MASTER'S THESIS

An Urban Planner's Guide to Space Syntax

A Study of Luleå City Illustrating the Uses of Space syntax

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Abstract

Space syntax analysis can be used to show pedestrian or vehicular density and flow for streets in a city. Luleå, a city in the northern parts of Sweden, has been used to create axial maps which shows the density and flow. This master thesis for architectural engineering describes the fundamentals of space syntax and shows the process of setting up axial maps. Using the integration values for each street relations between density and crime, road maintenance, retail distribution are examined. This thesis offers a short guideline with seven steps to completing a space syntax analysis and ends with a discussion on why some discrepancies might arise.

Sammanfattning

Space syntax analyser kan användas för att visa människors och bilars densitet och flöden genom stadens alla gator. Luleå, en stad i norra Sverige, har använts som fall studie för att upprätta axiala kartor som visar densitet och flöden. Det här examensarbetet för civilingenjör i arkitektur beskriver olika begrepp inom space syntax och visar hur axiala kartor kan upprättas. Genom att använda integrationsvärden för varje gata så har densitet och bland annat kriminalitet, gators underhåll, affärsverksamhet undersökts. Arbetet ger en vägledning i form av en guide med sju enkla steg till att göra klart en space syntax analys och avslutas med en diskussion om varför vissa felaktigheter kan uppstå.

Acknowledgements

I want to start off by thanking my supervisor, Kristina Laurell-Stenlund, for her invaluable assistence, continuous guidance and support. She has also shown remarkable patience towards me by putting up with my twists and turns, thereby allowing me the creative freedom in this process. Without her patience, this thesis would have been something completely different. One simply could not wish for a better or a friendlier supervisor.

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Content

1. Introduction

Throughout the history of urban planning, from Hippodamian city plans of ancient Greek and Roman cities to today's sustainable development theories, there has always been a compulsion to investigate, research and study cities to optimize the social, economical and geographical needs of an efficient city. Many methods have been used and some even fanaticaly practiced but only some have outlived the test of times. One thing these methods have had in common, be it Kevin Lynch's "image of the city" or Jan Gehls "Life Between Buildings", is that the study methods frequently emphasises quality as an unmeasurable element which easily leads to bias and prejudice amongst the researcher.[1]

Space syntax however is a step away from that way of exploring cities. It allows a possibility to study cities in a quantitative manner, with emphasis on numbers rather then subjective assumptions and intuitions. Over the last few years crime has become an interesting topic for investigation through space syntax but archeology, retail distribution and real estate prices are some areas that also have been studied[2]. By studying these relationships an urban planner can better understand the impacts their work might have if density and flow are altered. It allows the urban planner to connect pedestrian density and movement with specific aspects of human behaviour, economics and physical designs[3]. How does these relationships guide the urban planner into making more informed decisions to create a more healthy, sustainable and efficient city?[4]

Space syntax is a way of investigating relationships between how cities are structured and the way they function. It does not supersede other methods, but merely compliments them. Urban planning will always be influenced to some degree by the theoretical understanding of the urban planners. Space syntax can help at the theoretical level to understand pedestrian flow and density which future planning may depend on.[5]

1.1 Aim of this study

The aim with this master thesis is to increase the awareness of space syntax among urban planners. It should act as a guide for urban planners to see how space syntax analysis can be set up for a particular town or city. After completing this analysis which should depict movement and flow, an investigation will be followed to see relationships between some aspects of human behaviour. It should encourage more urban planners to delve into this method to study their city. Although the term "urban planner" is used loosely in this thesis, throughout that term will also include any type of planner working on an urban level wanting to investigate the density relationships with their specific work. It should answer the question how space syntax can help urban planners in their work. This master thesis will outline the basics of space syntax so that hopefully other urban planners can incorporate the method in their line of work. This thesis should also underline the necessary steps and show a concrete path to perform a space syntax analysis.

[1] Eriksson (2010)
[2] www.spacesyntax.com
[3] Ibid
[4] Ibid
[5] www.rudi.net/books/6057

1.2 Focus and delimitations

This study focuses on the methods of space syntax by creating axial maps. Visibility graphs, isovists and convex maps are mentioned but not used. Two axial maps have been set up, one for vehicular movement and one for pedestrian movement, to investigate the integration values (pedestrian and vehicular density) of the axial lines. The city chosen for this thesis is Luleå, which is a middle sized city in northern Sweden. In studying the relationships, the only limitations have been the availability of information and the time frame to finish this thesis. For these reasons real estate values and pollution will not be thoroughly investigated for Luleå although it will be shown how to perform these analyses if the time and information were to be readily available for the city.

2. Theory

How can our intuitions of people's movement and actions be studied in a scientific manner in order to make more informed and accurate decisions when it comes to urban planning? Most people have a fairly good idea of what streets in their cities are the busiest. What space syntax offers is a way of scientifically identifying these streets and then going beyond that plotting a whole map dividing each street into a separate colour to show the intensity of each street. This way pedestrian density and flow is turned into a scientific method of studying human patterns.[6]

Bill Hillier and Julianne Hanson are the founders of this tool which was first formulated in the mid 70s[7]. Since then the idea has been materialised into a wide range of institutions and consultancies world wide.[8] Figure 1 shows an axial map which was the first method used in predicting movement and flow by Bill Hillier and his team and has since then become to be known as space syntax[9].

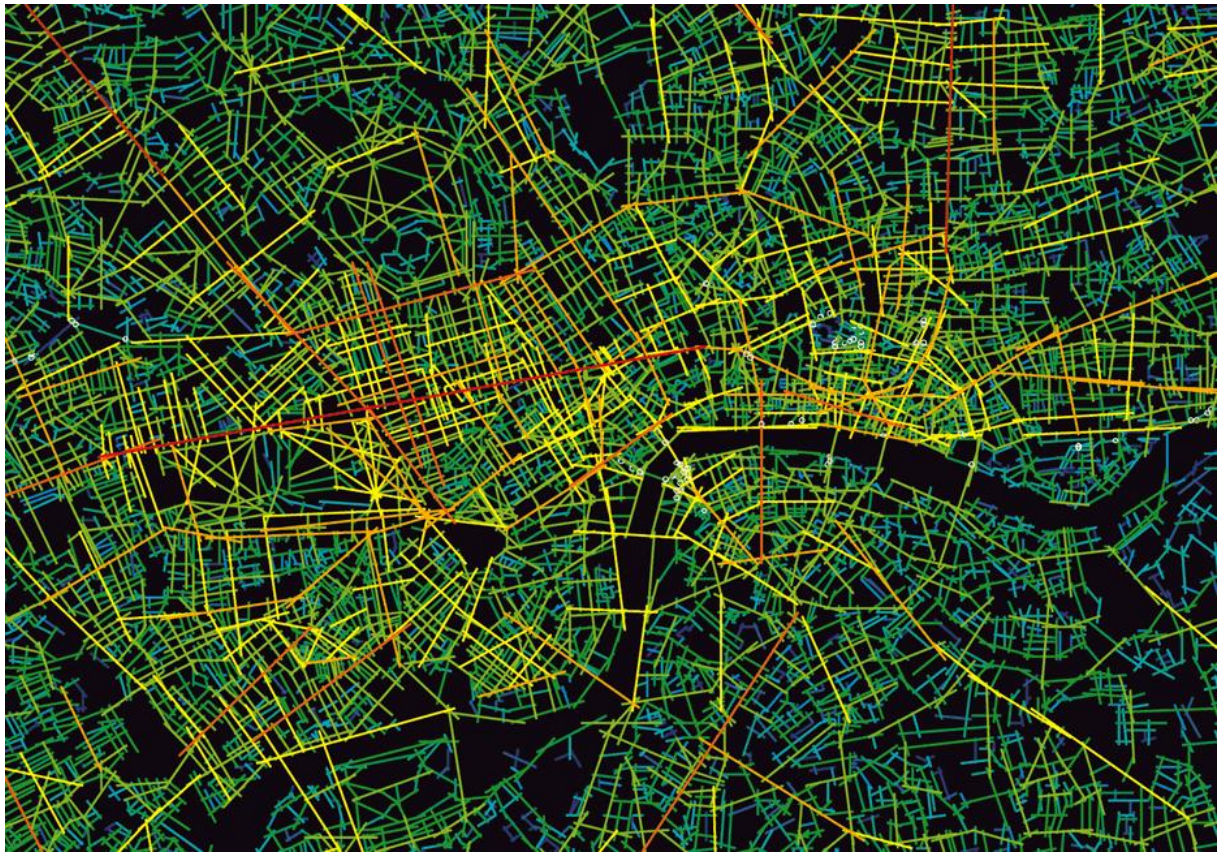


Figure 1: This figure shows an axial map over London which is probably the most thoroughly studied city with space syntax as both the University College of London and Space Syntax Limited operate there. (Source: www.spacesyntax.com)

[6] Hillier & Hanson (1984)
[7] Ibid
[8] www.spacesyntax.com
[9] Hillier & Hanson (1984)

Space is referred to any open area where people can walk. While the dictionary definition of syntax, a word used in linguistics, is "the study of the patterns of formation of sentences and phrases from words"[10].

2.1 Space Syntax methods and tools

There are a lot of different methods under the space syntax umbrella that have been developed since the 80s. Most of these new tools are developed at Space Syntax Laboratory at University College London, however there are similar studies in a large variety of countries. These methods are based on analysing spaces and on the visual perception of pedestrians.

Isovists

An area visible to the perceiver from a location in a space is called an isovist. The term isovist originates from Tandy (1967) which he used to describe landscapes[11]. Tandy called an isovist as "taking away from the site a permanent record of what would otherwise be dependent on either memory or upon an unwieldy number of annotated photographs."[12] However it was Michael Benedikt who popularized isovist analysis of architectural spaces and set up the guidelines for its use.[13]

In isovist analysis a generating location is used from which a polygon is made of all the visible areas in all directions from that point. This way the analysis focuses on the user's point of view and how they perceive spaces. There is empirical evidence from case studies on spatial behaviour at Tate Gallery suggesting that there is a high correlation between the isovist analysis and the statistical data.[14]

Convex Spaces

Convex analysis consists of drawing polygons covering all spaces with one polygon for each axial line. All the points in these polygons are visible from any other point in the same polygon. Creating convex spaces is regarded as a tedious job and has been replaced by an automated process which instead creates an all-axial line. All possible axial lines are drawn by a computer in the open spaces which then is perceived as polygons.[15]

Axial Lines

Axial lines are created in open spaces as a straight line of sight. The longest and fewest lines are traced out in the area which is studied. The axial lines will cross and intersect each other creating an axial map which thereafter can be thoroughly studied. Axial lines were first proposed by Bill Hillier and Julianne Hanson in 1984.[16]

Having created an axial map there are a number of different methods that can be used to analyse the area. These can be divided into two different ways of thinking about the analysis. One way of thinking about it is as a "to-movement" which shows how easily accessible a space is or how easy it is to get to a place or an area. The other way is by looking at it as "through-movement" which allows one to analyse the likelihood of a pedestrian or vehicle going through a specific road. To-movement is analysed by methods such as integration. While through-movements can be analysed by a method called choice. To-movement and through-

[10] www.dictionary.com
[11] Turner, Doxa, O'Sullivan & Penn (2001)
[12] Tandy (1967), p 9
[13] Benedikt (1979)
[14] Turner & Penn (1999)
[15] Fanek (1997)
[16] Hillier & Hanson (1984)

movement can be exposed to different radii giving nearer or further apart streets either more or less weight. By adding different radii a global or a local measurement can be set up. Local measurements will have a smaller radius which will put a higher weight on the network nearby. A larger radius would be an example of a global measure, which focuses on the grid for a larger part of that area.

This raises the issue of distances between the streets. Distances can be broken down to either metric distance or topological distance. Metric distances calculate the real distance between spaces and measurements of such are among others the shortest path method. A topological distance does not consider the real metric distance between the streets but rather the distance between each street by the configuration of the network. This can either be calculated as the fewest turns between the streets, or perhaps by the least angular change. Combining these methods allows one to study spaces in a countless number of ways.[17]

[17] Hillier & Stonor (2010)

2.2 Spatial Configurations

At the heart of axial maps created with space syntax is the configuration of spaces. It analyses how spaces are connected to each other. It can be said that through configurations, a topological description is made rather than a geometrical one. It does not consider the land use of an area (industrial, commerical, private and so forth) but rather how these spaces are connected to each other. These configurations are essential to its function[18]. The configuration of A in Figure 2 could be perhaps a main road linking it to other smaller roads. Without such a configuration its function would be different. While the configuration of B in Figure 2 could be a network seen in the suburbs. It has been shown through several studies that by analysing the network of city grids and configurations it is possible to illustrate and predict pedestrian flow and density (Ragford & Ragland, 2006; Penn et al., 1998: Hillier, 1996; Hillier & Hanson, 1984).

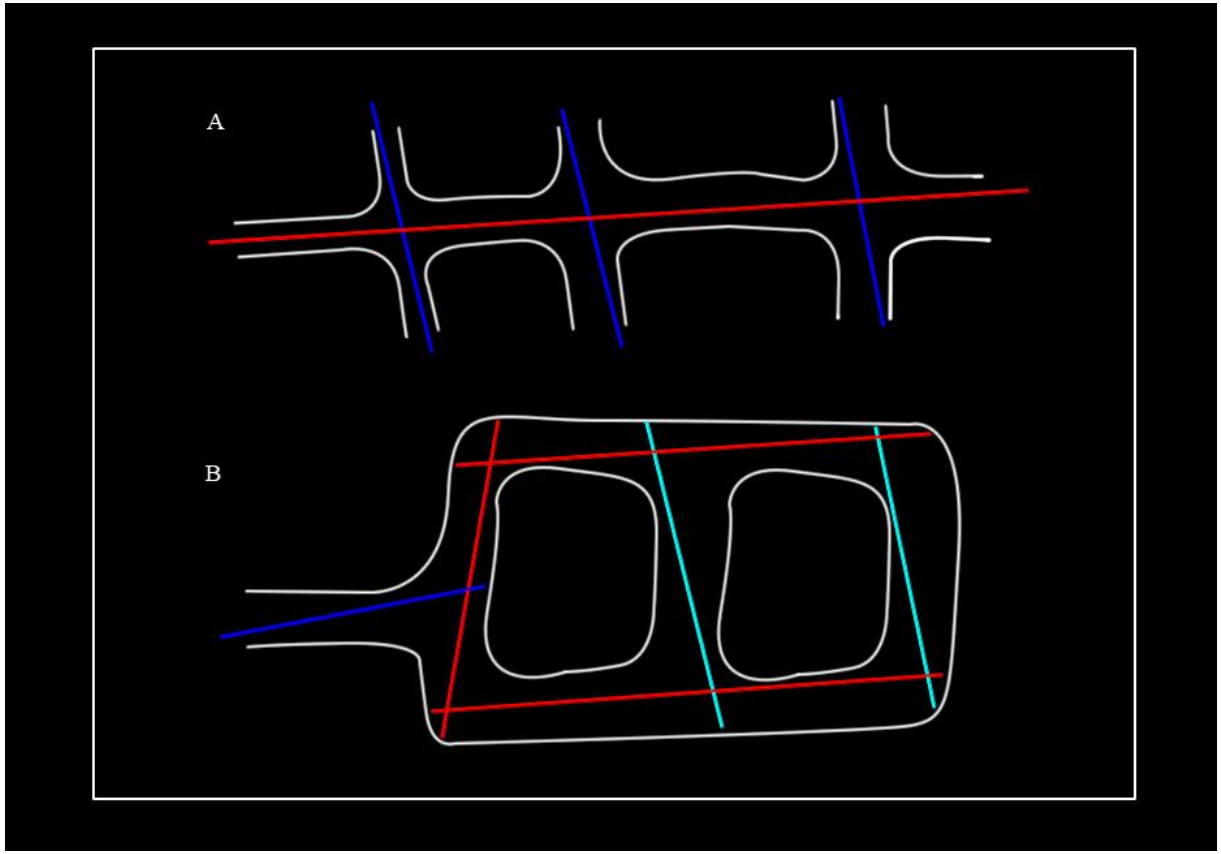


Figure 2: Different road configurations.

2.3 Mathematics behind Space Syntax

There are many different types of calculations that can be categorized as a space syntax analysis. Two common calculations are the

[18] Hillier (1996)

integration method and choice[19]. To get to the integration values, mean depth and the total number of axial lines have to be calculated[20].

The integration value is calculated for each line with the formula shown in Equation 1[21]:

$$\frac{\left\{k\left\{\log_2\left(\frac{k+2}{3}\right)-1\right\}+1\right\}\Big/(k-1)}{MD-1}$$

Equation 1: Formula for the integration Value (p.11)[22].

MD is the mean depth while k is the number of lines in the axial map. To find out the mean depth of a certain line a network configuration should be set up.

Figure 3: This figure shows a random area with the axial lines kept simple. The numbered axial lines in this figure are used to show a network configuration which is the basis for space syntax.

[19] Kärrholm (1999)
[20] Hillier & Hanson (1984)
[21] Netzell (2007)
[22] Ibid

Using the axial map in Figure 5 a network configuration can be easily put together as illustrated in Figure 4. Starting from the left side of line 1 a calculation is made of how many turns are needed to reach all other lines.

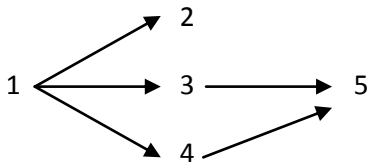


Figure 4: This simple network configuration is used to find the mean depth for line 1.

The network configuration in Figure 4 is then turned into mathematical terms as seen in Table 1 to calculate the mean depth.

Table 1: Network configuration in mathematical terms.

From	To	Turns
1	2	1
1	3	1
1	4	1
1	5	2

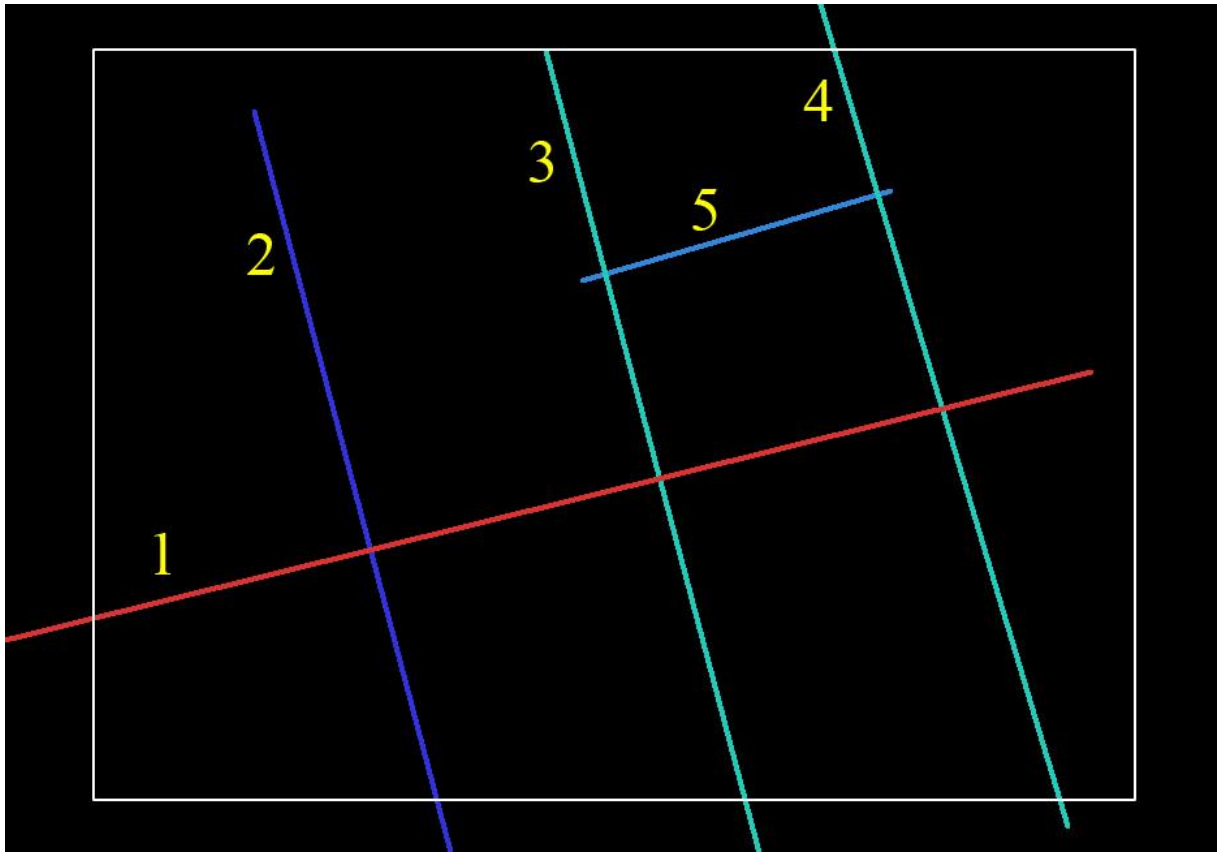


Figure 5: A network configuration is made out of this axial map.

To find the mean depth using Table 1, for line 1 simply add the turns for each path (1+1+1+2) and divide by the number of possible paths (4). The mean depth should always be calculated for the lowest amount of turns (or the least number of angular changes). Line 1 in the axial map in Figure 5 has therefore a mean depth of 1.25. Lines that are highly integrated will have lower mean depth values. The inverse of mean depth will therefore indicate which lines are the most integrated in an axial map. As the mean depth value is now acquired the integration value can now be calculated as seen in Equation 2.

$$\frac{\left\{5\left\{\log_2\left(\frac{5+2}{3}\right)-1\right\}+1\right\}\Big/(5-1)}{1.25-1}$$

Equation 2: Formula for integration value with numbers inserted.

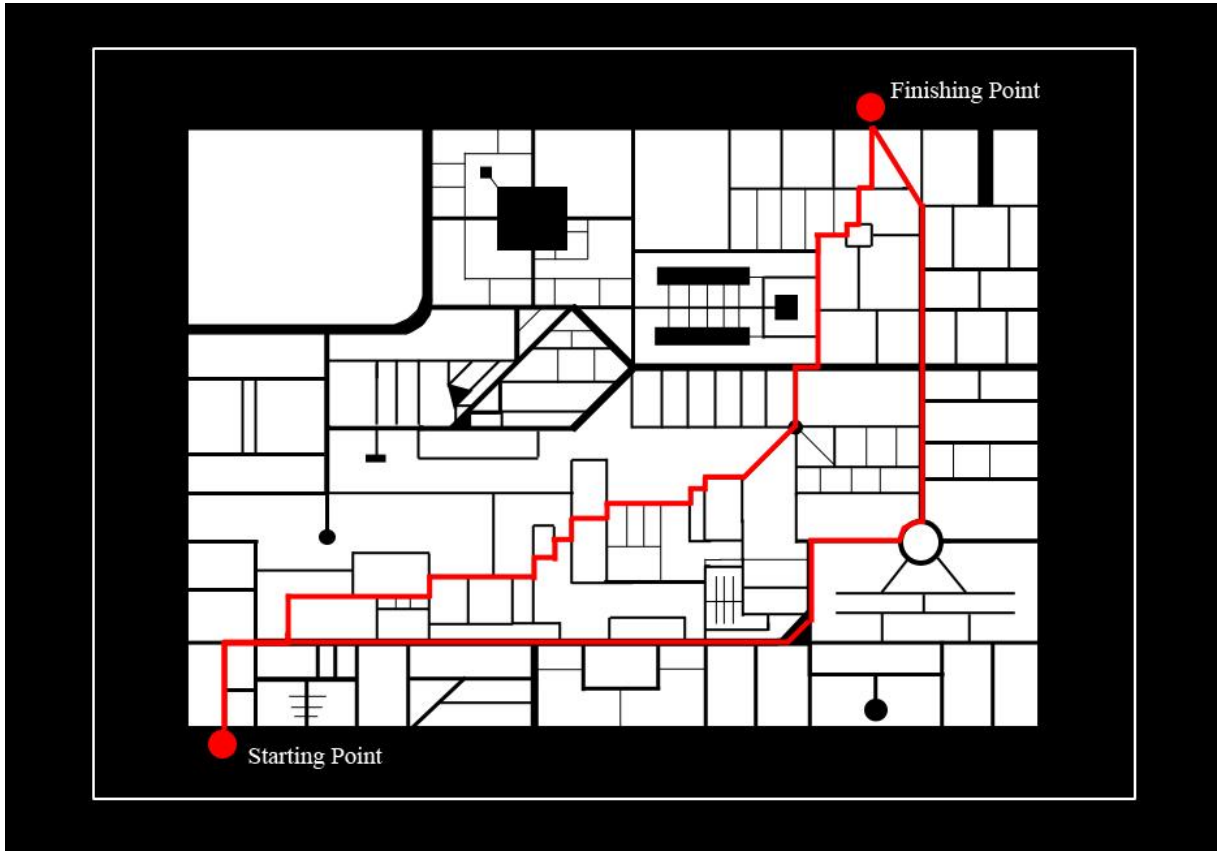
Equation 2 gives an integration value of 2.112 for line 1 in Figure 5. These steps are then repeated for each line. Although computer programs that are used for space syntax do these calculations much faster and efficiently removing all the time consuming barriers. As mentioned earlier, it is also possible to calculate integration values with different weights and radii to achieve local or global values. The axial lines only in that radius would then be considered. The lower the radius is the more local the values are said to be[23]. These equations should help in the understanding of how the integration values are calculated as they are used in the following pages.

[23] Hillier & Hanson (1984)

2.4 Space Syntax Philosophy

There is enough evidence to suggest that people use routes with the least angle changes and least number of turns while travelling from A to B[24]. A lot of research and time has been spent on showing how space syntax actually works, how accurate predictions are made through space syntax analysis and how human beings travel more on highly integrated streets[25]. It is still a confusing thought as many of us believe either conciously or unconciously that the routes taken are the shortest. Unless a street on a particular path is of a higher interest to the pedestrian, in which case the street might have an attractor which is dealt further in place syntax, then it would seem irrational to take a route with less turns rather then the shortest route.

This paradox is illustrated in Figure 6. To get from the starting point to the finishing point the shortest distance would be to go through the middle of this imaginary city plan. Although the shortest path might be the logical route to take, space syntax counts the integration values through fewest turns and angular changes. In this



Figur 6: A description of two possible routes between two points. Space syntax suggests that the longer but more integrated route is chosen by most people.

[24] Hillier & Stonor (2010)
[25] udeworld.com/dissemination/publications/47-wayfinding-design/104-space-syntax.html

case the longer route is more integrated and therefore the pedestrian density should be higher on these particular streets (see Figure 6).

An error with the shortest path argument is to believe that space syntax helps pedestrians to make choices on what paths to take in the first place. Space syntax does not predict the best (shortest, easiest or likewise) routes for individuals to take. Space syntax merely suggests which streets, hundreds or perhaps thousands of pedestrains might populate by analysing which streets are the most integrated into the city's grid or network. Routes and paths do not correlate to the methods used in space syntax analysis, perhaps rightfully so. What space syntax does suggest is the density of people at a given street and not the individual's routes.

Looking at the big picture, major streets of cities should therefore according to space syntax, and what is found to be the case in reality, be the busiest streets in a city. Major streets and main streets are often the most integrated naturally, due to its location in the middle of a city's heart. These are the focal points from which other streets arise to move further out from the city centers. An isolated main street would probably over time loose its status as a main street since less people would be able to reach it easily. From that standpoint it should be quite logical to believe that space syntax should work as a predictor for pedestrian density. Integration values suggest movement and density potentials of a city and in general there is a 60-80 % correlation between the potential and the observed rates[26].

There are probably a lot more factors that come into play besides street integration. For one, space syntax does not consider attractions that might bring people to different streets. These attractions could be shopping malls, transportstations, workplaces, and so forth. It is believed that place syntax can contribute to more accurately predicting pedestrian density by taking into account all forms of attractions on a street.[27]

Yet there are possibly even more factors that may play an important role to determine pedestrian flow. These could be the population of residents in areas around the city, the width of walking streets, different barriers on streets that may decrease the likelihood of pedestrians using it, and so forth[28].

2.5 Relationships

Crime

Studying crime as a urban planner is different from the approach taken by criminologists. A criminologist concentrates on sociodemographic differences in a region. The focus in that case would be upon the income levels, ethnical backgrounds and education among the inhabitants. Urban planner's approach usually is on design factors such as ease of access, lighting and entrance points. Although both these approaches should be evaluated to make any accurate conclusions, this thesis focuses on the urban planner's approach. There are two schools of thought when it comes to criminality and pedestrian density on the streets. The first one origins from Jane Jacobs book "The Death and Life of the Great American Cities" in 1962 where the author argues for open and more public spaces which allows for the citizens to act as the "eyes on the streets", in order to prevent crime. It is believed that strangers and bypassers will lower the crime rates as criminals will be less prone to engage in criminal activities

[26] Hillier & Sahbaz (2008)

[27] www.spacescape.se

[28] Naess (2006)

in these areas. However in Oscar Newman's book "Defensible Space" from 1972, the author argues for more closed of spaces as it is believed too many people would create the anonymity that the criminals need. Crime rates would therefore be less in areas with low densities as strangers would be identified as intruders and are then more easily exposed as criminals.[29]

It might however be more accurate to say that both these strategies work on different types of crime. Some criminal activity may advocate a more isolated, secluded and closed off area for a particular crime, while open and public spaces might attract other types of criminal activity.

It is also important to consider cultural differences while investigating crime and space syntax. There has been a lot of research done on the relationships between the two but with some varying results. For example, it has been shown in London that theft occurs in places where there is an everyday movement of people and/or near the perpetrators neighborhoods. Meanwhile robbery is more prevelant near the cities main entrances[30]. An opposite relationship has been found in Recife, Brazil[31]. Another study shows that higher integration values usually means more people and more eyes on the streets preventing crime[32], but other studies show a high concentration of commercial land uses (which also might mean more people) may increase criminal activity[33]. Some studies point out that cultural difference might be at play resulting in these trend differences. One example being USA, with a more prominent car usage, where cars are used even for travelling shorter distances, and therefore the "eyes on the streets" might have a different effect on crime[34]. With vast differences like these, making any general conclusions should be avoided. What works in one culture might not work in another. Even predicting crime with the help of space syntax, from city to city in the same country may be problematic.

Another factor in studying crime is alcohol. Physical aggression, one of the crimes that have been studied in this thesis, has a strong correlation with alcohol. A study in Sweden showed that about 78% of all types of physical aggression were committed by the perpetrator being under the influence[35].

Other Aspects

Air and noise pollution can also be studied with space syntax. Both of these increase as car density increases. Also interestingly air pollution and real estate prices have an inverse correlation. The more air pollution there is the lower the real estate prices tend to be[36]. So it is perhaps possible to predict real estate prices with space syntax as well.

It should also be possible to study the spread of viruses and bacteria as it will occur at places where there is lots of human contact (like schools)[37]. It can be argued that at places with high density of people, might also be vulnerable to an outbreak[38]. As bacteria and viruses are obtained through contact (or transference of fluids) it is reasonable to believe that areas

[29] Hillier & Sahbaz (2008)
[30] Ibid
[31] Monteiro & Puttini Lannicelli (2009)
[32] Hillier & Shu (1999)
[33] Baran, Smith & Toker (2007)
[34] Nubani & Wineman (2005)
[35] sverigesradio.se/sida/artikel.aspx?programid=83&artikel=2792743
[36] Chiaradia et al (2009)
[37] news.discovery.com/human/disease-spread-high-school-model101213.html
[38] Ibid

where the integration values are high and therefore a larger concentration of people, these areas will be more susceptible to transference of diseases. Retail shops, libraries, restaurants, facilities that attract people to the streets with higher integration value, could be places of higher risk in case of a pandemic. Although it is believed that schools and hospitals are higher contributors to the spreading of a disease[39].

2.6 Other Travel Pattern Trends and Methods

Space syntax methods focus on spatial configurations and urban structures. Other methods of studying travel patterns are conducted through questionaires and take socio-economic, lifestyle and attitudes into account[40].

Vilhelmson has studied travel behaviour and patterns in Sweden for ages 20 to 64 and provides some relevant data for this study[41]. The author suggests four ways of categorizing our trips. These are bounded trips which have a fixed time and location (such as school or work). Then there are the trips where the time may vary but the location is fixed and trips with neither time nor location fixed. Non-bounded trips do not have a fixed time but do have a fixed location. From the results gathered in 1990-1991 59 % of the trips on weekdays are bounded trips. The same figure for weekends is 29 %. For the whole week the numbers of bounded trips are 52 %.

[39] RMS (2007)
[40] Naess (2006)
[41] Vilhelmson (1999)

3. Method

3.1 How to conduct spatial analysis

The program that I have used to conduct my space syntax analysis for the Luleå city center is the UCL DepthMap. This was developed by Alasdair Turner at the Space Syntax Laboratory, which is an affiliate of The Bartlett, University College London.

UCL Depthmap is a very user-friendly program and easy to work with. It requires .dxf files (an AutoCAD format) which I have obtained through Luleå University of Technology and with the help of Majvor Eriksson at the National Land Survey (Lantmäteriet) who has very kindly provided me with .dxf maps of the whole of Luleå municipality.

UCL Depthmap allows you to automatically create axial lines. However for this to work, the maps need to be closed off, otherwise the axial lines would ”spill out” and create incorrect lines. The .dxf maps that I have worked with had a lot of openings so working with that specific tool was not an option. Axial lines in this work have been hand-drawn in the program. This becomes an easy task once the .dxf file is imported in to UCL Depthmap.

An axial map has been set up for Luleå city to investigate car traffic and Luleå city center for pedestrian density. The axial map for Luleå city center has been particularly interesting and has served as the groundwork for studying relationships between criminality, distribution of retail shops, money spent on road maintenance, transportation networks and possible areas for future developments. This author’s location and the fact that the city has not yet been analysed in its entirety through space syntax methods are the reasons for why Luleå is interesting for this study. There have been some space syntax studies of smaller parts and areas of the city before.

3.2 Guidelines followed for consistency

Dirt tracks and other walking paths that are not paved have not been included in the space syntax analysis. As the axial map in this work is intended to show pedestrian flow through the city, car roads with pedestrian walks on both sides, as most of the roads in Luleå are, are shown as one line in the axial line map. Also in an attempt to create as straight lines as possible to give accurate analyses of the Luleå city center level differences have not been taken under consideration. This is due to Luleå city being a fairly flat region and therefore not examined to avoid as many irregularities as possible.

3.3 Studying flowcharts and observation data

A more realistic space syntax map has been created using the observational data. The Technical Administration (Tekniska Förvaltningen) of Luleå has also been kind enough to provide flow charts and maps over the Luleå region. These charts have been used in a couple of ways. Firstly they have been used to create the more realistic space syntax map by using data of pedestrians on different points that were not calculated during the observational data collection. This has helped in setting up a better picture of the pedestrian flow in the Luleå city center. The data from the Technical Administration (Tekniska Förvaltningen) have also been a guideline for checking how accurate the space syntax analysis is. The flow charts provided by the Technical Administration for the measurement of pedestrian density only show the number of bicycles crossed at a certain point. So people walking through these imaginary gates are not included in the official statistics. The flow charts of bicyclists

which are highly dependent on good weather have been recorded in May 2010.

3.4 Collecting the observation data

Observational data was colleced in the week between 11th of October and 16th October, these dates were selected randomly. The data was collected from Monday to Friday for five different locations in Luleå city center. Each day 20 minutes were spent at each location while 3 locations were observed in one day. The times for the observations were 09:30 AM, 10:00 AM and 10:30 AM. Observations were conducted before noon when the pedestrian flow was thought to be lower so that the observations could be charted down more easily and accurately. The observations would provide three different data sets for each of the five different locations. The average of these three was then used to evaluate the accuracy of the space syntax analysis.

The locations chosen in this data collection survey were chosen because of either its integration with the city or there isolation from the city to allow a wider base for evaluation.

The purpose of this was to see how dense each street is to form an idea of the flow of people in the city. So for that purpose pedestrians and people on cycles were counted. However what were not included were travellers with moped or scooters, the former being a popular way of travelling here in Sweden. Although due to the temperatures during that week meant that very few were travelling this way. Temperatures would also have affected the number of pedestrians during these periods. It is widely accepted that the summer seasons (May- August in Luleå) are the times when the city is the busiest with pedestrians. At the time of this observational data collection the temperatures remained around 0-5 degrees celsius.

Cars were not included in the observational data study since the space syntax analysis of Luleå city center have been formed for pedestrians only.

3.5 Gathering data on crimes

The statistics for this study were collected from a publicly available website which shows data of different crimes. The website bases its statistics on police incident reports which the police are required to write for every situation that may arise. The statistics are taken from 1st of January 2005 up till 1st of November 2010. Magnus Pettersen, one of the hosts of the website, points out that most crimes are published on the website however some crimes are filtered away. These may be crimes committed by children or crimes of lesser economical value. Some crimes may also be impossible to geolocate due to various reasons and are then searchable on the website rather then located on the maps if they have an interesting enough value to the websites members. A common crime overlooked by the website is theft of products from shops or other business establishments. Although Mr Pettersen also points out that as many crimes as possible are published on the website to provide their webviewers a better understanding of crime patterns in their neighborhoods and goes on to say that the purpose of the website is for viewers to see the crimes directly and to be able to protect themselves by being more alert in certain areas.

3.6 Accumulating information on retailers

Information about where existing stores are located in the Luleå city center has been gathered through Google Maps. Google Maps has a fairly new function which allows the user to get down to the street level and view the streets as if they were standing on that particular street. Google have taken pictures on a street level using cars to provide a stunning amount of photographic material over each city. Using these photographs a list of all retailers in Luleå city has been set up for this study. Although this method has made things a lot easier for studying the local businesses that exist in the assigned area there are a few problems. Firstly the photographic collections of the streets are approximately 2 years old. During this period a few businesses have relocated or closed down completely. However the figures are still very low to elicit a considerable amount of inaccuracy. In this study the research on local business's current statues have therefore been ignored. Although over 200 different businesses and shops have been included in this study, this does not provide a full list of all the shops in Luleå city center. The list of retailers can be seen in the Appendix B.

3.7 Information through Interviews

A number of people have assisted me in collecting information through interviews carried out in November. Patrick Ruumensaari at the Technical Administration has provided with information on road maintenance in Luleå city. That information shows the amount of money spent over the course of 5 years.

Frida Wikström at City Planning Administration (Stadsbyggnadskontoret) provided information on where current projects, new buildings and reconstructions are being planned or constructed.

4. Results

4.1 Important factors to consider

There are a number of factors that may affect the pedestrian density and flow inside Luleå city. The main factors are population, entrance points and attractors.

Population

Figure 7 shows the number of inhabitants living in the city which might lead to some streets being more occupied then others. The region called the Innerstaden (official names from the Luleå municipality, may therefore differ from the common names used by the inhabitants) has by far the highest number of people living in it and is also the largest area in the city. ÖstermalmC and Oskarsvarv are two other important regions with a population of over 1,000 people each. It should also be noted that the total population of Luleå is around 73,950[42].

Figure 7: Population in Luleå Innerstaden.

[42] www.lulea.se

Entrance Points

Since Luleå city is located on a peninsula, with a lake, a sea and a river encompassing most of the boundaries of Luleå city, there are only 3 major entrance points with car to reach the city which are shown in Figure 8. These are Bergnäset Bridge, Malmudden Bridge and the road in the north called Bodenvägen. Kungsgatan is a street frequently used and has the highest number of cyclists in Luleå as it is a popular passageway connecting students of Luleå University of Technology with the city. These are the main gateways to the city. They are therefore usually very dense and populated by both pedenstrians and vehicles during most hours of the day.

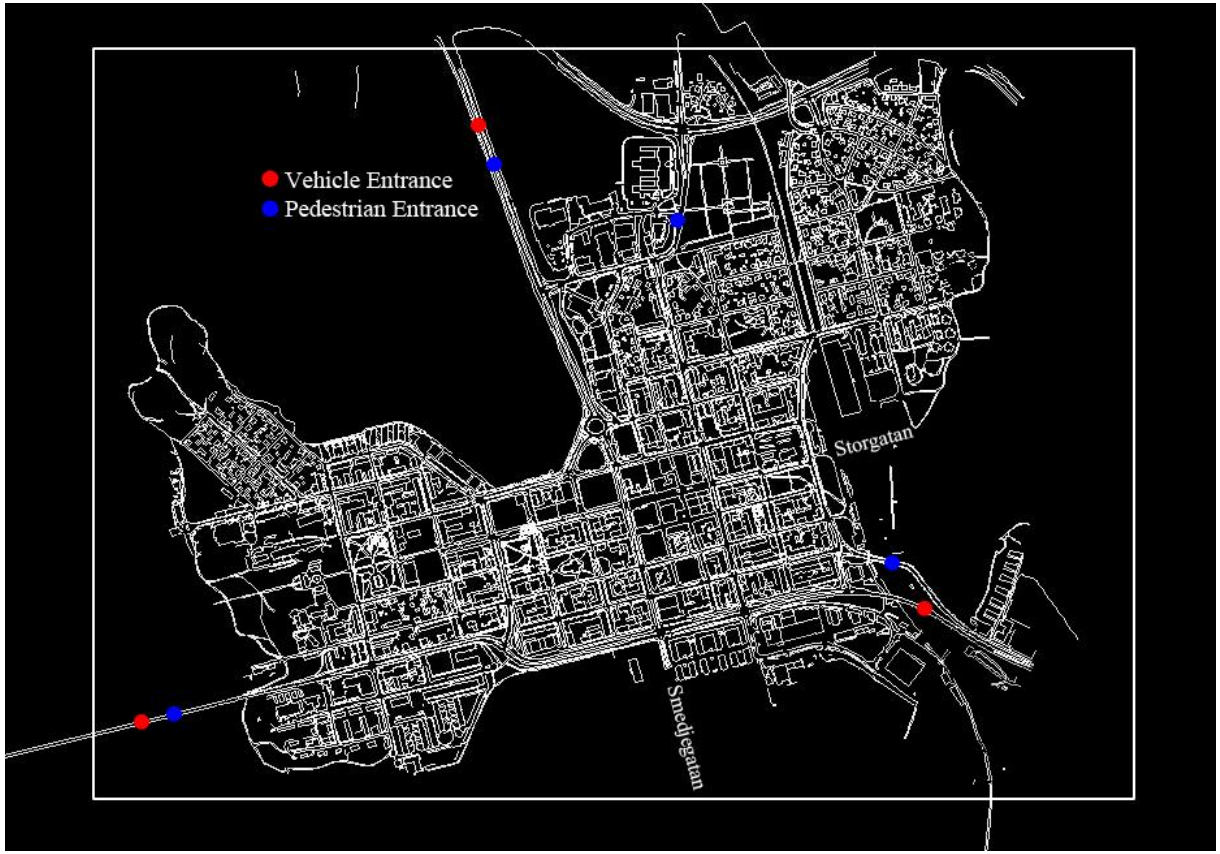


Figure 8: Entrance points to Luleå city center.

Attractors

Figure 9 shows the main attractions frequently used by the inhabitants of Luleå. The high school campus in the city have about 3,000 students[43], the shopping malls with their entrances all located towards Storgatan attract people from the whole Norrbotten County and the House Of Culture had 464,000 visitors the first eight months of 2008[44].

Figure 9: This illustration shows the main attractors in the city center.

43

www.aurorum.se/gymnasieskola/luleagymnasieskola.4.25249d4c10fa6856c84800025509.html

44

www.nsd.se/nyheter/lulea/artikel.aspx?ArticleId=4009630

4.2 Observational Data

The observation data was collected on 5 different points throughout the city illustrated in Figure 10. 20 minutes were spent at each location, 3 locations a day as seen in Table 2 and Table 3.

Table 2: This shows the time and date of observational data collected.

	Mon	Tue	Wed	Thu	Fri
09:30	B 41	D 104	C 36	A 204	E 19
10:00	E 28	B 54	A 234	D 89	C 30
10:30	A 242	E 22	B 68	C 37	D 114

Table 3: Averages of the observational data.

Location	09:30	10:00	10:30	Average
A	242	234	204	227
B	41	54	68	54
C	36	37	30	34
D	104	89	114	102
E	28	22	19	23

Figure 10: These are the points where data was collected.

4.3 Conceptualizing the axial maps

Integration Values of Luleå

The following figure shows the axial map of Luleå using the integration method, which shows the integration values of each street in different colours. The colour spectrum used in space syntax is from dark blue which are the coldest, or least used streets to dark red showing the most used streets. The axial map in Figure 11 shows the vehicular density in Luleå as only roads for cars have been analysed.

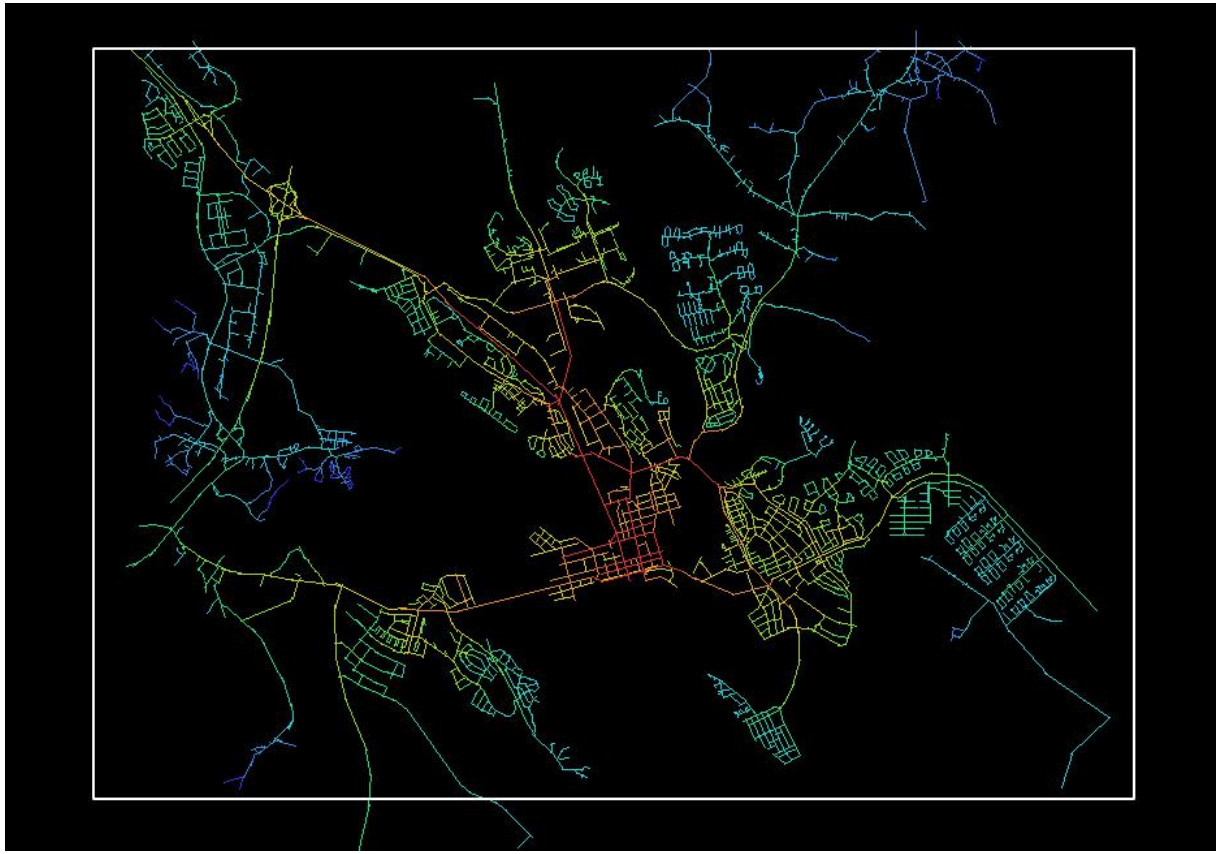


Figure 11: Axial map over Luleå for vehicles showing lines coloured by their integration values. From dark red with highest integration values to dark blue with the lowest.

Choice of Luleå

Figure 12 shows the same axial map but instead of integration values it shows the choice values (an example of a through-movement calculation). These are the roads that we are most likely to drive through. It accurately depicts the flow on different roads. The blue lines are streets which we are most likely not to travel through, while the red lines show the opposite. Indeed by observation, the yellow and red roads are the ones most often travelled through.

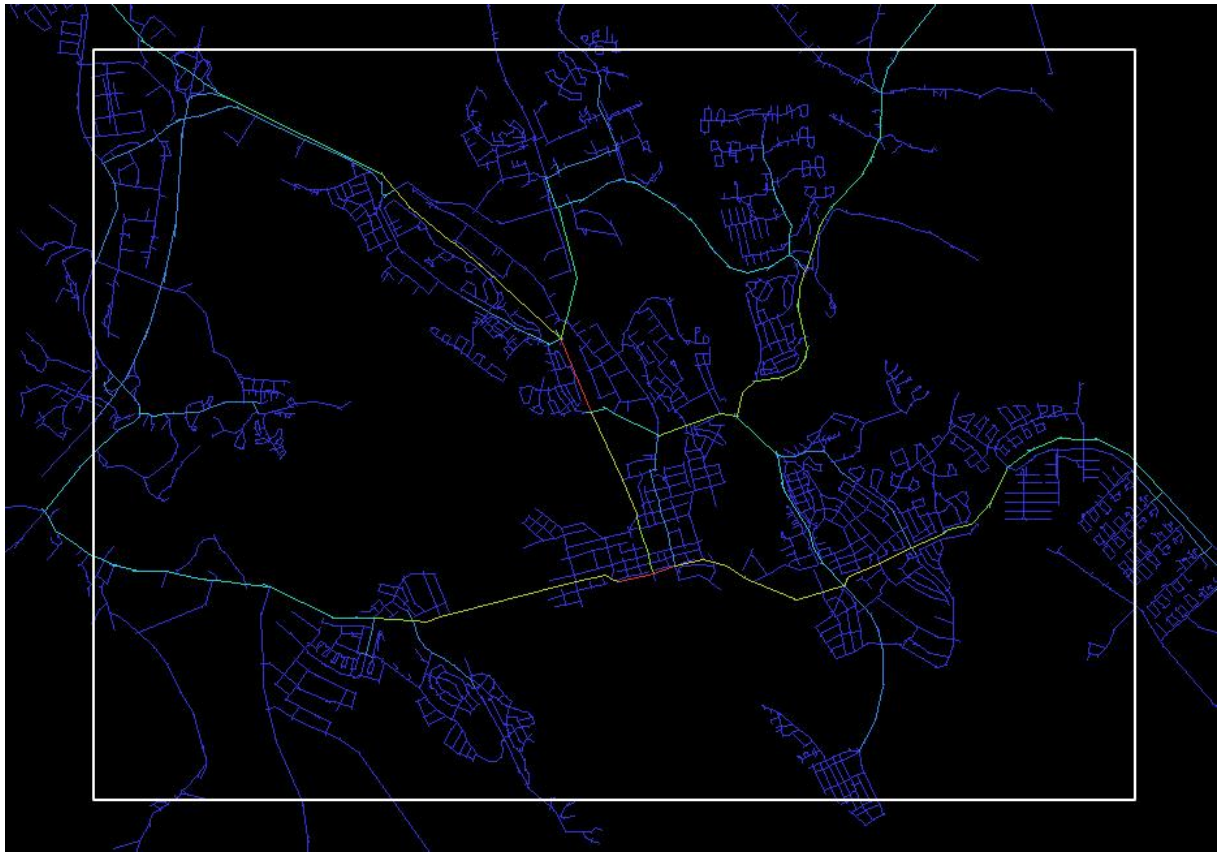


Figure 12: Axial map over Luleå showing Choice (a through-movement calculation).

Integration Values of Luleå City

Another axial map was made for the pedestrian movement in the Luleå city. Figure 13 shows this axial map.

The axial map however is somewhat different from how the pedestrian density in Luleå city is perceived and also from the observational data that was collected for some of the streets (for integration values see Appendix A).

Figure 13: Axial map over Luleå city center for pedestrian density and flow.

An axial map with different weights or radii was therefore set up as shown in Figure 14. Having different radii means that the computer program will calculate only the lines in that radius, for each specific line. So with a radius set to 3 would mean that the computer calculates three lines or turns away from the specific line putting more importance on the streets close by, which is described as either a local or global measurement. Figure 14 has a radius level set to 6, as it was found that this corresponds best to street densities of Luleå city. Once again, the axial map's colour scheme is ranked by the integration values of each line. The integration value here is the highest for Storgatan, which is Luleås main street and has by far the highest number of pedestrians at any given time.

Figure 14: An axial map using radius 6.

A third axial map has been set up where the integration values were manually changed in order to fit into the realities of pedestrian flow in the city. The reasons for why there is such a big discrepancy between the space syntax analysis and the reality are discussed on page 46. The axial map in Figure 15 was created using the observational data for a few locations in Luleå city and with the help of statistics that were made available by Hanna Ahnlund at Technical Administration (Tekniska Förvaltningen) in Luleå.

Figure 15 clearly shows the higher pedestrian density of Storgatan. It also shows the importance of the horizontal streets as these are the most frequently used in the city.

Figure 15: An axial map with integration values manually inserted to illustrate a more realistic pedestrian density and flow. Values have been inserted for the five points where observational data was collected and some other points from other sources.

Density

Figure 16 illustrates areas with higher density of pedestrians according to the space syntax analysis. Discrepancies with observational data are discussed in chapter 5. The streets with highest integration values in the R6 axial map have been highlighted to indicate where the highest density of pedestrians might be found in the city. This can be used to understand crime, road maintenance costs and so forth as will be shown in the following pages. But it can also suggest possibly higher air and noise pollutions[45] or anything else that might be considered to be related with higher density.

Figure 16: Streets with higher density according to the space syntax analysis.

[45] Chiaradia et al (2009)

Metric Total Depth

The metric total depth shows the central area in the axial map. The center point of the city can be located by using this option. The axial map in Figure 17 has been inversed for these calculations by the program. The program calculates the distance between the lines, the nearer they are to the center point the smaller the number as the distance should be the least in the center. So the red lines in Figure 17 are the central streets of Luleå city. It should also be noted that this is a metric analysis and calculations are performed in real distance.

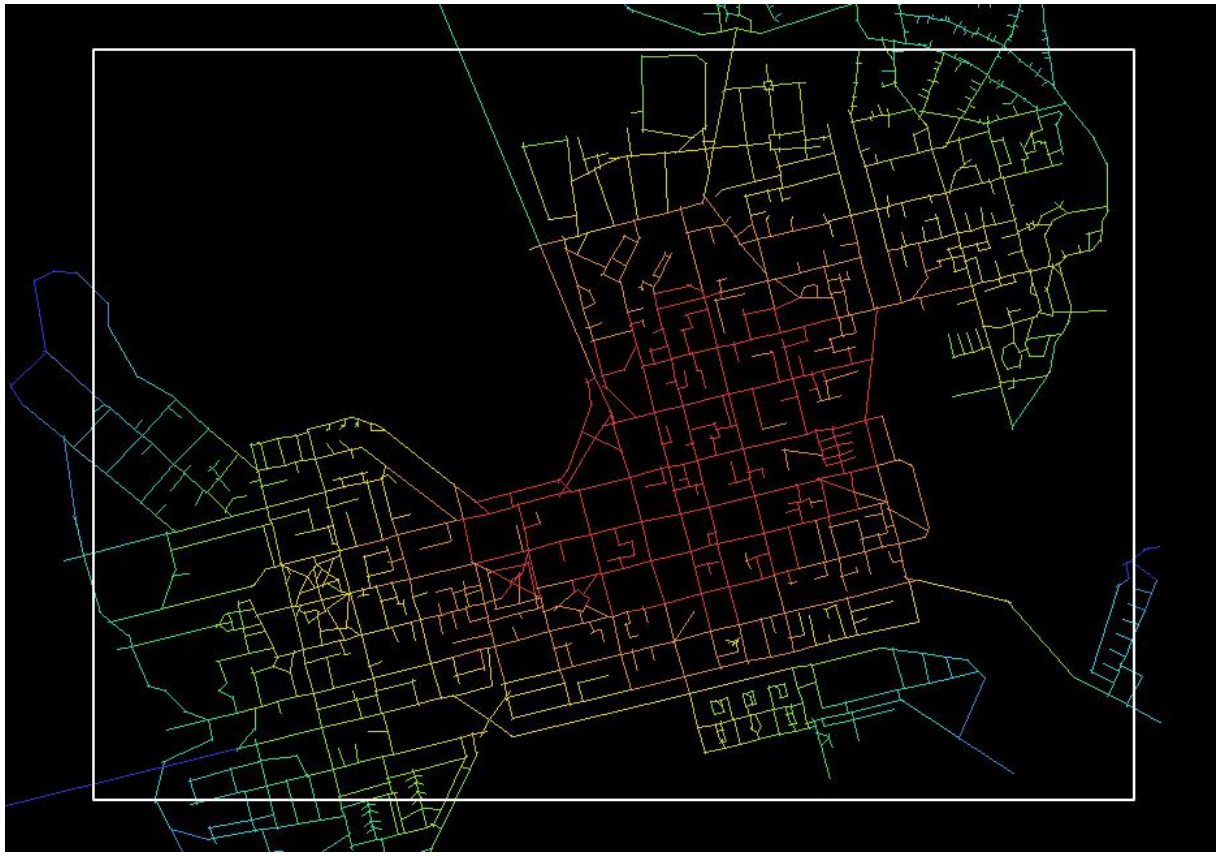


Figure 17: Metric total depth showing the center point.

Topological Total Depth

Figure 18 shows the topological total depth. Instead of metric distances it calculates the distance as the number of turns from each line. The center point becomes a lot vaguer if it exists at all, this could be due to the grid structure of the city.

Figure 18: A topological total distance measurement.

4.4 Criminality

Figures 19 to 27 show the criminal activity in Luleå city. Criminal statistics and information have been obtained through a publicly accessible website with its main goal being to deter crime. All major crimes between 1st January 2005 to 1st November 2010 are however visible on these axial maps (the axial map used for these figures are maps weighted with a radius of 6 unless a different axial map is mentioned) and have been considered sufficient for these analysis.

Figure 19 shows a clear concentration of crimes on Storgatan. Around 40 % of all crimes in Luleå city occur on one street alone.

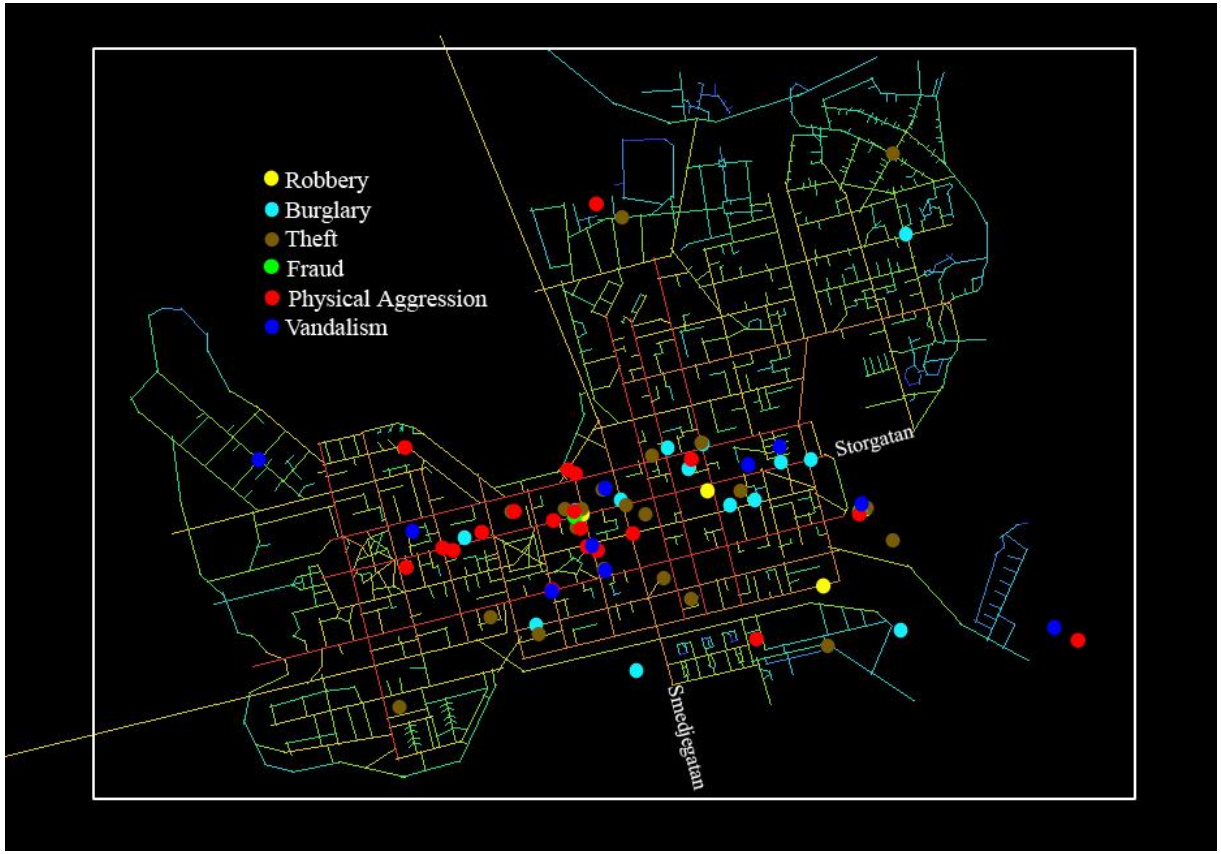


Figure 19: Location of crimes commited in the city center using integration values with radius 6.

Figure 20 shows the crimes depicted on a different axial map. The axial map shown in the figure has been manually configured to show density as has been observed on different locations in the city. The concentration of crimes here is on Storgatan which now has a darker colour because of the higher observed density on this street. So the actual observed density correlates very well with the crime rate atleast on Storgatan. The higher the real density of pedestrians on a street, the more crime occurs on that street.

Figure 20: The manually entered integration values axial map is used to illustrate the same crimes. A clear pattern can be seen with higher crime rates at Storgatan.

Burglary

Figure 21 shows statistics on burglary and examplifies the trends of criminality in Luleå city with 40 % of burglarys commited on the main street of Storgatan. All criminal activity of the 5 types studied, are on average commited 40 % on Storgatan or the blocks in direct connection to Storgatan while the rest of the city stands for 60 % of the criminality.

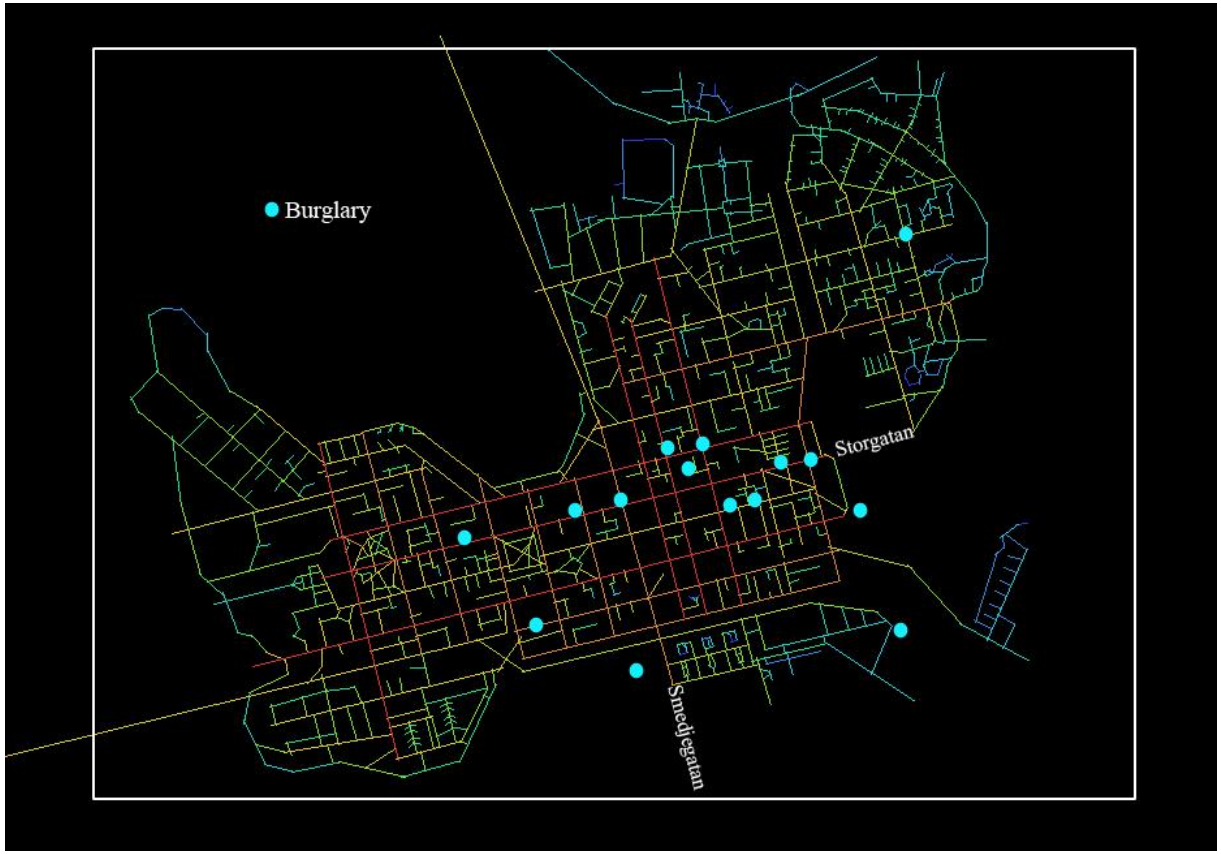


Figure 21: Crimes of burglary commited in the city center.

Physical Aggression

Figure 22 shows physical aggressions in the form of fights, brawls and other types of violence towards others, 45 % occur on Storgatan and its nearby blocks. Another interesting trend is that 75 % of this type of crime is commited either on or to the west of Smedjegatan. The most likely reason for this is that nightclubs, bars and pubs are located to the west of Smedjegatan. Studies show that about 78 % of all types of physical aggression are committed by the perpetrator being under the influence of alcohol[46], so the higher frequency of physical aggression commited on the west might not be so surprising.

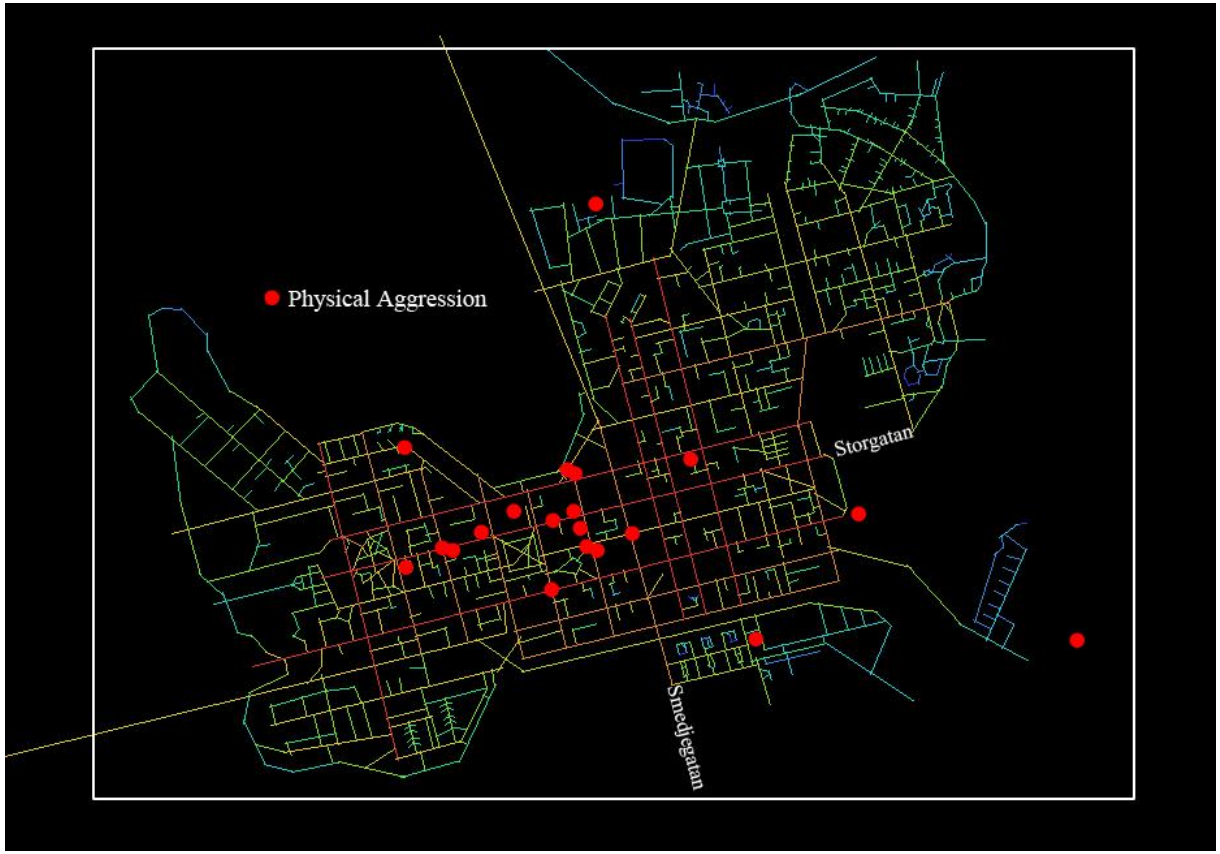


Figure 22: Crimes of physical aggression.

46

Sverigesradio.se/sida/artikel.aspx?programid=83&artikel=2792743

Robbery

There is not enough information on robberies to make any assumptions or to consider any trends of robbery in Luleå city. Figure 23 shows two robberies commited on Storgatan and two on other streets. It should also be noted that these robberies are not personal robberies as these statistics only show robberies commited towards businesses as shops, banks and so forth.

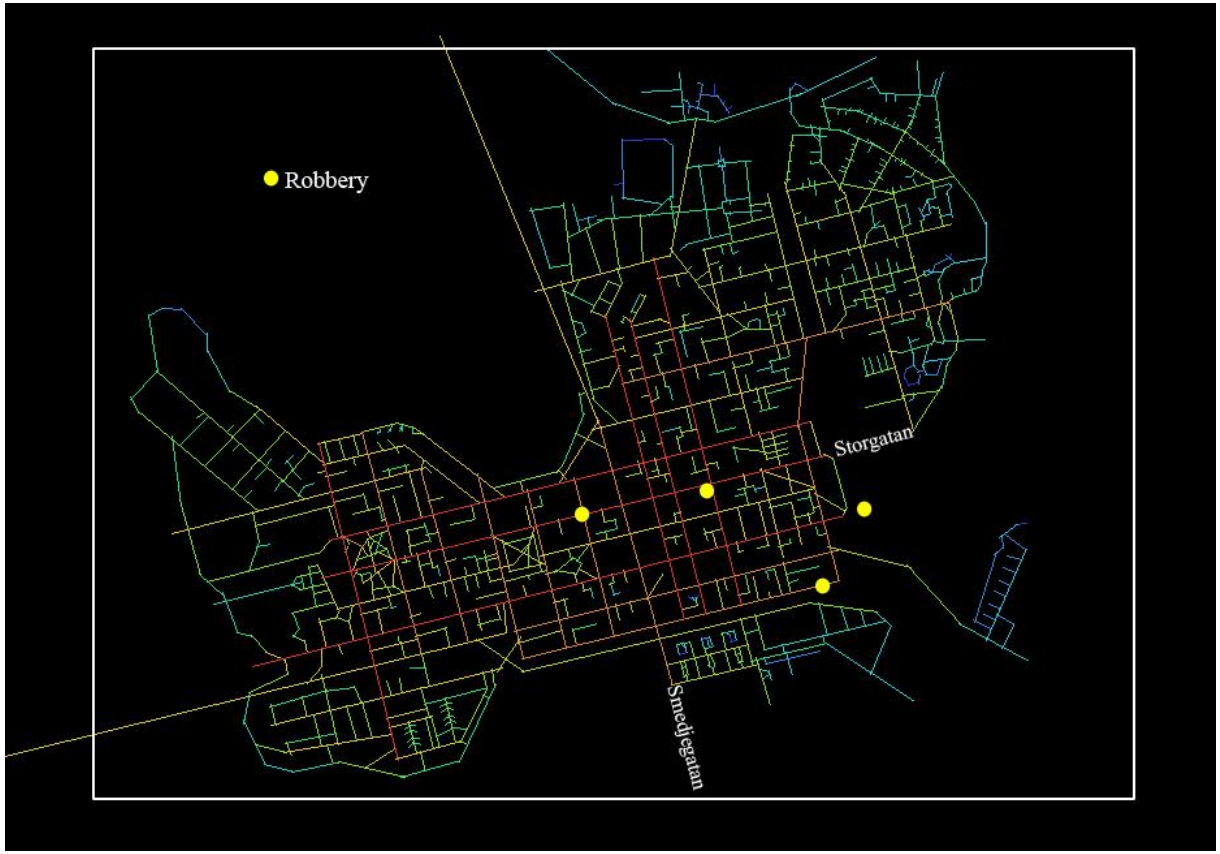


Figure 23: The robbery data here excludes personal robberies.

Theft

Out of the 5 types of crimes studied, theft has the lowest percentage of criminal acts commited on Storgatan. Figure 24 shows about 38 % of theft commited on Storgatan or on the nearby blocks. It might be possible to believe that the more dense a street is the less theft is committed on that street (although comparing statistics on crimes at Storgatan the differences are very small).

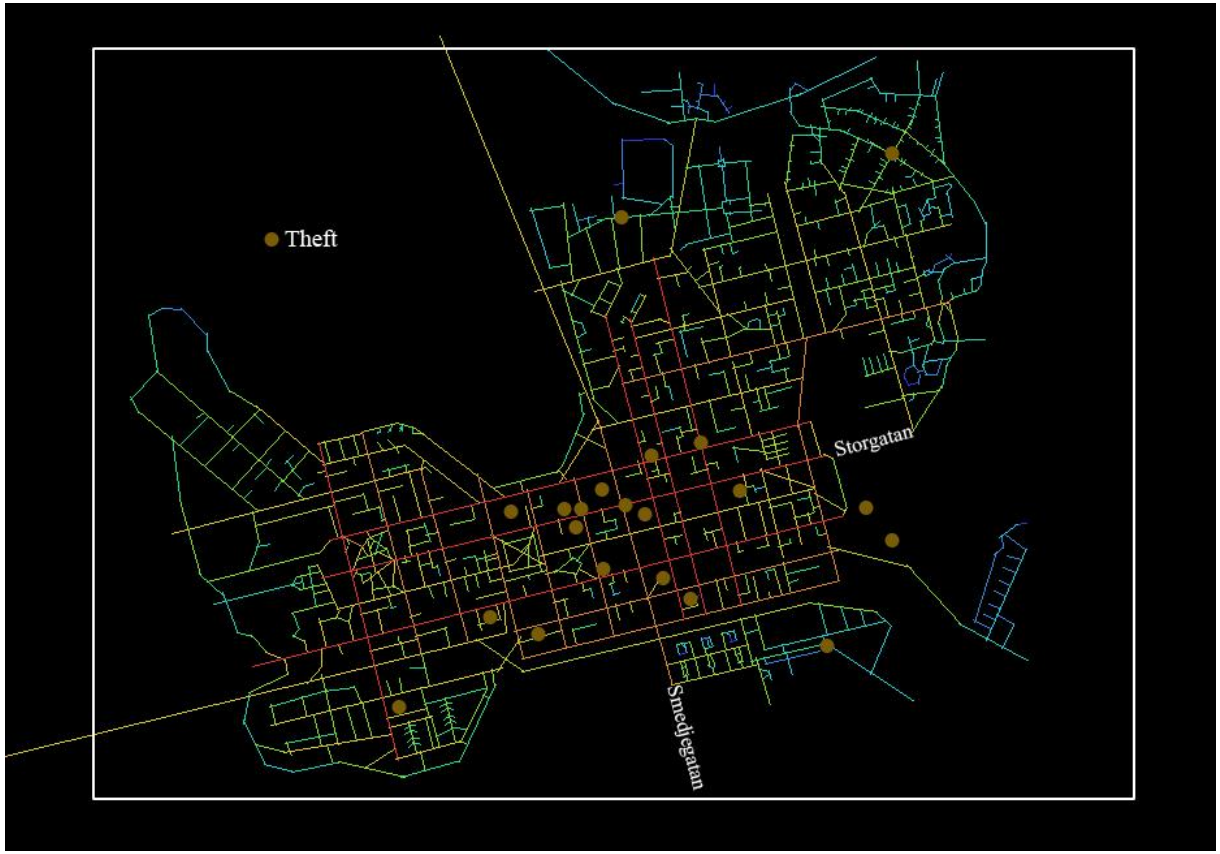


Figure 24: Theft crimes in the city center although these do not include shoplifting.

This trend becomes a bit more apparent when a different axial map is used. The following axial map in Figure 25 was made from the observational data and statistics on density in the city. Using that axial map with the same criminal data on theft a clearer pattern emerges of how theft is commited less on streets with more people on them. This can also be seen by the more sporadic and spread out locations of the crimes committed.

Figure 25: This figure illustrates the theft crimes using a different axial map. The axial map used here has the integration values entered manually.

Vandalism

Vandalism is another type of crime which seems to occur more frequently on streets with less people travelling on them. Although 40 % of the vandalism crimes are committed on Storgatan or the blocks in direct connection with Storgatan, none of the crimes are directly on Storgatan, see Figure 26. This might indicate that vandalism occurs in more secluded and private areas, which might give the perpetrator the time and privacy to commit the crime as no one else might be watching.

Figure 26: Vandalism seems to occur more frequently off Storgatan then the other crimes.

As with theft, a different axial map shows this trend more clearly. In Figure 27, the axial map used has manually entered integration values.

For Luleå it seems that the claims put forward by Baran, Smith and Toker (2007) are true for this particular region. Shops, restaurants and other facilities for daily activity attract criminals. Storgatan, having the highest number of retailer distribution and the highest density of people suggests that crime is concentrated on this street. The only crime type studied in this thesis that does not follow that logic is vandalism although a lot of it also occurs nearby. To draw any more significant conclusions, more data and a larger area of investigation is needed.

Figure 27: Using the axial map showing real pedestrian flow and density the trend of vandalism occuring off well integrated streets becomes a bit more apparent.

4.5 Retail

Space syntax can be used to study patterns and trends of shop locations. It has been found that streets with higher integration values tend to have more stores. This would seem logical as a healthy number of pedestrians and potential customers attract private businesses.

Table 4 shows that higher integration values converts to a higher amount of stores and restaurants. The four streets with the highest integration values have 60,1 % of all stores in Luleå city center located on them. These figures do not include the 76 retailers that are located in the 3 shopping malls at Storgatan.

Table 4: Number of retailers and integration values.

Street	Integration Value	Amount
Storgatan	2,69618	62
Kungsgatan	2,62191	32
Stationsgatan	2,66472	24
Skeppsbrogatan	2,6416	16
Smedjegatan	2,4683	13
Köpmansgatan	2,2424	13
Sandviksgatan	2,2998	11
Skomakargatan	2,56223	8
Hermelinsgatan	2,18309	7
Timmermansgatan	2,57015	6

So this trend seems to be consistent with integration values found in Luleå city, except for the streets of Skomakargatan and Timmermansgatan. However these streets do not have a high number pedestrians and therefore perhaps making them less attractive for private businesses to flourish here. The reasons for discrepancies between integration values and pedestrian density at these streets are discussed at page 46.

Some types of stores seem to be more reliant on pedestrian densities. A higher number of fashion and apparel stores are located on streets with higher integration values, as shown in Table 5. It could be argued that stores specialising on selling clothes, shoes and apparel have a bigger need to be seen for the business to be successful. Perhaps customers rate these stores higher if they are located on popular streets.

Table 5: The amount of retailers focusing on fashion and integration values for the streets.

Apparel		
Street	Integration value	Amount
Storgatan	2,69618	10
Stationsgatan	2,66472	3
Kungsgatan	2,62191	3
Smedjegatan	2,4683	3
Köpmansgatan	2,2424	3
Skomakargatan	2,56223	2
Rådhustorget	1,91811	1
Tullgatan	2,35736	1

The higher frequency of apparel stores at Storgatan and other streets with higher integration value could perhaps also be explained simply by the higher number of stores located on these streets. Although at

Storgatan there is one apparel store for every 6 stores which is compared to other streets quite high.

Restaurants also seem to be more prevelant on streets with higher integration values although once again this could be because of the higher prevelance of small private businesses here, see Table 6. Once again at Storgatan there is a 6 to 1 ratio.

Table 6: Restaurants located at each street and their integration value.

Street	Integration Value	Amount
Storgatan	2,69618	11
Skeppsbrogatan	2,6416	5
Stationsgatan	2,66472	5
Kungsgatan	2,62191	4
Köpmansgatan	2,2424	3
Nygatan	2,28069	3
Timmermansgatan	2,57015	3

It has also been found that stores that specialise in sales of out of the ordinary equipment, such as aquariums, or hardware appliances tend to be located on streets with lower integration values.

4.6 Road Maintenance

With more people or cars, it is logical to believe that more maintenance work might be required. According to Patrik Ruumensaari at the Technical Administration (Tekniska Förvaltningen) in Luleå, this is exactly the case as a higher amount of money has been poured onto Storgatan (Luleå's mainstreet) over the last few years. During a 6 year period approximately 44, 5 million SKR have been spent on that particular road for maintenance, expansion and renovation as shown in Figure 28. This also highlights the importance put upon this street by the Technical Administration as other streets have not received much attention. This concentration of funds could be one of the reasons why Storgatan has become the dominant street that it is today.

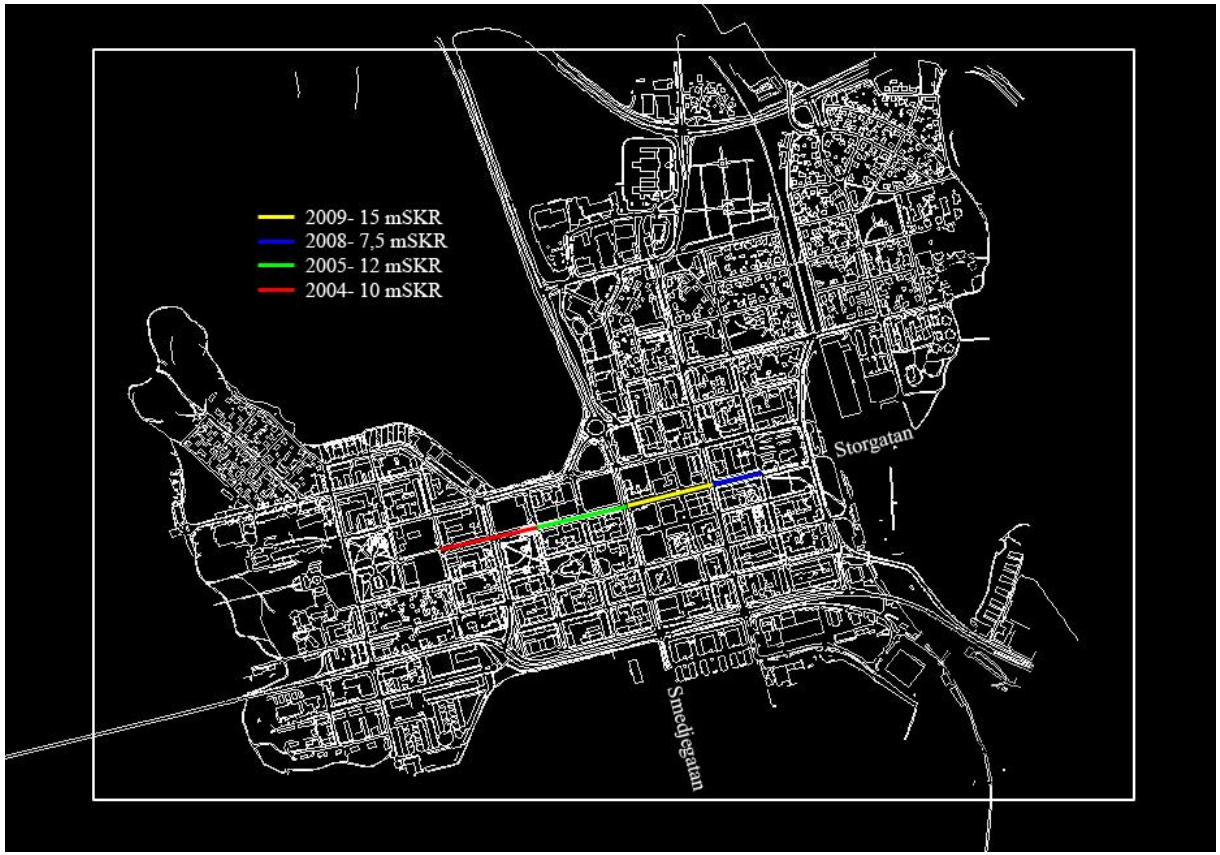


Figure 28: Maintenance work at Storgatan.

4.7 Ongoing Projects in the City

Space syntax can be helpful when new buildings and projects are being planned. Buildings at higher integrated streets will most likely also bring more people. For planners space syntax might be helpful in predicting what locations to use for projects to achieve its potentials.

As an urban planner, space syntax can help in predicting which way the city is growing. This might be useful when the infrastructure is planned for the future. Figure 29 shows the plans for upcoming projects in Luleå city.

Figure 29 shows that a lot of the current plans are outside and off the main street. This might indicate a decentralisation process as more and more buildings are being built away from Storgatan. Although one of the three buildings at Storgatan is a shopping mall which will probably increase the density of pedestrians even more.[47]

Figure 29: Ongoing and future construction projects in the city center.

[47] Interview: Frida Wikström

Figure 30 shows the axial map with integration values manually obtained through observational data and statistics. It shows the decentralisation process with most of the buildings being developed off the main street.

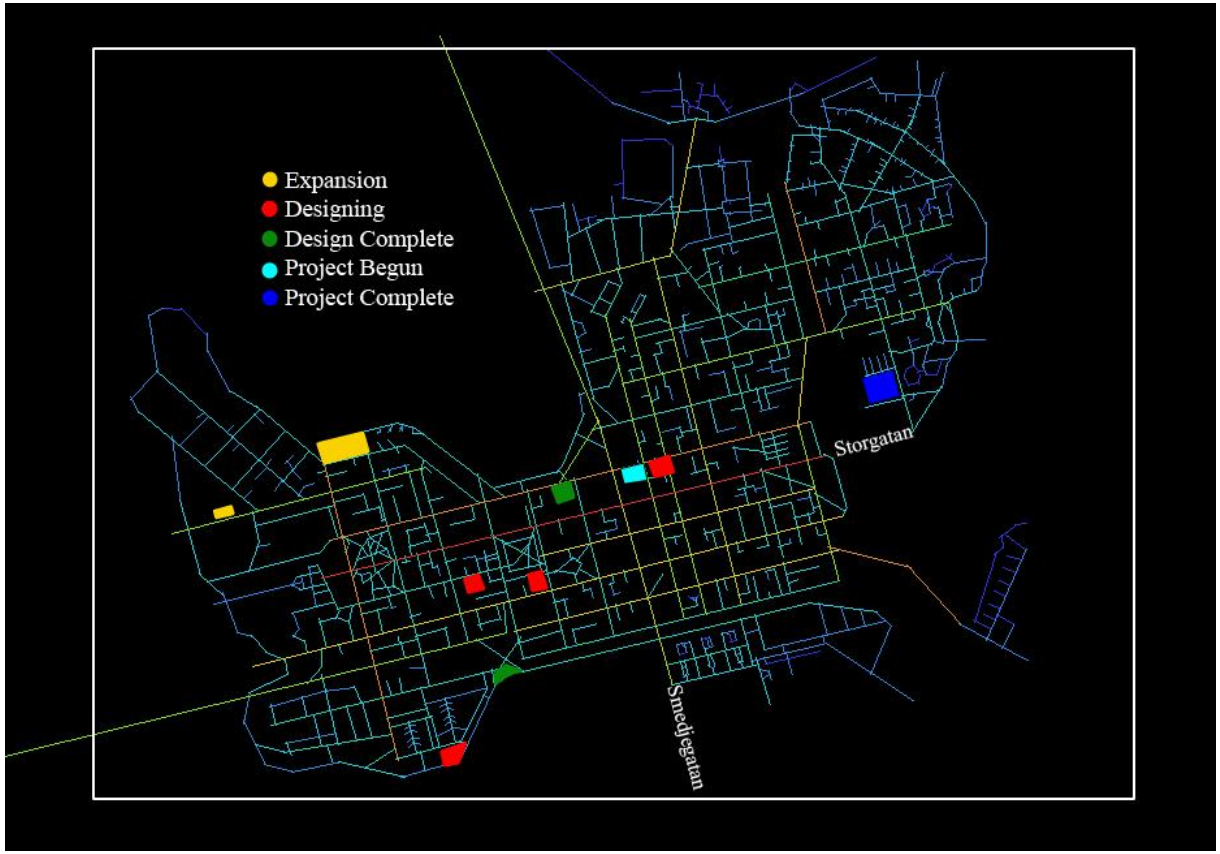


Figure 30: Axial map with manual pedestrian flow and density showing future and ongoing construction projects.

4.8 Other Aspects that can be studied through Space Syntax

An important factor in urban planning is air and noise pollution. Air and noise pollution from cars can be easily studied through space syntax as both of these increase as the car density increases.

Trainstations, busstops and other forms of transportation nodes can also be studied with the aid of space syntax. It might be useful to plan for new stops where the pedestrian density is the highest. Figure 31 shows the busstops (this also includes busstops that aren't used on a regular basis) placed around Luleå city.

Most of the busstops are placed at highly integrated streets, which is a trend that should be found in almost all cities. New, planned busstops should be placed on integrated streets to ensure the bus network's efficency.

Apart from the benefits in city planning, space syntax is regularly used in indoor building designs. This could be particularly helpful when designing buildings that may have high number of first time visitors to ensure the best possible orientation.

Figure 31: Busstops located in the city center. Some of these busstops are only trafficed for limited periods such as rush hours during weekdays.

4.9 A few steps to set up a space syntax analysis

Space syntax analysis can be helpful for urban planners in a number of ways. First and foremost it allows the urban planners to better understand the relationship between pedestrian or vehicular density and flow with crime and so forth. The decisions an urban planner makes in regards to spaces will inadvertently effect the socio-economic situation of the area.

Changing the road layout can affect the pedestrian flow and density of areas. Squares filled with a high pedestrian density can loose its popularity with introduction of new roads.

It can also help planners with implementing government policies. For example in England space syntax is regularly used to help urban planners with Planning Policy Statement 12 (PPS12) which serves as a guidance in ”local spatial planning” for LDF regulations[48]. In Luleå there is a vision set out for the year 2050 called the Luleå Vision 2050. One of the tasks that it outlines is the so called ”Space With Proximity” which asks for a closeness to activities at a comfortable distance[49].

A General Guideline

1 Decide what method to use. This will depend on your needs. Axial maps are good for studies of larger areas. Visibility graphs work very well for indoor spaces.

2 Decide on what computer program to use. UCL Depthmap is a good program for space syntax analysis. It does however require maps in autocad format. Once all the appropriate files are obtained, the analysis can be set up.

3 If an axial map is the goal, then make sure that consistent rules are followed. General rules for how the axial lines are created for roundabouts, parks, tracks and so forth should be clear.

4 The space syntax analysis can now be started. Axial lines can be set up automatically if the autocad map is closed. This means that all the streets need to have clear boundaries enclosed by lines. Otherwise the axial lines can be created manually by tracing each individual line in the program.

5 Determine the accuracy of the axial map. This should be done using observational data. Calculate how many pedestrians or vehicles are moving through invisible gates. What segment of the street where the collection of this data occurs is also important as the density and flow are rarely consistent throughout the whole street. Try to collect data from the busiest segment of the street. By being consistent a more reliable dataset will be obtained.

6 Check with the created axial map how consistent it is with the real data. There are a number of different calculations that can be used to depict the density and flow. Integration, choice, total depth are some examples. These can also be fine tuned with different weights and radii.

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48 http://www.communities.gov.uk/planningandbuilding/planningsystem/planningpolicy/planningpolicystatements/pps12/

49 http://www.aurorum.se/download/18.6ecc774c129d62edb5180001556/Lule%C3%A5+2050+sept08_engelska.pdf

7 Once the analysis is complete, a wide variety of different aspects can be studied. Having all the necessary information available, they can either be plotted onto different maps which might help in spotting different relationships or tables can be set up to study these with numbers.

5. Discussion and Future Studies

5.1 Discrepancies in space syntax

The space syntax analysis created for Luleå city do not accurately match the pedestrian flow as seen in real life (see Figure 32). There are three areas where the differences are noteworthy and are discussed more thoroughly below. These are Storgatan, the vertical streets and Stationsgatan. Although it should also be noted that space syntax at its simplest form is a way of analysing spaces and not a prediction of pedestrian density and flow. The integration values for example, show how well the streets are integrated in a network and not the pedestrian density. The integration value does depict the density with a 60-80 % accuracy[50]. Its strength is in analysing the spatial configuration in the built environment of a city. It only takes a few variables into account, such as the amount of connections on each street. However the spatial configuration of a city does influence the movement, with its effects perhaps not being as strong in all places.

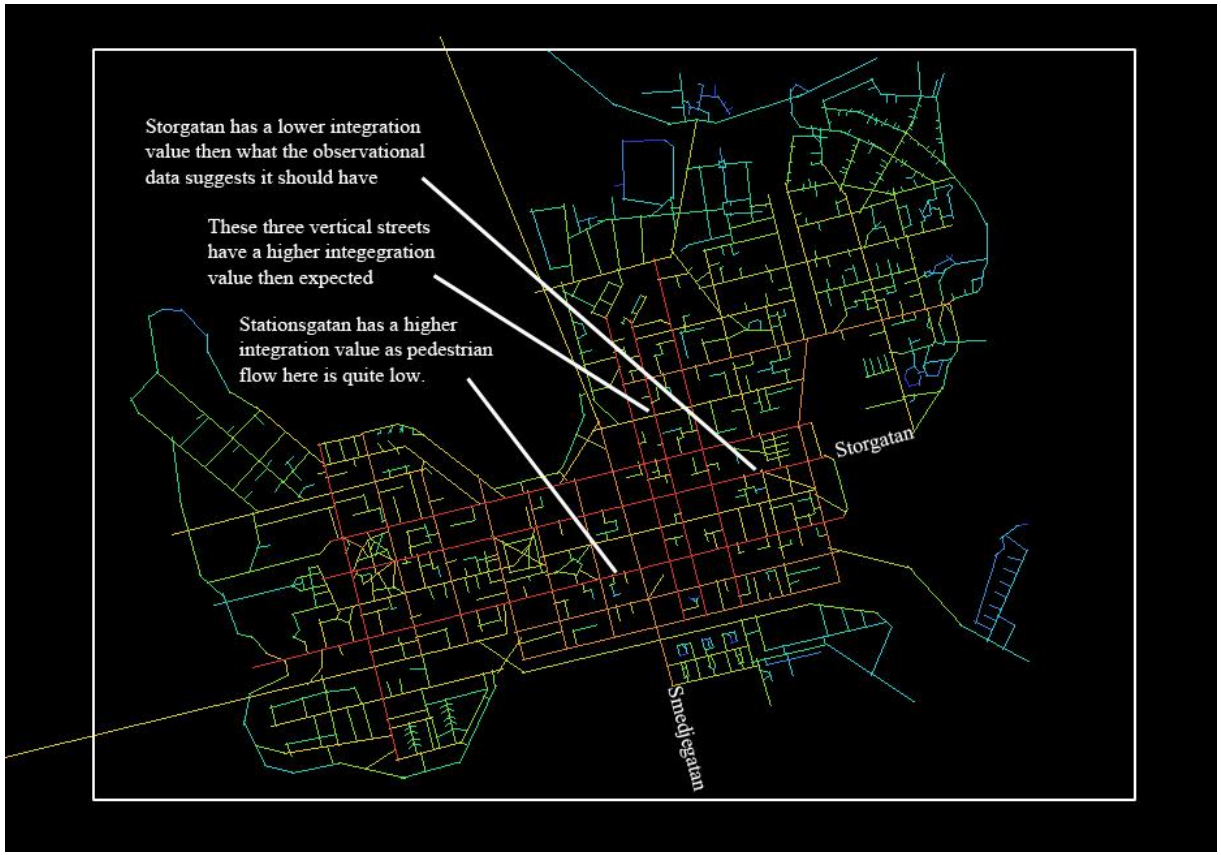

FIgure 32: Main discrepancies with the space syntax analysis and the real pedestrian density and flow.

[50] Hillier & Sahbaz (2008)

Storgatan

The difference is especially high for Storgatan which is the main street in the city with most of the pedestrians choosing to walk through this street. The integration value is therefore low compared to real life statistics for this particular street, or the integration values are high for the rest of the streets in Storgatans vicinity. In other words, there should be a higher difference in the integration values between Storgatan and the rest of the streets. The current integration values for the axial map with radius 6 shows inaccurately a very small difference.

Storgatan being the main street of Luleå provides a lot of the shopping and services in Luleå as well as social activities for the inhabitants of the whole region. There are three shopping malls connected with their main entrances towards the street and two transportation stations (local and regional busstations). Counting all the retailers on Storgatan together with all the shops inside the three shopping malls, Storgatan has more retailers than all the other streets put together (138 at Storgatan compared to 130 at all the other streets).

With its importance it is only natural for a higher pedestrian density at this street. Space syntax is not capable of taking these variables into account. However there is a strive to improve these tools to achieve a better understanding of cities. Place syntax is one of these methods, which takes into account all attractions in an area. As there are attractors pulling pedestrians to Storgatan, place syntax might be able to more accurately illustrate the pedestrian flow and density.

A reason for the higher number of retailers at Storgatan might be the population growth (or the lack thereof) in the city. There have been very small changes in population since 1975 (an increase of approximately 5500 people over a 35 year period[51]). This might be an explanation to Storgatan's popularity. New businesses knowing that the growth rate is slow might choose Storgatan as a place for establishment. It is perhaps seen as a higher risk to establish on other streets in case the city doesn't grow sufficiently enough over the years. This might lead new businesses to make safer choices about their placements.

[51] www.lulea.se

Vertical Streets

Another discrepancy in the analysis is the high integration values on the vertical streets to the east of Smedjegatan. Luleå city is perceived as dominated by horizontal streets with most of its shopping areas, and other activities lying on the horizontal streets rather then the vertical streets which have also been confirmed by some of the observational data. The three vertical streets portrayed by space syntax in Figure 33 with higher integration values are Skomakargatan, Timmermansgatan and Kungsgatan. Kungsgatan does have a lot of traffic as it is one of the entrance points to the city, although not as high as Storgatan, so the integration value might therefore be justifiable. The other two streets on the other hand do not carry a lot of pedestrian traffic. A pedestrian count has not been conducted on these streets but from observations it is safe to say that the pedestrian flow is quite low on these streets.

This discrepancy is probably due to the fact that the axial lines for these three streets are the only ones that are unbroken in this particular area. Since they are unbroken they have more connections which inturn increases the integration values of these three streets.

Figure 33: This figure shows the axial lines of the vertical streets to the east of smedjegatan.

Stationsgatan

A third discrepancy has been identified at Stationsgatan which according to the space syntax analysis would suggest a higher pedestrian flow then what it really has.The axial line for Stationsgatan is the longest line on the map. As a pedestrian, a walk through Stationsgatan would be the longest journey in a straight line then compared to walking on any other street. Since it is the longest it also naturally has the most connections and intersections on it. For this reason the integration value of the street turns out to be higher then what is perceived.

The highest point in Luleå city is also near this axial line, with the church located at this point. It can be argued that there should be a break here in the axial line since the line of sight is blocked due to the small hill. To stay consistent, however, the axial lines have been made with the consideration that the city is completely flat.

Figure 34 shows the lines ranked by its length. Red lines being the longest and blue the shortest.

Figure 34: Line lengths in real distance are depicted in this illustration. Red being the longest lines while blue the shortest.

Meanwhile Figure 35 shows lines ranked by connectivity, red being the lines with most connections and blue lines with the least amount of connections. Stationsgatan has a total of 38 connections (Storgatan has 34 connections).

Connectivity is one of the most important variables (as it affects the mean depth) that are taken into consideration in a space syntax analysis and for this reason the integration value for Stationsgatan his higher.

5.2 Potentials rather than predictions

Even though the results of the space syntax analysis weren't as accurate as hoped, I do believe that these analysis point out the potentials that lay within the city. The integration values which should depict the density shows how well integrated the streets are. As the city grows I believe that these streets where a significant discrepancy exists today will be the first streets to be more frequently used in the future. Today most of the new attractors are being set up at or around Storgatan. This might be possible because of the available properties at Storgatan and its seemingly endless expansion throughout its length. As these spaces will be taken up in the future new attractors might start growing on

Figure 35: The amount of connections to each line is shown here.

other streets which in turn might lead new pedestrian flows to these streets as well.

5.3 A Refined Way

The discrepancies in the space syntax analysis in Luleå have made it harder to study the relationships between crimes, retail distribution and so on. There needs to be a concise and accurate way of depicting pedestrian density and flow, before these types of studies can be performed to draw any meaningful conclusions. This has led me to investigate different paths to illustrate densities in a better way. A good place to start has been methods that deal with locations. It is apparent that the reasons for much higher density at Storgatan are due to a higher number of facilities at this street.

Future studies for Luleå could perhaps be conducted using place syntax instead. This might be a better way of analysing Luleå as I believe all the attractors at Storgatan will be more accurately picked up by that method. I think that it is these attractors that go a long way in explaining the reasons for the high pedestrian densities at Storgatan and perhaps also the lack of density at other streets.

This method was first developed at the Royal Institute of Technology in Stockholm. It combines information of an area with space syntax. After a space syntax analysis has been set up a program called the Place Syntax Tool can be used to conduct a place syntax analysis. It uses attractors, which can be shops, bus stops, landmarks and so forth, in order to study pedestrian flow and density.

Place syntax integrates quantitative information such as the number of people living, working, studying in an area. This can be useful whilst trying to find out or predict the amount of visitors in an area, or to an attraction. It can also evaluate the amount of attractors in an area and the ease of access to these attractors.[52] Place Syntax emphasizes the importance of locations by indicating attractors which affects the travel patterns.

Looking at an individual's travelling pattern, there is always a starting point and a finishing point (in a one way travel). Attractors could perhaps be best categorized as the finishing point as people will be flocking to these places and reaching their destinations. However it might also be interesting to take a look at where people originate from, the starting point of their route, to tell the whole story as shown in Figure 36. On an individual level this would perhaps be very time consuming as every person leaves their homes to start their journey. By generalizing the starting point it might be possible to overcome this problem. It should be possible to generalize the starting point as busstops, parking lots or entrances to larger residential buildings from where many people begin their journey on foot and entrance ramps to highways which might be commonly used for a suburb or even for vehicular illustrations. These locations, repellors which people walk away from (the word repellor is only used as an opposite to the word attractor), could be used to link it with lines to attractors showing every individuals path. These pathways could be drawn for a limited time, anywhere from a 5 minute or an hour timeframe depending on the resources and the accuracy needed by the analysizer. These paths could also serve as estimates of exactly how many pedestrians are walking at which segments.

[52] http://www.spacescape.se/pdf/Om_Place%20Syntax_Spacescape_AB.pdf

One possible error with this method is its focus on starting points and finishing points. Most people while travelling do not stop at one location and then head back, but stop at different places to perhaps run a number of errands. Although it might be possible to use the furthest location as a finishing point and therefore assuming this to be the point of return.

This would however induce discrepancies of the exact path if that path is not known. Another problem might be the time consumption to set up such an analysis. However I do believe that this would more accurately illustrate actual people's pathways which are needed to investigate correlations and relationships with other aspects. Perhaps this way flow and density can be studied in its rawest form without considering socio-economic, lifestyles, attitudes or spatial configurations which are obviously important but perhaps do more to answer the why question rather than answering where we travel. So this way, in its finest form, this refined method could illustrate where we travel while space syntax and the socio-economic factors could explain why, allowing a place for all methods to coexist and perhaps enhancing our understanding of travel behaviour.

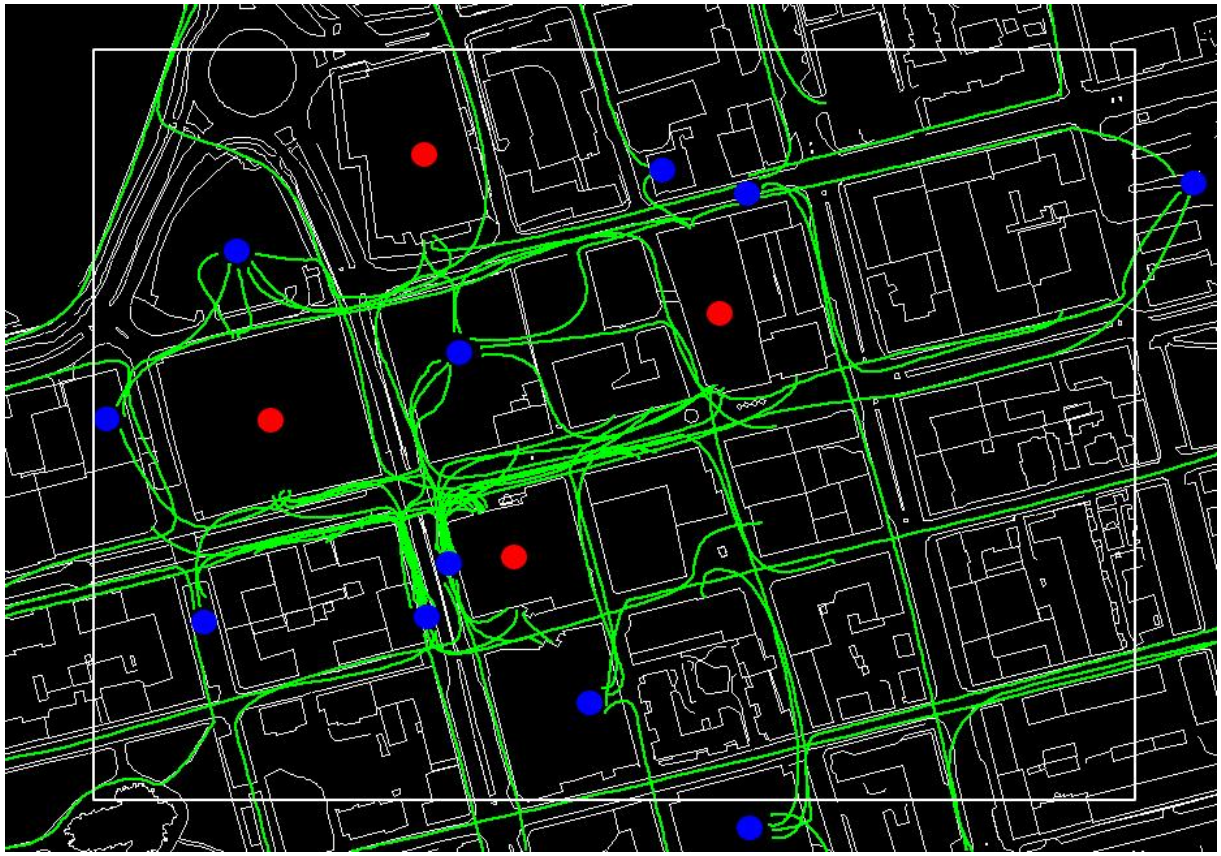

Figure 36: Repellors in red and attractors in blue, it shows the pedestrian flow (green) and perhaps density between these two points.

5.4 Impacts of Urban Structure versus Socio-Economic Factors

An interesting study might be to see if there are any differences in pedestrian density and space syntax at weekends. At week days the majority of our trips consist of bounded trips which are trips with fixed location and a fixed time (59 % bounded trips with travelling to school and work being examples of these). According to Naess (2006) the urban structure has a higher affect on these trips. At weekends 29 % of our travels consist of bounded trips. Socio-economic and lifestyle factors should therefore have a higher impact on our travel patterns on the weekends. So it is reasonable to assume that urban structures matter more on weekdays while socio-economic and lifestyle factors matter more on weekends. If space syntax is used to make the comparison, and it already accurately depicts the pedestrian/vehicular density, then generally speaking there are two possible outcomes. At weekends the correlations are not as strong or the correlations remain the same (space syntax accurately predicting density both on week days and weekends). If the correlations are not as strong then that would indicate that socio-economic and life style factors are important. If the correlations remain the same then that would indicate that urban structures matter more. Depending on the results this might settle the arguments between these two sides and answer the question what matters more urban structures or socio-economic and lifestyle factors? At the very least it might indicate to what degree these two aspects play a role in our travel patterns.

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Appendix A: Integration Values

Integration values of the axial map without any weights.

Number	Street Name	Integration Value	Connectivity
10	Kungsgatan	2,43007	18
9	Timmermansgatan	2,32781	19
8	Skomakargatan	2,32698	18
2	Storgatan	2,30642	34
4	Stationsgatan	2,28702	38
1	Skeppsbrogatan	2,27269	31
11	Lulsundsgatan	2,2492	31
12	Prästgatan	2,17572	4
13	Prästgatan	2,06818	12
5	Sandviksgatan	2,04293	16
6	Varvsgatan	2,03402	14
7	Smedjegatan	2,00651	14
3	Köpmangatan	2,00281	18
14	Residensgatan	1,98757	24
15	Trädgårdsgatan	1,9294	16

Integration Values of the axial map with radius set to 6.

Number	Street Name	Integration Value	Connectivity
2	Storgatan	2,69618	34
4	Stationsgatan	2,66472	38
1	Skeppsbrogatan	2,6416	31
10	Kungsgatan	2,62191	18
9	Timmermansgatan	2,57015	19
8	Skomakargatan	2,56223	18
14	Residensgatan	2,55559	24
7	Smedjegatan	2,4683	14
15	Trädgårdsgatan	2,42768	16
11	Lulsundsgatan	2,41794	31
13	Prästgatan	2,3898	12
12	Prästgatan	2,36738	4
5	Sandviksgatan	2,2998	16
6	Varvsgatan	2,28975	14
3	Köpmangatan	2,2424	18

Appendix B: List of Retailers

Horizontala Gator

Hornsgatan-	Berglunds Salong
Småbåtsgatan-	Willys
Västra Varvsgatan-	Restaurang Bryggeriet Mumma Smörgås Service
Varvsgatan-	Restaurang Ripan
Sandviksgatan-	Börjes Trafikskola Vågelinds Trafikskola Britts Damfrisering Chillout PADI (dykarskola) Tattoo Piercing Akvarie Center Magic Tan (spray tan salong) Cykelstället Artic Hotel Köpmannens Kök
Stationsgatan-	Katt & hund Skandiamäklarna Nordanmak (kafé och restaurang) Hemmia textile & inspiration Restaurang Diamant (indisk mat) Anetts Klippin Flytcenter (massage) Sushi & Té Solsystemet (Solarium) Sko o Nyckel Verkstan Lena Ellinor (konstpäls och hattbutik) Café Wienerhörnan –närmast rådstugatan Behandlingscentret (ansiktsbehandling, kroppsbehandling, naglar) Lins Lusen (Jenny Pettersson Photography) Kringlan (kläder, adress smedjegatan) Boströms Ur & Guld (adress smedjegatan) Paraffine Ljuslyan (adress smedjegatan) Fina Former (kläder, adress smedjegatan) Zan Kök och bar (Persisk Restaurang, adress smedjegatan) ICA Supermarket (adress skomakargatan) Memory (Hårvård, Hälsa & Skönhet) Park Hotell Hotell Amber Ayurveda (Hälsobutik)
Rådhustorget-	Gneis (kläder) Luleå Begravningsbyrå
Köpmansgatan-	Norrbottens Museum Tapa Chula (mexikansk restaurang) Kläder och Form Anatolia (bar vid korsning köpman, nygatan, byt till Corner) Arktis Smedjan (guld, juveler)

	Studio Znygg (Hårvård, make-up, fransar och bryn)
Storgatan-	Sushibar
	Heroes Pasta-Baren
	Café Fröjd
	Klippman
	Trafikskolan
	Stinas Mat (Grillat, Pan pizza, smörgåsar, sallad)
	Specsavers Optik
	Olivers
	The Bishops Arms
	Stadshotellet
	Cleo
	Äventyrsbutiken Hägglunds
	Kungskiosken
	Baan Thai
	Guns Skor
	Lindgrens Mode
	Klipperian
	Life
	T.a Take Away
	Comfort Hotell
	Hemmakväll
	Grafit (Apple butik)
	Fresh Up (skönhetsvård)
	Handarbetshörnan (konst och hantverk)
	Konst och inramningar, Tobak
	Atelje Grodan (fotografering, bild, reklam)
	The Phone House
	System Bolaget
	Börje Olssons Konditori
	Pressbyrån
Skeppsbrogatan-	Yoga
	Pos Trafikskola
	Fonus Begravningar
	Bistro Bar Brygga
	Kebab-Huset
	Waldorf
	Kiosk Baren
	Condis (café bageri)
	Ramus Musik
	Klippt & skuret
	Klockslaget
	Singer Pfaff (sy maskiner)
	Lindbergs Konst & Ram
	Kemtvätt
	Chim’s Orientaliska café butik bingo
	Kiropraktor
Repslagargatan-	Pepperoni Pizza
Norra Strandgatan-	Företags hotell Lina
Magasinsgatan-	Pasta Restaurang
	Ögonfröjd
Lulsundsgatan-	Sax & maskin

Vertikala Gator

Trädgårdsgatan-	Ninas Trafikskola
Tullgatan-	Skräddarn

	Tinas Rum (Hotell)
Rådstugatan-	Hägglunds Outlet (industri maskiner) Magazin du Nord (varma underkläder i naturmaterial) OMT Kliniken (Ortopedisk Manuell Terapi)
Kungsgatan-	Gennys Bar och Restaurang Inpuls (gym) City Sleep Hostel
Nygatan-	Myresjöhus (mäklare) Corsica Roya Café & Salladsbar Salong Carita Salong Alfonso Matstället (kebab, pizza o dylikt, finns ej längre)
S. Smedjegatan-	Sun Tan Guapo (kläder) Carinas Nails Annelis Hårdesign Kafelino Hagström Musik Modelljärnvägsspecialisten Luleå Resebyrå Vitre (kläder) Konst & Hantverk Resebyrå Gossip (hårklippning) Bengts (kläder) Preutz-Synsam
Skomakargatan-	Kalufsen (frisör) Tati (tapeter, tyger, inredning) Mosaik (mode, skor, accessoarer, inspiration, kafé) Eriks Elektriska (elkedjan) Café Lina
Timmermansgatan-	Ann-Britts Klippotek (frisör)
Kungsgatan-	QL Inredning Park Hotell Affärsnamn saknas (inredning, hem) Restaurang Exotic (kinesisk & pizzeria) Forma (frisör) Xtreme Beauty (nagel, ögonfransar, hårförlängning) Svensk Fastighetsförmedling Mack-bar (Café smörgåsbutik) Symaskiner Killerqueen (Aeon Tattoos) Rabalder (kläder) Café Metropol Naturkompaniet (kläder) Matthörnan (mattor) Kungskiosken Erikssons Frisörshop Takt & ton (hembio, hifi, bilstereo, projektorer) Nordkalott Fastigheter Möbelhus Hair Team Dermal Anchor (piercing)

	New Life (frisör)
	Luleå Hifi & Hembio
	Hafva (kläder)
	Väv & Garn
	Mäklarhuset
	Solarna Center (solarium)
	HW Data (datasystem, nätverk)
	Lilla Köksboden (köksredskap)
	Cantarellen (restaurang & catering)
	Kärleksbutiken
	Eurobild (professionell fotografering)
Hermelinsgatan-	Hotell Aveny
	Flora Tandklinik (tandvård)
	Pearlshop (smycken)
	Studio Zacks (frisör)
	Go On (datorer, skrivare, tillbehör)
	Frisyrstudion
	Österns Pärla
Prästgatan-	(Artic Hotel)
	Fyndhörnan (allt i allo, hemmet)

Inventering Av Luleå City

Storgatan-	Hanzéns (kläder)
	Optilens
	Jala Färg Tapet
	Salong Maskulin
	Pressbutiken Aurora
	Annorlunda (hem)
	Winbergs Intim (kläder)
	Euroflorist
	Bellis (blommor)
	Korvgubben
	Thai Thai
	Roasters
	Gameshop
	Ticket
	Fritz Olsson (guld, smycken)
	Kjell & Company (elektriska apparater)
	Interflora (blommor)
	Lush (hem)
	Dressman
	Din Sko
	Klarsynt
	Önska (hem)
	MQ
	Hardwear
	Zotano (skor)
	Gallerix (bild)
	Face Stockholm (make-up, salong)
	Apoteket
	Synoptik
	Forex
	Guldfynd
Timmermansgatan-	Lyxx (skönhetsbutik)
	Pentik (hem)
	NEX (resebyrå)
	Filmstaden
	Max
Köpmansgatan-	Berlins (kläder)
	Sportprodukter
	Hälsokällan

	Bastukällan
	Doffi (kläder)
	Elkedjan
	Lilla Salongen
Skomakargatan-	Café Symphanie
	Sub & Co (mat)
	Mode Magnifique (kläder)