and risk-factors than the one of rewards. People doesn’t seem to travel out from their regular activity nodes and awareness
spaces to take a more expensive car. The regression analysis instead showed a positive
correlation between public transit stops, major roads, commercial areas and parks. There is
always a high number of cars parked close to where many bus- tram- and tube stops are
located, as well as by parks and commercial areas – which could easily explain this relation
with the crime generating term – this is a straight forward opportunistic explanation as the
availability of cars (crime opportunities) where people travel through makes the probability of
crime higher. It is possible many park by major roads too, but that major road makes an
escape with a newly occupied car easy might also explain the strong correlation between
motor vehicle theft and this variable.

The correlation between motor vehicle theft and drug addict facilities is the strongest of all
correlations in the regression analysis of this crime (model 3). This variable was included
because of the thought of it impact of a higher number of potential offenders in the area,
which has been showed as an important feature in environmental criminology and in
neighboring grid-cells for the other crime types in this thesis. For motor vehicle theft, drug
addiction facilities the probability for crime was higher both in the area where these facilities
are located and in neighboring grid-cells. Because of the strong correlation with vehicle theft,
I decided to look closer at this and plotted drug addiction facilities as a layer on top of the
result of the crime mapping of this crime in an exploratory map (excluded here because of
space limitations). This clearly showed the drug addiction facilities where not placed right in
the central of the hot spots, but at the end of the two wings of the V-pattern we saw the
concentration of vehicle theft in figure 7. If this variable is highly significant because of the
residents of drug addiction facilities, it is plausible these potential offenders are moving from
their overnight facilities toward the central area during the day as most people do. As
mentioned earlier, no offender data is accessible here, but if we assume people living in these
facilities are more likely to commit these crimes, as emphasized in previous research, and that
these homes and the down town area of Oslo is their main activity nodes – the distribution of
high crime in between these nodes and the high probability of crime in and close to these
facilities indicate a strengthening of environmental criminology in general and more
specifically the routine activity- and journey to crime-perspective; that potential offenders
stumble upon vehicles they perceive as suitable to steal or break in to during their daily
activity because of a low risk and/or effort. Another explanation could be drug addiction
facilities are just usually located in and close to areas were a high volume of people constantly
move, and many vehicles are parked on the streets.
The number of juveniles has also been used in spatial studies to measure the number of motivated offenders in an area (Weisburd et al., 2009), and schools are regularly highlighted as having great potential for crime prevention because they provide regular access to the young population (Gottfredson et al., 2002). Nevertheless, neither the regular regression model (measuring schools impact on crime within the same grid cell as the school is located) or the spatial lag model (measuring neighborhood effects in grid cells surrounding the school) showed any significant relation between the presence of a school and higher crime probability for any of the crimes investigated in this thesis.

6.3 Summary

Environmental characteristics in the city constrain human activity and provide specific opportunities for crimes in certain areas. This is the main reason environmental criminology put forward for why and how place matters for crime patterns and crime prevention, and some places more than others (e.g. Sherman et al., 1989, Weisburd et al., 2016).

The study of commercial- and residential burglary and motor vehicle theft in Oslo, Norway, shows that the main reason that some places experience more crime than others is a convergence of a large amount of crime opportunities in areas where there is also a high volume of people. This is basically driven by the land use and peoples’ law-abiding activity pattern. This confirms the importance of the term of some areas as crime generators – their characteristic brings together a large number of potential offenders and targets, which creates a high probability of crime here. The most important environmental characteristic for crimes spatial patterning thus seems to be the concentration of shared routine activity nodes for people that creates this flow through certain areas that contain specific crime opportunities. When these characteristics cluster in an area – so does crime.

Hot spots of crime are present for all three crime types in Oslo, but the spatial distribution and the level of concentration differ between them. Logically, crime opportunities differ somewhat for different crimes (Sherman et al., 1989, Clarke and Felson, 1993, Eck, 2005) and the land use of an area will consequentially produce crime specific opportunities and hot spots of crime, making place matter (Weisburd et al., 2016). But as emphasized by Sherman and his colleges (1989) already 30 years ago – to what degree some places matters more than others is crime specific. Consequently, one should be careful with aggregations across crime types or
making statements about crime concentration coupling if the analysis is not specific enough. The empirical analysis of property crimes in Oslo indicate that when crime opportunities are spread more widely across areas that many people travel through or spend their time, crime is also more widely spread throughout the city. For some crime types, the results showed a lower spatial concentration tightness than expected. Residential burglaries and motor vehicle theft in Oslo does not follow the 80/20-rule (or the law of crime concentration at places) unless we alternate the calculation and include a very large amount of grid cells that we know has never experienced crime – which could be seen as a strong indication of that crime opportunities is not even present in these grid cells, which makes them less valid for analysis.

Environmental criminology also highlights how the environment interact and change the crime template to potential offenders (see figure 1 and; Brantingham and Brantingham, 1993). The empirical result of the spatial distribution of residential burglaries and vehicle theft showed how reward does not seem to be the most important feature of a crime opportunity, but more specifically how peoples’ perceptions of effort and risk seem to be vital. “Hot targets” are thus not necessarily the ones that equals a high reward, but the ones that people perceive as requiring less effort and/or that involves less risk. The analysis showed how people seem to commit opportunistic crimes in their awareness spaces, thus the journey to crime is short. The most “crime attracting” features that might lead to a decision making of committing crime for potential offenders seems to be a high accessibility of targets. Accessibility could here point to both close in distance or low effort or risk – findings that aligns with the journey to crime-literature (see part 3.2).

6.4 Implications

My explorative and descriptive study of spatial distribution of burglaries and vehicle theft in Oslo confirmed the importance of environmental criminology as a research field. As this tradition states, place characteristic brings together many potential offenders and crime opportunities in space and time which makes land use and environmental variables highly important for crime studies.

An important finding in Oslo, with direct methodological implications, is that the spatial pattern and the concentration tightness is highly crime specific, and not all crimes concentration follow the 80/20-rule. A subset of recent research has previously shown that
spatial crime concentration patterns are different across crime types and raised questions regarding the appropriateness of aggregating crime types such as for example property and violent crime (e.g de Melo et al., 2015, Andresen and Linning, 2012), and the results of this empirical analysis of different property crimes in Oslo does not bode well for the use of the quite common “property crime”-assembly when wanting to raise our knowledge about crime opportunities and environmental variables impact on crime. Not even “burglary” composed as a group is beneficial considering the empirical finding of different spatial patterns and a huge difference in the level of concentration for commercial- and residential burglary. Only when different property crimes were mapped and analyzed separately, we could observe vital spatial facts for the specific crime that are informative and reliable for research and any following policy discussions. If not separated, the mapping easily leads to a misinterpretation caused by spurious interference, which gives a clear implication for place-based crime analysis and prevention measures that we must be very crime specific. This might not sound very controversial and scholars in the theory of situational crime prevention has, amongst others, long recognized this (e.g. Clarke and Cornish, 1985, Felson and Clarke, 1998). But, as for example Andresen and Linning (2012) and de Melo et al. (2015) also argues – groups such as ‘property crime’ or ‘violent crime’ should also be disaggregated in spatial analyses. Yet, many spatial criminologists has not done so, and strong assumptions in the field are based on empirical research that might suffer from this very methodological fallacy of crime type aggregation as well as an inclusion of micro-units that might skew any concentration-result and make crime look more clustered at places than what actually might be the case. One primary example of this is Weisburd’s and his colleagues (2012) “law of crime concentration at places” that is a geographical application of the 80/20-rule that states that “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”. They advocate this law as applicable across different cities as well as within them, but this thesis showed how this was not the case for residential burglary or vehicle theft and might merely be an effect of methodological choices. The rule did not apply for these crimes in Oslo unless one used a crime type aggregation or included a large amount of additional zero value grid cells (grid cells with no reported crime during the years of analysis) – which could be argued to make the cumulative percentage-count of crime at places to show exaggerated or misleading numbers (part 6.2.1).
A general finding for all crime types in my thesis was how areas where less people travel through or spend time regularly is also less exposed to crime even if the area might contain many crime opportunities. In Oslo, commercial areas that people don’t regularly pass is not as hard hit by commercial burglaries than the ones downtown, and suburban areas experience way less residential burglaries than central areas even if the reward might be higher here. This implicate people seem to take advantage of crime opportunities in their awareness space during their daily routine activity, instead of making an extra effort of traveling a long distance to crime. This strengthen the underlying thoughts of humans as making a utilitarian calculation of whether to commit a crime during their law-abiding activity (Cohen and Felson, 1979). It is essential to mention that even if this theoretical tradition understand all people as potential offenders (see part 2.3.1), rational choice theory - and therefore environmental criminology in general - could be understood as suggesting that individuals will not commit crimes when the right opportunity is missing. The calculation is both subjective and highly contextual and most importantly; rewards and benefits of committing a crime must out-rule people’s perceptions of effort and risk of committing the crime for them to engage in the illegal activity (Clarke and Felson, 1993, Cornish and Clarke, 2008). The fact that the environment prime people’s crime calculating thoughts during their regular activity and influence their perceptions of crime opportunities has important implications for crime prevention, as an alteration of the environment might change their perceptions and calculation of the opportunities and result in less crime.

It is known from other criminological fields the perception of getting caught is more important than the severance of the punishment and that an alteration in perception of risk has a high preventive effect on potential offenders (Sherman, 1990, Sherman, 1993, Sutherland, 1940). Environmental criminology has also highlighted this as one of the most important crime preventive aspects, and the findings of this thesis support the thought of risk as a prominent factor in peoples’ utilitarian calculation. Motor vehicle crimes are spread in all central areas of Oslo while residential burglary is more concentrated in less affluent ones. The fact that cars are usually parked unsecured in the street across all neighborhoods in Oslo, while built-in security etc. is more likely higher in residents in affluent neighborhoods, could contribute to this difference in the spatial patterning between the two crimes. That the suburb and affluent central areas are less hit by residential burglary also indicate that risk and effort (of a potential higher security here or of traveling outside familiar places) weights more than potential higher rewards of a crime. This gives a strong implication that crime prevention
could be reached by altering or controlling the physical environments to make crime harder and riskier to commit. Particularly for property crime, the likelihood of arresting suspects, and therefore also the perceived risk of committing a crime, is low, and this is one reason for why police responses to property crime patterns focus more on deterring offenders by encourage potential victims to protect their property, and less in arrests. As stated by environmental criminology 30 years ago: It is far easier to modify the routine activities of places than people (Sherman et al., 1989) and if we can modify crime opportunities by modifying how people routinely use the environment, the potential from crime reduction and is significant (Cornish and Clarke, 2003, Clarke and Eck, 2014, Perry et al., 2013). Taking action on hot spot with crime mapping through control agencies also poses minor challenges compared with the civil and privacy rights concerns that arise when applying similar techniques to finding “hot people” (Perry et al., 2013). Securitization of potential targets (target hardening) is important to increase both the effort and risk of a crime (Farrell et al., 2011, Fujita and Maxfield, 2012, Tilley et al., 2015, Tseloni et al., 2017), and if implemented correctly we would assume less people to take advantage of crime opportunities (Clarke and Felson, 1993, Cornish and Clarke, 2008, Kinney, 2010).

Environmental criminology and especially situational crime prevention-studies already offers potential victims, city-planners and policymakers a huge number of specific techniques of target hardening one can use to prevent specific crime (e.g. Clarke and Eck, 2005) and they have also already contributed notably with improvement in crime preventive measures for control agencies as the police (Ferguson, 2017, Weisburd et al., 2016). Research and evaluations of implementations show how evidence-based policing has great potential for crime prevention, especially if implemented at specific places and for specific crimes together with CTED-applications and careful informed city planning (Braga et al., 2014). It is possible that Oslo will suffer less from motor vehicle theft in the future, when the policy of a “car-free-city” is implemented fully and opportunities for vehicle crime where people spend their time will largely disappear. But, the contemporary urban developments in Oslo highlights major residential and commercial areas will be located foremost in the inner city and close to public transport nodes – which is shown to be important generating characteristics of places that raise the probability for both commercial and residential burglaries. Here, burglary hot spots might be strengthened, or new ones develop, and it will be important to ensure new buildings are properly secured and assess how different control actors could cooperate to prevent or reduce burglaries at these places.
7 Conclusion

In contemporary western countries, a dominating trend of professionalization and evidence-based policing have lately emerged from an enforced pressure toward crime prevention measures (Mohler et al., 2015, Ferguson, 2017, Tilley and Laycock, 2018). The police force in Norway has undergone huge reforms and continuously get pushed to make better use of technology by adding predictive data-analyses in their daily operational work to calculate risk associated with specific areas (Gundhus, 2018). Greater efforts are put into equip the police with information and tools needed to accomplish these new tasks alongside their old ones. But, regardless of the type of crime preventive intervention and who’s carrying it out, we need to investigate if and where crime cluster as well as gaining a full understanding of why an area is more exposed to crime than others to execute this work successfully.

The field of environmental criminology is specifically designed to complement other criminological theories by addressing the role of the interaction between the individual and the environment (Brantingham and Brantingham, 1993, Andresen, 2014, Santos, 2016). Collectively, the theories of this field provide a representation of the whole environment of which the crime occurs within; the social environment (routine activity theory), the built environment (geometric theory of crime) and the cognitive environment (rational choice theory). Scholars of this tradition therefore look at how the immediate environment influence peoples’ preservation of their action alternatives and their choice about (not) committing crime based on anticipated efforts, risks and rewards of their actions (e.g. Clarke and Cornish, 1985, J. Buck et al., 1993, Brantingham and Brantingham, 1993, Felson and Clarke, 1998, Cornish and Clarke, 2003, Clarke and Eck, 2005, Bernasco, 2010, Vandeviver et al., 2015, Townsley et al., 2015, Nee, 2015).

This field is now the fastest growing approach in criminology, and the practical implications (situational crime prevention) gain larger acceptance and influence by the day, and is viewed as a well-placed respond to the increasingly global, organized and technologically assisted nature of crime in the twenty-first century (Wortley and Townsley, 2017). With technical development, crime analysis of this tradition has become more detailed and scholars are focusing more on micro-units of analysis, like specific locations that have disproportionate volumes of criminal events (hot spots) in places within nations, cities or neighborhoods that are said to have tremendous potential for crime reduction and prevention.
Drawing on the theoretical framework of the meta theory in environmental criminology (crime pattern theory) and key insights from empirical research in the whole field, this thesis explore, map and analyze the ecological distribution and concentration of commercial- and residential burglaries and motor vehicle theft in Oslo, Norway. It investigates to what degree these crimes are spatially concentrated at a relatively small number of places in the city of Oslo, what characterize these hot spots, and what environmental characteristics highlighted in previous research seem to generate the crimes.

Through crime mapping by GIS-technology and an additional cumulative calculation of crime in each micro-unit of analysis, this study found land use that concentrate peoples’ routine activities makes shared activity nodes work as crime generators (e.g. public transportation or the central district). When these converge a high volume of people with crime opportunities, they create hot spots of crime. This confirms the usefulness of environmental criminology as a field, and the importance of studying hot spots to understand the environments role in the crime equation.

Although some degree of concentration was found for all crimes, the concentration tightness was found to be highly crime specific. The spatial distribution of residential burglary and motor vehicle theft did not follow the suggestions that only a few hot spots will amount for the vast majority of the crimes put forward by the 80/20-rule or the “law of crime concentration at places” by central scholars of this field. This gives a clear implication for crime analysists to not take these claims at face value, but to look more closely at previous findings and be specific enough in future research to find the most effective preventive techniques.

Making use of a regular OLS regression model and one OLS model that controls for spatial lag/neighborhood-effects, the relation between crime levels at micro-units and additional ecological variables highlighted in previous research as raising the probability of crime at places, was examined. The estimates were analyzed together with the visualization of the different crimes’ spatial distribution and additional plotting of some prominent factors in the regression models, which showed how people most likely evaluated perceived effort and risk of travelling outside of their awareness space or long distances ranged higher than possible higher rewards in other areas. Malls outside peoples’ main activity nodes, or suburbs and well-off residential areas in Oslo experience less crime than central- or more disadvantage areas. For motor vehicle theft, crime was spread more into wealthier central parts of Oslo too,
which might indicate securitization is important. To confirm these thoughts and get a deeper understanding of the crime calculation, future research should investigate offender-pattern more specifically, and could benefit of offender data that is missing in the data of this thesis.

If crime concentration is dependent on a concentration of crime opportunities and people’s routine movement towards these areas, the crime hot spot will imaginably be relatively stable in this area – as long as the land use and the areas characteristics are static. Reiss (1986) early recognized that communities as well as individuals had crime careers, and Bursik (1986) argued stability of social characteristics of places made crime seem spatially stable. He claimed instability in places would lead to instability in number of crimes, and I argue environmental characteristics has the same effect on crime patterns. Opportunities for crime would emerge, disappear or move as the urban landscape changes (Wilson and Paulsen 2008), and an important implication of this is that both studies and policy need to be based on up-to-date data and always consider any change in the city that could transform an areas dominant land use and have an effect on the spatial crime pattern and hot spots – but it also gives hope for an alteration of physical space or peoples’ perceptions about it, to turn hot spots cold or prevent a new area to develop into a hot spot of crime.

Further research is needed, especially since Norway embrace practices developed in other countries based on empirical findings that might not be applicable here. A cooperation between research (crime analysis to understand what generate, attract and stabilize certain crimes at places and what might prevent it), city planning (to know if the city is changing) and police or other social control agencies (to evaluate implementations) is also suggested, and might be vital for best possible prevention effects.
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