Tuuli Rantala, Pasi Metsäpuro, Terhi Luukkonen, Kaisa Karhula, Kalle Vaismaa & Jorma Mäntynen

VITALITY FROM WALKING AND CYCLING

VERNE
TRANSPORT
RESEARCH CENTRE

TAMPERE UNIVERSITY OF TECHNOLOGY

Tuuli Rantala, Pasi Metsäpuro, Terhi Luukkonen, Kaisa Karhula, Kalle Vaismaa & Jorma Mäntynen

VITALITY FROM WALKING AND CYCLING

Tampere University of Technology, Transport Research Centre Verne
Tampere 2014

Steering group

Jouni Mattsson (chairman), the City of Hyvinkää
Timo Seimelä, the City of Tampere
Veikko Vänskä, the City of Tampere
Marek Salermo, the City of Helsinki
Alpo Tani, the City of Helsinki
Penelope Sala-Sorsimo, the City of Helsinki
Timo Vuoriainen, the City of Jyväskylä
Reijo Teivastenaho, the City of Jyväskylä
Veli-Pekka Koivu, the City of Kokkola
Matti Hoikkanen, the City of Lahti
Saara Vauramo, the City of Lahti
Pasi Leimi, the City of Lappeenranta
Pentti Multaharju, the City of Lappeenranta
Jorma Heikkinen, the City of Oulu
Sanna Välimäki, the City of Pori
Eija Riihimäki, the City of Pori
Katariina Myllärniemi, Ministry of Transport and Communications
Kaisa Mäkelä, Ministry of the Environment
Risto Järvelä, Ministry of Education and Culture
Matti Hirvonen, the Network of Finnish Cycling Municipalities

PYKÄLÄ research group

Jorma Mäntynen, Professor, Project Leader
Kalle Vaismaa, Project Manager
Kaisa Karhula
Terhi Luukkonen
Pasi Metsäpuro
Tuuli Rantala

Pictures (unless otherwise stated)

Kaisa Karhula
Terhi Luukkonen
Pasi Metsäpuro
Tuuli Rantala
Kalle Vaismaa

Translation by Translatum Oy

Transport Research Centre Verne
Tampere University of Technology,
PL 541, 33101 Tampere, Finland
www.tut.fi/verne

Tampereen yliopistopaino Oy – Juvenes Print
Tampere 2014

ISBN 978-952-15-3305-1 (printed)
ISBN 978-952-15-3306-8 (PDF)

Foreword

PYKÄLÄ-projects conducted by Transport Research Centre Verne from Tampere University of Technology have given a strong push to the promotion of walking and cycling in Finland. During the first PYKÄLÄ-project (2009–2011) the best European practices in promoting walking and cycling were gathered and these practices were then applied to Finland. The results of the project were published in two books from which the book Best European practices in promoting cycling and walking has been noted also internationally.

PYKÄLÄ II -project (2011–2013) continued the work that started during the previous project. Even more precise information for the base of urban planning has been produced for planners and decision makers about the effects of pedestrian areas to business life, city centre transport system that promotes walking, the principles of pedestrian traffic planning, the potential of bicycle commuting based on geographical information, the principles of bicycle network planning and the best practices for cycle path winter maintenance processes. We hope that this book increases enthusiasm and knowledge on how to develop walking and cycling conditions in cities. The promotion of walking and cycling is a key question when improving the vitality of our cities.

On behalf of the research group we would like to acknowledge the partners of the PYKÄLÄ II -project: Finnish Ministry of Transport and Communications, Ministry of the Environment, Ministry of Education and Culture, Network of Finnish Cycling Cities and the cities of Helsinki, Tampere, Oulu, Lahti, Jyväskylä, Lappeenranta, Pori, Hyvinkää and Kokkola. We are also grateful to the European example cities: Copenhagen, Lund, Linköping, Umeå, Delft, ´s-Hertogenbosch, Nijmegen, Utrecht, Peterborough, Sheffield and Oulu. The representatives of these cities made us feel welcome and gave us worthy information to go forward. Acknowledgements to EDGE Laboratory for Architectural and Urban Research in Tampere University of Technology and especially to professor Ari Hynynen with whom the co-operation was very fruitful. We are also thankful to specialists in Decisio (Amsterdam) and in TU Delft for the rewarding interviews. Special acknowledgements to Gehl Architects for the valuable comments in different phases of the study.

We hope that promotion of walking and cycling provides life and vitality to all cities!

Jorma Mäntynen
Professor of Transportation Engineering

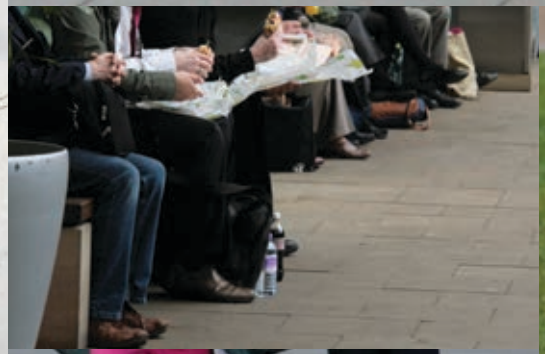
Kalle Vaismaa
Project Manager of PYKÄLÄ II -project






ETON




CONVERSE
ALL STAR


Content


Grote Markt
Bedum 10
Winsum 15
Fietsenstalling
Camping
TAXI

Introduction

Walking and cycling for the best of the cities

Walking is the oldest and most natural way for humans to move around. Yet, even today, walking is not seen as a transport mode in its own right with a legitimate role in modern transport systems and urban planning. Equally surprising is the fact that there is not a lot of support material available for the pedestrian area planners.

Why then is walking so important? Walking is connected to a vast array of things required to obtain a high quality of living. It forms the basis for vibrant urban life. A safe and comfortable pedestrian environment provides the most natural way for people to interact with each other. One indicator used to measure the viability of city centres is the number of pedestrians in the centre. Walking is also healthy. It is vital to the well-being of the people as well as to the public health.

Pedestrian centres are good for business. This has been proved in numerous studies. Many Central European cities provide excellent examples of viable pedestrian-oriented areas with diversified business life. Businesses have often had reservations about the cities' plans to implement pedestrian areas. However, once the situation has normalised following the completion of the projects, most cities and businesses involved have requested more pedestrian areas to be built.

Cycling once significantly extended our range of mobility which had until then been defined by walking. Later motorized traffic brought an even bigger area in the reach of our daily activities. Being a pleasant form of traffic on moderate distances cycling is, however, making its comeback. Cycling is good for health which is why many countries want to promote public health by investing in improving the conditions for cycling. Cycling is also an environmentally friendly way to travel in urban areas where many are typically exposed to emissions from motorized traffic. Promoting cycling reduces congestion and improves air quality, especially if motorized traffic is restricted simultaneously. Time costs become also lower while cycling as valuable minutes or even hours aren't wasted in traffic jams. In the best cycling cities of Europe cycling is flowing, easy and fast. That is why most of the people choose bicycle over the car for example on their way to work.

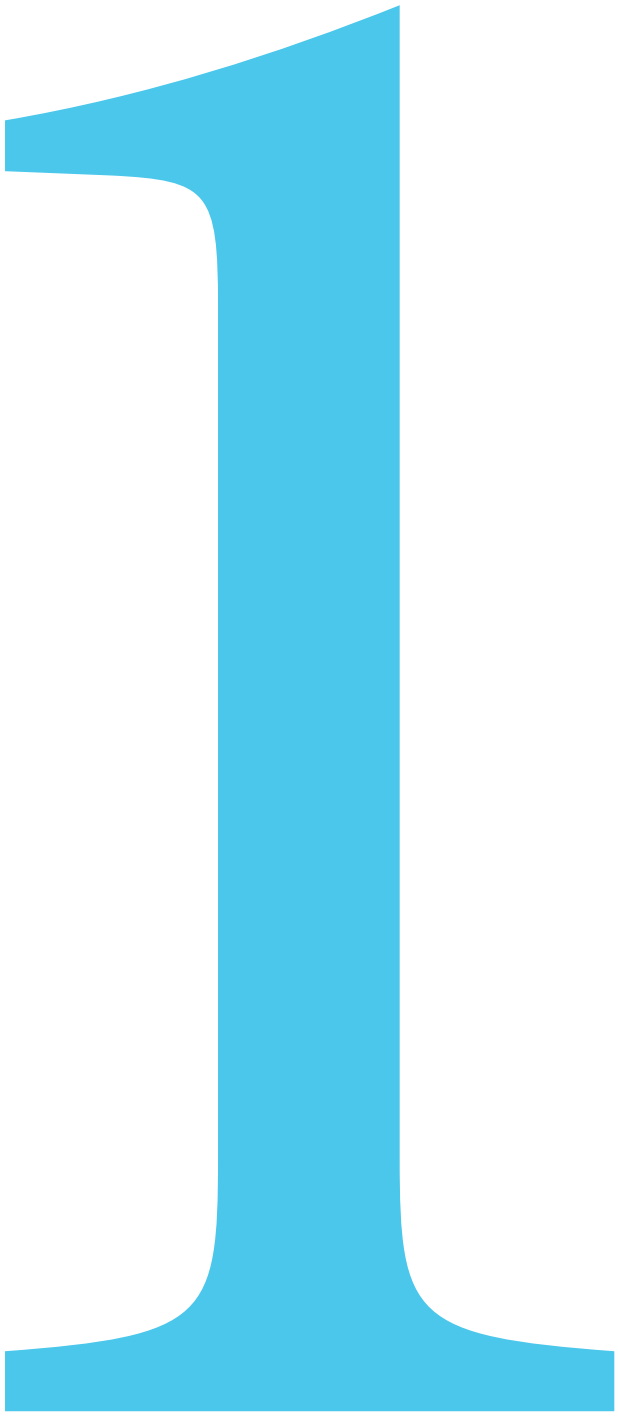
The book is part of PYKÄLÄ II -project

Vitality from walking and cycling presents results from PYKÄLÄ II –project which was carried out in 2009-2013 in Transport Research Centre Verne of Tampere University of Technology. The aim of the project was to produce new knowledge in order to tap into the potential for walking and cycling even better. The four components of the project were increasing the share of cycling in urban traffic, pedestrian areas as part of city life, developing the monitoring of walking and cycling and best practices in cycling winter maintenance processes as well as in cost-benefit analyses of cycling schemes. Material was collected from several European countries and cities. Case cities in the project were Linköping, Lund and Umeå (Sweden); Copenhagen (Denmark); Nijmegen, Delft, Utrecht and 's-Hertogenbosch (the Netherlands); Sheffield and Peterborough (Great Britain) and Oulu (Finland). In addition, expert interviews were held with Gehl Architects (Copenhagen) and Decisio companies (Amsterdam) as well as in TU Delft.

The purpose of this book is to serve as stimulus for developing high-quality walking and cycling conditions in Finnish cities. The book gathers diverse knowledge for instance on how improving pedestrian conditions affects businesses and how geographical data may be utilized in the designing of a cycling network. In addition, it provides concrete guidance for designing spaces for pedestrians and to improve cycling conditions year-round. One picture is worth a thousand words, and thus the results are presented with the help of multitude of figures. This book is continuation to Best European practices in promoting cycling and walking, which was published in 2011 by Transport Research Centre Verne.


VILLAGE
2:-

Part I
VITALITY FROM WALKING



Kaisa Karhula

The principles of pedestrian traffic planning

Pedestrians enliven city life

The city is experienced by walking

Many city centres and streets have been designed for motor traffic. It is easy to drive from the residential area to the city centre, as well as within the centre. As a rule, urban spaces are designed with motorists in mind: the centre is accessible to cars and there are plenty of car parks. [1] [2] [3]

Today, however, the importance of planning for people has been acknowledged. Genuine interaction and contact between people can only take place when people move on foot. Pedestrians can stop to talk to each other whenever they want to, or notice the small details in the environment. Pedestrians get more experiences than passengers sitting in a car. The positive health impacts of walking also encourage cities to take pedestrians into account in planning. Supply increases demand, and increasing road capacity likewise increases motor traffic. In addition to adding the number of people walking, improving the pedestrian conditions makes moving around safer and more pleasant and, most importantly, enlivens city life. [1] [2] [3] [4] [5]

Fig. 1. *Pedestrians are in direct contact with other people and the environment. Moving at pedestrian pace allows people to stop and talk with each other or to look in the shop windows. (Lund)*

Fig. 2. *A good urban environment consists of various components in balance with each other. [6]*

Activities invite to stay

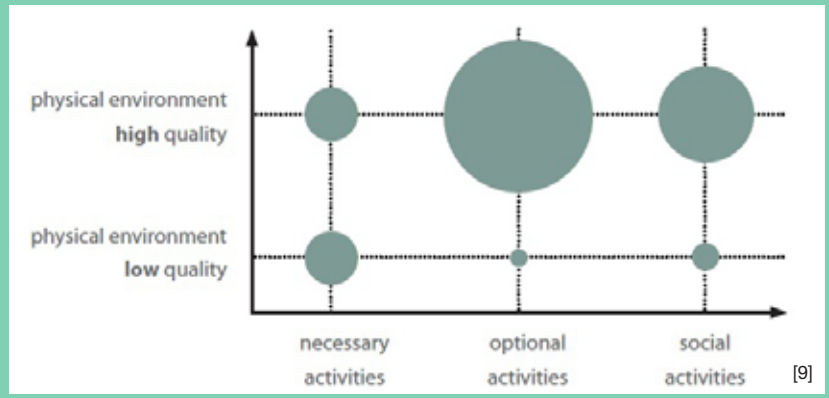
To get people to spend time in the city centre, the centre must offer various options for this. Mixing different kinds of functions, activities and attractive and comfortable public spaces is particularly important in creating a good pedestrian environment. Versatile interests attract more visitors. [1] [2] [5] [7] [8]

Urban spaces should also be as adaptable as possible to cater for various events, like markets and festivals. A monotonously planned urban space often remains empty outside certain time frames, and it may therefore create a gap in the centre's active pedestrian network. [1] [2] [5] [7] [8]

Urban spaces should be suited to adapt to various events and activities.

Activities in the centre

In a nutshell, there are three groups of urban space activities: necessary, optional and social activities. Necessary activities are those that must be performed at one level or another, regardless of the space or other people, such as going to school, work or shopping. Optional activities are those that people do if they so decide or desire. These include, for example, sitting on a park bench, going to a cafeteria or just passing the time. An unattractive or poorly-designed urban space leads to only necessary activities being performed. By creating high-quality environments, the number of optional activities can be increased. Social contacts are created as a result of other activities. Social contacts include all interaction between humans, such as chance encounters on the street, conversations or just saying hello. The more there are optional and social activities in the area, the more there are people and city life. [1] [2]



[9]

People in the centre of planning

Developing starts from the needs of the pedestrians

When planning an urban mobility environment, the requirements of all forms of traffic should be taken into account. A traffic system is a whole in which all components must work smoothly with each other. However, the planning of city centres and pedestrian areas in particular should start with the needs of the pedestrian. The first task is to ensure a safe and comfortable environment for pedestrian and cycle traffic. The next step is to create smoothly-operating public transportation connections, and only then should you focus on the motorists. [1] [2] [5] [8]

Unique planning solutions

When planning the pedestrian areas and pathways, the most important thing is to find the best solution taking into account the special characteristics of the city and the area or walkway in question. A pedestrian street may be a good solution in a city centre where there are a lot of different services. On the edges of the city core, however, it may suffice to improve pedestrian conditions by widening the pavements or making the environment more pleasing, for example. The planning should always set out by considering how the pedestrian conditions on each street could be improved. Besides improving the existing routes, you should always consider new walking routes between attractive points of interest. Channels, rivers, train tracks and other obstacles can be handled using footbridges or underpasses. This way, it is possible to create new and significant pedestrian flows between various areas and to make walking a more attractive option than driving. [1] [2] [5] [8]

The aim is to find the best solution for each situation, taking into account the special characteristics of both the city and the pathway.

The character of the city matters

Each city is different: a pedestrian environment that works well in one city doesn't necessarily work in another. It is important to consider any special characteristics in the area. There is something unique to every city, and these unique characteristics are often those that people will remember from the city. In the Finnish city of Tampere, for example, the red brick industrial buildings predominate the cityscape in the centre, creating a strong atmosphere of the old industrial city. Another characteristic feature of Tampere is the river that runs through its centre. These special characteristics of the city should be built upon, and their potential should be utilised. [7]

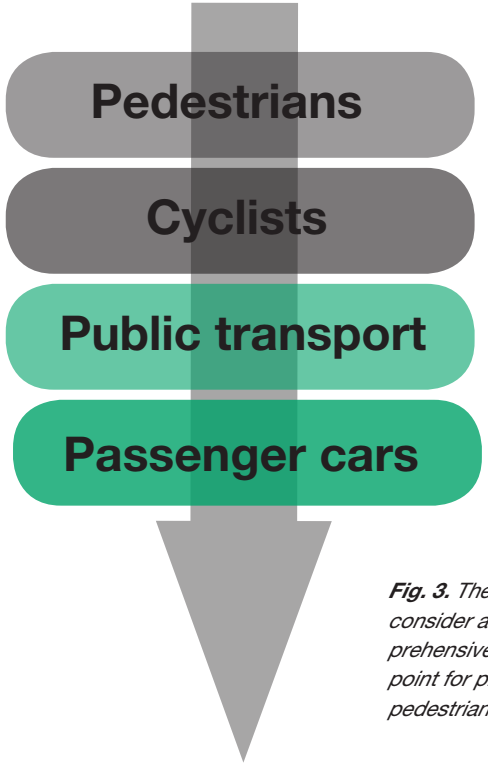


Fig. 3. *The transport systems must consider all modes of travel comprehensively. However, the starting point for planning should always be pedestrians and cyclists.*

The main street, Hämeenkatu, in the city centre of Tampere, Finland converted to a street for pedestrians, cyclists and public transport. Pedestrians are the kings of the street and can move freely around.

Urban Space Illustration: Tiia Ruutikainen

Pedestrian data required to support the planning

In order to plan effective pedestrian environments, you need information about the people in the city. The information is needed at least from [1] [2]:

- walking routes
- destinations
- people themselves.

In many cases, the motor traffic censuses carried out in city centres are used as the basis for planning. This tends to guide the planners to adopt a motor traffic-oriented point of view. To create a functional traffic system, however, you also need information on pedestrian and cycle traffic volumes and routes. The planners must form an overall picture of the city and find out what is already working and what needs to be developed. [1] [2]

Observation is the easiest way to study people and their movements in a given area. Therefore, data gathering can be a simple and easy task, and necessary information can be made available for the planners quickly. [1] [2]

When do people use the centre?

Day

Evening

What kind of people there are in the city centre?

Age

Men/women

What do people do in the centre?

Stationary activities

Functional activities

Where are the biggest pedestrian flows?

Empty streets

Active streets

Quality criteria to facilitate evaluation of city environments

Gehl Architects, a Danish architects' office, has developed 12 quality criteria for evaluation of the pleasantness of a city environment. The criteria is divided into three categories: protection, comfort and enjoyment. Protection refers to the minimising of unpleasant experiences, like crime, traffic accidents and adverse weather conditions. Comfort refers to the pleasantness of the walking experience and remaining in the space. Enjoyment refers to the observance of dimensions and the importance of good quality design. [1] [8] [10]

The quality criteria are meant to be used when reviewing the relationship between people and their physical environment. Although they facilitate the reviewing of the character and quality of a space, the criteria as such do not guarantee that the pedestrian environment is meaningful. First we must understand the needs of the different user groups and the character of the city and how its environment could be made more attractive. Therefore, the quality criteria should not be viewed simply as a set of rules but more as guidelines toward planning for people. [1] [8] [10]

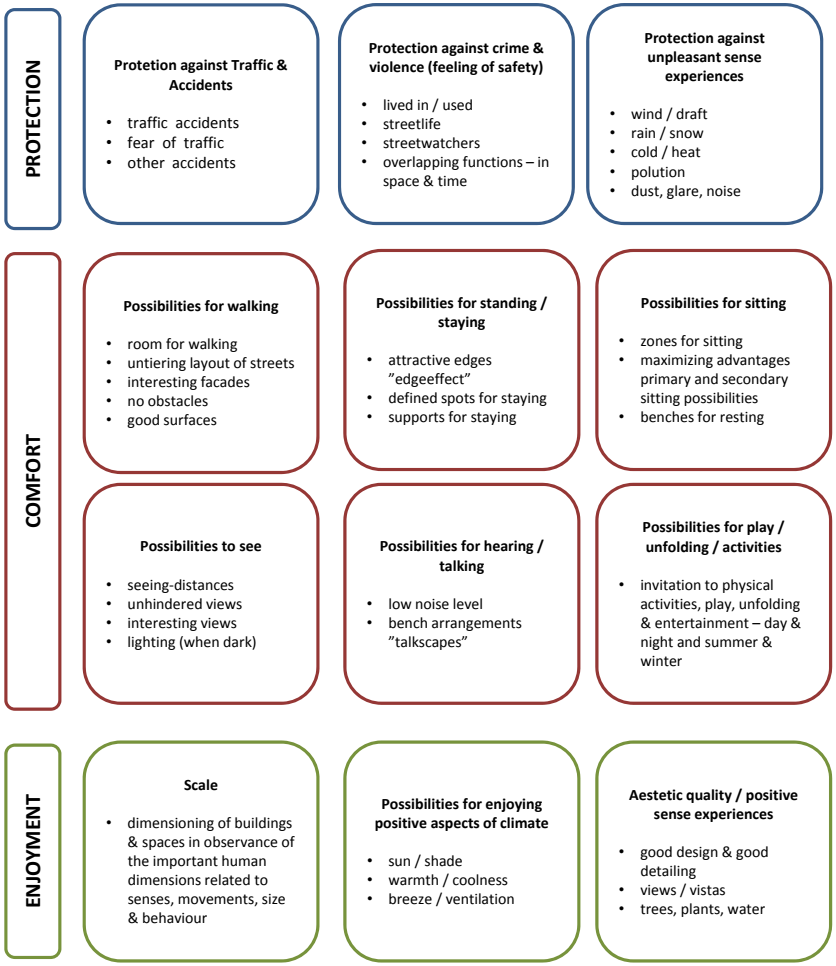


Fig. 4. *The 12 quality criteria developed by Gehl Architects are used as a basis when evaluating vibrant pedestrian environments. [11]*

The quality criteria can be used to study the comfort of the urban spaces in a concrete manner. A simple way to make quality assessment is to go through the 12 criteria and mark them as good (white), fair (grey) or poor (black) according to the characteristics of the space. In this way, it is easy to determine the general comfort of the space and the things that need to be improved. [8]

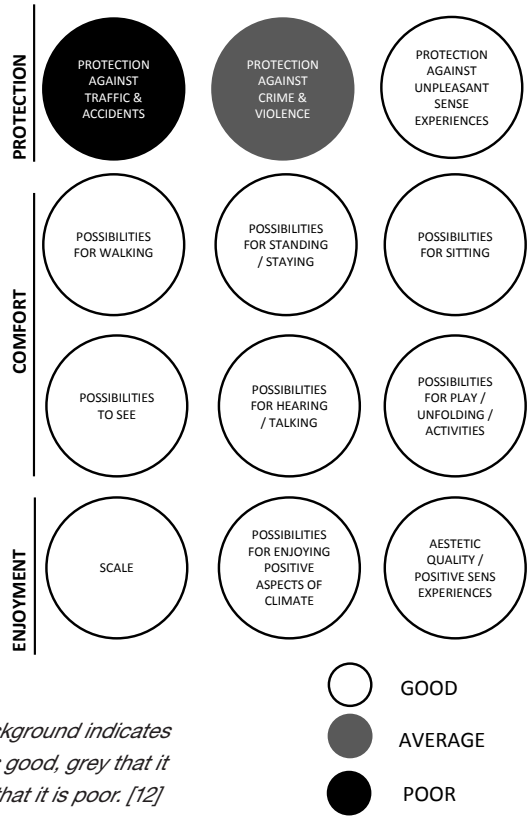


Fig. 5. *White background indicates that the quality is good, grey that it is fair and black that it is poor. [12]*

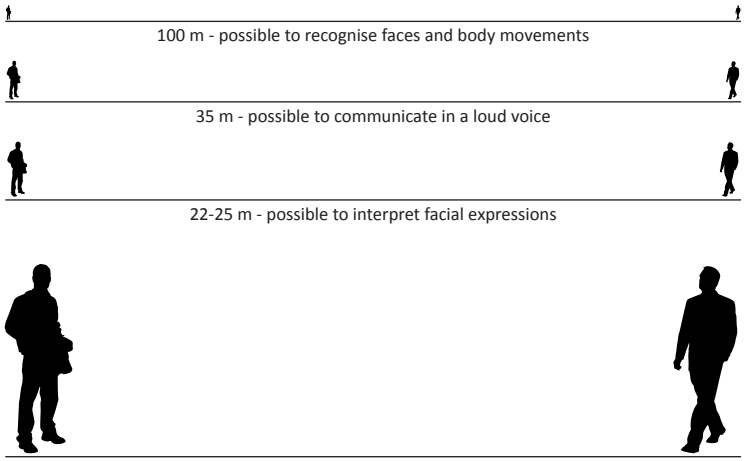
Fig. 6. *The 12 quality criteria are an easy way to form an overall picture of the quality of a square, for example. These squares are in Strasbourg (above) and Odense (below).*

Measures and dimensions

Human-sized dimensioning

In order to create a comfortable, safe and interesting pedestrian environment, the dimensions of the space must be right. The dimensions should be on a human scale, based on how we perceive our environment and what kind of dimensions we can embrace. Pedestrians observe the surroundings closely, so even the small details are significant. [1] [2]

Our social field of vision is limited to approximately 100 metres. From longer distances, it becomes very difficult to identify the movements and characteristics of another individual. **Therefore, even large squares should not exceed the 100 metre limit** in order to keep the scale comfortable for humans [13]. [1] [2]



[13]

“When in doubt, leave some space out”

In a pedestrian environment, a small space tends to work better than a larger one. It is easier to grasp the whole in a small space, so people feel safer, and the details also become easier to notice. Therefore, it is usually not a good idea to add more space just to be sure – better to leave unnecessary space out. [1] [2]

Fig. 7. *On large squares the enclosure is often weak, and the atmosphere can be desolate. Smaller spaces are easier to comprehend, and the presence of other people promotes a feeling of safety.*

Maria-square in Lappeenranta, Finland could also be used for a space for people. With things to do and see, the square could be a meeting place for all people in the city.

Urban Space Illustration: Tiia Ruutikainen

Dimensioning a pedestrian street

People should be able to walk on the pedestrian streets and pavements quite freely without unnecessary congestion. It is extremely difficult to determine the width of the street so that it is narrow enough to provide a wealth of experience and also wide enough to allow unobstructed movement. According to Jan Gehl, the appropriate flow rate for pedestrian streets and pavements is approximately **13 pedestrians per minute per meter of walkway width** [14]. On the other hand, if the number of pedestrians on the walkway is very limited, the width can also be quite small. [1] [2]

Fig. 8. *A pedestrian street should be wide enough for sufficient flow rate, but narrow enough to meet other people and enjoy the environment. (Dublin)*

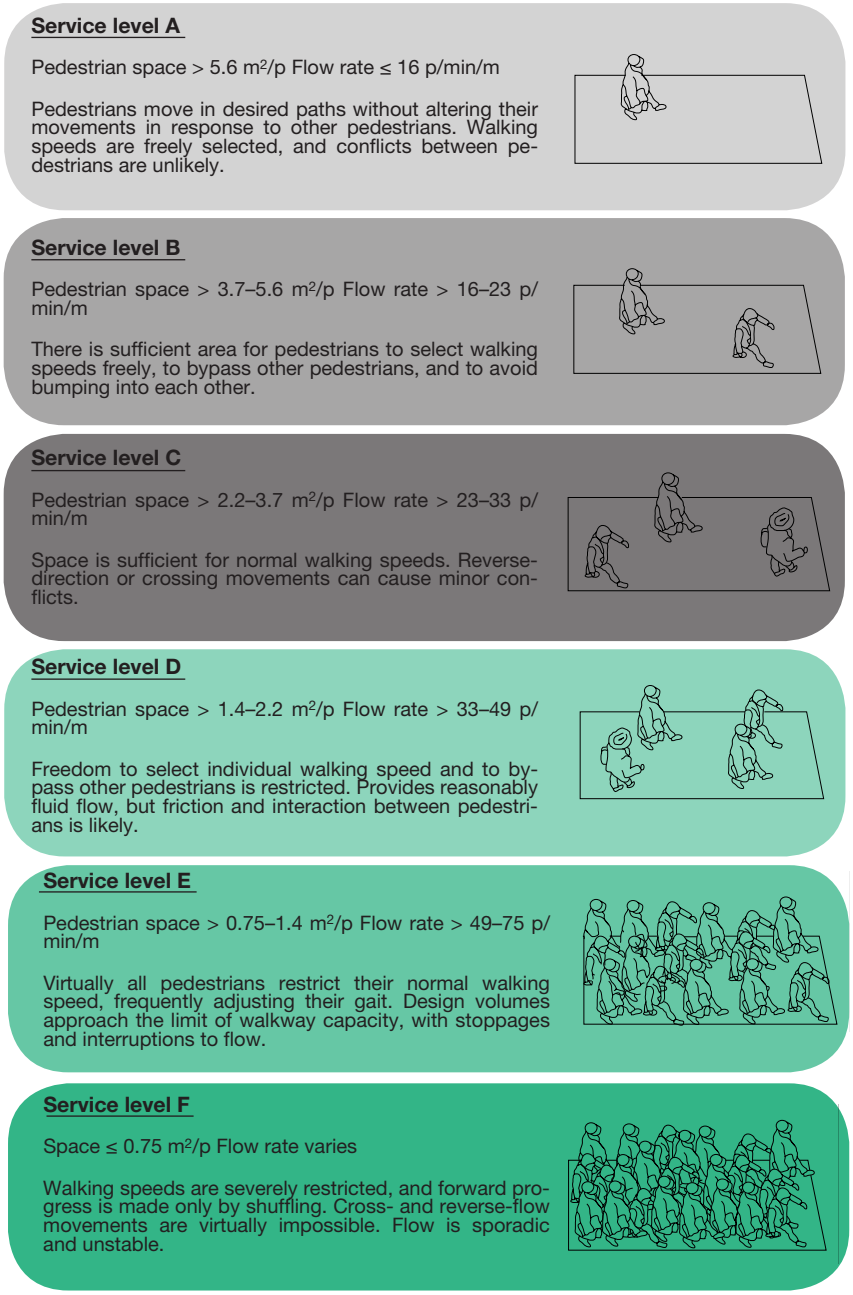
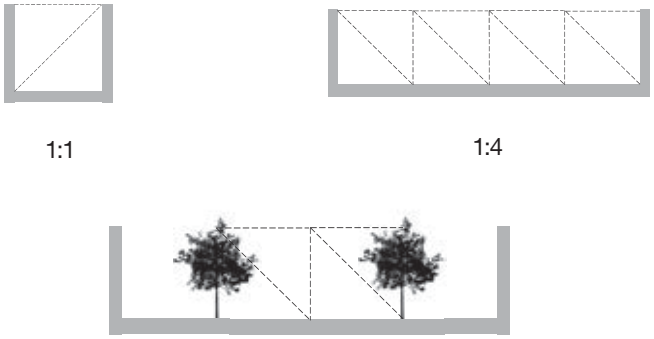


Fig. 9. *In the US, walkway services are categorised into six levels, from A to F. When planning pedestrian traffic, it is important to take the number of people moving in the area into account, and to avoid congestion. [15]*

Height of the buildings

Buildings edge the squares and streets, creating the feeling of space. Therefore, urban spaces can be defined by the ratio between the height of the buildings and the width of the space. Buildings that are too tall to edge a narrow street create a shady space with an unfavourable microclimate. Low buildings edging a wide square, however, do not define the space clearly enough. This can lead to a rather vague feeling of space. To change the feeling of space, trees can be planted to divide a wide street into smaller sections. The table depicts an indicative British guideline for the ratio of the street width and building height. In the figures, the scale is building height:space width. [16] [2]



	Maximum	Minimum
Minor streets	1:1,5	1:1
Typical streets	1:3	1:1.5
Squares	1:6	1:4

Fig. 10. *The ratio between the height and width of the buildings determines the enclosure. According to English guidelines, the ratio can be quite small on narrow streets and considerably higher in squares. [17]*

Different levels

Level changes should be avoided in a pedestrian environment, as they make moving around more difficult and, especially for those with physical disabilities, children and older people, uncomfortable or almost impossible to use. In a conventional city environment, pedestrians consider a one-metre climb equal to a 10-metre roundabout route on a level walkway. If different levels cannot be avoided, they should be planned carefully. For wheelchair and pushchair users, for example, slopes are the easiest and most convenient solution. For some people, on the other hand, stairs might be a more accessible solution due to stiffness of their ankles, for example. Therefore, both solutions must be considered in the planning process. [18] [19]

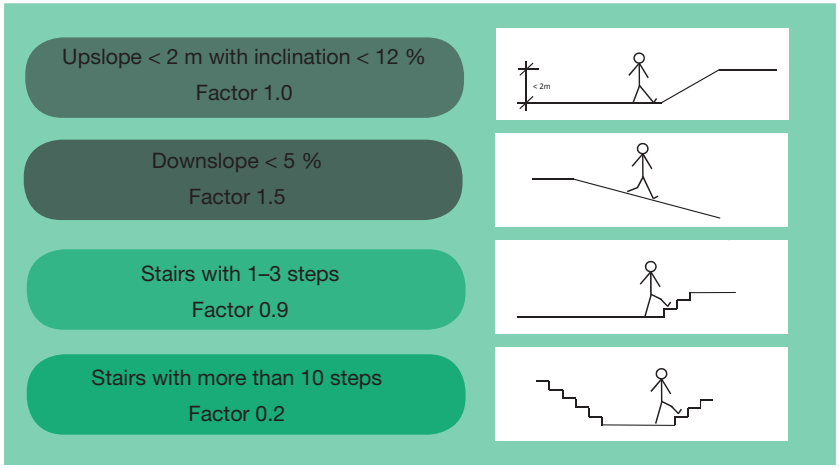


Fig. 11. *Ramps and stairs can influence the pedestrian's route selection. In the figure, the route is attractive to pedestrians when the factor is above '1'. If the factor is below '1', the route is less likely to be chosen. [20]*

Walking distance

Under normal circumstances, people are willing to walk some 400–500 metres in one go. In the case of disabled people, children and older people, the distance may be considerably shorter. However, besides the actual distance covered, the walking distance depends on the meaningfulness of the walk. People are ready to walk much greater distances in interesting surroundings. [2] [21]

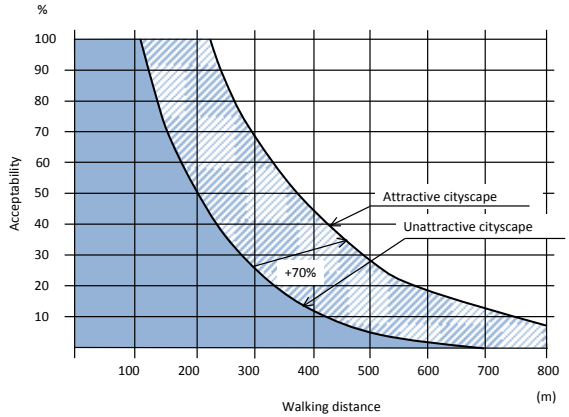


Fig. 12. *The impact of the cityscape's attractiveness on people's willingness to walk has been studied from the viewpoint of public transport users. Compared to an unattractive environment, people are up to 70% more willing to walk longer distances in an attractive urban environment. [22]*

Microclimates

Due to the large buildings, urban spaces often have their own microclimates. Tall buildings, for example, can mean stronger winds at street level. Tall buildings can also cast shadows on the space, causing a drop in temperature. In the Nordic countries, the amount of light and heat reaching the earth's surface should be maximised in most cases, for the sun is rarely too hot, even in the summer. In the autumn and winter seasons, people tend to look for sunny places, and there should also be some cover against rain and wind available in this half of the year. Buildings located in a parallel arrangement intensify the winds, especially if the streets are aligned parallel to the wind. If the buildings are located in a parallel shifted arrangement, they form a barrier against the wind. Vegetation can also be used to minimise negative wind effects. [1] [2] [23] [24]

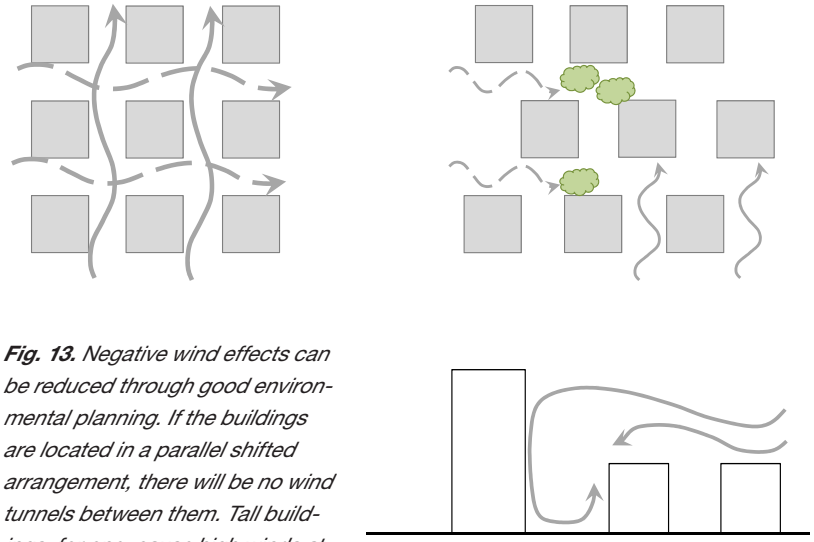
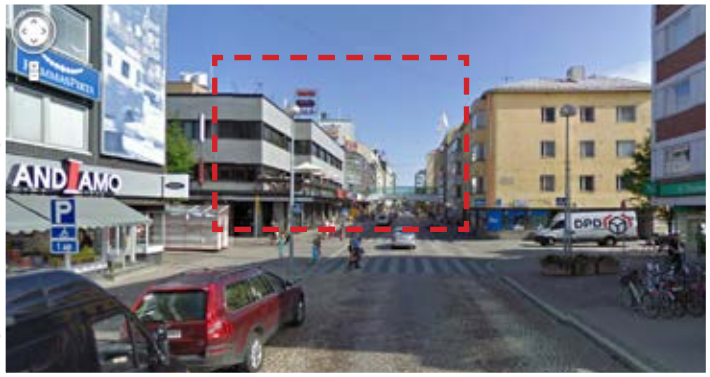


Fig. 13. *Negative wind effects can be reduced through good environmental planning. If the buildings are located in a parallel shifted arrangement, there will be no wind tunnels between them. Tall buildings, for one, cause high winds at street level.*



Google Maps - ©2013 Google

In Isokatu Oulu, Finland the plan is to build a covered corridor between two buildings. If planned carefully the corridor could be inviting place to visit and it could protect visitors from the cold autumn wind.

Urban Space Illustration: Tiia Ruutikainen

Details matter

Besides the physical road, an interesting environment providing experiential stimuli is needed to create a quality walking experience. On a street with a good pedestrian environment, events and interesting details are presented at the level of the human eye. [1] [2]

In order to keep the interest up and make walking more meaningful, the streets should offer new experiences every four seconds. This means, for example, having several small shops next to each other rather than the long and often monotonous frontages often found in shopping centres. The four-second rule can be seen concretely on various shopping streets around the world where, as a rule, the frontages have approximately 15 to 25 shops or activities per every 100 metres [25]. [1] [2]

On a large scale, a city must be well-defined and uncluttered and the street plan structured and logical. This reduces the risk of getting lost and makes moving around the city easy and straightforward. On a smaller scale, however, there should be small details and points of interest in the city to make walking more meaningful and to ensure the high quality of the environment. [26] [5]

Fig. 14. *Green elements can easily be used to change the overall face of a space. In Mexico City, this otherwise monotonous street comes alive with verdant trees lining the street.*

Fig. 15. *Residential area Bo01 in Malmö has been designed for people. The street plan is straightforward, but interesting details and carefully selected colours create an attractive pedestrian environment.*

Active frontages

In the city centres in particular, the quality of the ground floors and frontages significantly dictate the face of the city. Dull frontages and frontages that appear closed make for a monotonous pedestrian environment. If there is nothing interesting to observe, the street does not make the pedestrian want to stay. [1] [2]

The frontages can be evaluated using, for example, Gehl Architects' A–E classification [27].

A. Active

- Small units, many doors
- 15–20 units per 100 m
- Diversity of functions
- No closed or passive units
- Quality materials and refined details

B. Pleasant

- Relatively small units
- 10–14 units per 100 m
- Some diversity of function
- Only a few closed or passive units
- Relatively good detailing

C. 'Somewhere in-between'

- Mixture of small and larger units
- 6–10 units per 100 m
- Some diversity of functions
- Only a few closed or passive units
- Uninteresting design of frontages
- Somewhat poor detailing.

D. Dull

- Larger units with few doors
- 2–5 units per 100 m
- Little diversity of functions
- Many closed units
- Predominantly unattractive frontages
- Few or no details

E. Inactive

- Large units with few or no doors
- No visible variation of functions
- Closed and passive frontages
- Monotonous frontages
- No details, nothing interesting to look at

Fig. 16. *A large scale mobility environment and a monotonous milieu is dull and uninspiring for pedestrians. Details and small scale create a pleasant pedestrian environment which offers something new to see all the time.*

Pedestrian network

A good pedestrian network is created by connecting the main points of interest to each other via attractive routes. Pedestrians, naturally, favour the shortest routes and shortcuts between destinations, especially when the destination can be seen. Therefore, pedestrian traffic should be guided to take the shortest routes possible. Long straight stretches of street are particularly tiresome for pedestrians. A good walking route is well-defined and continues uninterrupted, and should include various diversions and interesting things to see. The route should be divided into smaller sections so that you cannot see the end from the starting point. Although the length of a walk is usually approximately 400–500 metres, an interesting and pleasant environment can increase the distance. [2] [28] [29]

Fig. 17. *In an pedestrian walking environment, you never know what you might find round the next corner.*

Connected	The walking routes should connect the most important destinations, like bus stops, schools and places of work, to each other. The routes should form a comprehensive network.
Convivial	The walking routes should be pleasant and they should allow social interaction between people. The routes should also be safe and inviting, with diversity of activity and continuous interest at ground floor level.
Conspicuous	Walking routes should be clear and legible, if necessary with the help of signposting and waymarking.
Comfortable	The pleasantness of the walking experience should be guaranteed with high-quality surface material and an interesting, unpolluted and noise-free environment. Opportunities for rest and shelter should be provided.
Convenient	Routes should be direct, and designed for the convenience of those on foot. Accessibility should be guaranteed for all users. Crossing opportunities should be provided as of right, located in relation to desire lines.

Fig. 18. *The '5Cs' of Good Walking Networks presented in the design guidelines for London [30].*

Accessibility

Accessibility refers to having taken into account all the city dwellers' needs, from wheelchair and pushchair users to children and older people. Accessibility solutions should be considered in the planning stage, as they facilitate the movement of all city dwellers. Furthermore, implementing the solutions doesn't usually cost anything extra, as long as they are planned carefully. Adding accessibility solutions later on, however, can be very difficult and expensive. [1] [2] [18]

Accessibility does not mean that the environment has to be dull and uninspiring. On the contrary, accessibility can be used to create a well-balanced and clear entity. Ease of movement, safety and sensuousness facilitate orientation in the urban environment and make mobility possible for all. [1] [2] [18]

Accessibility to all

- Accessibility should be an integral part of all planning.
- When planning, it should be ensured that the main routes to the most important destinations (like shops, post offices and health centres) and main entrances are accessible and can be easily detected.
- The accessibility should also be guaranteed in the winter time, and accessible main routes must be of high priority in winter maintenance.
- To ensure the quality of the solutions, accessibility experts should be included in the planning process.

[18] [31]

Accessibility of route

- The surface must be smooth and anti-skid.
- The width and inclination of the route must allow for wheelchair use, for example.
- No risks of collision, tripping or falling down.
- If differences in level cannot be avoided, a slope or stairs should be available depending on the situation.
- Areas designated for different forms of traffic should be marked clearly and logically.
- Lighting should be sufficient.
- Resting places should be available at even intervals.

[31] [19]

Fig. 19. *On an accessible pedestrian and cycle path, the pedestrians and cyclists are clearly segregated. The surface is smooth, and there is enough room for wheelchairs and pushchairs. (Odense)*

Dimensions

- Road width ≥ 1,500 mm
- Headroom ≥ 2,200 mm
- Longitudinal gradient ≤ 8%
- Crossfall ≤ 3%
- Evenness deviations ≤ 20 mm

[31]

Accessible crossings

- A pedestrian crossing should be clearly marked and perceivable.
- A pedestrian crossing should have an upright section and a sloped curb.
- The curb should be perpendicular with respect to the crossing direction to guide those with impaired vision.
- Audible signals facilitate traffic light observance.
- Any push buttons should be located no further than 300 mm from the pedestrian crossing, and the button should be no higher than 900–1,100 mm from the ground.

[31] [32]

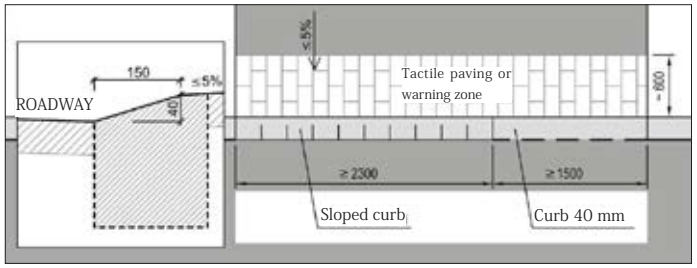


Fig. 20. *Crossings should be clearly distinct from the environment, and easy to negotiate. Sloped curbs facilitate wheelchair use and provide navigational help to the visually impaired when crossing the road. [33]*

Guidance paving

- Paving can be used to guide traffic (guiding tiles) and to warn about obstacles (warning tiles).
- The colour or the paving surface pattern should be distinct from the surrounding environment.
- Paving should be placed in a systematic and well-thought-out manner.

[31] [34]

Fig. 21. *Tactile paving indicating the beginning and end of the crossing. The distinctive colour helps to perceive the paving. (Odense)*

Other methods of guidance

- Audible signals are particularly important for people with visual impairments, as they have to rely on their hearing.
- Contrasting colours make the environment more legible and comprehensible.
- Lighting can be used to bring out the colour contrasts and to facilitate the perception of the outlines of different levels and crossings in the dark, for example.
- Distinctive and fixed landmarks, like fountains, facilitate orientation.
- The environment should be multi-sensuous, offering information through all the senses. Overloading the senses, however, must be avoided.

[31] [34] [18]

Fig. 22. *In a Malmö residential area, the pathways are clearly indicated in a specific yellow colour. The street furniture is located to the side of the path so as not to obstruct the traffic.*

Lighting

Lighting can be used to make the environment feel significantly safer for people. Lit shop windows promote a feeling of safety outside business hours, whereas closed shop fronts can create a threatening atmosphere. If lighting is inadequate, the mood of a busy street or other urban space may change significantly when it gets dark. [1] [2] [5]

Lighting should be focused on people and frontages, that is, on things that have social significance. Often, lighting is focused on street surfaces, even though it would be just as important to direct some light on upright surfaces, such as the walls of the buildings. This way, it is possible to emphasise significant buildings and create a feeling of space outside the street area. One should also remember that brightness is not the only lighting quality criteria. Bright lights do not necessarily create safe environments: lighting must be focused and located correctly. [1] [2] [5]

Lighting should be directed at points with social significance, like building frontages.

Fig. 23. *Lit frontages can be used to emphasise important buildings and to illuminate the environment effectively. (Lund, Gent)*

Fig. 24. *Illuminated shop windows after closing time create a feeling of safety on the streets. Dark frontages can be frightening. (Lund)*

Safety

Accident statistics do not reveal the whole truth of safety in a given space: the feeling of safety should also be taken into consideration. The feeling of safety plays a significant role when people decide whether to walk or not, so it is an important part of the design of a city centre. [2] [3] [4]

Being surrounded by other people is one key factor that creates safety. Often people evaluate the pleasantness and safety of a space based on other people being in the same space. An empty space is often regarded as unsafe, no matter what the statistics might say about its safety. Many cities have responded to general safety concerns by adding camera surveillance. That, however, does not increase the feeling of safety people experience in the city centre. Instead, the number of people present should be increased. Lights shining from the windows of the houses create a feeling of other people being present, thus adding the feeling of safety more than any surveillance cameras. When the centre, as a rule, quietens down after the shops are closed, the lights in the windows of the city centre inhabitants create an impression of a safe environment. [2] [3] [4]

Fig. 25. (above) *Lighting can be designed in a creative way. In Lund, the light comes from under the benches.*

Fig. 26. (below) *Uplights often illuminate better than downlights. In Gent, the lighting is focused so that it almost eliminates the need for traditional street lights.*

Pedestrians, cyclists and car drivers could share the same street inYrjönkatu Pori, Finland. Lighted shop windows at the eye level bring more light and make the street feel safe.

Urban Space Illustration: Tiia Ruutikainen

Sitting opportunities

Good opportunities for sitting provide excellent conditions for people to stay and spend some time in the centre. If there are no or not enough seats or if they are of poor quality, people will often walk by them without stopping. Sitting down can also promote activities that otherwise wouldn't take place, like reading, eating or watching passers-by. [1] [2] [4]

The different needs of various user groups must be taken into consideration when planning seating arrangements. Children don't care much where they sit, whereas older people value the comfort and practicability of the seats highly. They may find it difficult to sit on a bench that is too low or too high. [1] [2] [4]

Primary and secondary sitting opportunities

Primary sitting opportunities refer to conventional benches that are clearly meant for sitting. Secondary sitting opportunities refer to those surfaces that are not specifically meant for sitting on but on which people, nevertheless, like to sit. These include stairs, low walls, steps, the edges of flower beds and rails. Secondary sitting opportunities also work well when there are only a few people in the space. Empty benches can create a desolate and depressing atmosphere. Using secondary sitting possibilities, the space does not appear so empty, even if the number of people varies, and the seats are always available when they are needed. [1] [2] [4]

There must be both primary and secondary sitting opportunities in an urban space.

Fig. 27. *Various constructions and stairs can act as secondary sitting opportunities, offering places to rest.*

Bench location

The location of the benches in an urban area is by no means insignificant, as poorly located benches do not attract users. The location of the benches should be based on the activities in the area as well as the space and its dimensional requirements. Most people prefer to sit by walls and on the perimeter of a space rather than in the middle of it. The fringe areas of the space promote a feeling of safety and create a comfortable place to watch other people and observe the environment. The benches can be located in niches or corners, providing an intimate and safe atmosphere and cover against the elements. [1] [2] [4]

Planning seating arrangements

- Benches should be situated in locations where people feel safe, such as next to a wall or in niches or corners.
- There should be a suitable ratio of primary and secondary opportunities for seating in a given space.
- Various user groups should be considered when planning the location of the benches.
- On a walking route, there should be a bench approximately every 100 metres.
- Benches should be located so that they facilitate conversation and social interaction.
- The benches should offer an unobstructed view of all events in the surrounding space. People like to watch what's going on around them.

[1] [2] [4]

Movable benches

Opportunities for sitting can be provided using movable chairs, for example. Compared to traditional benches, they are reasonably cheap and can be moved to a desired location flexibly and easily. With movable chairs, it is also possible to provide seats in places where conventional fixed benches cannot be located. [4]

Fig. 28. *Movable chairs can be used for various purposes wherever there is a need for seating arrangements. With imagination, chairs can also be used in the winter. (Tampere)*

Fig. 29. *People like to sit so that they cannot be surprised from behind. A good view of the surrounding area and other people is also important. (Lund)*

Vitality through the year

A high-quality winter-time pedestrian environment is possible

In the summer, people like to stay and spend time in urban spaces, whereas in the winter they tend to walk across streets without stopping. Even though the number of pedestrians is the same in the summer and the winter, more people stay outside when it is sunny. [1] [2] [4]

However, people can also be persuaded to spend time in the city centre in the winter. Cafeterias can offer people warm blankets or electric heaters to keep them warm, and various winter markets and events draw visitors regardless of the snow and freezing temperatures. If the pathways are maintained during the snowy and slippery season as well, city dwellers have the choice to move safely and comfortably throughout the year. [1] [2] [4]

Safe movement for all

Winter maintenance is especially important for people with physical disabilities. Inadequate route maintenance means that in the winter, people in wheelchairs, for example, cannot move outdoors without help.

An accessible and comfortable mobility environment is enjoyed in particular by those in wheelchairs or pushing pushchairs, as they need more space than average pedestrians. On Copenhagen's Strøget, for example, the extra space needed for pushchairs became obvious after pedestrianisation. As the number of pedestrians increased by about 35 per cent in the first year, the number of pushchairs increased by as much as 400 per cent [35]. [2]

Fig. 30. (left) *Despite the windy November weather, people are enjoying the street cafés on a pedestrian street in Copenhagen. Infrared lamps and blankets protect them from the cold weather.*

Fig. 31. (right) *In the Nordic countries, sunshine is rarely scorching, and in the autumn in particular, people tend look for sunny places. Benches that are in the shade are not used. (Lund)*

Parks are more than green areas

Parks and green areas have been found to have several positive impacts on both the urban environment and the well-being of the people. Among other things, the green areas [36] [3]

- provide cover from the scorching sun
- cool down the temperature in cities with a warm climate
- clean up air pollution
- absorb rain and drainage water
- can (when planned correctly) diminish crime in residential areas
- relieve stress and mental fatigue.

Park planning

- Parks should be located near other activities so that they have users round-the-clock.
- Parks and other green areas should form a tight network and a whole that encourages people to move about on foot. Isolated parks do not function as well.
- Parks should be maintained regularly so that they give an impression of a safe and clean environment.
- A park should be not only an attractive place in itself but also an optional route for moving from one place to another.
- Each park should have a functional purpose. Different activities attract different user groups.
- In order to create common places where people want to spend time, citizens should always be included in the planning and maintenance of parks.

[36] [3]

Fig. 32. *Parks must be maintained in order to keep them tidy and attractive. Graffiti, for example, can cause playground users to abandon the park.*

Fig. 33. *Parks should offer various activities attracting various people.*

Pedestrian conditions in residential areas

In a pedestrian-friendly residential area, there are many services within a 10-minute (800 metre) walking distance. However, walking can also replace driving longer distances of up to 2 kilometres. People can be encouraged to walk by locating the various activities in the residential area so that most of the inhabitants can perform their everyday activities on foot. [16] [21]

Connections to existing services must be taken into account when planning new dwellings. People should be able to move about on foot, by bike or on public transport. [16] [21]

Dense building can be used to guarantee appropriate walking distances in a residential area. Compactness enables short walking distances and makes it easier to provide various services for more people. And with enough potential users, offering more services makes more sense. In the UK, national guidelines state that there should be **30 homes per hectare (10,000 m^3)** in a residential area [37]. [16] [21]

Promoting walking in residential areas

- The pathways should be unobstructed and continuing, and the street plan well defined.
- The area should include versatile services and points of interest within walking distance.
- The pathways should be well lit and they should inspire confidence. The traffic-orientated environment must also be safe.
- The area should have clear, straightforward and accessible routes to shops, services and public transport stops.
- A compact residential area with good connections means short distances that promote walking.

[16] [21]

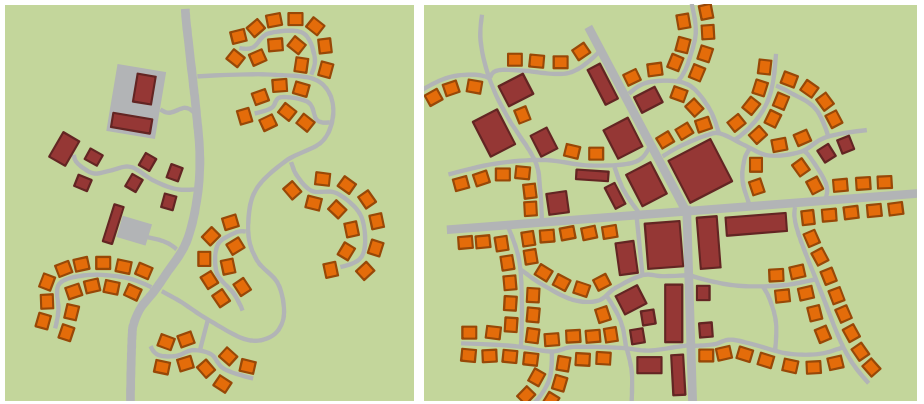


Fig. 34. *A densely developed residential area (figure on the right) and services located to benefit all the people living in the area shorten walking distances and encourage people to go on foot. [38]*

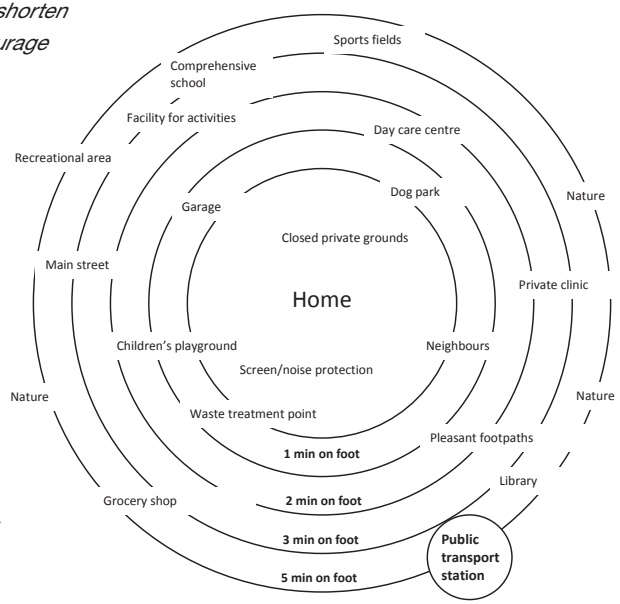


Fig. 35. *There should be services within short walking distances from houses in the residential area. Public transport possibilities should also be close by, to reduce the need for private cars. [39]*

Fig. 36. *In a pedestrian-friendly residential area, the streets have been planned so they are safe for pedestrians. Motorists are visitors here. (Odense)*

Attractive and safe walking and cycling facilities right under your window encourage to move outside using your own feet. New residential area Kangas in Jyväskylä, Finland could be enjoyable place to move and stay.

Urban Space Illustration: Tiia Ruutikainen

With small steps towards the goal

From street for cars to space for people

In recent years, the development of New York City has gone in a much more pedestrian-friendly direction by improving the quality of the urban spaces through limitation of motoring. One significant decision was to convert the world-famous Times Square from a congested street to a square for people. However, it wasn't easy to convince the decision-makers of the usefulness and necessity of the changes. Therefore, the city decided to start by closing part of the street to motorists and giving more space to pedestrians. The street surface was painted red, and movable chairs and sunshades were scattered all over the square. Even through these small actions, the result was remarkable. People quickly took the space for themselves, using it to spend time and meet other people. After this, it was easy to convince the decision-makers of the benefits of the changes. [40]

This proves that urban space development can start from relatively modest actions. Once the citizens and decision-makers have been convinced on the benefits, it is easier to justify larger scale actions and investments. When everybody has a common overall view of the result, urban spaces can be developed towards the final goal step-by-step.

Urban spaces can be developed towards the final goal step-by-step.

Fig. 37. *Times Square before and after the changes made. Small changes had a big impact. [41]*

The five steps in developing pedestrian areas

Set goals and vision

Design goals and visions should be defined before starting planning. It is difficult to achieve any goals without a clear objective.

Study the pedestrians

To support planning, you need to know where the pedestrians are, who they are and what they do. Without this information, it is impossible to plan a working pedestrian environment.

Include interest groups in the planning process

The citizens are experts on their own areas, and also the end users of the urban spaces designed. A working dialogue with various interest groups guarantees a satisfying result for everyone.

Start with small actions

It is not necessary to implement everything at once. Instead, you can take small steps to test how the area develops and how it should be developed in the future.

Develop continuously

Public spaces need to be continuously developed. People and their needs change, and the city should change accordingly. A functional public space can be altered and developed in the future.

References

[1] Gehl, Jan. 2010. *Cities for people*. Island Press. 269 pages. 2010 Jan Gehl.

[2] Gehl, Jan. 2010. *Life Between Buildings, Using Public Space*. Sixth edition. Second issue. Copenhagen, The Danish Architectural Press.

[3] Jacobs, Jane. 1961. *The Death and Life of Great American Cities*. New York: Random House. 1961

[4] Shaftoe, H. 2008. *Convivial Urban Spaces, Creating Effective Public Places*. London. Earthscan. 154 pages.

[5] Tibbalds, Francis. 2001. *Making people-friendly towns: Improving the public environment in towns and cities*. London. Spon Press. 116 pages.

[6] Gehl Architects. 2010. *Öresundsregionen i ögonhöjd - Värdegrundad planeringsprocess med människan i centrum*. Februari 2010. s. 61. Gehl architects - Urban quality consultants. p. 27

[7] DETR. 2000. *By Design - Urban design in the planning system: towards better practice*. Department of the Environment, Transport and the Regions, Commission for Architecutre and the Build Environment. Crow. Printed in Great Britain.

[8] Gehl, J., Gemzøe, L., Kirknæs, S. & Søndergaard, B. S. 2006. *New City Life*. First Edition. The Danish Architectural Press. Copenhagen 2006. 180 pages.

[9] Gehl, Jan. 2010. *Cities for people*. Island Press. 269 pages. 2010 Jan Gehl. p. 21

[10] Gemzøe, Lars. 2006. *Quality for people: A set of quality criteria for the design of pedestrian places and networks - with people in mind*. Paper presented at Walk21-VII, October 23-25 2006, Melbourne Australia.

[11] Gemzøe, Lars. 2006. *Quality for people: A set of quality criteria for the design of pedestrian places and networks - with people in mind*. Paper presented at Walk21-VII, October 23-25 2006, Melbourne Australia. p. 12

[12] Gehl, J., Gemzøe, L., Kirknæs, S. & Søndergaard, B. S. 2006. *New City Life*. First Edition. The Danish Architectural Press. Copenhagen 2006. 180 pages. p. 107

[13] Gehl, Jan. 2010. *Cities for people*. Island Press. 269 pages. 2010 Jan Gehl. pp. 35-38

[14] Gehl, Jan. 2010. *Life Between Buildings, Using Public Space*. Sixth edition. Second issue. Copenhagen, The Danish Architectural Press. p. 134

[15] TRB (Transportation Research Board). 2000. *Highway Capacity Manual.* Chapter 11: Bedestrian and Bicycle Concepts. p. 11-9

[16] Department for Transport. 2007. *Manual for Streets.* Thomes Telford Publishing. Great Britain 2007.144 pages.

[17] Department for Transport. 2007. *Manual for Streets.* Thomes Telford Publishing. Great Britain 2007.144 pages. p. 54

[18] Pesola, Kirsti. 2009. *Esteettömyysopas: mitä, miksi, miten*. Invalidiliiton julkaisuja O.39., 2009. Tyylipaino Oy. 41 pages.

[19] Tielaitos. 1998. Kevyen liikenteen suunnittelu. Tiehallinto, Tie- ja liikennetekniikka. TIEL 2130016. Helsinki 1998. 151 pages.

[20] Tielaitos. 1998. Kevyen liikenteen suunnittelu. Tiehallinto, Tie- ja liikennetekniikka. TIEL 2130016. Helsinki 1998. 151 sivua. p. 17

[21] Knoflacher, Hermann. 1994. *Kaupungin ja liikenteen harmonia*. Saksankielinen alkuteos Zur Harmonie von Stadt und Verkehr: Freiheit vom Zwang zum Autofahren. Suomeksi toimittaneet 1994 Jarmo Kalanti ja Pekka Rytilä. 100 pages.

[22] Knoflacher, Hermann. 1994. *Kaupungin ja liikenteen harmonia*. Saksankielinen alkuteos Zur Harmonie von Stadt und Verkehr: Freiheit vom Zwang zum Autofahren. Suomeksi toimittaneet 1994 Jarmo Kalanti ja Pekka Rytilä. 100 sivua. p. 63

[23] Oke, T.R. 1978. Boundary Layer Climates. Second Edition. Methuen & Co. NY. 435 pages.

[24] Shaftoe, H. 2008. *Convivial Urban Spaces, Creating Effective Public Places*. London. Earthscan. 154 pages.

[25] Gehl, Jan. 2010. *Cities for people*. Island Press. 269 pages. 2010 Jan Gehl. p. 77

[26] Tham, Klas. 2012. Lecture given at Lund University course ”Urban Quality and Urban Form”

[27] Gehl Architects. 2009. Public Spaces and Public Life Apeldoorn 2009. Gemeente Apledoorn, Gehl Architects - Urban Quality Consultants. 117 pages. p. 66

[28] Southworth, Michael. 2005. Designing the Walkable City. Journal of Urban Planning and Development. ASCE. December 2005. pp. 246-257.

[29] Transport for London. 2005. I*mproving Walkability; Good practice guidance on improving pedestrian conditions as part of development opportunities*. Transport for London. September 2005.

[30] Transport for London. 2005. *Improving Walkability; Good practice guidance on improving pedestrian conditions as part of development opportunities*. Transport for London. September 2005. p. 21

[31] Invalidiliitto. 2009. Rakennetun ympäristön esteettömyyskartoitus: Opas kartoituksen tilaajalle ja toteuttajalle. Invalidiliiton julkaisuja O.38., 2009. 173 pages.

[32] SuRaKu. 2008. *Esteetön ympäristö: Suojatiet ja jalkakäytävät*. Esteettömän ympäristön suunnitteluohjekortti 1/8. SuRaKu-projekti 2004/2008. 6.2.2008.

[33] SuRaKu. 2008. *Esteetön ympäristö: Suojatiet ja jalkakäytävät*. Esteettömän ympäristön suunnitteluohjekortti 1/8. SuRaKu-projekti 2004/2008. 6.2.2008. p. 1

[34] Näkövammaisten keskusliitto ry. 2013. [WWW] Näkövammaisten keskusliiton virallinen Internet-sivusto. Available: www.nkl.fi (4.3.2013)

[35] Gehl, Jan. 2010. *Life Between Buildings, Using Public Space*. Sixth edition. Second issue. Copenhagen, The Danish Architectural Press. p. 134

[36] City Parks Forum. 2013. [WWW]. American Planning Association - City Parks Forum. Briefing Papers online. Available: http://www.planning.org/cityparks (12.2.2013)

[37] Department for Transport. 2007. *Manual for Streets.* Thomes Telford Publishing. Great Britain 2007.144 pages. p. 45

[38] Department for Transport. 2007. *Manual for Streets.* Thomes Telford Publishing. Great Britain 2007.144 pages. p. 44

[39] Knoflacher, Hermann. 1994. *Kaupungin ja liikenteen harmonia*. Saksankielinen alkuteos Zur Harmonie von Stadt und Verkehr: Freiheit vom Zwang zum Autofahren. Suomeksi toimittaneet 1994 Jarmo Kalanti ja Pekka Rytilä. 100 sivua. p. 71

[40] The City of New York. 2010. planNYC Progress report 2010: A Greener, Greater New York. The City of New York.

[41] The City of New York. 2010. planNYC Progress report 2010: A Greener, Greater New York. The City of New York. p. 44

2

Terhi Luukkonen

Pedestrian-friendly city centre transport system

Example cities

Five visions to improve the pedestrian environment

Several actions are needed to create a vibrant city centre. A functional pedestrian centre with a surrounding transport system does not appear by chance. It requires meticulous background planning and visioning, refined strategies and bold decisions and actions. Organisational operations behind the vision and strategy are also important: it would be challenging to implement the actions included in the vision and strategy without effective and viable working methods. This study determined the basis for successful pedestrian environments and functional pedestrian arrangements in five European cities.

In this section, we look at the cities involved in the study, namely Delft in the Netherlands, Linköping and Lund in Sweden and Sheffield and Peterborough in the United Kingdom. Delft, Linköping and Lund were included in the study based on transport system changes already implemented. Peterborough and Sheffield were selected due to their excellent transport plans and the challenging conditions under which they promote pedestrian traffic. For the purpose of the study, eight city transport planners and university researchers that have studied the subject were interviewed. [1] [2] [3] [4] [5] [6] [7] [8]

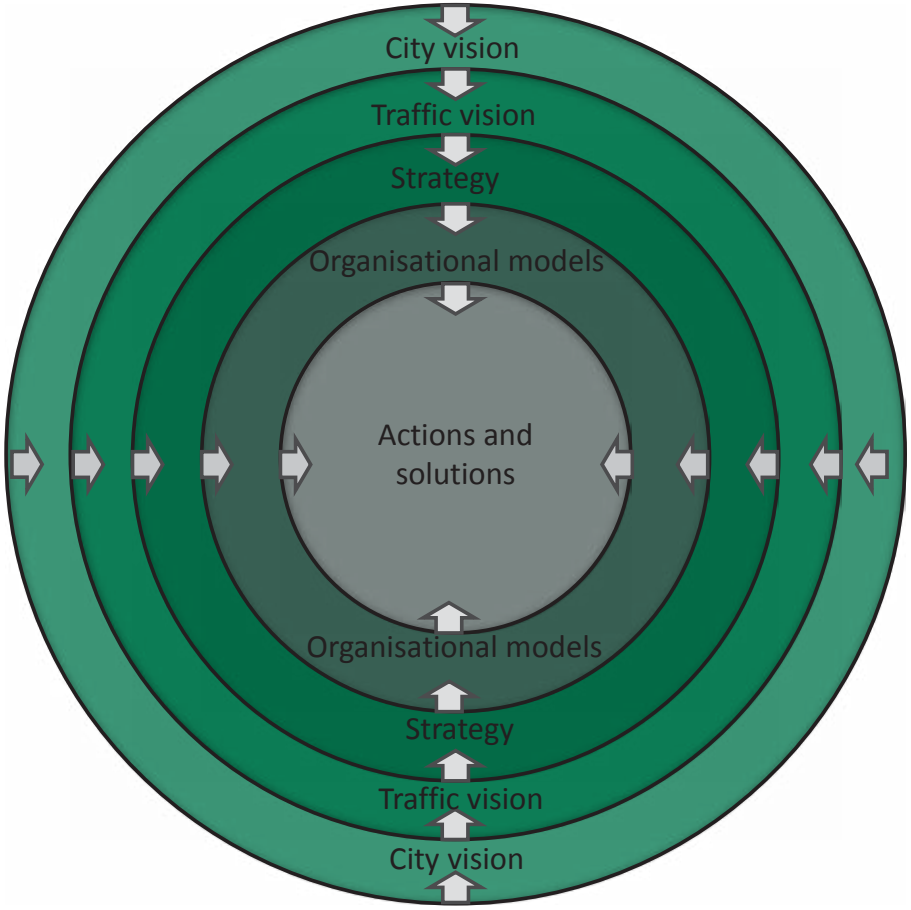


Fig. 1. *A thoroughly envisioned city and transport vision forms a basis for the strategy, while a viable organisation facilitates its implementation.*

	Profile	Transport mode share%	Incentive	Vision	Strategy	Actions
Delft		43/27/26/4	Congestion in the 1970s, preservation of the historical city centre	Centre for the people, sustainable traffic	Pedestrian centre development in four stages	Motor traffic excluded from the streets, parking rearrangements
Linköping	/	27/-/60/13	Oil crisis and helth hazards in thr 1970s	Sustainable transport system, city centre accessible to all, improving the quality of urban life, a carbon dioxide-neutral municipality by 2025	Pedestrian plan and route development, promoting cycling, improving the centre parking ring route	Travel centre relocation on a more centralised area, converting the public transport street in the centre into a pedestrian and cycling street
Lund	/	26/16/42/16	Municipal ballot: no to a street splitting the centre into two. Emphasis on a plesant environment	Sustainable transport system, support for urban life, traget follow-up	Lunda MaTs: kcomprehensive sustainable transport strategy	Improving the urban environment by converting the biggest streets into boulevards and the main street into a public transport and pedestrian street
Sheffield	/	1/18/59/22	Decline of the city´s steel industry	To attract business and enterprises to the city, a vibrant and pleasant city centre, regional business hub	High quality urban spaces, pedestrian routes and business areas	Building of wide and pleasant pavements, design and lighting, branding of pedestrian connections
Peterborough		1/4/91/4	Desire to shrug off the image of being a car city, preservation of the historical city centre	To become the UK´s Environmental Capital, growth inside the city, improving the urban life	Reducing motor traffic on the fringes of the city centre, prioritising the pedestrian routes	Converting the main motor vehicle street into a boulevard, improving the pedestrian environment beyond the pedestrian centre

Fig. 2. *Profiles and characteristics of the studied cities* [1] [2] [4] [5] [7] [8]

Lund – innovative traffic planning

Motorway through the city centre

Located in southern Sweden, Lund is a university town of approximately 110,000 inhabitants and 40,000 students. The medieval street plan has been a challenge for the city's traffic planning, and changes to improve cycling, pedestrian and public transport environment in the city have been made ever since the 1950s.

In 1969, a transport and environment committee was established in Lund. This was due to a plan to build a wide motor traffic street through the city centre. There had been discussions about the four-lane street for 30 year, and visions of growing car use in the future fuelled the plans.

However, opinions about the future of the city centre were varied among both the inhabitants and the political parties. Finally, the majority of the inhabitants and politicians decided to oppose the street, which was never built. [1] [9]

Emphasis on environment and comfort

In 1971, driving through the city centre was prohibited by closing the Stortorget area and the centre main street, with a daily traffic flow of 21,000 vehicles. After that, the main street has supported a flow of approximately 3,000 vehicles per day, half of them buses and the rest other vehicles subject to permit. The city centre was divided into four sectors, between which direct traffic was prohibited from moving.

Closing the street through the city centre for motor traffic with the exception of public transport paved the way for modern traffic planning and preservation of the streets in Lund city centre. The city also decided that traffic in the centre should be environmentally sound. As a consequence, the cycleway network was expanded and public transport developed during the 1970s. [9]

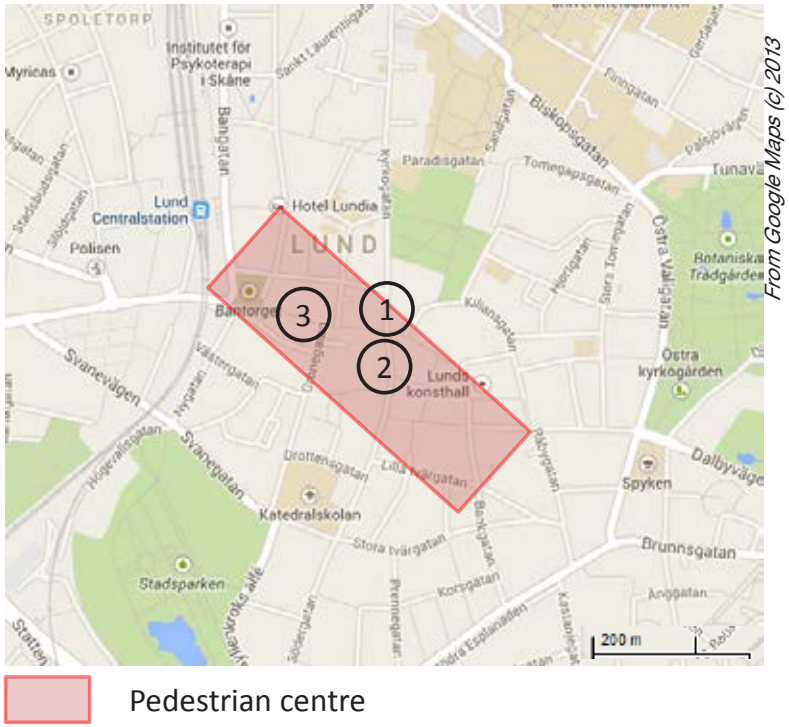


Fig. 3. Before and after: (1) *Kyrkogatan, (2) Stortorget and (3) Lilla Fiskaregatan.*

Lund's vision 2030: toward sustainable development

In the future, traffic will be an important factor influencing the quality of life of the citizens. The urban environment is attractive.

Important points in the vision:

- Preservation and development of the city's nature and green areas.
- Further promotion of walking, cycling and public transport.
- Decrease in car traffic.
- Significant decrease in factors causing climate change, pollution and traffic noise.
- Elimination of traffic fatalities and serious injuries once the transport system has adopted the requirements.

The most ambitious development plans for Lund city centre are the pedestrianisation of the main street currently in public transport use and redesigning the area around the railway station. [1] [10]

Fig. 4. *The narrow streets in Lund city centre are reserved for pedestrians and cyclists*

Linköping – motivated by health hazards

Rapid growth, precise planning

With approximately 150,000 inhabitants, Linköping is one of the fastest growing cities in Sweden. The fifth largest city in the country, Linköping hosts a university with 27,000 students and a leading European technology park.

The development of Linköping city centre is driven by traffic-related health hazards and general comfort in the centre. The oil crisis of the 1970s and the subsequent increase in fuel prices helped to turn the minds of the planners from cars to public transport, walking and cycling. The city got its first pedestrian street in 1967 and the second in the 1970s.

City centre development started for real in 2008–2009 with the emergence of topics like climate change and comfort and the amount of motor traffic in the centre. Subsequently, in 2009 Linköping's centre was named Sweden's pedestrian centre of the year. [2]

Power of cooperation

In traffic planning and implementation, Linköping has joined forces with the neighbouring city of Norrköping. The idea of the cooperation is to keep the cities compact and to develop the small villages along the railway line connecting the two cities. There are a lot of commuters in the area, and the local train system has been a success. [12]

Pedestrian-specific goals

The City of Linköping has realised that there is not enough space in the centre to facilitate all transport modes, and that it is not necessary, either. Based on this, the city has decided to prioritise some modes of transport. The order of priority used by the city is as follows:

1 Pedestrians and cyclists.

2 Public transport.

3 Vehicular traffic. [2] [11]

Not all travel modes can be prioritised at the same time

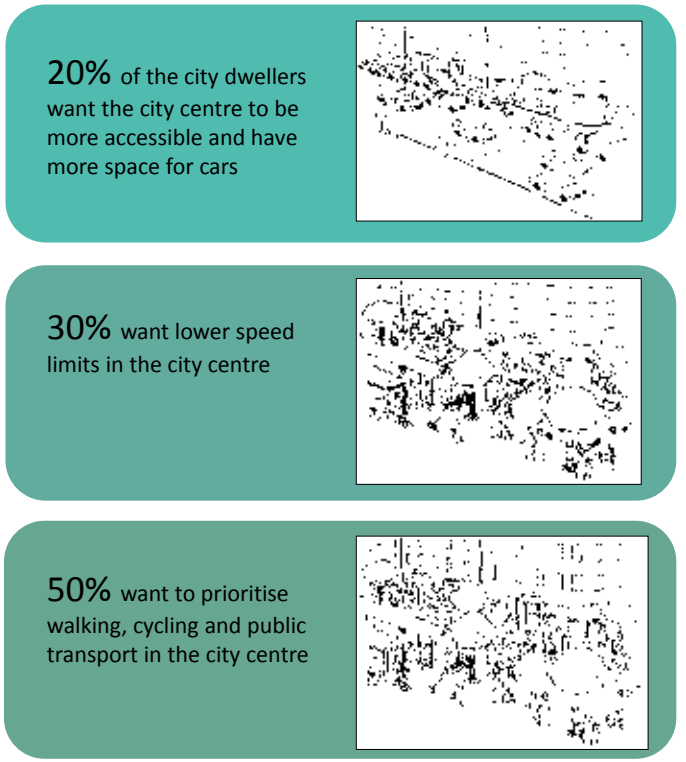


Fig. 5. *A questionnaire taken in 2010 by 2,500 Linköping-born individuals aged 16–79 on three city development scenarios.* [13]

New location for the travel centre

The growing city of Linköping aims to expand in a sustainable manner with the overall picture in mind. The city is divided by the Stångån river running through it, and to bring the two halves together, there are plans to integrate the river as part of urban life in the city centre. As the desired direction for expansion is to the east across the river, new pedestrian and cycling bridges are designed to ensure comfortable connections.

There are plans for a high-speed railway connection, Ostlänken, between Linköping and Stockholm. As the number of passengers is likely to increase significantly from what it is now, the railway station facilities need to be updated. To accommodate the increased passenger flow, the new travel centre is planned in a more favourable location within the expanding pedestrian area, on the east side of the river. The new area also incorporates several large companies that are potential users for the high-speed train. Compared to the old location, the new location is better for the potential users living in the surrounding residential areas, too. Furthermore, the new travel centre facilitates growth in the planned direction. [2] [15]

Linköping's vision: good city, good life

Linköping calls itself the city "where ideas become reality". In cooperation with the inhabitants and neighbouring municipalities, Linköping aims to develop a sustainable transport system that is

- competitive
- resource-efficient
- versatile in terms of options.

In its traffic planning, Linköping systematically favours walking and cycling. The city aims to be a carbon dioxide-neutral municipality by 2025. At the moment, the focus is on compact building design, biofuel buses, developing the car parking facilities and expanding the pedestrian area. [11] [13]

Fig. 6. *(Right) Linköping city centre and travel centre today (Left) New travel centre located within the pedestrian area.* [14]

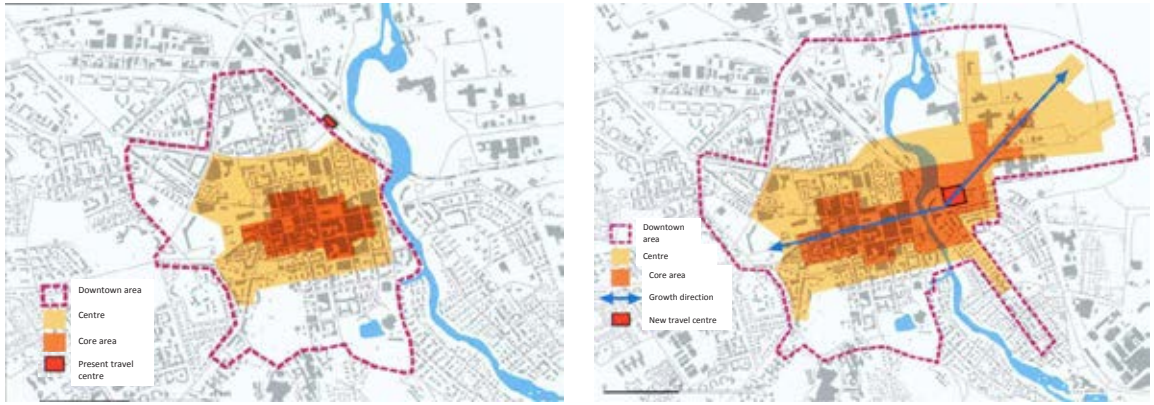


Fig. 7. *Linköping city centre has a peaceful pedestrian area*

Delft – urban space for people, not cars

Medieval scenery and canals

Located between Rotterdam and The Hague, Delft is a densely populated (4,000 people/km²) medieval city with population just shy of 100,000. Delft is also the home of the Delft University of Technology, with approximately 16,000 students.

Pedestrian area planned in stages

There are many streets built to run parallel to the numerous canals in the historic city centre, and these straight and fast routes facilitated the growth of traffic through the centre. As congestion increased in the 1970s, the straight routes through the city were converted into one-way streets. This meant that driving through the centre was no longer the fastest route to the other side of the city. This approach decreased tourist traffic, but the residents quickly learnt to navigate the one-way streets and the problem persisted.

In the beginning of the 1990s, the politicians acknowledged the pressing need to preserve the culturally and historically valuable areas in the city centre. In 1998, a vision emphasising improvements to the urban environment in the city centre was drafted. The aim was to restrict motor traffic and to free urban space for pedestrians and cyclists. Regardless of the opposition, in 2000 the city decided to convert the centre into a car-free zone. The conversion took place in four stages, starting with the creation of several small pedestrian areas by restricting car parking. In total, the conversion took 10 years to implement. The stages included investments to develop the urban space as well as parking facilities on the fringes of the centre. [4] [5] [16] [17]

Fig. 8. *Delft city centre consists of narrow streets and canals.*

Fig. 9. *The market area in the city centre used to serve as a car park (above), Figure* [18]. *Now it serves as a market and common space (below).*

Removing substantial barrier effects

The city centre of Delft consists of the old historical centre and new residental area, separated by the railway. There is no good pedestrian connection from the residential area across the tracks. Started in 2009, a 10-year project aims to relocate the current railway station area and the tracks below ground in order to create new urban space and to unite the new and old Delft.

With the tracks below the ground, there will be new street-level space available. Even though Delft is densely built up and desperate for space, there are no plans to construct new buildings in this area. Instead, the street level will be converted into a pedestrian area benefiting all citizens. Furthermore, the busy street running alongside the tracks will be converted into a pedestrian-friendly street. The new four-rail track will run underground for over 2 kilometres, and the current two-rail track will be removed. There will also be a car park located underground, with approximately 650 bays, bicycle parking facilities for 8000 bicycles and the new station. The old station will be reused, and new office and residential buildings and a park will be built in the area.

Besides the city centre, the new railway will serve the 16,000 students studying at the relatively large university campus in Delft. Even now, many students use the train to get to the university, and the passenger flow is expected to grow. In connection with the building of the new underground railway, there will be improvements done also at station located at the university, meaning Delft will continue to have two major stations in the centre. The purpose of the university station is to relieve some of the passenger load from the main railway station.

In total, the project will cost some 650 million euro before its estimated completion in 2020. [19] [20]

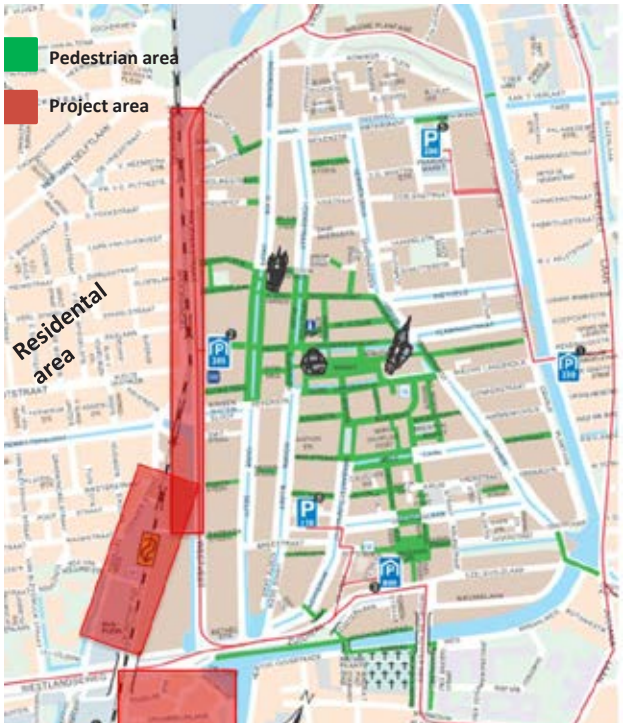


Fig. 10. *Railway project locations with respect to the new residential area and the old centre (pedestrian area)* [16, *edited*].

Delft's vision 2020: safe, accessible and thriving

In 2020, the densely populated cycling city of Delft aims to be a healthy, accessible, inspiring and safe city. The city has a traffic vision to promote accessibility, thriving business and traffic safety. In the shorter term, the goal is to increase the volume of cyclists and public transport passengers, to decrease traffic through the city centre and to continue transport planning with close regard to land use and new construction projects. The new organisational structure of traffic planning has already improved the efficiency of the planning.

Besides the organisational changes, the city has major plans for an underground railway station in order to free up land for new urban space and connect the new and old city centres together. [4] [5] [21]

Sheffield – an industrial city renewed

The rise and fall of the steel industry

Located in South Yorkshire, United Kingdom, Sheffield is a city with approximately 500,000 inhabitants. One of the fastest growing business centres in the country outside London, Sheffield hosts two universities with almost 60,000 students.

Sheffield is famous as a city of steel, and as such has excellent rail links. The topography of this distinctly green city is varied. There is a national park next to the city, and almost 80 parks within the city.

The rise of the steel industry in the 19th century saw the city grow exponentially. There were problems with air quality in the centre. The development of public transport started in the 1950s and 60s, and with more people using buses, air quality improved. Following the decline of the steel industry in the 1970s, reuse of the industrial facilities became topical as there were concerns that the city was in danger of withering away. Also, the attractiveness of the city centre had to be addressed as it did not fare at all well in comparison with those of neighbouring cities. However, public transport regulation decreased the public transport passenger volumes in the city that once had a successful public transport system, causing congestion and a return to poor air quality. [8] [22]

High-quality pedestrian connections

Development of the old industrial areas brought about new shopping centres and various activities, giving the city's economy a much needed push. Once pleasant environment was acknowledged as an important factor promoting economic growth and attracting businesses to the city, serious attention was paid to the cityscape.

The explosive growth of the city had created slums on the fringes of the city centre. After the decline of the steel industry, poorly maintained residential areas were renovated with government subsidies, and in 1999 the city got a tram line. Between 1990 and 2000, the city got EU funding to promote business in the city centre. The funding was used to implement significant urban space and pedestrian environment improvements. [8] [22]

Fig. 11. *One of many high-quality common spaces in Sheffield.*

Sheffield's vision: new role

Sheffield's vision for 2020 is to revitalise the economy of the city and to find a new role as a competitive, innovative and creative technology city as opposed to the old image of traditional steel town. Sheffield wants to come across as an inventive city and to attract new businesses and investors to the city by creating an attractive urban environment of high quality. The streets are of high priority with regard to urban life, and the pedestrian's experience of mobility is of the utmost importance. In 2020, Sheffield wants to be

- a city standing proud among other cities
- a regional economy and technology hub
- a non-discriminatory and accessible city
- a cultural, sports and innovation hub
- a sustainable, low-carbon, low-waste city.

In the urban plan of 2000, the vision was divided into smaller and more manageable projects. These projects included new urban spaces like the Winter Gardens and Millennium Square, along with plans to improve the pedestrian centre and options. [23] [24]

Fig. 12. *Sheffield invites new businesses and investors through attractive surroundings.*

Peterborough – bold plans

Development in a car city

Located in eastern England, Peterborough is a rapidly growing city with approximately 173,000 inhabitants and a relatively young building stock. The population, however, is expected to increase by one-third by 2026. At the same time, the city aims to claim the title of UK's Environment Capital by ensuring sustainable growth and development.

Peterborough is located next to excellent road links at a motorway junction and is on the UK's East Coast Mainline. The location and city structure encourage private motoring, creating a challenge for the city. [7] [25]

Focus on comfort in the centre

In recent years, Peterborough has acknowledged the need to maintain its city centre. In 2008, the city launched a Public Realm project which aimed to create more urban life and comfort in the centre area. Walking and cycling have been placed alongside motoring as equally valuable modes of transport, and buildings renovated in the 1960s to the style of that decade have had their frontages restored to the original designs.

Planned for motor traffic, the busy main street right next to the city centre is a formidable barrier to pedestrians. Regardless of the challenges of being a car city and going through economic hardship, Peterborough has managed to edge the city into a more pleasant and pedestrian-friendly direction. [7] [25] [26]

Fig. 13. *Small changes have made Peterborough city centre more pedestrian-friendly*

Peterborough's vision: sustainable growth

Peterborough's vision for 2026 is to improve the quality of life of the citizens by growing in a sustainable and environmentally friendly way. The four targets set by the City of Peterborough are:

- to create opportunities
- to become a strong city supporting the surrounding municipalities
- to become the UK's Environment Capital
- to grow the city in a sustainable manner.

Based on the vision, Peterborough has improved the pedestrian environment in the city centre, eliminated barrier effects and prepared plans to further promote pedestrian traffic. The city has made organisational changes to improve planning procedures, and brought together the strategies of the different city traffic sectors for a comprehensive overall picture. [25]

Mobility brand: Travel Choice

Established in 2004, Travel Choice is a branded mobility information campaign in Peterborough. Peterborough is one of three sustainable travel towns in the United Kingdom. The city has received a five-year funding package of about 4 million euro for the branding project.

The aim is to gather all transport modes under one brand in order to promote and market sustainable mobility in the city. However, the brand is not based on environmental arguments. Instead, it tries to convince the citizens by focusing on the freedom of movement and financial savings gained. The brand includes traffic information (travel plans, kiosks, maps, applications, travel centres), marketing efforts (car sharing, branding of routes, Travel Choice Week), route planning (residential area route plan, school route plans, My Travel Choice service) and other actions (cycle training for adults, cheap PLUSBUS bus and train pass). [7] [27]

Funding for the campaign ended in 2009, after which the impact was evaluated by a questionnaire survey of the transport habits of the citizens. For reference, a similar survey had been conducted in 2004, before the campaign. The sample for the travel log survey was 4,000 individuals on both occasions. The survey showed that travelling by walking and cycling had increased while travelling by car had decreased, even though car ownership was not affected in anyway. [28]

Fig. 14. *Peterborough travel centre obeys the travel choice campaign brand, even though public transport in the city is run privately.* [27]

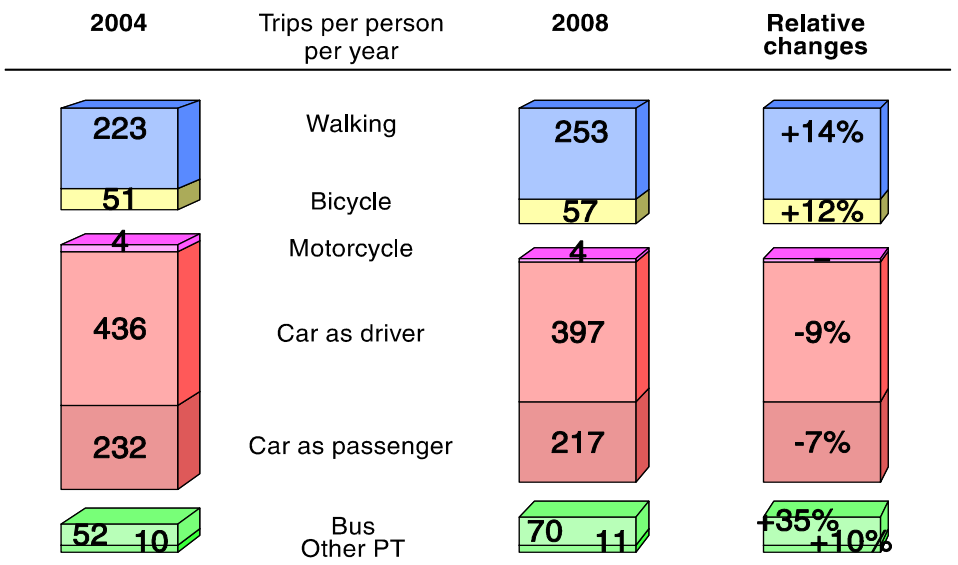


Fig. 15. *A Travel log survey taken before and after the campaign showed that the citizens were travelling in a more sustainable manner.* [28]

Comprehensive strategy to implement the vision

LundaMaTs – improved city centre transport system

Starting from 1999, the city of Lund has been implementing a plan for a sustainable transport system in a novel and comprehensive manner. The plan is called LundaMaTs, a strategy to develop the city's transport system. It is also the first Swedish Sustainable Urban Transport Plan (SUTP). The goals are set for 2030, and the principles and follow-up procedures are in wide use throughout the entire city organisation.

In Lund, climate change and environmental impacts were already discussed in the mid-1990s. Transport issues were found to be one of the most important ways to regulate the impacts. Local politicians realised that by adopting a proactive approach to traffic within, to and from the city, it was possible to create a sustainable and pleasant city. By the end of the 1990s the politicians had reached an agreement on Lunda-MaTs, today utilised throughout the city government in order to achieve the sustainable economic and social goals and to monitor any negative impacts on the environment. [1] [29]

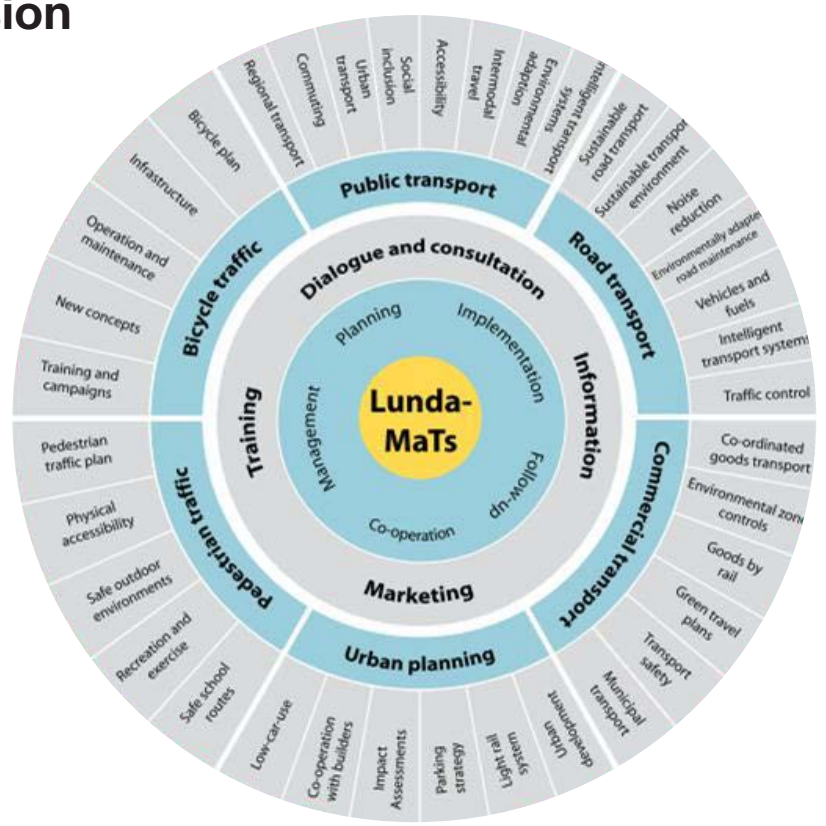


Fig. 16. *The LundaMaTs wheel, with the vision at the centre, two inner rings representing the organisational components for achieving the vision and two outer rings containing the reform areas and actions* [30]

One vision, six reform areas, 18 goals

The goal of the LundaMaTs is to create a city with consideration for environmental, economic and societal sustainability. The goals include the following six reform areas:

1. Road transport
2. Public transport
3. Bicycle traffic
4. Pedestrian traffic
5. Urban planning
6. Commercial traffic

The strategy also contains 18 goals, such as plans for pedestrian and bicycle traffic, accessibility, noise reduction, transport safety, parking strategy, low car use and intermodal travel. The LundaMaTs goals are reviewed through annual reports. The list clearly shows the goals that have been advanced, goals that have not changed at all and goals that require stronger actions in order to be achieved. [30]

Goal		Goal 2013	Goal 2030	Outcome 2008 (base year 2004)	Signal
1	Increase proportion of inhabitants in the local authority who live in 'CP circles' within built-up areas. (CP circles = priority areas for expansion and utilisation according to the Comprehensive Plan).	increase	increase	increased	
2	District programme with development needs, proposed measures and focus will be produced for all built-up areas/districts.	all	-	follow-up in progress	
3	The physical traffic environment will be designed to increase the average speed of city bus traffic from 18 km/h to 22 km/h by 2013, and 23 km/h by 2030.	22 km/h	23 km/h	18 km/h	
4	Increase the number of pedestrian and cycle paths by 10% by the year 2013, and 30% by the year 2030.	+10%	+30%	+ 5%	
5	The proportion of safety-adapted pedestrian and bicycle crossings should be 30% by 2013 and 100% by 2030.	+30%	+100%	+ 46%	
6	Increase pedestrian traffic per inhabitant.	increase	increase	reduced	
7	Bicycle traffic per inhabitant will increase by 5% by the year 2013 and by 10% by the year 2030.	+5%	+10%	± 0	
8	Continually increase travel by public transport per inhabitant.	increase	increase	+15%	
9	Reduce motorvehicle traffic per inhabitant on the state and municipal road network.	reduce	reduce	increased	
10	Reducemotor vehicle traffic per inhabitant on the municipal road network by 2% by the year 2013 and 5% by the year 2030.	-2%	-5%	+ 3%	
11	After new constructions, the travel time index for bicycles/cars will be less than 1.5 for journeys to district centres and built-up areas (relates to both housing and workplaces).	75% of future buildings	75% of future buildings	follow-up in progress	
12	After new constructions, the travel time index for public transport/cars will be less than 2.0 for journeys to district centres and built-up areas (relates to both housing and workplaces).	75% of future buildings	75% of future buildings	follow-up in progress	
13	Increase physical accessibility for disabled people, children and older people.	increase	increase	increased	
14	Reduce proportion of people who feel that the traffic environment is unsafe.	reduce	reduce	increased	
15	Reduce the number of serious injuries and deaths on roads by 25% by the year 2013 and 50% by 2030 (relates to both the municipal and state road network and the basic data comprises road accidents reported to police).	-25%	-50%	± 0	
16	Reduce emissions of carbon dioxide per inhabitant from traffic in the municipality by 10% by the year 2013 and 40% by 2030.	-10%	-40%	+12% (data from 2007)	
17	By 2013, all properties located along the municipal road network that are exposed to noise levels exceeding 61 dBA will have been offered grants towards noise reduction measures. By 2030, all properties exposed to noise levels exceeding 54 dBA will have been offered a grant. Noise levels relate to the Community Noise Equivalent Level, CNEL.	100 % with equiv. noise level exceeding 61 dBA	100 % with equiv. noise level exceeding 54 dBA	Offer according to plan. Since 2004 the number of residents affected by noise levels has decreased by 33%	
18	Increase the proportion of inhabitants in the City of Lund who state that they have been influenced by LundaMaTs.	increase	increase	+ 33%	

Source: [30]

Peterborough's Public Realm Strategy

In 2008, Peterborough announced the Peterborough Public Realm Strategy, which aimed to develop the cityscape in the city centre. The goal of the strategy is to improve the pedestrian environment and links in the centre, create comfortable and functional urban spaces and restore the frontages of the city centre buildings to their former glory. The actions to achieve the goals include calming vehicular traffic, improving the pedestrian environment, and the building of more comfortable urban spaces. It is hoped that new urban spaces and improved pedestrian comfort will unify the centre, attract new business to the city and increase the use ratio of the centre in the evenings. [7] [26]

Pulling down buildings to create new urban spaces

Most of Peterborough's city centre was built in the 1960s, with little or no attention paid to matching the frontages of the new buildings with those of the medieval buildings.

Located next to the cathedral, an eight-storey office building from the 1960s, ill-fitting in the cityscape, was pulled down from the Cathedral Square in the city core. The office building obstructed city views and drew attention away from the cathedral next to it. By demolishing the building, the city gained an extra 620 m² of green urban space for recreational use and events.

The area around the cathedral was developed by adding seating and water elements, new paving and by removing the kerb stones. The adjacent street was closed to what little vehicular traffic there was. Completed in 2010, funding of approximately 7 million euro was reserved to demolish the building and develop the area. [31]

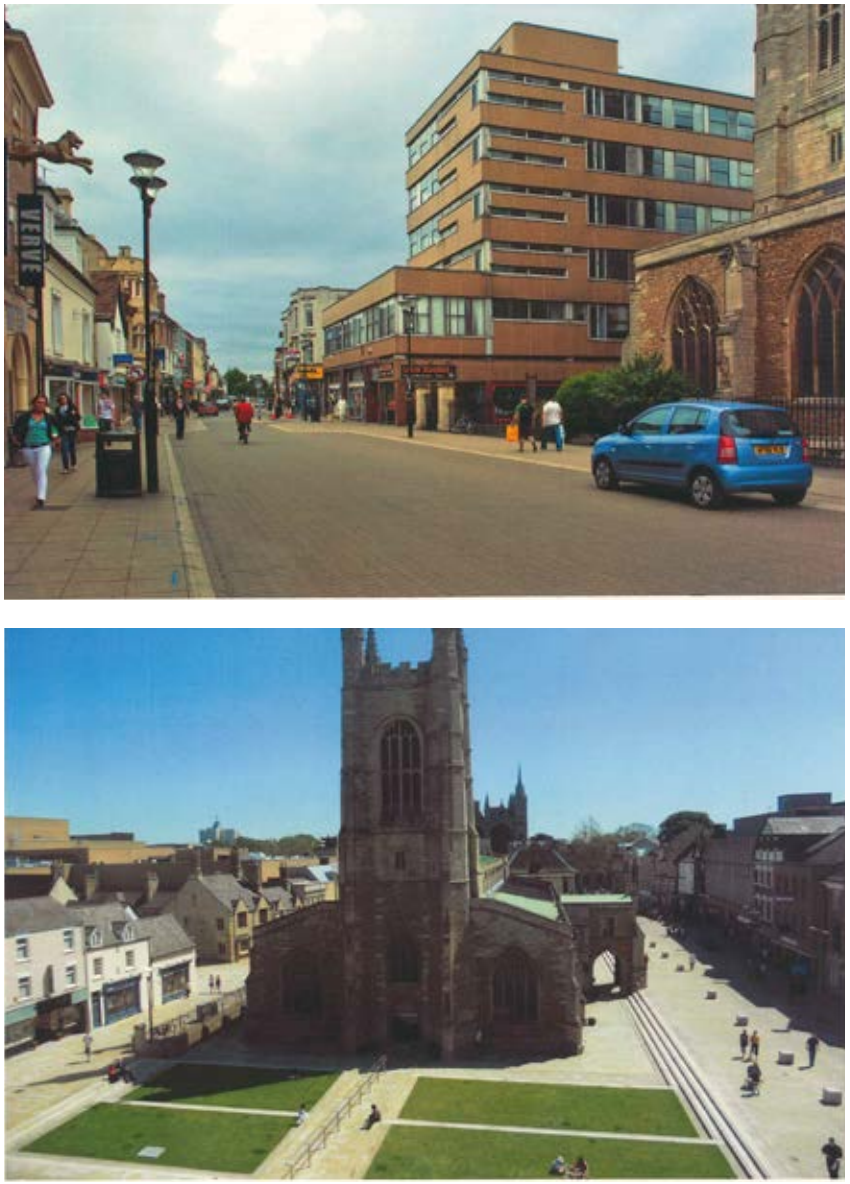


Fig. 17. The forecourt of the cathedral before (above) and after (below) the building was removed [31].

From ring road to boulevard

Bourges Boulevard was built in the 1970s, at the same time as the building of the city centre expansion and the ring road, to establish a link between the new and old parts of the city. Since then, the centre has expanded, and now Bourges Boulevard runs between the pedestrian area and the railway station, creating a significant barrier effect. At the moment, it is more like a thoroughfare rather than a city street.

To match its name, the street will be converted into a more comfortable and greener boulevard with lower traffic flow, and several natural and convenient pedestrian crossings. After changing the nature of the street, fast flowing through-traffic will be directed to the ring road. [7]

Fig. 18. *Currently, the multi-lane Bourges Boulevard is not so much a city street but a major thoroughfare. To cross it, pedestrians need to use the overpass or take a long detour to get to the underpass (right). The street will be converted into a boulevard with convenient crossings for pedestrians (left).* [32]**.**

Transport plans under single covers

Every five years Peterborough publishes a Local Transport Plan, the current one being based on the transport strategy for 2026. To avoid overlaps, the city has brought the plan and the strategy under the same cover. The publication brings together the visions and goals for transport, transport strategies for various transport modes, priorities, challenges and options for plans.

Covering all transport modes, the document pays attention to the following:

- plans for the city core
- transport policy
- transport strategies (including all transport modes, new innovations, urban life, accessibility, safety, traffic management...)
- innovations
- large- and small-scale transport plans
- follow-up
- economy
- risks.

Containing a lot of tables and summaries, the publication provides a good overall picture and acts as an everyday tool for the city traffic planners. The planners can use it as a reference book, eliminating the need to search for information in separate transport mode-specific strategy documents. The publication is also an agenda and check list for various operators for the next 10 years, ensuring city-wide development. [7] [25]

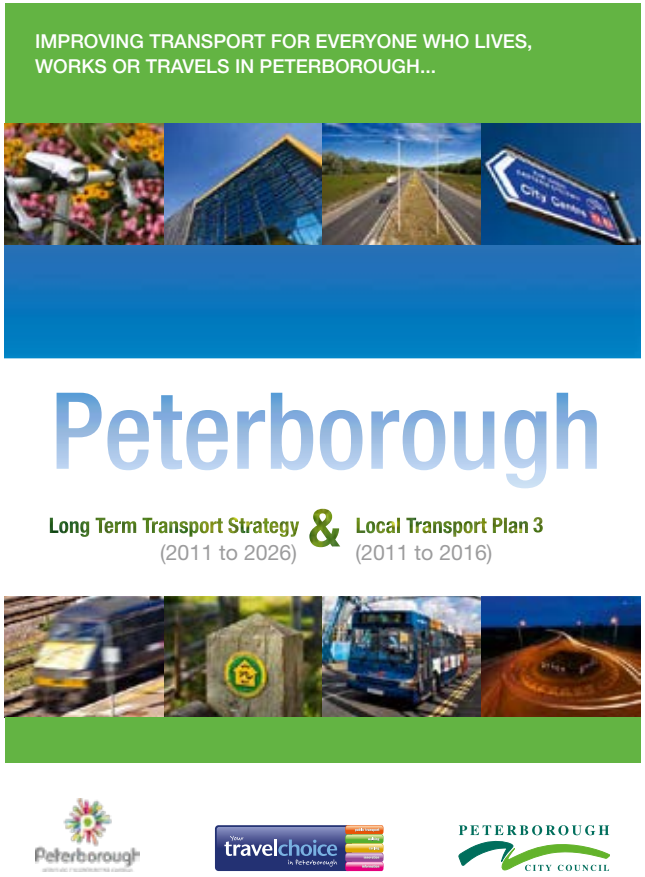


Fig. 19. *In Peterborough, strategies and plans are compiled in an easy-to-use format under the same cover.* [25]

Sheffield's Public Realm Works

Sheffield's urban spaces have undergone a dramatic change over the last 15 years. Despite the economic insecurity of recent years, the development plans (1994, 2000, 2008 and 2013) have made a difference in the city centre. Sheffield implemented a series of urban space development schemes. Good-quality spaces were created using public art, water elements and lighting in the evenings and through pedestrian-friendly changes. Different spaces were planned to have different functions. The aim was to create pleasant and clear pedestrian routes through the various urban spaces. In most cases, the pedestrian routes run separate from the centre's vehicular traffic, and the good-quality street crossings are planned with pedestrians in mind. The principle of the city has been that plain pedestrian routes are not enough, they also need to be comfortable and interesting in order to attract more pedestrians and other users.

During the Millennium Public Realm Works development project of 1998–2003, not only did the city core get new residential and office buildings but also new urban spaces like the Peace Gardens, Millennium Square and Winter Garden. The combined budget for these development projects was approximately 20 million euro. Of the city centre project costs, the city paid 25% itself and got another 25% from investors. Almost half of the money came from the National Lottery fund. Besides major projects improving vehicular traffic and public transport, the UK government also significantly funds projects that improve the pedestrian environment and attractiveness of the city.

In the 21st century, the city development has continued systematically with the improving of pedestrian links, entry to the station, university and shopping districts. [8] [33]

Fig. 20. *According to a survey conducted following the numerous urban space and pedestrian environment improvements implemented in Sheffield city centre, the number of shopping trips to the centre has increased significantly.* [34]

Fig. 21. *In the past decade, Sheffield's urban spaces have been developed intensely.*

Frequency of shopping visits to Sheffield city centre
Peace Gardens survey

Activity	Before redevelopment	After redevelopment
Less than once a year	16,4%	5,9%
Once a tear	3%	1,2%
Once a month	40,3%	49,4%
Weekly	37,3%	36,5%
Daily	3%	7,1%
An overall 35% uplift in the number of visits for shopping		

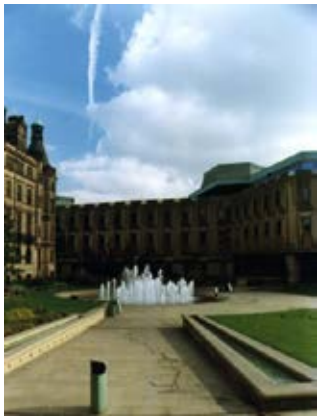


Fig. 22. *Before redevelopment: Peace Garden and the Winter Garden area dominated by the City Hall annex.* [35] [36]

Fig. 23. *City centre after redevelopment: new seating, lighting, water elements and the Winter Garden where used to be a city hall extension. (Picture under* [34])

The all-important first impression

In Sheffield, the single most important project in recent years has been the Sheaf Square redevelopment. Earlier, the station forecourt was used for parking, and taxi cabs occupied the foreground of the station entrance. A busy four-lane street ran alongside the area.

The city decided to improve the forecourt environment in order to give travellers a positive first impression. Therefore, the car park was removed and the area was made more pedestrian-friendly by prohibiting driving from the area with the exception of taxi cabs.

Good-quality seating, fountains and a water wall illuminated at night were built to create an area on a pedestrian-friendly scale, protected from the traffic noise of the adjacent busy street. [8]

Route to the station

The natural route from the station to the city core goes through Howard Street. The street was already the most popular pedestrian route from the station to the centre, but the environment did not facilitate significant pedestrian flows. Combined with the substantial pedestrian flow, vehicular traffic on the street caused conflicts. In conjunction with the station redevelopment, the street was pedestrianised to form a link between the station, university and city core.

The redevelopment of Sheaf Square and Howard Street cost approximately 27 million euro in total, half of which was funded by the government. [8] [34]

Fig. 24. *Station forecourt before and after redevelopment.* [34]

Fig. 25. *Howard Street before and after redevelopment.* [73]

Organisational models and redevelopment

Results through organisational restructuring

The implementation of the city's vision and plans and the development of the city depend heavily on the efficiency of the planning organisations. Therefore, efforts have been made to rationalise and facilitate city development and working methods as well as cooperation between the various planning teams. Cooperation and sharing of information between specialised teams is often challenging, with problems within a unit or, in particular, between the various planning teams. This causes delays and problems in following the projects through to completion. What is more, lack of relevant information may lead to undesired results. The various sectors do not always have the time needed for systematic city development. Therefore, separate development units may also be required. Organisational models that increase information sharing and cooperation between experts in different fields have a proven positive influence on following the projects through to completion. The changes are not always easy to implement, but teams combining multiple sectors do seem to have a positive impact on cooperation and performance in work.

Under one roof in Peterborough

In Peterborough, city transport planners and the city engineer's office moved into joint office premises within the same building. The offices were previously located in separate buildings, and there were problems in cooperation and sharing of information. Lack of relevant information led to disagreements, especially when delegating responsibilities from one unit to another or when the original plans were not followed as intended, due to insufficient information.

Joint premises improved dialogue between the offices and facilitated cooperation in project management. There have also been fewer conflicts between the two offices. In Peterborough, there were no need for major restructuring because the desired results were achieved by simply relocating the offices. [7]

Sheffield One

After the decline of the steel industry, Sheffield decided that in order to prosper the city needed to be redeveloped and find other strengths. The redevelopment was considered so important that the city did not want to add it to the burden of any of the existent organisations. Therefore, in 2000 the Sheffield One city centre redevelopment organisation to regenerate the cityscape was established. The organisation received government funding, and Sheffield was one of three cities to participate in the experiment.

The Sheffield One organisation operates in cooperation with both the regional city and the national redevelopment offices. The main purpose of the organisation is to find funding and partners for the city centre redevelopment projects in order to ensure sustainable development while considering the following:

- the economy
- transport
- environment
- residence
- planning.

In 2007, the successful Sheffield One organisation was merged into Creative Sheffield city development organisation, the first city development company in the United Kingdom. [7] [37]

Organisational changes in Delft

The organisation of Delft's city government underwent major restructuring in the autumn of 2011. The aim of the organisational changes was to reorganise the existing highly specialised teams in order to rationalise city planning and working methods. Communication and cooperation between the various sectors had been challenging with the traffic planning, urban planning, environmental issues and legal expertise in separate units of 10–15 individuals. In total, the planning organisation consisted of 40–50 employees. Each sector was found to operate too independently with insufficient cooperation and sharing of information.

In the restructuring, the planners were organised by areas instead of the earlier designated homogeneous teams based on training and skills. Separate planning teams were established for southern and northern Delft and for the overall plan covering the entire Delft planning area. Each new planning area got a mix of transport, urban planning, environment and legislative experts. In the new teams, the transport planners, urban planners, environmental planners and legislation experts work together every day. This way, the plans can better incorporate the special characteristics of each sector, and an uninterrupted flow of information between the experts is possible.

In the beginning, the new organisation was found to be challenging. There were differences in the working culture and practices so it took some time to establish new methods and internal work flows. Despite the challenges, the cooperation is better now. The employees are happy with the ease of cooperation, how the projects are followed through and plans implemented. [4] [5]

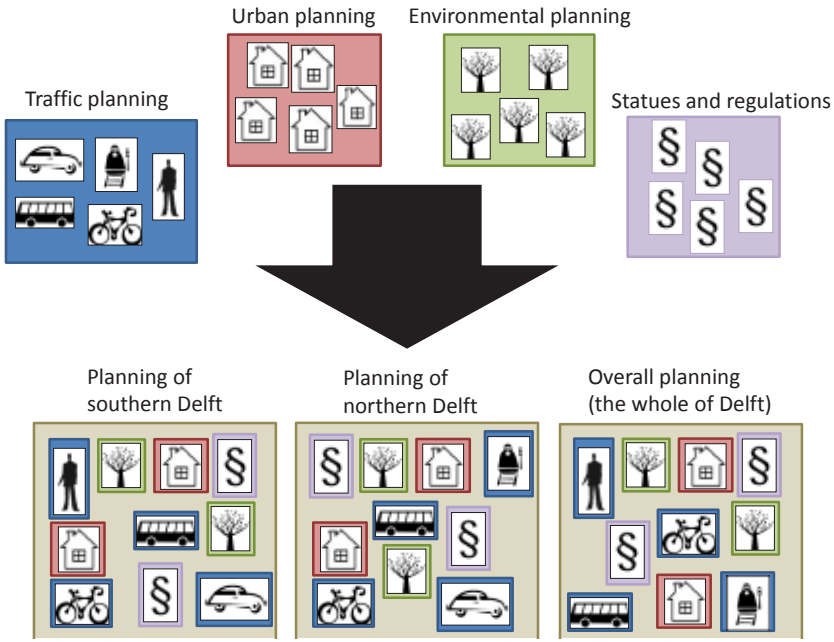


Fig. 26. *In Delft, the city's organisational changes included a thorough restructuring of the planning teams.*

Pedestrian environment

Combining areas and functions

To successfully promote walking as a transport mode, the whole city centre transport system must support pedestrian traffic. The pedestrian environment can be improved through many actions, like making the pavements wider and by creating motor vehicle-free zones. When creating a good-quality pedestrian environment, it is important to create safe and fluent links between the city centre and other areas within the city. The links should connect the pedestrian areas, shopping districts and other areas in which trips on foot originate, including the residential areas.

Changes in four stages

Delft city centre was redeveloped in a very systematic manner in four stages carried out in 2000–2010. Before the project, there were some unconnected pedestrian streets in the centre. In the middle of the historic centre there was a large parking area for cars. In the four stages, the pedestrian streets were linked, parking was arranged in the surroundings outside the pedestrian area and new areas and pedestrian routes were defined better.

Since the redevelopment, there are three types of urban area in Delft:

- pedestrian-only zones, with cycling allowed in some parts
- car-free zones for pedestrians and cyclists, cars allowed only as guests in the area
- other zones with no traffic restrictions.

A car-free zone requires well-planned entrances for delivery traffic, short-term parking near the centre, and long-term parking on the fringes of the centre. [16] [17]

Fig. 27. *Citizens of Delft are happy with the new car-free look of the city centre and improved accessibility.*

Fig. 28. (Next page). *The different stages of Delft city centre change.*

Satisfaction with the centre

An Internet questionnaire survey of 1,700 individuals conducted in Delft in 2009 after the city centre redevelopment determined the citizens' satisfaction with the centre. [38]

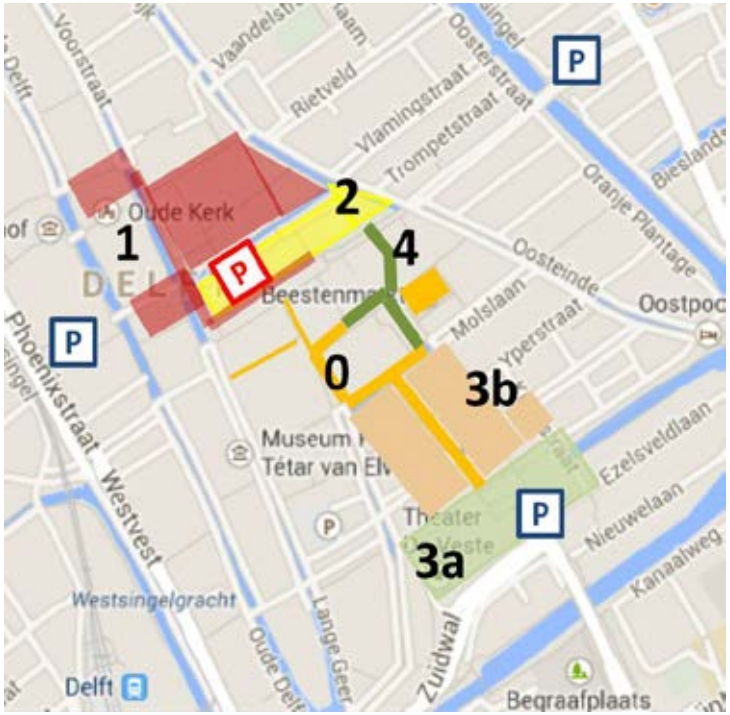
- 70% wished for an even larger car-free zone
- More than 70% thought the car-free zone improved the city centre

Stage 0: Initial state

In 2000, the pedestrian areas in the city centre were not connected logically and movement from one area to another was neither safe nor fluent. Furthermore, there was a large and busy car park in the middle of the centre.

Stage 1: Connecting the pedestrian streets

In stage 1 (2001–2002), the pedestrian streets of the shopping district were connected. At this stage, the emphasis was to remove pedestrian barrier effects.



From Google Maps (c) 2013

Stage 2: Parking removed from the market area

In 2003–2004, car parking was removed from the market area and the streets leading up to the market were reserved for public transport and urban logistics. This caused friction with businesses, as they were worried that the change would harm their trade. Subsequently, three underground parking facilities with approximately 1,400 bays in them were built on the fringes of the centre.

Stage 4: Pedestrian route improvements

In stage 4 (2006–2010), parking bays were removed from the streets and squares around the pedestrian centre. Overall comfort and functionality of the common places and the pedestrian routes from the parking facilities to the centre were also improved.

Stages 3a and 3b: Connecting the pedestrian streets

In stage 3a (2004–2005), the southern part of the area and the market zone were improved. In stage 3b (2004–2006), the southern pedestrian area was incorporated into the northern pedestrian area.

Source: edited [16] [17]

Pedestrian-oriented streets

Sheffield has emphasised good pedestrian connections in the city centre. Besides the pedestrian streets, several squares in the city are used as pedestrian areas. The squares and pedestrian streets are linked by pedestrian-oriented streets. The pedestrian environment has been improved with wider pavements and convenient crossings. The city centre is a good example of how to create a city environment more pleasant and pedestrian-friendly without making dramatic changes to the transport system.

The city has also branded high-quality pedestrian links to make them known to both the locals and visitors. A high-quality and well-known pedestrian link encourages walking and also brings design in the cityscape in the form of the various common spaces, benches, street art and events. [7]

Fig. 29. *Peterborough has also successfully linked various city centre areas using wide pavements. The pavements are made wider by taking space from the cars and converting two-way streets into one-way streets.*

Even small improvements can make a street environment more pedestrian-friendly

Fig. 30. *In 2013, Peterborough prohibited on-street parking from Cowgate to create a more pedestrian-oriented street. The pavement on the street linking the city centre and railway station is similar to a pedestrian area. This way, the motorists know that they are entering a pedestrian-oriented shared space street. The cost of the conversion was approximately one million euro.* [39]. *Left figure: [26].*

The Gold Route – branded pedestrian route

Built in 1996–2006, the approximately 1.3 kilometre-long Gold Route links Sheffield railway station to the city's central shopping district. The combination of various urban spaces along the route make for an interesting walk. Each urban space is characterised by unique water elements, lighting or urban art. The 47 million euro project (including the urban spaces like the Peace Gardens and Millennium Square mentioned above) symbolises the city's cultural and economic life. Typical of the city, steel is a recurring theme element along the route. The route takes visitors arriving at the station through one of the city's two university campuses and then on through various gardens and squares to the new shopping district. [40]

The route contains several street crossings, the first one right in the station forecourt crossing the busy four-lane Inner Relief Road. The high-quality street crossings are made of uniform revetment and equipped with convenient traffic lights, allowing for smooth and safe passage.

Following the success of the Gold Route, Sheffield is now planning to build more pedestrian routes. After the redevelopment, there has been an annual increase of 3% in turnover in city centre businesses, and office rents have also increased. The Steel Route is a new branded route through the major commercial and business area, linking the business districts and hotels. [35]

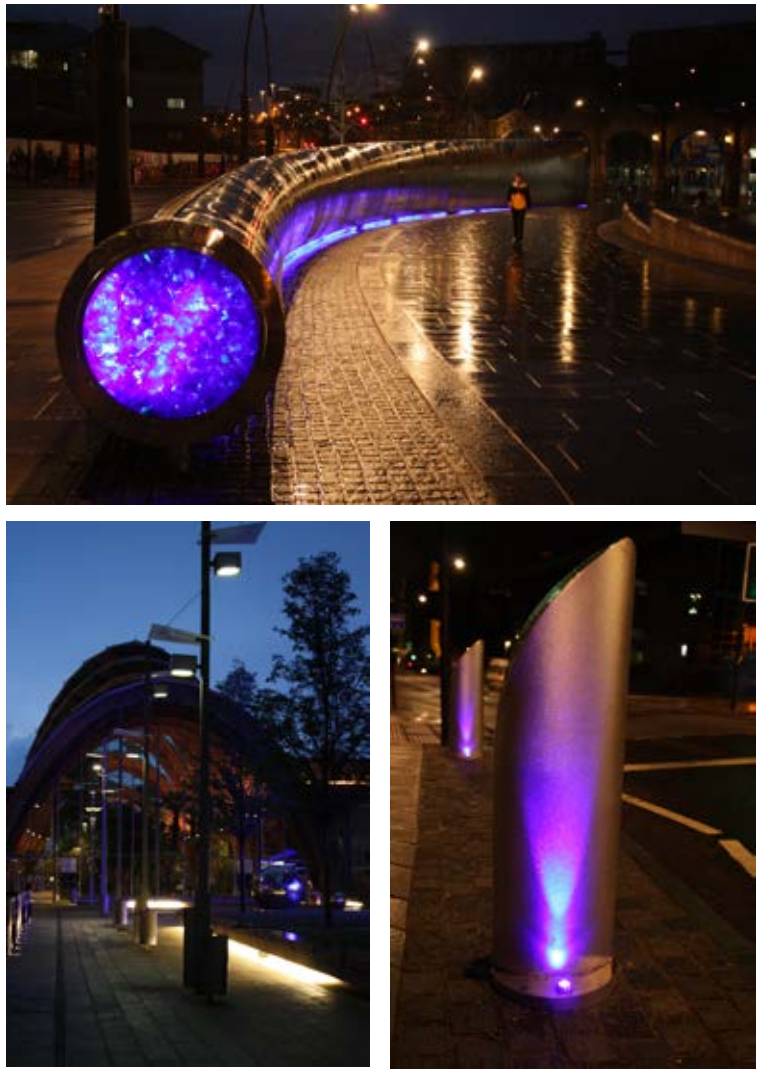


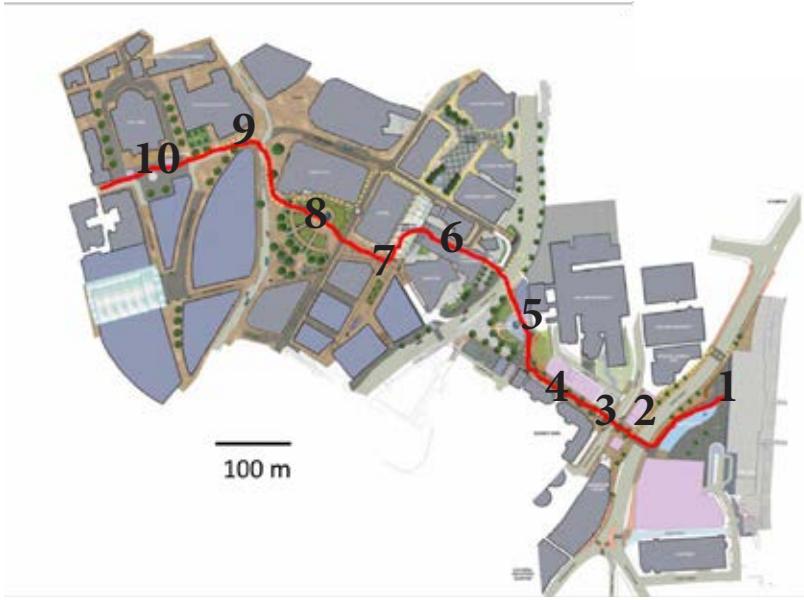
Fig. 31. *The Gold Route at night. Aesthetic lighting makes the route pleasant and safe, even when it is dark.*

7

6

5

8



4

9

3

Fig. 32. *The approximately 1.3 kilometre-long Gold Route linking the city core with major sites like the railway station, university campus, cultural facilities and central shopping district makes the walk a pleasure. Edited map,* [35].

10

1

2

Attractive to walk in throughout the year

The winter maintenance of the cycleways and pedestrian areas was studied in more detail as a sub-project of the Pykälä II project. The target of the study was winter maintenance in the cities of Oulu, Linköping, Umeå and Copenhagen, and the aim was to establish how the cities have achieved high level winter maintenance that enables cycling and walking throughout the year.

Each of the studied cities have invested in the winter maintenance of the city centre pedestrian area. In Umeå, Linköping and Oulu, a heating system keeps the pedestrian areas clear of ice. In Linköping, property owners participate in covering the heating costs by paying a certain monthly sum. Copenhagen uses salt to keep the pedestrian area free of ice. [41] [42] [43] [44] [45] [46]

Pavement maintenance

In all of the cities studied, pavement maintenance is the responsibility of the property owner. However, the level of pavement winter maintenance quality varies, as not all the property owners take care of their obligations as per the required standards. Hence, Linköping started a project in the winter of 2012–13 with the aim of encouraging the property owners to use local contractors for the winter maintenance of their respective pavements. This way, the pavements could be maintained at the same time as the other parts of the routes, thus improving quality levels. Though just started, the project shows promising results. [46]

Fig. 33. *To keep the city centre pedestrian area clear of ice, Oulu (left) uses a heating system and Copenhagen (right) salt.*

Umeå invests in safe under- and overpasses

In Umeå, the most important cycling and pedestrian under- and overpasses are heated. The aim is to create safe routes, like the entrance to the underpass to the railway station (Figure 34). In some cases, heating is used in order to minimise the risk of ploughing damage to the surface material. The heating system utilises district heating circulating water. [41] [42]

Heating costs about 2.5–3 times more than standard winter maintenance, but the city wants to invest more in the maintenance of particular sites. The benefits of the de-icing system are deemed to outweigh the higher costs. [41] [42]

Fig. 34. *In Umeå, some underpasses, like the one leading to the railway station, are heated. Lighting is also carefully designed.*

Four approaches to a pleasant city centre

Based on the desired outcome, available resources and current conditions, there are different ways to approach the development of the city centre pedestrian environment. The approaches vary, and not all of them are suitable for all cities. Among the example cities, however, it is possible to distinguish between the following four operational models that can be used to calm city centre traffic, to make the area more pleasant and to improve the pedestrian environment:

1. Separate pedestrian areas are created in stages and then combined to form a single whole.
2. Pedestrian routes are created one by one by linking major sites to each other.
3. A pedestrian-oriented area is expanded, starting from a single origin in the city core, like a market area, street section by street section.
4. Reducing vehicular traffic through changes in the transport system so that the pedestrian environment improves “naturally” as the traffic in the city core decreases.

Cycling to support walking

The city core must be accessible by bicycle

The focus for bicycle traffic supporting the pedestrian centre is the accessibility of the centre. In order to have fluent bicycle traffic supporting business and other activities in the pedestrian centre, bicycles must have access to the centre. Besides fluent routes to the pedestrian centre, it is important to have short-term bicycle parking to enable shopping trips by bike. The layout of the city centre, space arrangements and pedestrian and cyclist flows dictate whether cycling should be allowed and whether there should be restrictions based on time, for example.

Centre must be accessible by bicycle by way of fast and direct routes.

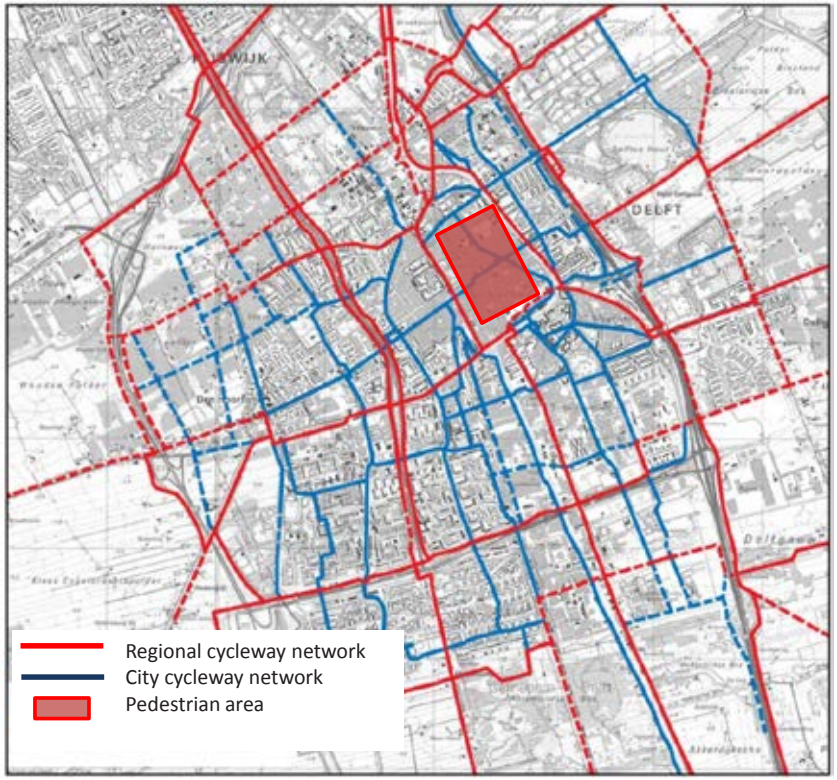


Fig. 35. *In Delft, the cycleway network supports fast and fluent access to the centre and central shopping district for shopping trips. The comprehensive network links the residential areas directly to the pedestrian centre* [47 *edited*].

Allowing cycling on the pedestrian street

In European cities, cycling in pedestrian areas is allowed case-specifically, often based on the centre's layout and the availability of alternative routes. Cycling can be permitted if the alternative route around the centre is particularly laborious. When cycling is allowed, a separate cycling area can be indicated with the use of different materials. However, the separation can be indicative only, allowing the pedestrians to use the area designated to the cyclists. Using material separation can clarify the division of space, but it can also lead to conflicts between the pedestrians and cyclists. When using common space, various transport modes tend to pay more attention to each other. In the Netherlands, there are often traffic signs informing the cyclists that they are guests in the pedestrian area. This means that the cyclists must navigate and adapt their speed based on the movements of the pedestrians. [4] [5]

	Cycling permitted in the pedestrian area	Practice	Reasons
Lund (SE)	yes	Material used to separate the areas, cyclists adapt their speed to that of the pedestrians	Too long a detour if prohibited: could lead to increase in motor traffic
Linköping (SE)	no	Cyclists walk their bikes within the pedestrian area	Detour around the pedestrian street via the cycleway is reasonable
Delft (NL)	yes	No material used to separate the areas: cyclists are permitted to ride their bikes as guests in the area, adapting to the movements of the pedestrians	Cyclists represent a substantial share of the spending power within the city; the aim is not to lose that.
Groningen (NL)	no/yes	No cycling during the daytime, permitted in the evening after shop closing hours	Pedestrian streets during the day, but cyclists can use the streets as a short cut through the city centre in the evening, night and morning
Odense (DK)	no/yes	No cycling during the daytime, permitted in the evening after shop closing hours	Pedestrian streets during the day, but cyclists can use the streets as a short cut through the city centre in the evening, night and morning

Fig. 36. *In Lund, different materials indicate transport mode-specific spaces (left). This causes minor conflicts every now and then. In Odense (right), cycling is allowed during the shops' closing time from 9 pm to 9 am.*

Bicycle parking near the shopping district

In the centre, there should be both short- and long-term bicycle parking available. Short-term parking is in demand right on the fringes or within the pedestrian area. It is important that the bicycle parking areas are located sufficiently close to the pedestrian area and that they are easy and quick to use. Even when cycling is prohibited in the pedestrian centre, cyclist expect to be able to park their bikes close to the shops. According to an estimate, cyclists prefer to walk within a 100–150 metre range from their parked bicycle. Any further than that, and they will take the bike with them. Therefore, it is important to have guarded and unguarded bicycle parking facilities available at sufficiently frequent intervals. [48]

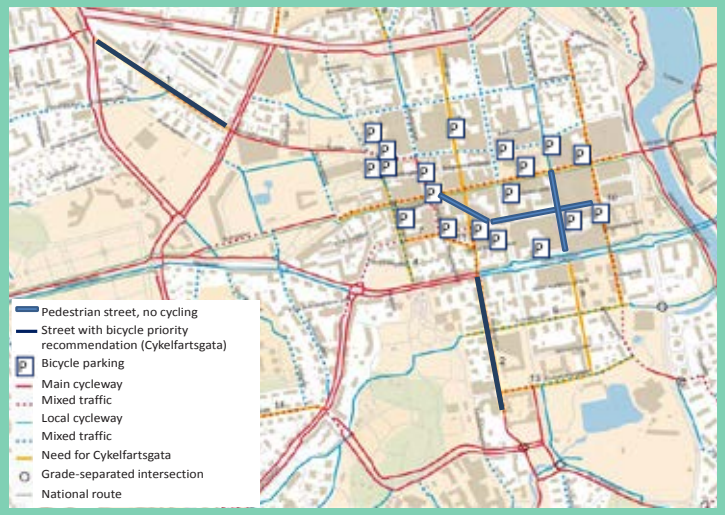


Fig. 18. *Linköping has prohibited cycling in the pedestrian centre. However, there are bicycle parking facilities available in the immediate surroundings.* [49, *edited*].

Fig. 37. *Guarded parking in the vicinity of the Delft pedestrian area, free of charge.*

Paid bicycle parking

Bicycle thefts are a problem in the Netherlands, so guarded bicycle parking is needed. In principle, even the guarded parking facilities should be free of charge, but this is not always possible due to costs. As a cycling city, Delft offers both paid and free of charge guarded parking options. Paid parking is available on the fringes of the pedestrian centre, by the railway station and in connection with the car parking facilities. Paid parking is usually available from dawn to dusk. In Southpoort, for example, the guarded paid bicycle parking in connection with the car parking facility is managed by the long-term unemployed. This way, the service also provides social benefits to the society.

The other paid alternative in the city are the boxed bicycle containers (Tromos), built by the municipality but operated by a private company. The boxed containers are located in the residential areas, and cyclists can purchase, for example, a monthly pass to use them.

Fig. 38. (*Delft also has paid and guarded parking facilities for bicycles (right). The boxed bicycle containers in Delft have been located in residential areas to make up for the lack of bicycle parking facilities in the old residential buildings (left).*

Principles of bicycle traffic

The bicycle is an excellent mode of transport in a city centre without vehicular traffic. Fast and quiet, it does not pollute or need much space. When planned the right way, bicycle traffic does not create problems in a pedestrian centre. Instead, it can support the centre's business activities as one of the main transport modes to the centre. Planning principles for a functioning bicycle traffic:

1. **The centre must be accessible by bicycle (well-functioning infrastructure and network)**
2. **When arranged properly, functional bicycle traffic is also possible in pedestrian areas (cyclists as guests)**
3. **There must be bicycle parking in the city core (short- and long-term)**

Functioning public transport in the city centre

Accessibility and unobstructed passage are of the highest priority

Public transport to the central shopping district must be able to reach the centre quickly and with ease. Good accessibility and a comfortable journey are beneficial for passengers and business life in the centre. A sufficient interval of good-quality stops combined with sufficient line frequency and good connections increase the competitiveness of public transport and encourages travellers to use it when coming to the centre.

The volume of public transport in the city core determines whether the public transport street acts as a barrier to the pedestrian area or not. Therefore, it must be decided whether the emphasis should be on accessibility or comfort, or if some kind of compromise is possible.

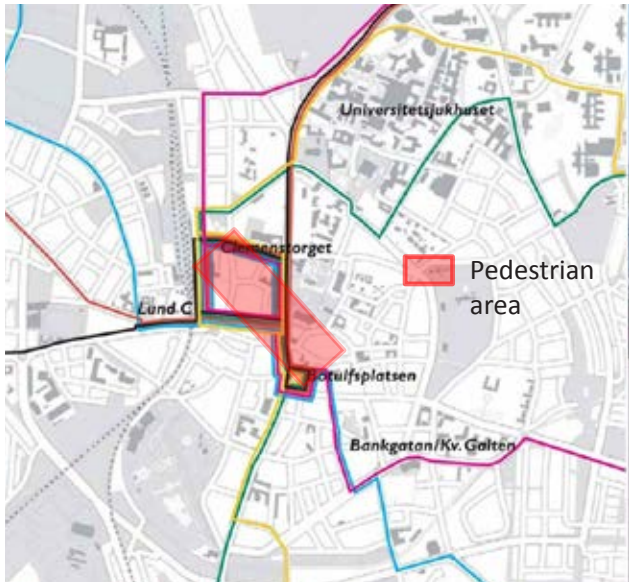


Fig. 39. *In Lund, public transport bus services provide good access to the pedestrian area.* [50]

Fig. 40. *Public transport street crossing located between two pedestrian areas in Lund (above). The same high-quality pavement outside the pedestrian area creates an image of extension to the area. Sheffield's Leopold Street, for public transport (below), is of the shared space type, with no barrier effect to pedestrians.*

Balancing between barrier effects

Planning a pedestrian centre requires balancing between comfort and efficient and accessible public transport. In Linköping, a public transport street divides the pedestrian area in the city centre. At the moment, the street is of great significance to the city's public transport but, on the other hand, the buses create a strong barrier effect for pedestrians. Therefore, the street will be pedestrianised and the buses will be moved further south to another parallel street.

The decision will create a more unified pedestrian area. However, it will also have an effect on the city centre's accessibility as the bus traffic will move away from the immediate city core. The arrangement means that the walking distance from the pedestrian area to public transportation increases. However, the pedestrian centre will be more coherent and comfortable.

Public transport can be used to achieve a compromise between comfort and longer walking distances

Fig. 41. *The bus street dominating the pedestrian area in Linköping will be pedestrianised. Above: before, below: after.* [13]

Free transport link between the shopping districts

Sheffield has several shopping districts at different locations, linked with each other through pedestrian-oriented streets. Even so, Sheffield wanted to increase the level of service in order to support business life. To this end, a free of charge FreeBee bus line between the shopping districts was established in 2007. Beside the shopping districts, the line also connects other popular city centre sites, like the university and Winter Gardens. The buses run every seven minutes from 7 am to 7 pm. The success of the first year of free service surpassed all expectations. Instead of the estimated 350,000 passengers, more than 400,000 passengers used the service. And out of them, more than 80% were very happy with the level of service. [51] [52]

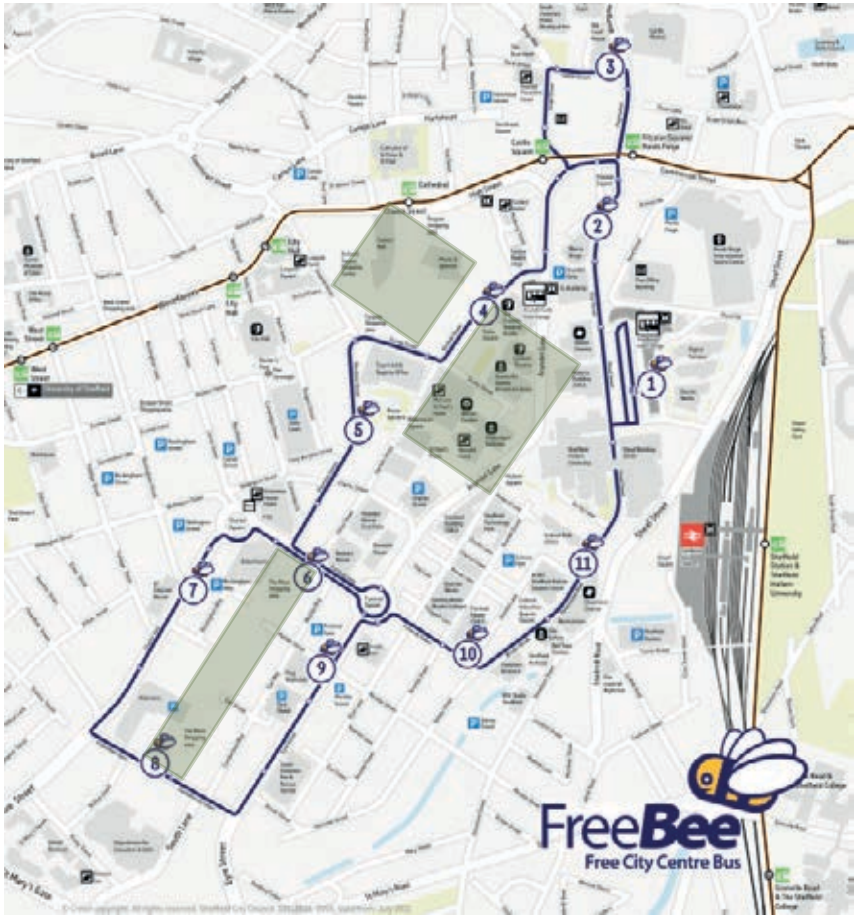


Fig. 42. *The free bus service in Sheffield links several shopping areas together, promoting the city centre's attractiveness and accessibility.* [53]

Vehicular traffic in the city centre

Smoothly along the ring road, to the city centre only on demand

Organising vehicular traffic around the pedestrian area calls for bold decisions. To build a pedestrian-oriented city centre, vehicular traffic must be restricted to certain areas. To have a functional pedestrian area, vehicular traffic circulating the city core must be calmed with slow streets and car-free zones. The important thing, however, is to create a functional parking ring route encircling the area and a high-speed ring road outside the city to take the bypass traffic away from the city and the centre. Furthermore, motoring in the city centre should be decreased by making the other modes of transport more competitive and ensuring good-quality travel chains. Delivery traffic to the pedestrian area should also be taken into account.

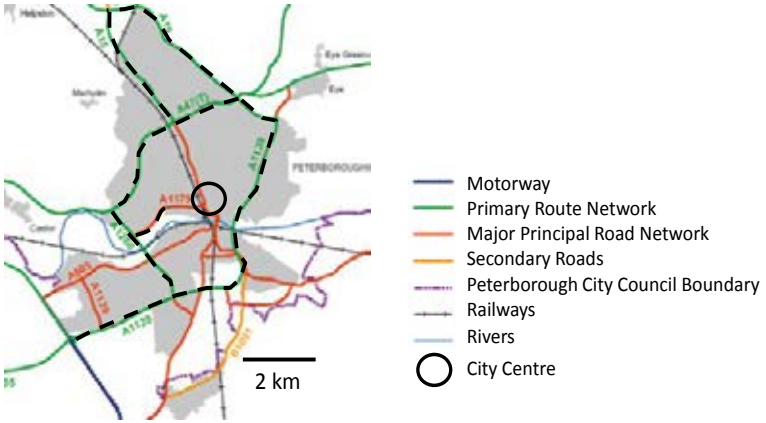


Fig. 43. *In Peterborough, the fast bypass around the city centre reduces and calms traffic through the centre.* [25]

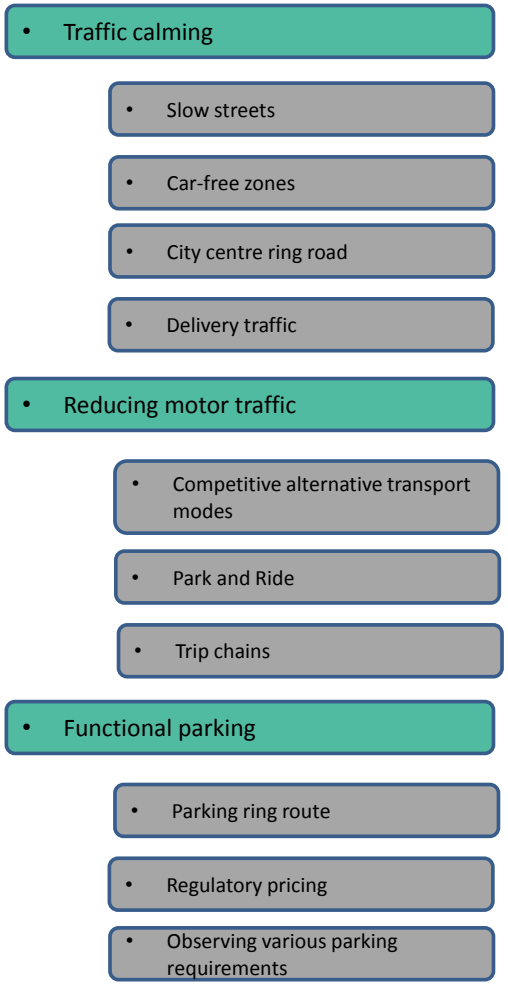
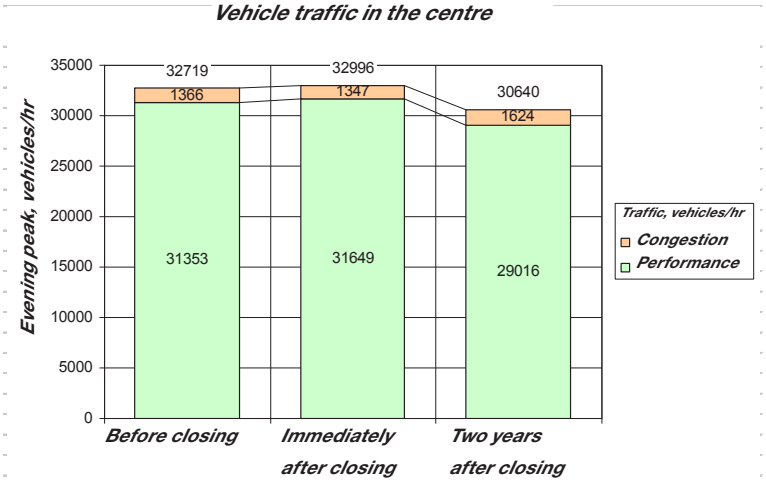


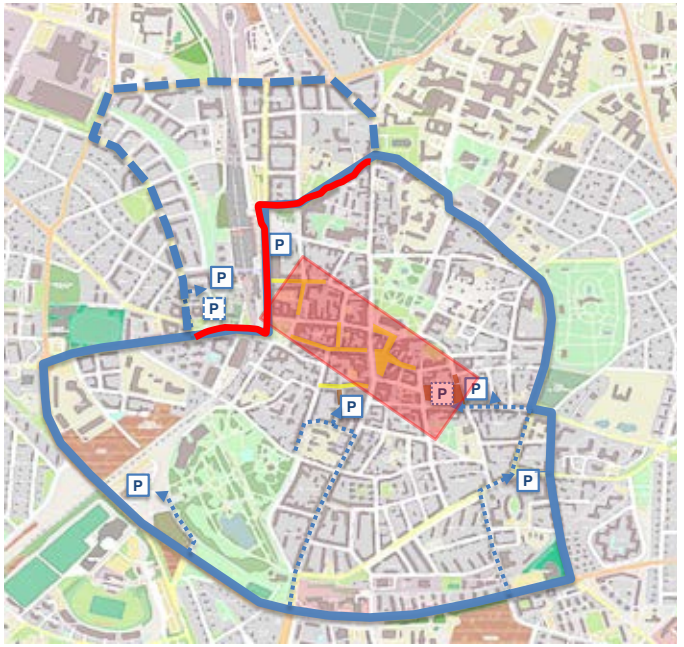
Fig. 44. *Organisation of vehicular traffic in the centre.*

Parking ring route location and traffic relocation

The location of the parking ring route around the city core must be decided with care. Due to the substantial traffic flow, the ring should be not be too close to the pedestrian area. At the same time, it should be close enough to allow fluent parking.

At the moment, the Lund city centre parking ring route runs from the station foreground to the fringes of the central shopping district. The traffic flow is too great for a street located between the pedestrian area and railway station. Therefore, the street will be converted into a public transport street. Changing the ring road will direct traffic elsewhere, and this must be compensated for through structural changes, by readjusting the traffic light control and by building noise barriers in residential areas. Closing the street running along the railway station forecourt to car traffic will increase traffic flow on the surrounding transport network, but the overall traffic flow in the area may also decrease. Relocating the ring road to a more suitable location improves connections to the railway station and removes the pedestrian barrier effect. In addition, car traffic will flow more quickly and smoothly, and the parking ring route will be more efficient and functionally improved. [1]





Source: © OpenStreetMap contributors

Fig. 45. *In Switzerland, a street through Zurich city centre with a peak hour traffic flow of approximately 960 vehicles an hour in 2004 was closed. The street was converted into a public transport street allowing cycling. Two years later, the traffic flow in the area had decreased by 8%.* [54]

Fig. 46. *In Lund, the parking ring route is relocated to better serve the city centre.*. ***Blue dash line: new parking ring route location , red line old location.***

Competitive transport modes

Passenger car traffic in the city centre can be reduced by offering competitive alternatives and travel chains for commuter traffic, for instance. In Lund, the pride of the public transport system is the efficient bus line Lundalänken, covering almost half of the workplaces in Lund. The route, consisting of 6 kilometres of separated bus streets, serves approximately 6,000 passengers each day. Most of the commuters arrive by train to the Lund railway station and take the Lundalänken to their respective workplaces. Commuter passengers use the same travel pass on the train and the bus, making for a smooth travel chain. There are plans to build a tramway line on the route. [55] [1]

Park and Ride offers an alternative for the private motorist visiting a city centre. In Sheffield, it is possible to combine private motoring and public transport in several locations outside the city centre. The majority of the safe parking facilities are free and have CCTV and service personnel. The users park for free and only pay for the bus or tram fare to the centre. Public transport intervals on the Park and Ride stops is approximately 10 minutes. With the service, it is possible to avoid parking fees in the city centre, congestion and the time required to park. [56]

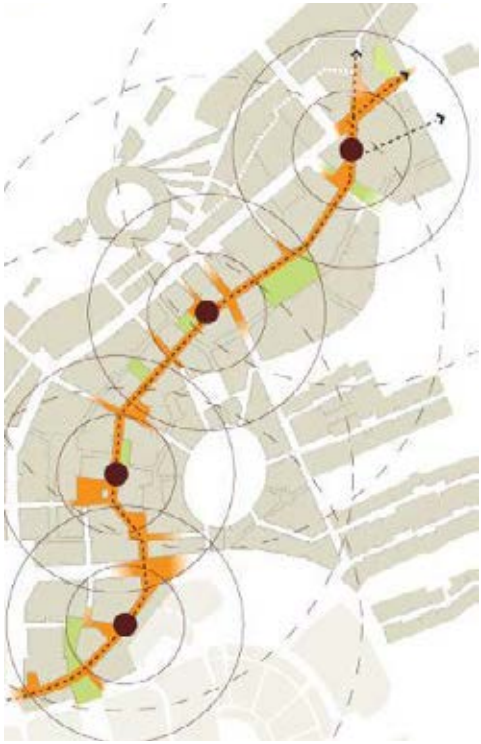


Fig. 47. *Lundalänken provides a commuting service to and from the employment areas outside the centre by train or bus.* [57]

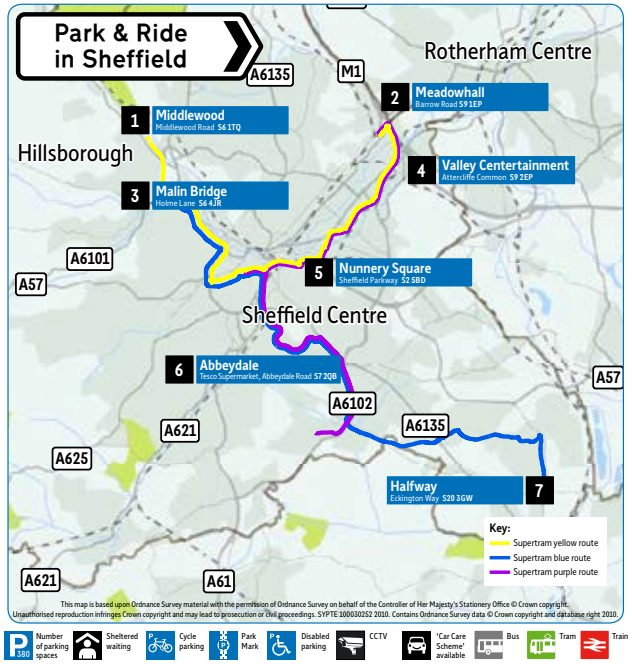


Fig. 48. *The Park and Ride service in Sheffield reduces private motoring in the centre by providing commuters with a smooth public transport link from the fringes of the city centre.* [56]

Delivery of goods into and out of pedestrian centres

Although motor vehicular traffic in the pedestrian area should be prohibited, delivery vehicles must have access to the area. Actions to combine smooth delivery traffic and comfort in the city centre include the following: [58]

- time windows
- low emission zones
- vehicle-specific restrictions
- load factor control
- measures related to unloading and parking
- cooperation between enterprises.

In the Netherlands, the city of Utrecht created an environmental zone in 2007. Only vehicles with engines and emissions that meet the requirements are allowed to enter the area [58]. In Sweden, the city centre of Lund is also an environmental zone. The zone imposes restrictions on vehicles entering the zone based on the weight (over 3.5 tonnes), age and emissions of the vehicles [59].

Furthermore, in Utrecht there is a consolidation centre in the city centre, combining freight for different operators into one delivery vehicle. A consolidation centre decreases the amount of unladen delivery traffic in the city centre [60].

Access to Delft's pedestrian centre is restricted using automatic bollards. For distribution and feeder services and other specialist traffic, there is an intercom system installed at the entrances to the pedestrian area to have the bollards retracted. Emergency and delivery vehicles have transmitters that retract the bollards automatically on approach. Rules within the pedestrian area: [16]

- maximum driving speed restricted to foot pace
- passenger pick up and drop off at the entrance points
- goods are loaded at the entrance points
- a special permit allows driving into the area for 30 minutes except on Friday nights from 6 pm to 9 pm and on Saturdays from 11 am to 5 pm.
- it is prohibited to drive a vehicle into the pedestrian centre when events are taking place.

In Lund, vehicle owners are permitted to drive in the pedestrian centre provided they are residents of the pedestrian street and have a designated parking bay within the pedestrian area. Without a personal parking bay, you are not allowed to drive in the centre, even to pick up or drop off something. [1]

Fig. 49. *Left: Automatic bollards recognise buses and passenger and delivery cars with an appropriate permit. Middle: An electric Cargohopper delivery vehicle is used in the city core* [61]. *Right: In Groningen, delivery traffic access to the pedestrian centre has been restricted by time limits.*

Car parking arrangements

Accessibility is essential for a city centre

It is important that the city centre is also accessible by car. A proper parking policy can be used to minimise the amount of cars cruising for a parking space, to avoid long-term parking in areas where it would reduce private business traffic, and to optimise the usage of the parking capacity to the fullest. When planning parking, it is important to consider the target group. Residents, visitors and employers all require specific parking solutions. Comfortable and interesting pedestrian routes make the walk seem shorter than it actually is, even from a parking facility a little further away; which makes these facilities more attractive. The quality of the parking facility in terms of the service level is also significant. Parking restrictions are often seen to have a negative impact on the business life in the city centre. However, a proper parking policy will make the centre more accessible.

Decrease in parking bays required			
	Low	Medium	High
Alternating unilateral parking	10%	20%	30%
Parking restrictions	10%	20%	30%
Implementation of flexible standards based on scientific data	10%	20%	30%
Maximum standards	10%	20%	30%
Improving the pedestrian and cycling capacity	10%	20%	30%
Increasing the existing parking capasity	5%	10%	15%
Paid parking	10%	20%	30%
Bicycle parking improvements	5%	10%	15%
Improved information and marketing	5%	10%	15%

Fig. 50. *Through parking management, it is possible to reduce the need for parking by up to 30%.* [62] [63]

Parking arrangements in the case cities

Residents

- Paid on-street parking/1 bay per household (limited availability)
- Paid parking bay in a parking facility
- Not necessarily next to the dwelling

Employers

- Businesses have scarcely any parking bays in the city centre
- On-street parking time limits do not allow parking for the duration of the workday: employer parking in parking facilities
- Encouragement to enter the city centre using alternative transport mode

Visitors

- Short-term on-street parking
- Long-term parking in parking facilities
- Efficient parking ring route facilitating fast parking

Fig. 51. *Different ways to meet parking requirements in the centre.*

Time limits and alternating unilateral parking

Most of the few on-street parking bays available in Lund city centre are paid bays with a 15- or 30-minute time limit. This solution allows goods and people to be collected from the vicinity of the pedestrian centre but prevents long-term parking. Long-term parking is available at the city-owned parking facilities. Disabled parking is also limited to three hours at a time in Lund city centre. Residential disabled parking issues are reviewed case-specifically. [1]

Car parking in Lund city centre is mainly reserved for residents and visitors. Most of the bays are in facilities, which are also recommended for the employers' cars. After all, the majority of the on-street bays are unsuitable for long-term employer parking, due to the time limits.

Parking is more efficient when the same bay serves multiple users, user groups or functions. If all users were offered dedicated parking bays, the need for general parking would increase. [62] In Linköping, for example, there are no designated paid on-street parking bays in the residential areas. Instead, residents must look for a bay within radius of a few blocks from their home. Any resident wanting a designated parking bay must rent one from a parking facility a little further away. [2] In Lund, the resident parking bays that are free in the night time are available for visitors during the day once the residents move their cars. [1]

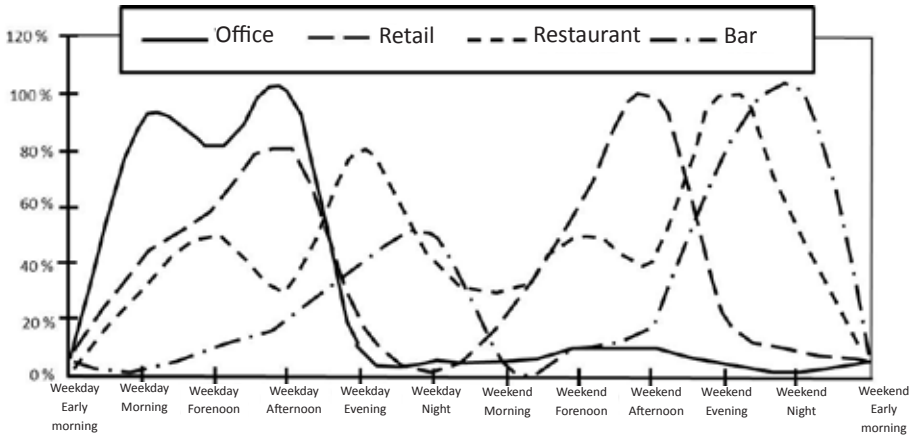


Fig. 52. *Alternating unilateral parking can be used to reduce the need for parking by some 10–30%, compared to a situation where all residents and employers have designated bays. [62] [63]. The figure describes the variation of daily parking by functions.*

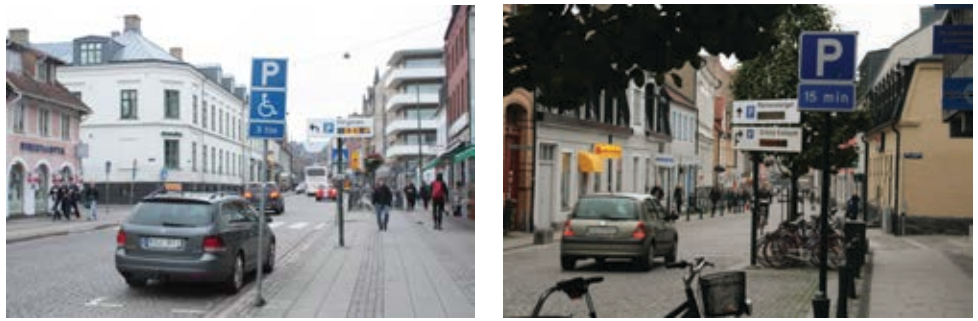


Fig. 53. *Disabled parking and short-term on-street parking in Lund*

Parking plays a key role in traffic calming

The role of parking is significant in calming traffic in the city centre or creating car-free zones. Car-free zone must also be reachable by car. Properly located parking facilities can improve the accessibility of the city centre within the car-free zone.

In the planning and implementing of Delft's pedestrian centre, parking was considered the second most important factor in calming the traffic after the introduction of the pedestrian area. The priority applied was as follows:

1. **Building of the car-free zone.**
2. **Building of the parking facilities.**
3. **Expanding the car-free zone area.**
4. **Improving the pedestrian and cycling environment at each stage.**

Without proper parking arrangements, the existing parking facilities in the pedestrian centre surroundings are congested, the number of cars cruising for free parking bays increases, and accessibility and comfort in the city centre suffers. In conjunction with the Delft centre redevelopment, three new parking facilities with more than 1,400 bays between them were built on the fringes of the central shopping district to improve accessibility and to reduce unnecessary cruising for parking spaces. [4] [5]

Fig. 54. *In Delft, the new parking facilities are located on the fringes of the shopping district.* [18]

Parking guidance

The feeder streets from the busy parking ring route guide the traffic directly to the parking facility without interrupting the city centre traffic. Message signs by the ring indicate the nearest free parking bays, and unambiguous road signs guide the motorists directly to the parking facility. It is important that the information about free parking bays is available at a sufficient distance on the ring road to allow the drivers to plan their route. For more efficient parking, a message sign indicating the location of the free parking bay inside the parking facility can be installed at the entrance to the facility. The estimated walking time from the facilities to the centre is also indicated. [2]

Fig. 55. *The signs by the Delft parking ring route indicate free parking bays in the facilities in the area.*

Fig. 56. *Delft parking facilities have signs indicating the walking time to the centre.*

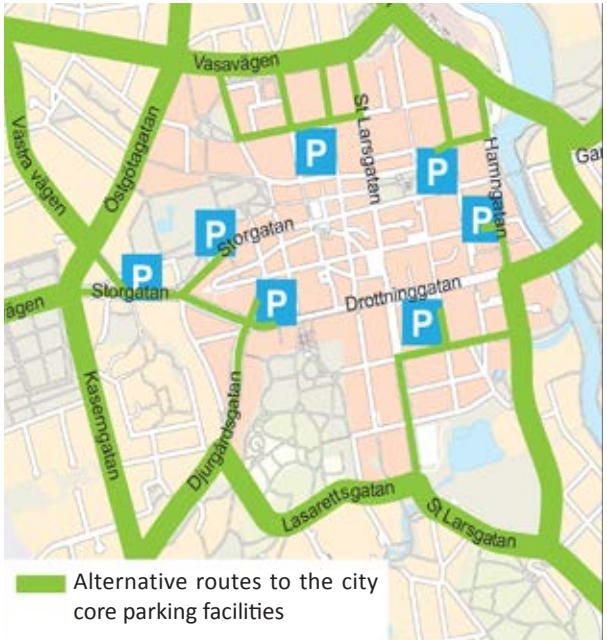


Fig. 57. *In Linköping, the parking facility of choice must be selected while on the ring. You cannot drive from one facility to another through the centre, only via the ring. This calms the parking traffic in the centre area.* [13]

Parking pricing

Free or affordable parking does not promote vitality in the centre. Instead, it increases the volumes of motoring and long-term parking and discourages the use of alternative modes of transport. Affordable fees and lack of time limits decrease parking bay turnover and makes it harder to find a bay. Parking bay pricing and time limits can be used to control motoring in the centre and to decrease long-term on-street parking. In order to direct the long-term parking to the car parks, the prices in the city- and, if possible, private-owned parking facilities should be made more affordable than the on-street parking fees. This will calm the vehicular traffic in the city centre streets. [63] [64]

	Parking facility	On-street
Linköping	€1.35/hr (SEK 12) from 8 am to 10 pm €0.10/hr (SEK 1) from 10 pm to 8 am	€4.5/hr (SEK 40)
	€9/24 hrs (SEK 80)	
	€90–95/month (SEK 800–850)	Residents: €56/year (SEK 500) Eco car: €56/year (SEK 500) Employer parking permit: €560/year (SEK 5,000)
Lund	€1.1–1.4/hr (SEK 10–12)	€1.8/hr (SEK 16) (city core) €1.1/hr (SEK 10) (areas surrounding the city centre)
		Residents €1.7/24 hrs (SEK 15) outside the city core Residents €35/month (SEK 300–315) outside the city core Employer parking permit SEK 5,000
Delft	€2.20–2.30/hr	€2.80/hr (max. 1 hr)
	€7–14/24 hrs €70/week	
	€175/month €1,575/year	Residents €132/car/year €51.60/3 hrs (guests)

Fig. 58. *Affordable pricing is used to encourage motorists to use the parking facilities instead of the more expensive and time limited short-term on-street parking bays.* [2] [65] [66] [67] [68] [69] [70] [71]

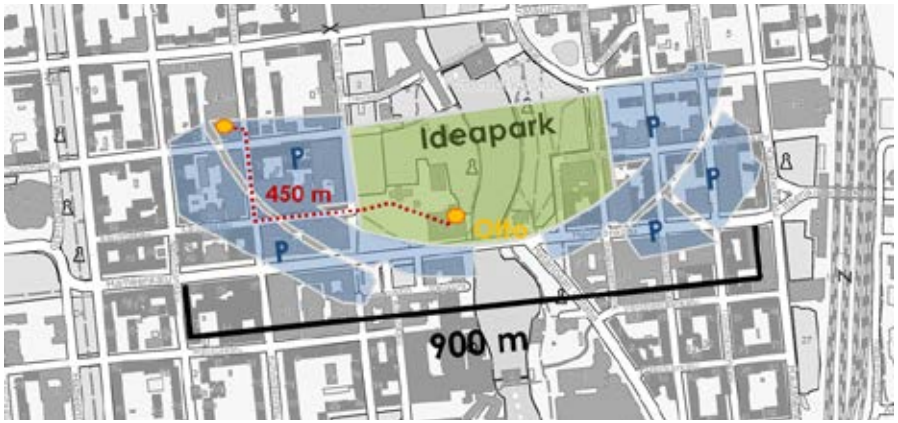
Parking pricing can either give strength or weaken the vitality of the centre

Stimuli to increase willingness to walk

The most popular parking facilities are often those located in the city core. However, the perception of distance from the parking facility to the destination also depends on the pleasantness of the route. If the route is pleasant and interesting, people are more willing to walk further than they would on a shorter but uncomfortable route.

In Lund, the utilisation rate of the parking facility located right on the fringe of the city core is lower than that of the other facilities located almost the same distance from the shopping street. Therefore, the city has decided to improve the pleasantness of the route from the facility to the centre with new plantings, street-level stores and a better pedestrian environment. The city believes that this will increase the utilisation rate significantly. [1]

By design, shopping centres are often more pleasant and interesting than city centres. An interesting environment takes one's mind off how far one is walking. The distance from a shopping centre parking lot to a specific store is often further than would be considered acceptable in a city centre.



The figure contains material from the Topographic database provided by the National Land Survey of Finland, 10/2013.

Fig. 59. *By locating the Lempäälä-based Ideapark shopping centre on top of the Tampere city core, it becomes clear that people walk a distance equal to half the length of Hämeenkatu from Ideapark's parking areas to the shopping centre without giving it a second thought.*

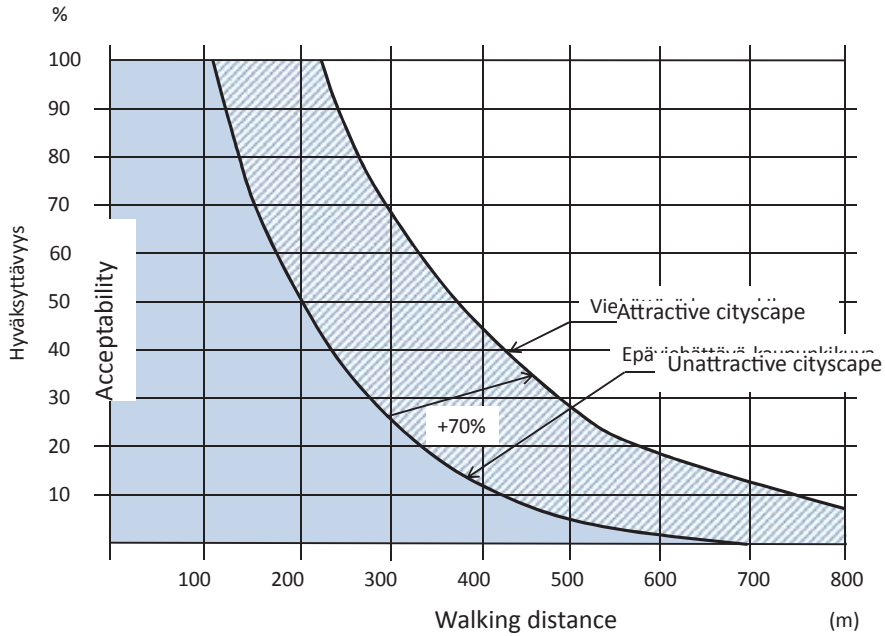


Fig. 60. *In a comfortable and interesting environment, people are ready to walk over 70 per cent further* [72, edited].

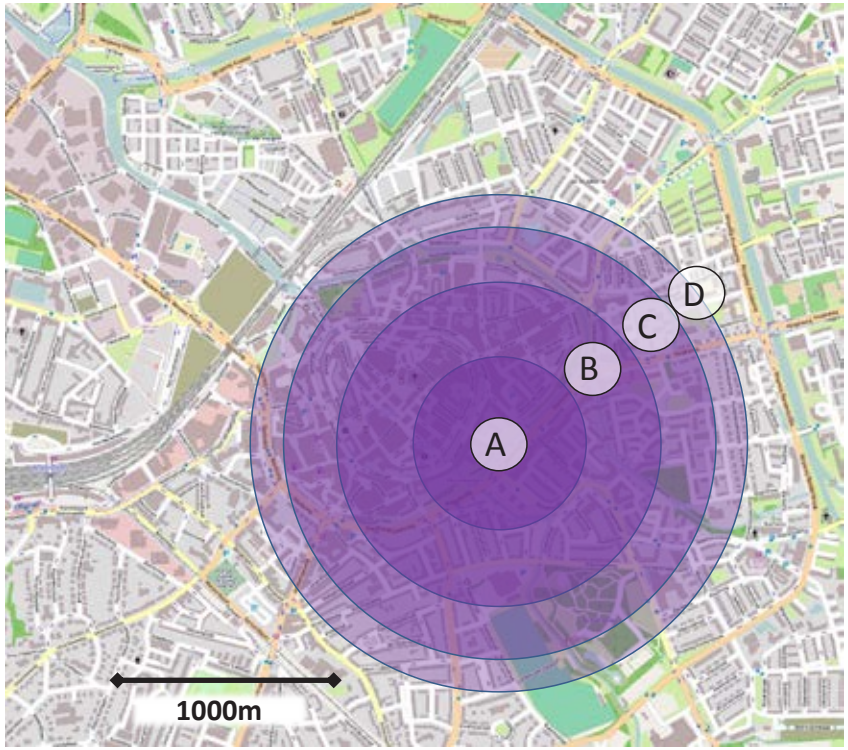
Prioritizing and balancing the transport modes

An exemplary transport system around the city centre

An exemplary city centre transport system ensures smooth, comfortable and safe mobility in the centre, be it in a car-free zone or amid public transport and cars. Car-free zones create a safe common space in the centre, providing smooth and unobstructed passage to the shopping district, for example. However, car-free zones are not necessary everywhere. Walking and comfort in the centre can also be promoted in other ways. Fast links, smooth parking, good-quality pedestrian crossings on busy streets and traffic calming in the city centre can be used to create a centre where each transport mode has its proper place.

By restricting car traffic on certain areas and on the other hand prioritizing it on other routes creates smoothness and comfort.

A: Pedestrian area
B: Core area, 30-zone
C: Public transport area
D: Parking ring route



Source: © OpenStreetMap contributors

Fig. 61. *An exemplary city transport system consists of a pedestrian-oriented city core with restricted vehicular traffic, surrounded by a low-speed zone, a public transport-oriented zone designed to ensure access to the centre, and a parking ring route with feeder routes on the fringes of the centre.*

A: Viable pedestrian area, Linköping

C: Pedestrian crossing over public transport street, Sheffield

D: Pedestrian crossing over ring road, Sheffield

B Restricted traffic street, Peterborough

B Efficient parking information, Delft

B Fast bicycle street, Delft

Top 10 solutions for the case cities

1. Creation of continuous routes or areas for pedestrians
2. Pedestrian environment can be improved by taking small actions
3. Accessibility to the city centre through a public transport street
4. Cycling should be promoted in the pedestrian centre with pedestrians in mind
5. Functional car parking ring route
6. Pricing and time limits to direct parking into the desired facilities
7. Instead of banning vehicular traffic, make the other transport modes more fluent
8. Visionary plans for the centre attract investors
9. City organisation restructuring from individual efforts to teamwork
10. Mediocre plans will provide mediocre results: courage in decision-making!

Sources

[1] Rydén, C., Trafikplaneringschef. Lund Municipality, Sweden. Interview, 3 October 2012.

[2] Nilsson, C., Senior city planner, Transport Planning and Policy Officer. Linköping Municipality, Sweden. Interview, 4 October 2012.

[3] Hahn, P.-E., Cycling planner, Gång-, cykel- och mopedsamordnare. Linköping Municipality, Sweden. Interview, 4 October 2012.

[4] Punt, J., Adviseur Verkeer en Vervoer. Gemeente Delft, the Netherlands. Interview, 16 November 2012.

[5] van Oers, M. Senior Adviseur Verkeer en Vervoer. Gemeente Delft, the Netherlands. Interview, 16 November 2012.

[6] Bekkering, H., Professor., Chair of Urban Design. University of Delft, the Netherlands. Interview, 15 November 2012.

[7] Speed, M., Transport and infrastructure planning manager. Peterborough City Council, United Kingdom. Interview, 15 May 2013.

[8] Sullivan, P., Transport Planner. Sheffield City Council, United Kingdom. Interview, 16 May 2013.

[9a] Wahl, C., 2005. Trafiken i Lund – från Genombrottet till LundaMaTs. Lunds Tekniska Gögskola, Institutionen för Teknik och Samhälle, Avdelning Trafikplanen. Thesis 128.

[9b] Lundcity.se, 2013. Parkera i Lund. Available at http://www.lundcity.se/parkera/

[10] LundaMaTs II, 2009. Background and results. Available at http://www.lund.se/Global/F%C3%B6rvaltningar/Tekniska%20f%C3%B6rvaltningen/Gatu-och%20trafikkontoret/LundaMats/Rapporter/LundaMaTs%20II_rapport%202008_ENGELSKA.pdf

[11] Linköping Municipality, 2011. Värdens bästa Linköping. Strategisk plan med övergripande mål för 2011–2014. Available at http://www.linkoping.se/Global/Om%20kommunen/Gemensamt/Planer%20och%20program/PoP%C3%96vergripande/Strategisk%20plan%20med%20%C3%B6vergripande%20m%C3%A5l%20.pdf

[12] Samverkan Norrköping Linköping, 2010. Gemensam översiktsplan för Linköping och Norrköping. Available at http://www.trafikverket.se/PageFiles/46484/Arbetsplan_vag23-34_Rimforsa-Skeda_udde_GOP_Linkoping-Norrkoping.pdf

[13] Nilsson, C., 2012, Linköping Municipality. Linköping – where ideas come to life. The region, the city and the city centre. PowerPoint slides.

[14] Linköping Municipality, 2011. Workshop Twincity. Linköping and Norrköping. Available at http://www.urban-impulse.eu/Urban_imPulse/Publicity_files/Workshopresults%20Linkoping%20May11-13%202011.pdf

[15] Linköping Municipality, 2010. Innerstaden växer över ån. Översiktsplan för Kallerstad (Stång) och nytt resecentrum. Available at http://weblisher.textalk.se/linkoping/10op_kallerstad/

{16] Hall, K. & Fagnand, A., 2011. Pedestrian Zones and Restricted Access Areas in the Historic Centre. Available at http://wiki.coe.neu.edu/groups/nl2011transpo/wiki/a6d23/5__Pedestrian_Zones_and_Restricted_Access_Areas_in_the_Historic_Center.html

[17] Spek, S., Improving city centres for pedestrians. Making the Historic City Centre of Delft car-free. Delft University of Technology. Available at http://www.walk21.com/papers/403_van%20der%20Spek_Improving%20City%20Centres%20for%20Pedestrians.pdf

[18] Nowalski, O. & Meissner, R., 2011. Policy for Shopping Centers. Available at http://wiki.coe.neu.edu/groups/nl2011transpo/wiki/a07dc/7_Policy_for_Shopping_Centers.html

[19] Spoorzone Delft, 2013. English summary. Available at http://www.spoorzonedelft.nl/Algemeen/English/

[20] Spoorzone Delft, 2013. Financiering. Available at http://www.spoorzonedelft.nl/Over_het_project/Bekostiging/

[21] Gemeente Delft, 2010. Delft in 2020: duurzaam bereikbaar. Available at http://raad.delft.nl/commissies/cultuur_kennis/2005/Bijlagenota/c_2005_028_bn.html

[22] Winkler, A., 2007. Sheffield City Report, Centre for Analysis of Social Exclusion, Case report 45. Available at http://eprints.lse.ac.uk/5133/1/CASEreport45.pdf

[23] Sheffield City Council, 2004. Sheffield city centre, Sheffield today. Available at http://sccplugins.sheffield.gov.uk/urban_design/pdf/part_2.2.pdf

[24] Sheffield First, 2010. The Sheffield City Strategy 2010–2020, Where People Shape the Future. Available at https://www.sheffieldfirst.com/key-documents/city-strategy.html

[25] Peterborough City Council, 2011. Long Term Transport Strategy (2011–2026) & Local Transport Plan 3 (2011–2016). Available at http://www.ltp3.org.uk/Peterborough_LTTS_&_LTP3_Final.pdf

[26] Peterborough City Council, 2008. Peterborough Public Realm Strategy. Available at http://www.peterborough.gov.uk/pdf/CouncilAndDemocracy-PublicRealm-PublicRealmStrategyMay2008.pdf

[27] Travel Choice, 2013. Peterborough. Available at http://travelchoice.org.uk/

[28] Social data/Sustrans, 2009. Peterborough – Sustainable Travel Demonstration Town. Travel behaviour research. Available at http://www.peterborough.gov.uk/pdf/tc-reports-finalevalreport-1-15.pdf

[29] Lund Municipality, 2013. LundaMaTs – hållbara resor och transporter. Available at http://www.lund.se/Medborgare/Trafik--infrastruktur/LundaMats---hallbara-transporter/

[30] Lund, 2009. LundaMaTs II. Background and results. Available at http://www.lund.se/Global/F%C3%B6rvaltningar/Tekniska%20f%C3%B6rvaltningen/Gatu-och%20trafikkontoret/LundaMats/Rapporter/LundaMaTs%20II_rapport%202008_ENGELSKA.pdf

[31] English Heritage, 2010. Valuing Places: Good Practices in Conservation Areas. Reinforcing Character – Public Realm. Removal of a visually intrusive office block has unlocked a major new public space. Available at http://www.english-heritage.org.uk/publications/valuing-places/valuing-places-good-practice-conservation-areas.pdf

[32] Peterborough City Council, Policy areas. Available at http://www.peterborough.gov.uk/pdf/env-plan-cc-policyareas.pdf

[33] Sheffield City Council, 2008. Sheffield City Centre Master Plan 2008.

34] Genecon, 2010. Research & Evaluation of Public Realm Schemes (utilising YF investment in Sheffield as a case study). Available at http://www.integreatplus.com/sites/default/files/genecon_public_realm_evaluation_sheffield.pdf

[35] Ogden, S., Sheffield´s City Centre Regeneration. Cabe seminar. Available at http://www.sed.man.ac.uk/research/events/seminars/urbandesign/SimonOgden.pdf

[36] Sheffield-fm. Views of the new Peace Gardens. Available at http://www.sheffield-fm.co.uk/sheffield_peace_gardens.htm

[37] Sheffield City Council, 2004. The City Centre. Sheffield One. Available at http://sccplugins.sheffield.gov.uk/urban_design/sheffield_one.htm

[38] Groenlinks.nl, 2011. Autoluw bevalt Delft. Available at http://delft.groenlinks.nl/node/38907

[39] Peterborough City Council, 2013. Cowgate Enhancement Scheme. Available at http://www.peterborough.gov.uk/council_and_democracy/public_realm_works/cowgate_enhancement.aspx

[40] Sheffield One. Sheffield City Centre Public Realm. The Gold Route. The journey from Sheffield Station to the Heart of the City.

[41] City of Umeå, Marie Frostvinge – traffic planning manager Interview, 12 December 2012.

[42] City of Umeå, Torbjörn Sandberg – person in charge of maintenance. Interview, 12 December 2012.

[43] City of Oulu, Kai Mäenpää – head of maintenance. Interview, 20 February 2013.

[44] City of Oulu, Minna Komulainen – maintenance supervisor. Interview, 20 February 2013.

[45] City of Copenhagen, Kim Sørensen – person in charge of maintenance. Interview, 14/12/2012.

[46] City of Linköping, Lise-Lotte Johansson – person in charge of maintenance. Interview, 5 December 2012.

[47] Gemeente Delft, Pauwmolen. Bovengronds (verkeer en vervoer). Available at http://www.ruimtelijkeplannen.nl/documents/NL.IMRO.0503.BP0008-1006/t_NL.IMRO.0503.BP0008-1006_7.1.html

[48] Celis, P. & Bolling-Ladegaart, E., 2008. Bicycle parking manual. Copenhagen, Denmark. The Danish Cyclist Federation.

[49] Linköping Municipality, Cykelkarta. Available at http://www.linkoping.se/Global/Bygga%20och%20bo/Planer%20och%20byggprojekt/%C3%96versiktsplaner/Cykelplan/Cykelplan_del_3_kartor_2_6_samt_beslut1.pdf

[50] Lund Municipality, Möjligheter i Lunds stadskärna. Available at http://www.lund.se/Global/F%C3%B6rvaltningar/Kommunkontoret/utvecklingen%20av%20centrum/Mojligheter-i-Lund-Stad-webb-2.pdf

[51] Travel South Yorkshire. FreeBee buses. Available at http://www.travelsouthyorkshire.com/freebee/

[52] Bus and Coach.com, 2013. Sheffield FreeBee exceeds forecast. Available at http://www.busandcoach.com/newspage.aspx?id=2164&categoryid=0

[53] FreeBee Route map. Sheffield. Available at http://www.google.fi/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CEoQjBAwAQ&url=http%3A%2F%2Fwww.travelsouthyorkshire.com%2Ffreebeesheffieldroutemap.pdf%2F&ei=fu-NUueIOYjWswaS_oH4Cg&usg=AFQjCNHK6aL7pBebT8w7HMxQodJGD83j3Q&bvm=bv.56987063,d.Yms

[54] Stadt Zürich, 2007. Die Sperre im mittleren Limmatquai für den durchgehenden Verkehr. Auswirkungen auf den Verkehrsablauf in der Innenstadt unmittelbar nachher, Auswirkungen auf den Verkehrsablauf in der Innenstadt 2 Jahre nachher, Überweisung des Stadtrates an den Gemeinderat der Stadt Zürich. GR Nr. 2007/225.

[55] Svanfelt, D., 2008. En verklig tillämpning. Spår på Lundalänken 2014. Trivector Traffic AB. Available at http://www.lightrail.se/FODRAL_material/081205_SparvagPaLundalanken_Daniel.pdf

[56] Travel South Yorkshire. Save time, money and hassle with Park & Ride. Available at http://www.travelsouthyorkshire.com/sheffieldparkandrideleaflet.pdf/

[57] Rydén, C., 2011. Transportstrategi för Lund NE / Brunnshög. Lund Municipality. Available at http://mmoresund.nu/wp-content/uploads/2011/10/Christian-Ryd%C3%A9n-Transportstrategi-Lund-NE-Brunnsh%C3%B6g.pdf

58] Quak, H., 2008. Sustainability of Urban Freight Transport: Retail Distribution and Local Regulations in Cities. Doctoral thesis. Rotterdam, Erasmus University Rotterdam, Erasmus Research Institute of Management, 242 pages.

[59] Pronet. Low Emission Zones (Miljözon) in Sweden (S). Traffic Restrictions. Available at http://www.umwelt.nrw.de/umwelt/pdf/pronet/factsheets/20.pdf

[60] Kiiskinen, E., Kallionpää, E., Metsäpuri, P. & Rantala, J., 2013. Methods to develop urban logistics. Tampere University of Technology. Transport Research Centre Verne. Research Report 87. Tampere, 2013.

[61] Cargohopper. Stadsdistributie. Zero emissie voor binnensteden. Available at http://www.cargohopper.nl/

[62] Litman, T., 2006. Parking Management Best Practices. American Planning Association, 2006. p. 292.

[63] Karhula, K., Tiikkaja, H., Palonen, T. & Kalenoja, H., 2013. City centre parking as a part of the traffic system. The development of parking conditions in Tampere city centre. Research Report 86. Tampere University of Technology. Transport Research Centre Verne. Tampere, 2013.

[64] COST, 2005. Parking policies and the effects on economy and mobility. Report on COST Action 342. Technical Committee on Transport. August, 2005.

[65] Lund, 2012. Parkeringstillstånd för yrkesfolk. Available at http://www.lund.se/Medborgare/Trafik--infrastruktur/Trafik-och-gator/Parkering/Nyttoparkering/

[66] Lund, Parkeringstaxa i Lunds centrum. Available at http://www.lund.se/Global/F%C3%B6rvaltningar/Tekniska%20f%C3%B6rvaltningen/Gatu-och%20trafikkontoret/Trafikvaktk%C3%A5ren/Kartor/Taxa-karta_2.pdf

[67] Lund, 2013. Boendeparkering. Available at http://www.lund.se/Medborgare/Trafik--infrastruktur/Trafik-och-gator/Parkering/Boendeparkering/

[68] Linköping, 2013. Nyttoparkeringstillstånd. Available at http://www.linkoping.se/nyttoparkering

[69] Linköping Municipality, Tillgänglighet till parkeringsanläggningar. City presentation slides.

[70] Delft, 2013. Parking in Delft. Available at http://www.delft.nl/delften/Tourists/Practical/Access_and_parking/Parking_in_Delft

[71] Centrumparkeren, 2013. Parkeren Delft. Available at http://www.centrumparkeren.nl/delft

[72] Knoflacher, H., 1994 (Finnish translation Kalanti & Rytilä). “Kaupungin ja liikenteen harmonia”. Zur Harmonie von Stadt und Verkehr. Freiheit vom Zwang zum Autofahren. Helsinki, 1994.

[73] CABE, 2011. Sheaf Square and Howard Street – Sheffield. Available at http://webarchive.nationalarchives.gov.uk/20110118095356/http:/www.cabe.org.uk/case-studies/sheaf-square-howard-street?photos=true&viewing=9050

3

Tuuli Rantala

Development of pedestrian areas and its influence on business

Literature review: previous studies

Relationship between walking and business

Our cities have changed. Traditional industry and factories have become scarce in cities, and consumer society is booming. Vibrant city centres live on retail trade and consumerism. Businesses and investments are drawn to the city centre, and various events, public transport and other such factors bring consumers to the centre. The city centre is at the heart of an operation that is based on the economy.

Pedestrian streets and areas are becoming ever more common around the world. The reason for this is not purely to do with infrastructure. Cities are engaged in what is called place-making. It is no longer enough for cities and city centres to fulfil their functional requirements. The city core is perceived as a “product” to be sold to residents, businesses, investors and tourists. Those cities that manage to turn themselves into a product and create an attractive image will win the contest over investment and tax money available to the municipalities. The competition for residents, businesses and taxpayers is on.

Walking and business have gone hand-in-hand from the beginning of time. In modern urban planning this positive relationship was recognised, at the latest, with the building of the first modern shopping centres in the United States in the 1950s. The shopping centre environment was designed to combine the maximum flow of customers, a versatile and abundant mix of businesses as well as pleasant shopping conditions.

The same applies to pedestrian areas. Instead of the number of vehicles, the focus is turned on the “density of wallets” with respect to which pedestrian streets compare well. Nevertheless, all ideas about converting a typical main street built in the 1950s, 60s or 70s into a pedestrian street is likely to be objected to in any given city or country. Usually those opposed to it are the entrepreneurs in the area in question, worrying that they will lose their customers who drive with the arrival of a pedestrian street. This is one of the reasons why the relationship between walking and commerce is studied. The aim is to find out whether these fears are justified.

In general, studies tend to concentrate on gathering information about the impacts of the actions based on predicting the economic and market-related reactions. However, the research activity available is quite scarce, as most studies are conducted privately and the influences are fairly difficult to study. Studying the economic impacts of the actions is challenging because it is difficult to definitively isolate the impact of a single action from the overall economic development, for example.

Thus, it is advisable to consider the study results as indicative information that does not reveal the value of any single action. On the other hand, the existing studies on the impacts of pedestrian environment improvement actions on the vitality of an area show quite consistently that the investments made benefit the consumers significantly. In addition to the economic impacts, improving the pedestrian environment brings forth proven benefits through improvements in the environmental and health conditions.

Room for shopping

In San Francisco, the car lanes on Valencia Street were made narrower and pavements wider in order to calm the traffic. After these actions, 40% of the shopkeepers reported an increase in their turnover. 60% noticed that the residents shopped more locally due to the short walking distance and convenience. Two-thirds of the shopkeepers stated that the pedestrian environment improvements had a positive impact on their business and sales.

[1]

Figures 1 (above) and 2 (below). *These photographs of two street views are taken from a Sheffield street corner. The picture below is of a street where on-street parking bays have been converted into pedestrian use and where the environment encourages drivers to decrease their speed, even though the street still is two-way. Shoppers can cross the street wherever they choose to.*

Pedestrians and cyclists are a significant customer group

According to an Auckland University of Technology study on the Takapuna shopping precinct [2], 65.8% of customers came to the area by car. Regardless of the transport mode, the customers spend approximately 20 NZD dollars on average per visit. However, pedestrian and cyclist customers visited the area twice as regularly as customers who arrived by car. Pedestrian and cyclist shoppers visited the area to shop 12 times a month, the motorists only six times. The sample for the study was 325 customers. Therefore, even though they only made up about one-third of the customers, the pedestrians and cyclists bring more money to the area than the motorists who form two-thirds of the customer base.

In Copenhagen [3], 32% of the turnover of the shops and supermarkets comes from motoring customers, another 32% from cyclists, 23% from pedestrians and 13% from public transport users. Cyclist spend less per visit, but they are more frequent shoppers. This is likely to be true of the pedestrians as well. 68% of shopping trips in Copenhagen are made by cycling or walking, 20% by car and 12% by public transport.

Walking, interaction and creativity

In a study by the Collaborative Economics consulting company, the kinds of built environments modern knowledge-intensive and service-oriented businesses prefer to settle in were surveyed. These kinds of businesses were found to cluster in the city core areas where the environment supports street-level stores and walking. The areas also had a mix of restaurants, offices and residential quarters. These factors were found to create interactivity that is of key importance in the new economy emphasising accessibility, networking and creativity.

[4]

Figure 3. *Some twenty years ago, Sheffield was one of the poorest cities in the UK. The city wanted to promote new businesses, growth and tax revenue in the city centre by investing in the urban environment.*

Impacts of improving public facilities and the pedestrian environment

Pedestrian flow is an indicator that depicts the attractiveness and quality of the pedestrian environment of an area or a street. The information is particularly valuable in cases where the pedestrian flow is studied even before implementing the improving actions.

- International studies indicate fairly incontestably that improving the pedestrian environment increases the pedestrian flow. In this respect, the pedestrian routes obey the same law of supply and demand as all other modes of transport: supply increases demand. However, pedestrian flow analysis is highly case-specific, and the increase in flows varies greatly between cities and times of applicability. According to international case studies, the increase can vary from approximately 30% in the first years to up to 70% later on (Aachen).

Footfall evaluation provides more accurate information on the amount of business conducted.

- International studies have shown that on average, footfall increases by approximately 20–40% following improvements to the pedestrian and urban environment. In addition to the increase in the number of visitors from further afield, local residents have been found to shop more locally.

Spending power is a term used in economics to describe the spending behaviour of individual consumers. When studying pedestrians and business, spending power usually refers to the amount of money the customers using various modes of transport spend in a certain area per month, for example. In other words, the aim is to determine the “value” of different customers to the shopping area. Some studies have also looked at the tax revenues collected from businesses in a certain area for any changes.

- Based on the studies, it can be concluded that although the monetary value of single purchases in the studies varies between different modes of transport, pedestrians and cyclist seem to have more spending power due to their more frequent visits. Pedestrians shop more often and also spend more time in the city, even if the value of their single purchase is less than that of the motorists.

Pedestrians attract businesses

In the Californian City of Lodi, with 60,000 inhabitants, the pedestrian environment in five city centre streets was improved through a combined public-private investment of 4.5 million US dollars (about 3.5 million euros). The improvement work included the widening and paving of pavements, the restoration of building frontages and the planting of 140 trees on the roadsides. After the improvements, 60 new businesses moved to the centre, the share of vacant rental properties dropped from 18% to 6% and the tax revenues from the centre's sales proceeds increased 30%.

[5]

The UK government recognises the spending power of pedestrians

In the United Kingdom, the Local Sustainable Transport Fund tool, established in 2011, acknowledges the promotion of walking and cycling for shopping trips as a means to improve economic growth and decrease carbon dioxide emissions. According to the studies, improving the street environment on shopping streets increases turnover in the area by 5–15%. The studies also show that the spending power of pedestrians, cyclist and public transport users is equal, if not greater, than that of the motorists.

[6]

Rent level is an indicator often used in the studies. It is known to be a reliable way to determine the attractiveness of an area. Provided that there is no surplus of rented spaces, the more demand there is for rented spaces in a certain area, the higher the asking prices for rent. Improving the pedestrian environment can raise rents through increasing the attractiveness of the area for business. The level of rent, or the change in value of an area, is the single most studied key figure in business studies.

- Studies show that improved pedestrian environment often lead to an increase in the attractiveness of the area and, subsequently, to an increase in the rent level. Based on the case study mean value, rents rose on average 20% (average range 10–30%). Office rents have seen above average increases.
- However, rising rents can prove to be too costly for businesses that are not able to compensate for the extra cost through increased pedestrian/customer flow. This is one reason why pedestrian streets' economic structure tends to change as time goes by. In addition, fear of rising rents is likely to raise objections to pedestrianisation.

Figure 4. *Although many studies show that rent levels go up following improvements to the pedestrian environment and attractiveness of an area, it does not have to be a fatal blow to local specialised trade. The pedestrian centre of Lund, Sweden, contains a colourful mix of local shops, and the rise in rent levels is not considered a problem.*

A pedestrian-friendly environment is attractive

According to a comprehensive literature survey into European and US before-and-after studies conducted by the universities of Oxford and Cambridge, pedestrianising a street had the following effect on retail trade:

- Footfall up 20–40% (10 cases in total).
- Turnover up 10–25% (22 cases in total).
- Commercial property rents up 10–30% (420 cases).

With regard to the office sector, the survey covered five studies on the influence of improvements in the walking environment on office rent levels. The environments studied were made more pleasant by including water elements into the street environment and by improving the walking environment alongside the waterways. The survey concluded that the above-mentioned actions had the following effect:

- Office rents rose 15–35% (10 cases). [7]

The utilisation rate of the properties also reveals the level of attractiveness of an area. From the utilisation rate, it is also possible to evaluate how well the business facility supply and price level corresponds with the demand.

- The utilisation rate of the properties and the amount of the increase are highly case-specific, but the changes can be significant. The case studies in the literature survey showed that the utilisation rate rose to at least 80% following the improvements.

Customer and entrepreneur satisfaction studies reveal more about just what the customers want from their shopping environment and, on the other hand, what factors are important to the entrepreneurs.

- Entrepreneur surveys often emphasise the importance of the customer parking facilities, but customers feel that the quality of the urban environment is important with respect to the area's attractiveness, and tend to favour pedestrian-friendly shopping environments. According to the studies, proprietors overestimate the importance of motor traffic with respect to other modes of transport.

The connection between the **value of an area** and the urban environment has been studied in various ways. The studies typically try to establish explanatory causal connections between the value of an area (usually in the form of value of the homes) and city structure.

- A pleasant and pedestrian-friendly urban environment is one factor explaining the value of an area. According to some studies, a wide range of functions within walking distance and good parks nearby increase property values.

Investments in the area reflect the potential, expectations and general attractiveness that the area in question holds in the eyes of various operators looking for profitable investment targets. Investments are important for development, but follow-up research information is scarce. According to some studies, public development investments have attracted additional private funding, too.

It is impossible to separate the impact of walking on the economy from other circumstantial factors, like global and local economic trends. However, the studies do show that there is a positive connection between a pedestrian-friendly environment and a boost in economic life, and that the impact can be significant.

Investments attract investments

Despite its central location, one of Dublin's oldest areas, the 30-hectare Temple Bar, was a "backwater" at the beginning of the 1980s. Properties had fallen into decay, the old industrial buildings were empty and the area had a questionable reputation as a place exclusively for young people, artists and nightlife. Therefore, there were plans to raze the Temple Bar area to the ground and rebuild it into a terminal for bus and railway traffic.

However, the city saw value in the alternative culture that had sprung up in the area and decided otherwise. There was a desire to protect the Temple Bar area from development driven by property value increases, which often leads to ruin for local small-scale entrepreneurs. Local entrepreneurs and organisations founded a development council and used it to lobby actively for the idea of a cultural quarter.

Founded in 1991, the government-owned temporary development company TBPL (Temple Bar Property Ltd.) with 20 employees was responsible for implementing the development plan. The TBPL, for example, bought some of the city centre properties before the centre renewal projects in order to ensure that there would be a mix of versatile activities and both large and small businesses. Rent incomes were used to develop the properties and support cultural projects.

In total, the Temple Bar cultural development project received public funding in excess of 40 million Irish pounds (about 51 million euro). In addition, approximately 60 million pounds (about 76 million euro) of loaned funding has been paid back. Furthermore, from 1991 to 2001, public investments and development in the area attracted approximately 100 million pounds (about 127 million euro) of private investment money into the area.

The impacts of the development actions were as follows (1991–1996):

- Number of restaurants: +50% (40 in total)
- Number of retail traders: +100% (200 in total)
- Number of hotels: +50% (5 in total)
- Number of inhabitants: +300% (2,000 in total) [8]

Figure: Copyright Irish Architectural Archive

Figure: Copyright Chris Whippet

International studies

Author and year	Target country	Nature of the study	Results
Hass-Klau, 1993 [9]	Germany	A case study on the number of users visiting the street after pedestrianisation. Figure in brackets indicates the number of years after which the comparative study was made.	Pedestrian flows: Aachen +25% (+ 12 y. after building), Bamberg +28–40% (+ 1 y.) Darmstadt +18% (+3 y.), Nuremberg +69% (+ 5 y.) Hertford +31% (+1 y.), Hertford +40% (+4 y.) Osnabrück +26% (+2 y.)
Sandahl & Lindh, 1995 [10]	Sweden	A before-and-after study (1990–1992). Impacts of actions aimed to increase comfort in a city centre, carried out in five Swedish cities. No actions took place in the sixth city used as a reference.	Retail trade turnover +5–9% Rent level increase potential +SEK 84/m2 (avg) Attractiveness of the area +13% (avg) Changes in the reference city: approximately 0%.
Santasalo & Heusala, 2002 [11]	Finland	Specialised trade industry survey on the economic value of various places of business.	Rent per square metre on the pedestrian streets and shopping centres +15% and +40% respectively in comparison to the median rent. Sales per square metre on the pedestrian street approximately +23% and in the shopping centres +15% in comparison to the median sales.
Drennen, E., 2003 [1]	United States of America	A before-and-after study. Actions: making the car lanes narrower and the pavements wider on Valencia Street.	40% of entrepreneurs reported an increase in turnover 60% of entrepreneurs reported an increase in local shopping by residents 66% of entrepreneurs reported that improving the pedestrian and cycling environment increased business and sales
Ryan, B., 2003 [12]	United States of America	A before-and-after study. Action: 4.5 million US dollar investments to improve the pedestrian environment on five main streets in the city of Lodi.	The utilisation rate of the properties increased from 82% to 94%. Sixty new companies moved into the city centre The city centre tax revenues increased by +30%
TSU & David Simmonds Consultancy, 2003 [7]	Several	Literature survey of studies investigating the effects of improved pedestrian conditions on the retail trade.	Footfalls +20–40%, avg 32.3% (sample 10) Turnover +10–25%, avg 17% (sample 22) Retail trade rent level +10–30%, avg 21.7% (sample 420) Office space rent level +15–35%, avg 24.3% (sample 10)
Wright & Montezuma, 2004 [13]	Colombia	A before-and-after study. Action: changing Zona Rosa into a pedestrian street	Property value +22% (cf. other streets +6%)
Cabe Space, 2005 [14]	United Kingdom	A comparative case study of home values near high quality parks compared to similar homes in the same market area but with no park nearby (10 cases from around the United Kingdom). Material used: independent estate agent estimations and expert interviews with city developers.	Homes located near high quality parks were on average 5–7% more valuable than corresponding homes beyond the sphere of the park. Significant dispersion in material, difference in home value up to approximately +34%.




Author and year	Target country	Nature of the study	Results
Kumar & Ross, 2006 [15]	Thailand	A questionnaire survey. Impact of the part-time pedestrian street (closed for traffic from 5 pm to 3 am and all day Monday) on companies on Khao San Road in Bangkok.	44% of respondents reported that the pedestrian street increased their turnover, 30% of respondents did not notice any change.
Whitehead, Simmonds & Preston, 2006 [16]	United Kingdom	A modelling of impacts of city environment development on business in the Manchester city core, including comparison to impacts caused by other actions.	Literature survey: Retail trade rent level +21.7% Rent level of other business facilities +24.2% (range 10–30%) Modelling: Retail trade turnover +10–25% (avg 17.5%) Footfall +32% (Impacts are of the same magnitude as the estimated benefits achieved by developing public transport)
Cortright, 2009 [17]	United States of America	A study of the connection between the quality of the pedestrian conditions and home values (study material: 95,000 housing transactions) using the Walk Score algorithm. Algorithm value 0 indicates a car-dependent area where amenities are not within walking distance from the target, and value 100 indicates an area where there are versatile amenities within short distance.	One point more in a Walk Score value meant a 700–3,000 dollar increase in the value of the homes.
Genecon, 2010 [18]	United Kingdom	Time series analysis. Evaluation of the effects of the urban environment and pedestrian improvements in Sheffield city centre. Total investments approximately 72 million pounds.	Number of hotel rooms +120% (2000–2010) Footfall in the centre +9% (2004–2009) Office prime rents +30% (2000–2010) Café/restaurant rent level +40–100% (1995–2010) Shopping trips to the city centre +35% (2000–2010) Recreational trips to the city centre +45% (2000–2010)
Rush et al., 2010 [19]	United States of America	A before-and-after study. Action: renewing the infamous West Palm Beach city centre.	The utilisation rate of the properties increased from 20% to 80%. The property price per square metre (value) increased from $64 to $430.
Wooller, L., 2010 [2]	Australia	A questionnaire survey of spending power in the Takapuna shopping precinct. Sample: 325 individuals visiting the precinct.	Average purchase regardless of transport mode: NZD 20 per visit Pedestrian/cyclist visiting frequency approximately 12 times/month Motorist visiting frequency 6 times/month
Yiu, 2010 [20]	Hong Kong	Impact of the pedestrianisation on the retail trade rents compared to the rent trend on the reference street.	Retail trade rent level 17
Transport for London, 2011 [21]	United Kingdom	A shopping survey conducted in Central London and town centres (15 pcs), total sample 4,746 visitors (about 300/centre).	Average spend per visit by mode of transport: car £41, train/tube £38, bus £32, walk £26 and cycle £21. Average spend per week by mode of transport: walk £93, bus £70, train/tube £59, car £56 and cycle £47.

Results from the study made in Finland

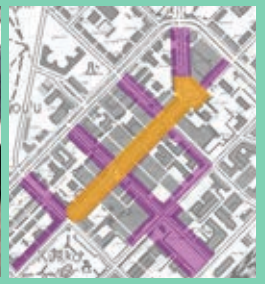
Information required on conditions in Finland

There is relatively little information available on the impacts of pedestrian areas on business in Finland, but there are some studies on changes in the pedestrian centre's business structure [11] [22]. Much like around the world, there is a debate in Finnish municipalities going on for and against pedestrian areas. In some cases, the public and media discussions can be quite colourful. In order to add surveyed information to the opinion-based discussion, a need to determine the views of the entrepreneurs on the development and the impact of city centre projects has been expressed.

For this purpose, a questionnaire study was conducted among street-level store operators in the following five Finnish cities: Jyväskylä, Kokkola, Oulu, Pori and Tampere. Of these, Jyväskylä, Oulu and Pori have had pedestrian main streets for a long time now, and they have been deemed successful. In Tampere, the pedestrian street is located beside the city core, the core being particularly busy with public transport. Representing a more recent conversion, Kokkola's main street was pedestrianised a few years ago. The selection of cities in the study include those with both established and new pedestrian streets of various structural composition. Therefore, the survey reveals similarities and differences between the two groups.

Although only conducted in the cities involved, the results of the survey can well be applied to other municipalities. The purpose of the survey was to chart the entrepreneur's estimations, hopes, fears and suggestions with regard to city core development. The results can also be applied and utilised in discussions with entrepreneurs in other municipalities, as many of the findings were similar regardless of the municipality.

Jyväskylä (pop. 134,500)



Sample: 144 street-level stores, response rate 29% (41 responses)

Kokkola (pop. 47,000)

Image: Katri Humppi

Sample: 91 street-level stores, response rate 34% (31 responses)

Oulu (pop. 140,000)

Sample: 121 street-level stores, response rate 22% (27 responses)

Pori (pop. 84,000)

Sample: 156 street-level stores, response rate 32% (50 responses)

Tampere (pop. 219,000)

Sample: 200 street-level stores, response rate 33% (65 responses)

The maps indicate the location of the street-level businesses surveyed. Pedestrian streets are marked in yellow.

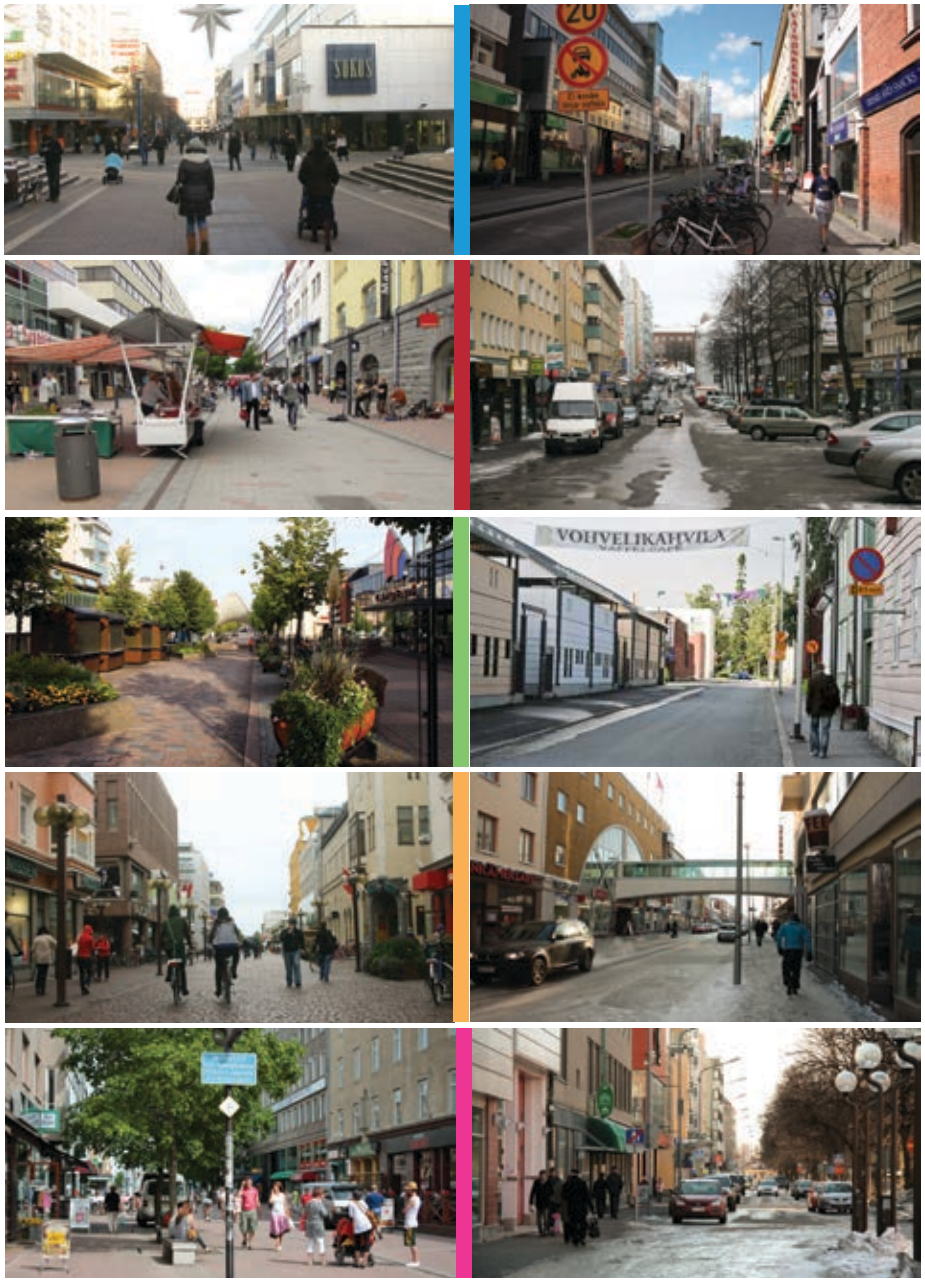
Implementation of the study

The study method used was a questionnaire survey answerable by mail or on the Internet. The selected sample area included the pedestrian street and one or two blocks next to it. Tampere was an exception to this, for its major pedestrian street is not the city's main street. Tampere is also an exception with regard to the fact that the survey was conducted there in May 2013 instead of November 2012.

The questionnaire was delivered personally in all street-level shops open for business. In total, it was delivered to 712 street-level shops, 213 of which returned it (response rate 30%). In Jyväskylä, Kokkola, Pori and Tampere the entrepreneurs were also informed of the survey through the city centre association.

The questions put forth were:

- Level of satisfaction with the business' street environment.
- Factors valued by the entrepreneur in the current location.
- Business challenges related to the urban environment.
- Willingness to relocate.
- Estimation of customers by transport mode.
- Estimation of the impact of the pedestrian street location on the turnover.
- Importance of various development actions.
- Entrepreneur's personal view of what an attractive city core should be like.
- Level of satisfaction on one's own possibilities to influence on the city core development (added into the Tampere questionnaire form).

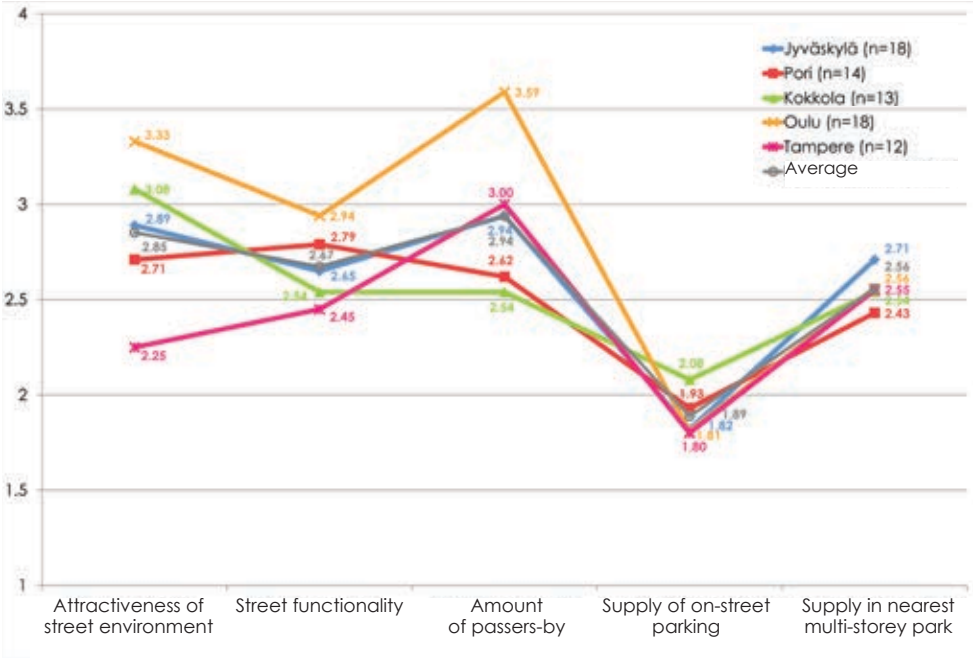


The amount of dissatisfaction a constant?

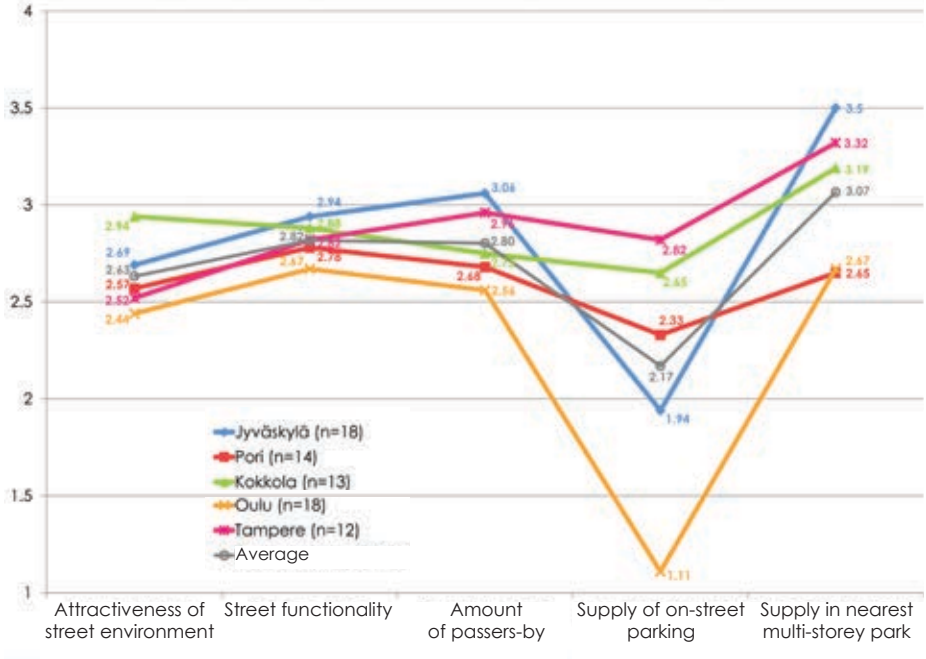
Even though additional research and analysis would be needed before drawing any definite conclusions, it would seem that there are certain similarities between the case cities regarding satisfaction. Respondents on a pedestrian street are somewhat less satisfied with on-street parking than other respondents, which is surely rather understandable on a street dedicated to walking. Parking facilities get a neutral grade from pedestrian street respondents; on average the respondents are neither satisfied nor dissatisfied. As for the respondents on a motor vehicle street, they are neither satisfied nor dissatisfied with attractiveness of the street environment. Satisfaction with street functionality would as well seem to be constant between the case cities.

When it comes to the other qualities, there is more divergence. Satisfaction with the attractiveness of a pedestrian street and with the amount of people passing by varies a little bit. Satisfaction with on-street parking varies considerably on a motor vehicle street. In the light of the results, one might assume that on-street car parking has been restricted in Jyväskylä and especially in Oulu. The only motor vehicle street respondents on average satisfied with on-street car parking are from Tampere and Kokkola. There are differences between motor vehicle street respondents also regarding satisfaction with multi-storey car parks.

Pedestrian street



Motor vehicle street



Grades:
4 = Very satisfied
3 = Somewhat satisfied
2 = Somewhat dissatisfied
1 = Very dissatisfied

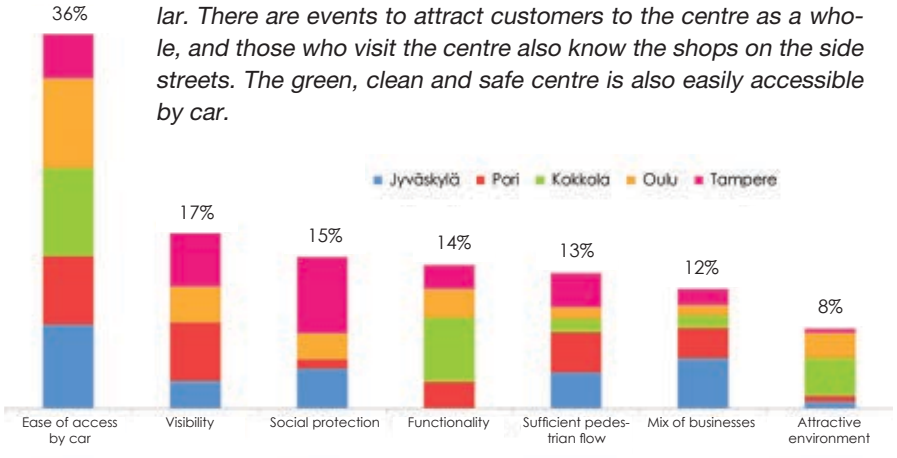
Entrepreneur's dream centre

The challenges faced by the entrepreneurs were similar in all cities. Recurring themes were ease of access by motor vehicles, store visibility, social protection, functionality of the street, lack of pedestrians and non-optimal mix of businesses. Ease of access by car and parking received less attention in Tampere. Instead, the local businesses emphasised social protection as a challenge for them. Functionality of the street was emphasised as a challenge on Kokkola's pedestrian street in particular.

To increase ease of access by motor vehicle, more affordable or free parking facilities and extra parking bays were on the wish list, and preferably as close to the store as possible. On the other hand, when asked to describe an ideal business centre, the top three attributes were ease of movement and good pedestrian environment, attractiveness and cleanliness. A pleasant and attractive centre was a particular favourite among motor vehicle street respondents, particularly in Pori. A versatile mix of businesses came up in responses related to Kokkola's pedestrian street in particular. In Tampere, protection was emphasised.

Setting small inconsistencies aside, it is possible to come up with a fairly uniform idea of what an entrepreneurs' dream centre would entail.

From the entrepreneurs' point of view, a perfect centre is attractive, easy to move in and around, and it is pedestrian friendly, with a versatile mix of businesses and plenty of small shops in particular. There are events to attract customers to the centre as a whole, and those who visit the centre also know the shops on the side streets. The green, clean and safe centre is also easily accessible by car.



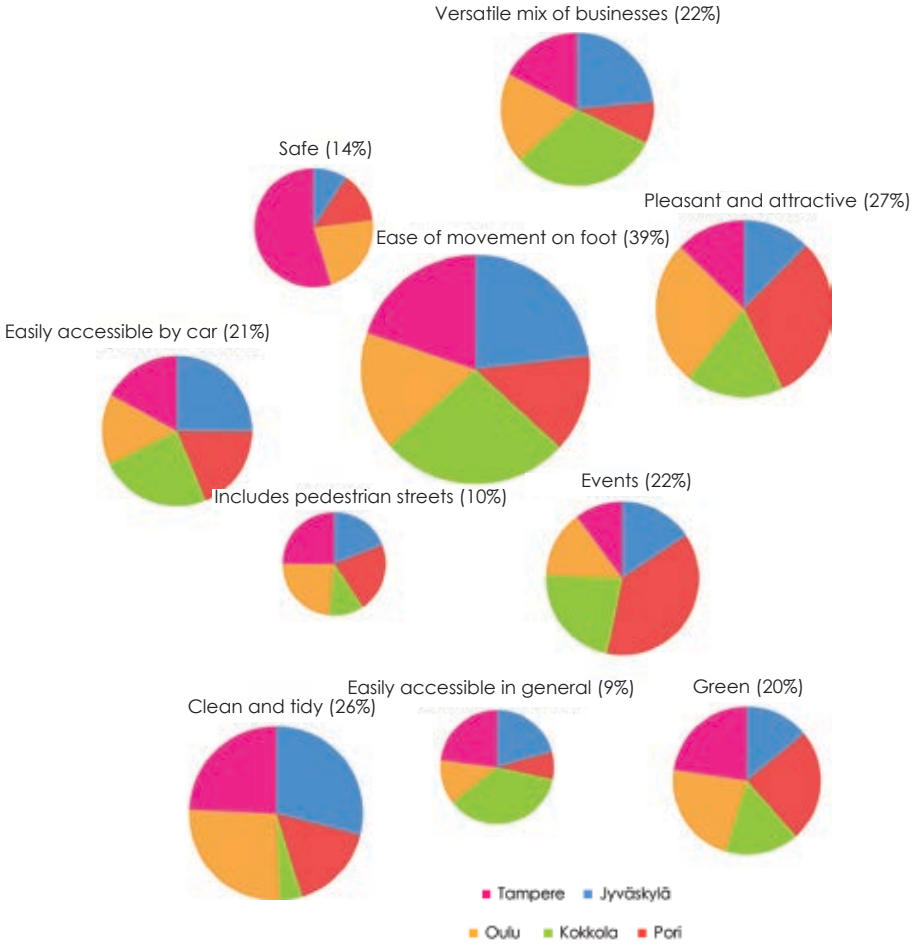


Figure 5. *Challenges related to location and urban environment. The graph indicates the number of answers related to each issue (n = 129). The city-specific sections indicate the proportional volume by cities (in proportion to the number of answers from each city).*

Figure 6. *An ideal centre from an entrepreneurial point of view. The figure in brackets indicates the share in terms of the total number of answers (n = 148). The city-specific sections indicate the proportional volume by cities (in proportion to the number of answers from each city).*

Visibility was valued in pedestrian streets, transport connections on non-pedestrianised streets

The most valued factors for entrepreneurs were reputation and visibility of the area, easy access by car, good business facilities and substantial pedestrian flow. Proportionally, pedestrianised street entrepreneurs value the reputation and visibility of the area, substantial pedestrian flow, versatile mix of businesses, pleasant street environment and good cycling conditions more highly. On non-pedestrianised streets, the proportion of entrepreneurs who value ease of accessibility by car (traffic conditions and parking) or public transport and affordable rents was higher. The pedestrian street responses were more divided between several factors, whereas non-pedestrianised street responses clearly emphasised ease of access by car.

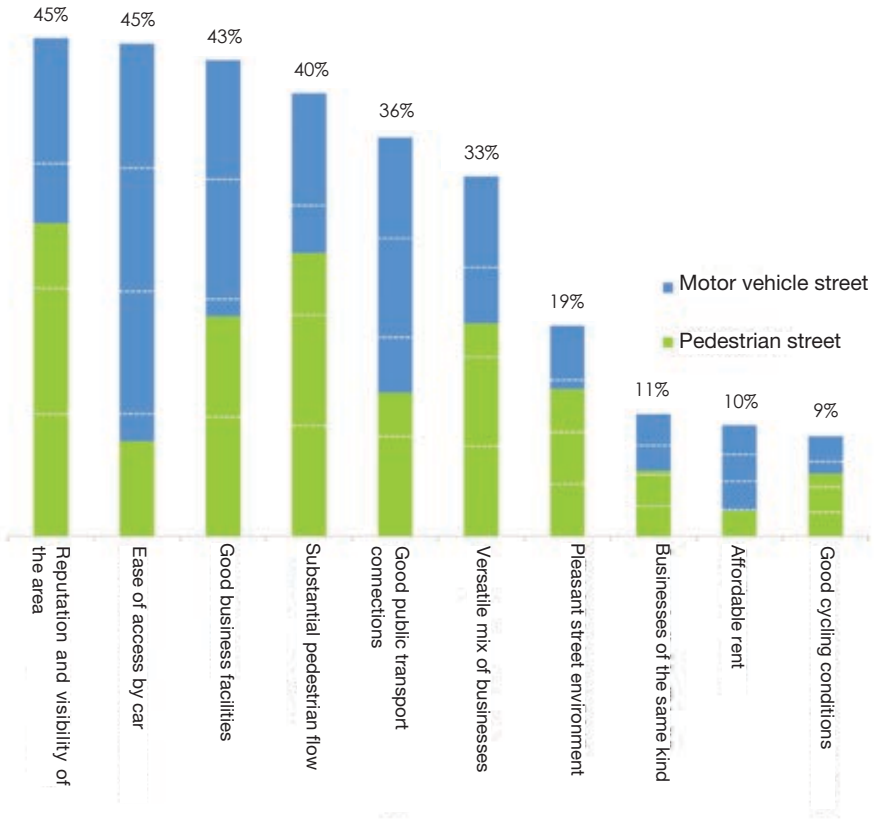


Figure 7. *Things that the entrepreneurs value in their current location (three main options). The size of the column indicates the importance of the factors among all respondents, with pedestrian and motor vehicle street responses separated. For example, the reputation and visibility of the area was valued by 45% of the respondents. Out of these, approximately three-fifths were located on the pedestrian street (proportional importance within respondent groups).*

Impact on the turnover

A good quality pedestrian environment attracts customers. Out of all respondents, 64% thought that location on a pedestrian street is positive or very positive with regard to the business' turnover. 20% of the respondents thought the impact was negative or very negative. Looking at the differences between the cities, there are significant statistical differences between the "old" pedestrians cities (Pori, Jyväskylä and Oulu) and the two other cities (Tampere and Kokkola).

Also, there are significant statistical differences internal to these groups when the businesses located on the pedestrianised and non-pedestrianised streets are studied separately. In the old pedestrian street cities, responses estimating the impact of location on the pedestrian street most positively were given by those located on the pedestrian street. The second most positive responses were given by businesses on the non-pedestrianised streets in these cities. These are followed by pedestrian street respondents from the "developing" pedestrian cities and non-pedestrianised street respondents, who were the most negative in their estimations.

All in all, a little over 60% of the respondents estimate the impact to be positive, and a little under 20% think that it has no bearing on turnover.

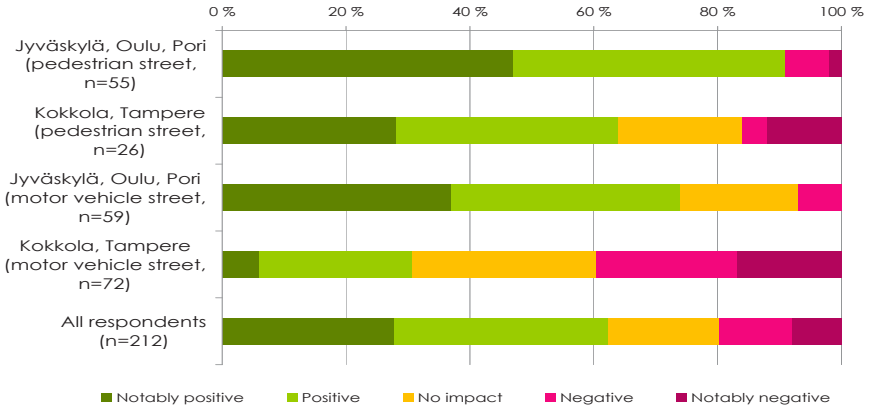


Figure 8. *Estimated impact of the business' location on a pedestrian street on the turnover.*

Pedestrianisation changes the commercial structure

The publication "Erikoiskauppa kaavoituksessa" ("Specialised stores and town planning") by Tuomas Santasalo and Heli Heusala [11] describes the changes taking place in a city core when a shopping street is converted into a pedestrian street. The material used in the publications includes, for example, changes that took place on seven different pedestrian streets in Finland.

- Pedestrian streets attract fashion and telecommunications shops, restaurants and other specialised stores like gift and interior design boutiques and opticians. Respectively, service providers like post offices, banks and insurance companies tend to move away. The more the commercial structure of the street already resembles that of a typical city core, the smaller the changes.

In a nutshell, according to the publication the most significant factors and planning principles to remember include the following:

- City centres should be developed actively into shopping districts so that there is no need to move outside the central business district.
- There should be uniform and original yet versatile store concentrations in the city centre, and psychological barriers between the customers and the stores should be minimised.
- There should be a versatile range of differently-sized business facilities available in the city core, including small ones that enable new business and newly-founded specialised stores to move to the centre.
- The best business locations enjoy the greatest flow of customers (up to fourfold on pedestrian streets). Clothing and book stores, florists, cafés and restaurants get the greatest number of buying customers.
- Women are the most important customer group for specialised stores (up to 80% of all customers). This should be taken into account in planning the commercial environment.
- There should be enough business facilities available to create competition that keeps the rents as low as possible.
- Using the street space for marketing and sales purposes enlivens the centre and creates a pleasant commercial environment.
- The city core should be developed constantly in cooperation with the interest groups, like property owners and trade associations.

Location, location, location

Location, as we all know, is one of the most important factors of business success. In their current locations, the respondents valued reputation and visibility the highest, the latter also being the factor that many of them would have liked to see improved. The respondents also valued good business facilities, substantial pedestrian flow, good public transport connections and a versatile mix of businesses around their location. Of the motor vehicle street businesses, a little more than one-third would like to relocate given the chance. Out of these, 53% would like to operate on a pedestrian street. Of the pedestrian street respondents, approximately one-quarter would like to relocate, and most of them (67%) to a better place on the pedestrian street.

Therefore, the study clearly showed that the cities have a rather strictly defined business “hotspot”, typically a certain street corner or address on the city’s pedestrian street. This conclusion is connected to the fact that the businesses would like to see the “hotspot” and the flow of customers distributed across a wider area.

Tampere is the only exception to this rule, as there the most sought-after location is not on the pedestrian street but on Hämeenkatu, which is the main street. Based on the survey findings, the reason for this is better visibility and flow of customers due to the superior number of passers-by. Furthermore, answers to the open questions show quite irrevocably that Kuninkaankatu pedestrian street in Tampere is not considered to be a particularly successful pedestrian street. This may also explain why so many respondents in Tampere had a negative view of the impact of pedestrian street on turnover.

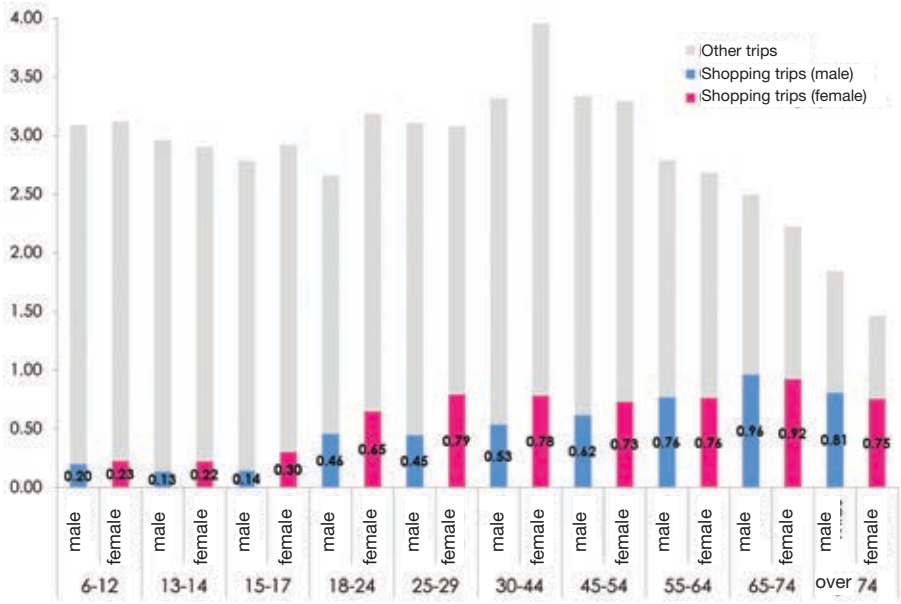
Figure 9 (above). *In Tampere, Hämeenkatu is the most sought-after business location. On a summer weekday, the diurnal pedestrian flow on Hämeenkatu is approximately 1,300 per hour (as of 2011).*

Figure 10 (below). *Pori’s pedestrian street was commended by the entrepreneurs. The diurnal pedestrian flow on a summer weekday on Yrjönkatu is also 1,300 per hour (as off 2011).*

Mode of transport and spending power: personal views vs. reality

Entrepreneurs, or the loudest of them at least, object to pedestrianisation virtually without exception in those cities that do not yet have a pedestrian centre. The greatest concern for entrepreneurs is that the pedestrianisation of the city's core streets would cost them customers who traditionally reach them by car. In international studies, this problem has been approached by studying the spending power of the customers by modes of transport and then comparing the views of the businesses to the actual transport mode of their customers. This is also true of the survey conducted in Finland.

Jyväskylä was found to be the only city where there were significant differences between the answers from pedestrian and non-pedestrian street respondents. In general, the importance of pedestrians is underestimated and that of cars overestimated. The role of public transport is also overestimated.



These findings conform to those made in international studies. Motorists are considered to be the most significant customer group even though the role of pedestrians and cyclists is also significant. Probably the best way to see this significance is to look at the daily shopping, commercial and pleasure- and hobby-related trips made to city centres by different modes of transport (Figure 14). It is also worth noticing that women make more shopping trips than men, and that shopping trips make for a considerable part of trips made by those over 65 (Figure 11). It is essential to understand the shopping visitor profiles when planning the mobility environment of shopping areas.

Figure 11. *Age and sex ratio of shopping trip travellers in the Tampere region [23]. The trend should be applicable to other cities. Already from an early age, women make more shopping trips than men. Differences between the sexes even out over the age of 55, or are even reversed. Shopping trips make up a significant part of all daily trips made by those over 65.*

Figure 12. *This photograph of Copenhagen's Strøget seems to validate the studies indicating that women make more shopping trips.*

The more pleasant the environment, the further we are prepared to walk

What is the distance that motorists are prepared to walk from the car park to their destination? This has been studied by measuring the distances motorists walk from shopping centre car parks. In Tampere, the issue can be studied by comparing Ideapark shopping centre, which is favoured by motorists, with the city centre. At Ideapark, cars are often parked approximately half a kilometre away from the shops. When the environment is pleasant and pedestrian-friendly, people are prepared to walk further without giving it a second thought. Therefore the City of Lund in Sweden, for example, has invested in making the routes from the parking facilities to the centre more pleasant. In Lund and Linköping, many parking facilities have connections to shopping centres from which there are exits leading directly to the pedestrian centre.

Figure contains material from the Topographic database provided by the NLS, 10/2013.

Figure 13. *The length and strenuousness of travelling distance is determined not only by how demanding it is physically but also by its "mental length". In Lund, attempts have been made to reduce the mental length from the fringes of the city core to the commercial by improving the pedestrian environment, for example. Different kinds of functions are located in connection to the parking facilities, increasing the feeling of social protection.*

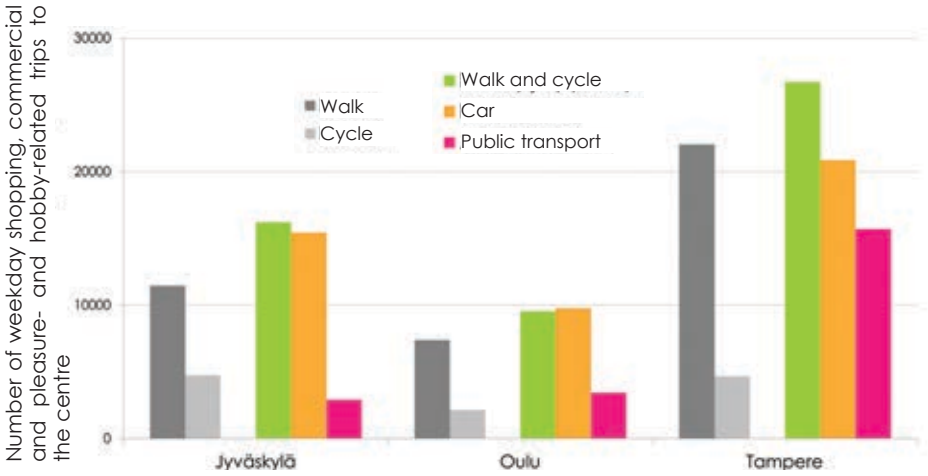


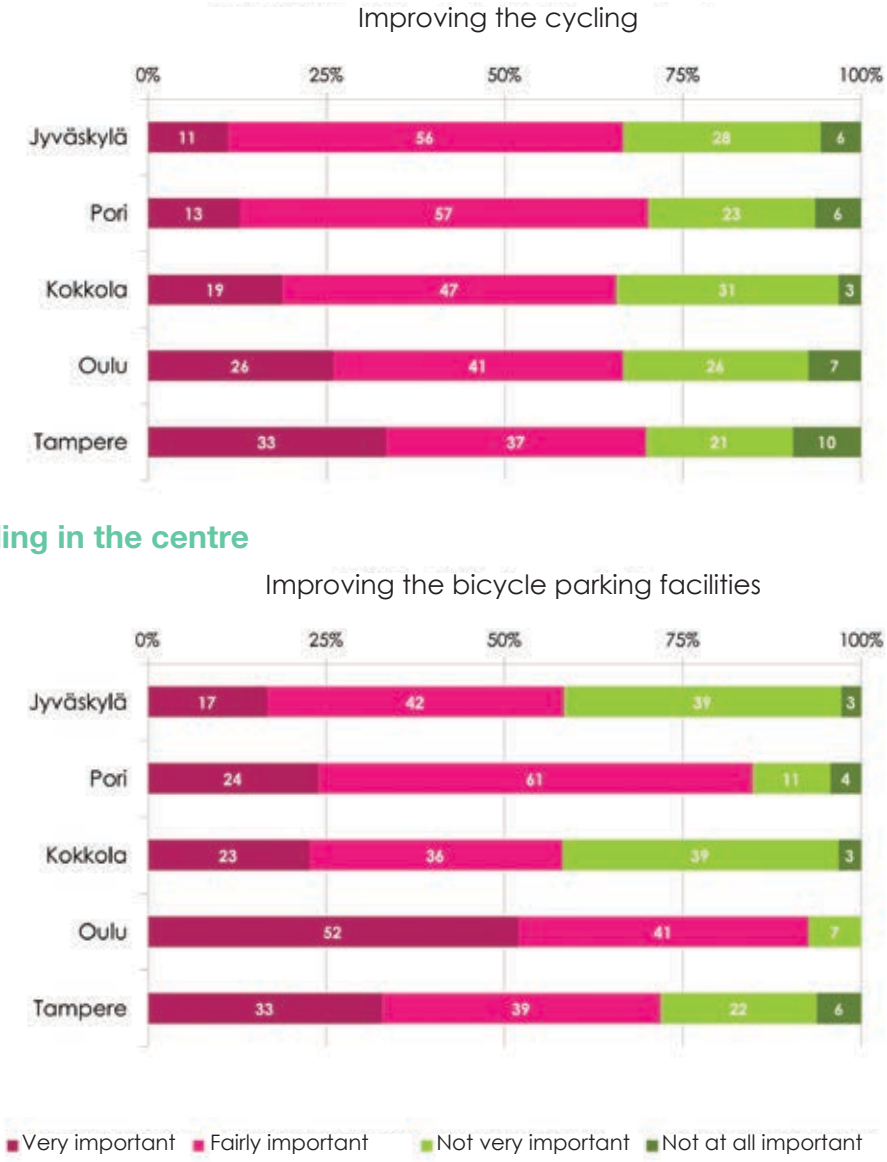
Figure 14. *Number of weekday shopping, commercial and pleasure- and hobby-related trips to the centre by main modes of transport in Jyväskylä, Pori and Tampere (Jyväskylä Regional Travel Survey, 2009; Oulu Regional Travel Survey, 2009; Tampere Regional Travel Survey, 2012).*

Importance of various actions

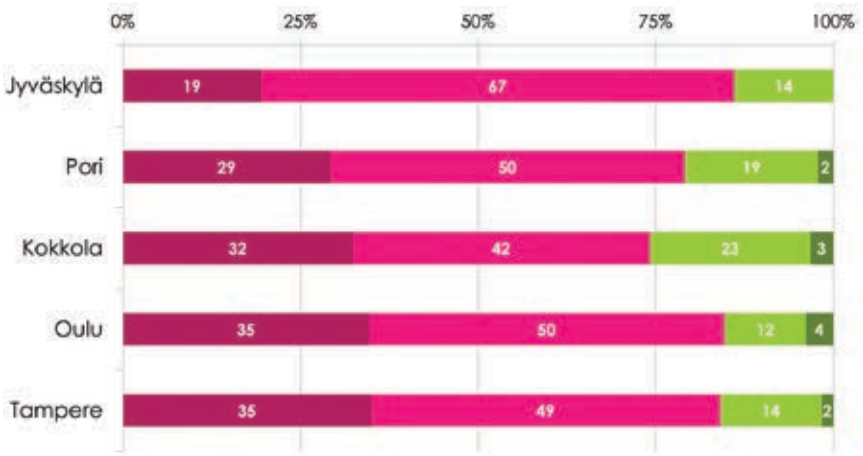
The respondents were asked to evaluate the importance of various city centre development actions in their respective cities. In general, all development in itself is probably considered important, but by comparing the cities with each other it is possible to estimate whether some actions are considered more important in one city than another.

In general, improving cycling conditions was considered relatively important in all of the cities. In Oulu, Pori and Tampere, improving cycling conditions was considered to be most important. In Tampere, there was an emphasis on improving mobility conditions, while in Oulu the emphasis was on the development of bicycle parking facilities. However, 10% of respondents in Tampere did not consider improving the cycling mobility conditions important at all.

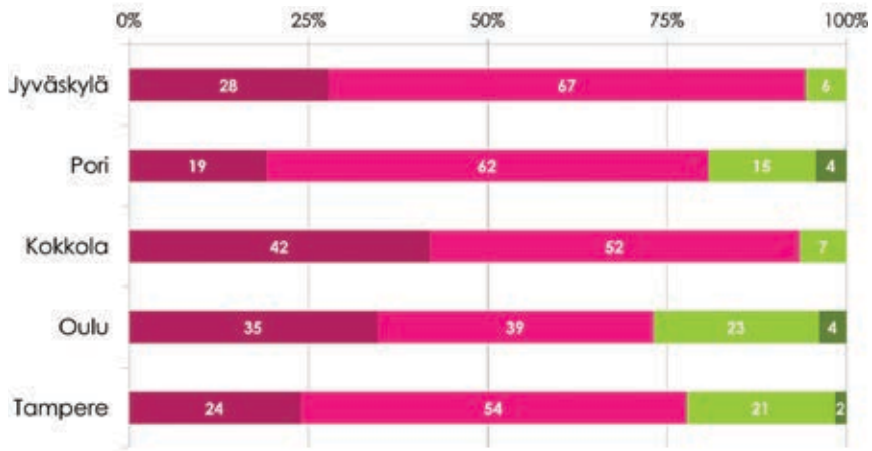
Cycling in the centre



Improving traffic safety



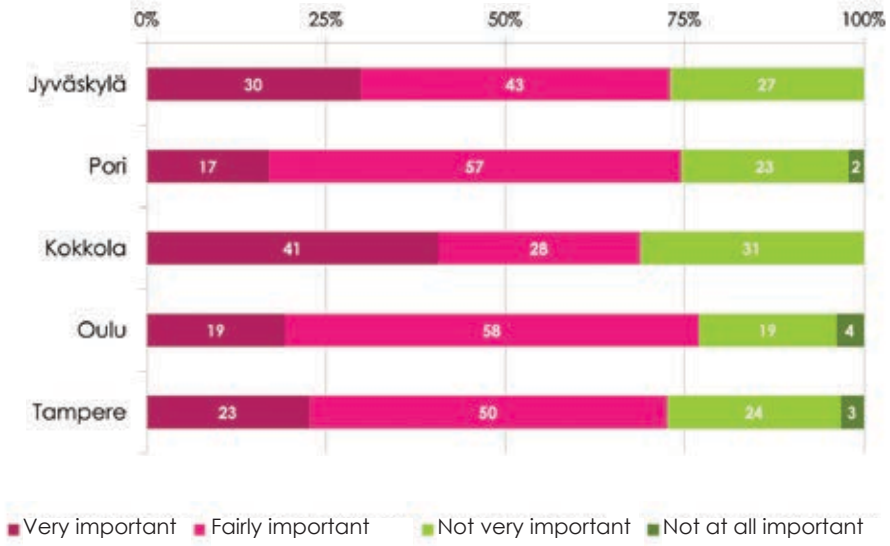
More consideration for the disabled people



Ease of movement

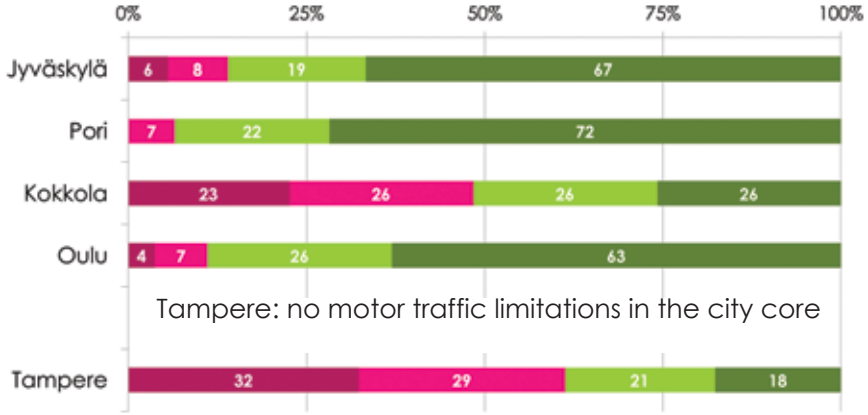
In Kokkola, improving information and guidance and considering the needs of disabled people more were considered more important actions than in other cities. In all the cities, at least three-quarters of the respondents felt that considering the needs of disabled people more and improving traffic safety were important.

Better information and signage



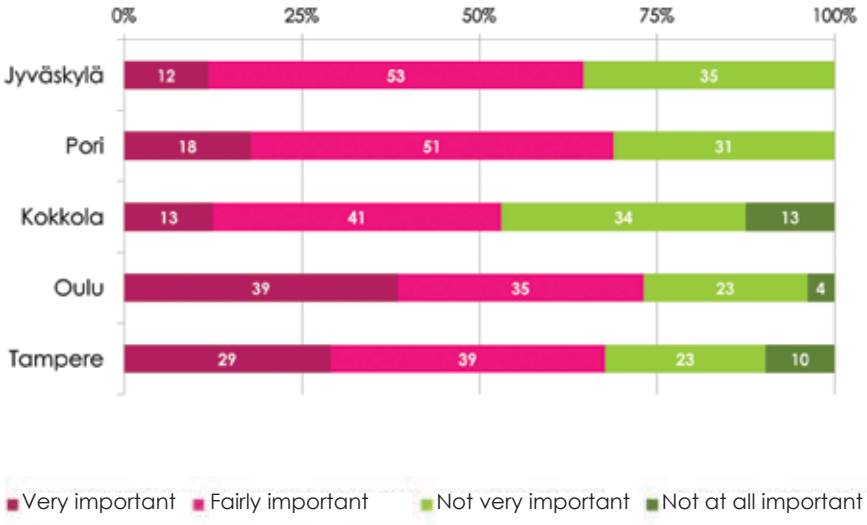
Expanding the pedestrian centre

Other: allowing motor traffic to the existing pedestrian streets



Level of pedestrian orientation in the centre

More space for pedestrians



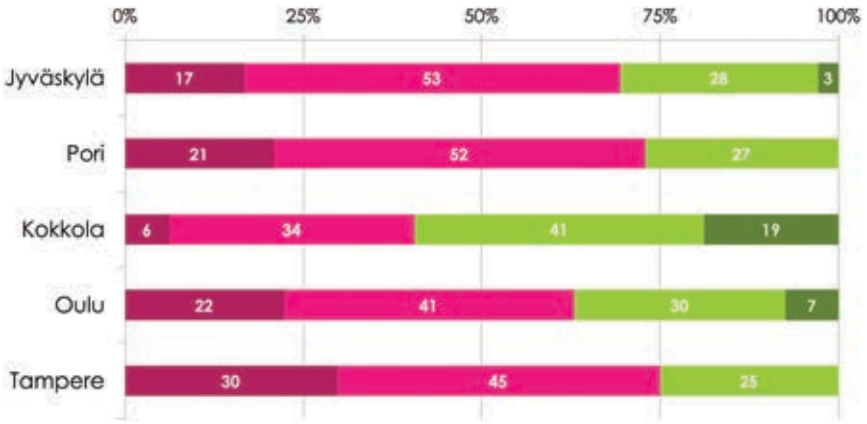
Respondents in Kokkola and Tampere objected most strenuously to suggestions to restrict motor traffic. 61% of the respondents in Tampere did not consider motor traffic restrictions in the centre to be important, although half of the respondents felt that expanding the pedestrian centre was an important development action.

Respondents in Pori were the most adamant about retaining their current pedestrian streets, and 61% of all respondents also felt that the pedestrian centre should be expanded. Jyväskylä and Oulu were also sympathetic towards their current pedestrian streets. In Jyväskylä and Oulu, 56% and 74% of the respondents respectively felt that the pedestrian centre should be expanded. Providing more space for pedestrians was considered the most important issue in Oulu and the least important in Kokkola and Tampere.

Increasing the number of common spaces was considered the least important issue in Kokkola and Tampere. However, increasing the number of trees and plants was considered the most important issue in Tampere. Events and markets were on the wishlist of cities in the open ended questions and this can be seen here as well. At least one third of respondents considered increasing the amount of events very important in all of the cities. In Oulu and Tampere up to 50% considered increasing the number of waste bins very important.

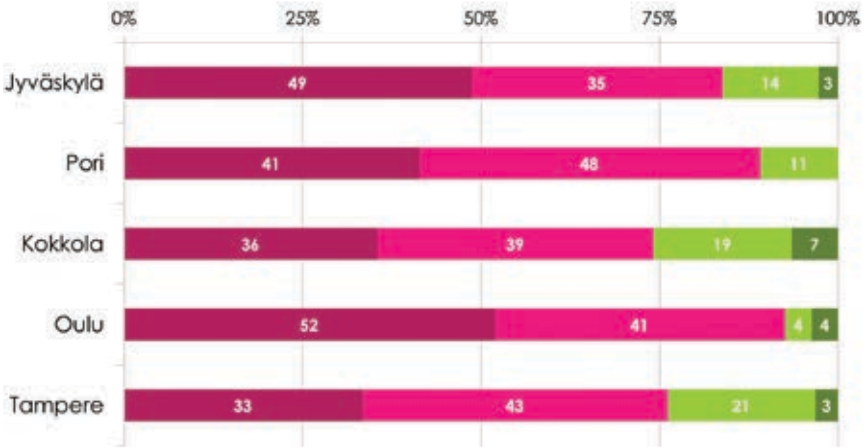
Comfort in the centre

Increasing the number of trees and plants

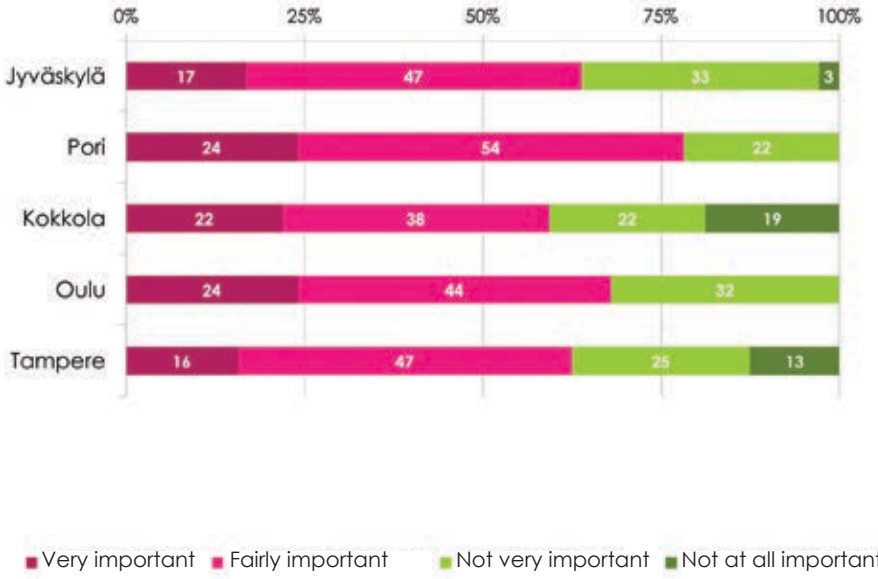


More waste bins

More events, market days etc.



More seating and common places



Cooperation with other entrepreneurs, but not with the city

In Tampere, the survey was conducted approximately half a year later than in the other cities, and the form had an extra question enquiring about the entrepreneurs' opinions on their opportunities to contribute and cooperate. Less than one-fifth of the respondents felt that they had good chances to give feedback on the development projects. However, the most negative overall score was given to their perceived opportunities to contribute on the development of the centre. More than half of the respondents were adamantly of the opinion that they cannot influence the way the centre is developed. The results are quite worrying for interest group cooperation, and they demonstrate that there is plenty of room for improvement in engaging with entrepreneurs and getting them involved.

On the positive side, the street-level stores seem to cooperate with each other and feel strongly about the identity of the surroundings of their own businesses. More than three-quarters of the respondents did not feel that they can utilise the street space in their business. This is, however, not surprising, bearing in mind that half of the respondents were located on a non-pedestrianised street. The questions are based on the expert findings regarding attractive shopping environments including street-level stores and cafés "sprawling" onto the street, and a clear and identifiable identity.

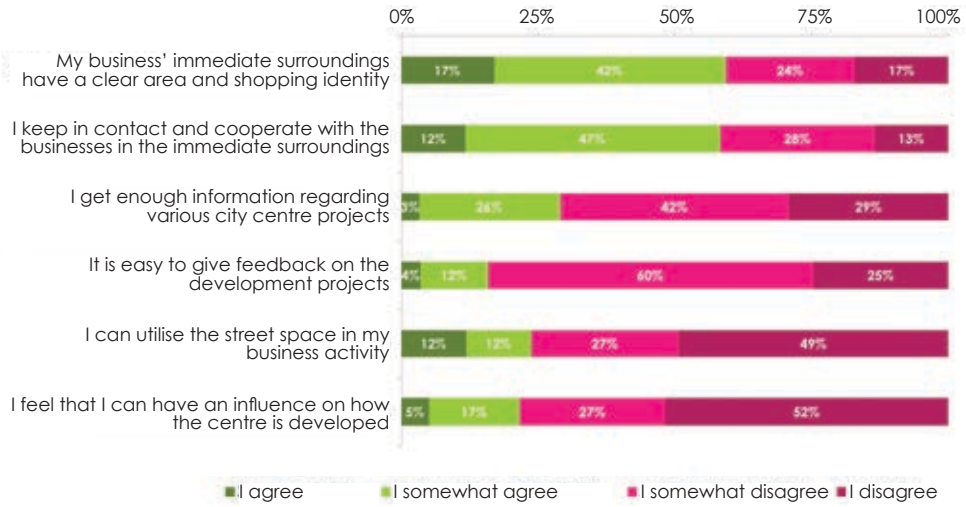


Figure 15 (above). *The Tampere survey, conducted half a year later than in the other cities, asked the respondents to comment on some statements regarding their opportunities to impact on decision-making.*

Figure 16 (on left). *The most typical businesses utilizing street space are florist's and fashion stores. This makes the street look interesting and lively as long as there is enough space for pedestrians as well.*

Figure 17 (next page). *Sheffield's propositions for better city centre on display in the Winter Gardens. Citizens and business owners are given a chance to comment on the plans and to discuss with the city officials.*

Deliberation

Supply increases demand, and demand means purchases on pedestrian routes.

"Wallet density" increases turnover, and the density is at its highest where there are pedestrians. In the city core, in particular, the most economically sound option is to invest in pedestrian routes that allow for a significantly greater capacity in the confined environment than non-pedestrianised routes. Though "supply creates demand" also applies to pedestrian routes, a pedestrian street is usually a good solution in places that already have substantial pedestrian traffic due to some factor attracting pedestrians. The analogy is similar to that applied when building motor vehicle routes: motorways are built in places where there are already busy main routes, in order to improve the existing services.

The most sought-after business location in the city centre is also the place where there is the biggest number of customers. A pleasant walking environment attracts people to stay longer in the city core, and this is positive to the entrepreneurs in the area. The significance of this on the city core economy should not be underestimated. It is also worth noting that significant positive effects have

Balancing the external and internal accessibility of a city core

Thull and Mersch [26] have studied the significance of accessibility and the quality of the urban environment on the city core's economic regeneration in Christchurch, New Zealand. There are three factors to be considered when studying the accessibility of a centre: distance between offices (travel time by various transport modes), transport modes available (options and services offered by the transport system) and socio-economic factors (like economic situation, physical condition, attitudes and opinions).

The attractiveness of a centre can be determined by the "quality and quantity of time utilisation possibilities". Therefore, the attractiveness of a centre can be guaranteed with a comprehensive mix of high quality activities. Attractiveness is strongly linked to traffic safety and social protection, noise and air pollution and the aesthetic character of the built environment.

City core attractiveness and accessibility are very closely linked to each other. Good accessibility by car requires a high class road network offering quick and easy access to parking facilities in the centre. However, the closer the cars get to the city core, the more the traffic causes negative urban environment problems, like congestion, lack of safety and noise and air pollution. High city core motor traffic volumes decrease comfort in the centre and make fluid pedestrian traffic more difficult.

Therefore, the accessibility of a centre can be divided into external and internal accessibility. Internal accessibility refers to the pedestrian environment within the city core. External accessibility refers to the ease of entering the city core from outside the centre. The challenge is to find a way to balance the attractiveness of the city core and internal accessibility with external accessibility.

[26]

The city centre as a shopping centre

Unfortunately, the law of supply and demand applies here, too: the rents of business facilities are often higher. The development actions should be planned in advance to ensure that the centre will have a diverse selection of businesses and that small local businesses can operate in the centre. An imbalanced mix of businesses, an impersonal street scene and a lack of individual identity in a city centre do not promote the centre's attractiveness and competitiveness. The business facilities offered should be varied in terms of size and price level.

One way to control rent levels is to ensure the visibility and versatility of the business facilities. If the identity and ownership base of a city core are still in the forming stage, development companies can be used to manage and develop the city core into a busy commercial and cultural hub. In Finland, we have different kinds of city centre associations. Elsewhere in the world there are examples like centre management services that have the power to develop and manage the city core as if it were a shopping centre. The aim is to achieve, among other things, an optimal mix of businesses. To do this, the management must be subtle.

As studies show, pedestrian streets best serve businesses and activities of a certain type. Therefore, the reality is that some types of businesses are simply excluded when planning the pedestrian centre. These businesses might later find themselves relocated on the fringes of the centre. Pedestrian streets or areas are just not equally suited to all kinds of businesses. This is a good thing to remember in case there is pressure to try to accommodate all parties.

Security is a part of pleasant city centre

City core management also has to do with factors that undermine social protection, like the disadvantaged and groups of youths that may cause disturbances. Even if the feeling of insecurity is not necessarily connected to actual vandalism or attacks, it is a significant factor influencing on the attractiveness of an area. Therefore, the city should discuss the matter with property holders and businesses. Planning the environment, including lighting and fields of view, with safety in mind is one way to control the situation. Some of the survey responses show signs demanding, for example, that the amount of seating should to be reduced because it seems to attract the disadvantaged. The problem should, however, be solved by some other way than taking away comfort-increasing services from all people using the centre.

Furthermore, it is important to remember that young people and the disadvantaged are also groups that use the services of the city. If they are evicted from one area, they will simply move to another. In the case of substance misusers, it would be advisable to utilise the know-how and experience of the police and social services on substance misuse treatment facilities. The problem does not go away merely by treating the symptoms, nor can the authorities simply remove the substance misusers from the city. However, security guards and camera surveillance has been used in the UK, for example, to improve security in certain areas. In the case of groups of youths, a dedicated facility for young people near the city centre might work.

Motor vehicle street converted to a common area

In Zürich, the busy Limmatquai, carrying motor and tram traffic along the banks of the Limmat, was converted into a shared space public transport street, and the pavement facilities were improved. Following the changes, the number of people spending time in the area rose 121%, while the number of cyclist rose 18% and that of pedestrians 17%. Cyclists in particular began to use the Limmatquai route by the river. However, the amount of pedestrian flow on the adjacent streets only dropped by few per cent. Furthermore, the number of seats available in the street cafés increased by 45%, with utilisation rate increasing from 21% to 30%; this without any changes to the adjacent streets. According to a survey, 94% of the visitors and 60% of the entrepreneurs thought that the conditions had improved.

[27]

Figure: Stadt Zürich

Seeing the forest for the trees

A city core must be seen as a whole, not just as a single market or a street corner. Although each city might have a point of interest or a centre point, it is a good idea to remember that businesses are located all over the centre. Visibility, which is closely linked to location, is extremely important for business. It is also beneficial to visitors in the city centre that they should know about services outside the main street. Here too, a working analogy would be a shopping centre where there are maps that guide you to find what you are looking for. Events are used to draw people to the centre, allowing diverse use of various urban facilities situated at different locations.

Strengthening the identity of the various areas in cooperation with the street-level storekeepers and property owners is one way of increasing the visibility of the side streets. Through uniform appearance of the street spaces and frontages, street events, advertising and branding, it is possible to turn certain quarters into products with a strong identity. The city can help by cooperating with the entrepreneurs and property owners. Examples of this kind of place-making include Tori Quarters in Helsinki, Carnaby Street in London, Temple Bar in Dublin and Old Porvoo. All these areas have dedicated web pages providing information on shops, restaurants, hotels, events and other points of interest.

Figure 18. *Pedestrian flow on the Limmatquai in Zürich increased by 17% after the street was converted into a shared space public transport street, increasing the overall comfort in the area. [27]*

Communication: stumbling stone or support?

Development of the city centre should be discussed among city officials and various interest groups, especially business owners, rather than on the pages of newspapers. Open and active communication and engagement with business owners and property owners as part of the development project should be an integral part of any development project.

Based on the survey, the entrepreneur's dream centre is not such a far cry from that which cities in general want their centres to be. Information gaps cause conflicts. Lack of information can lead to false assumptions, dissatisfaction based on uncertainty and feelings of disrespect. After all, what is at stake here is the business' immediate operating environment that should, ideally, be an asset for the entrepreneur. This is the entrepreneur's "turf". In addition to what is about to be done, it is just as important to impart how and why it is done.

Mutual understanding can be greatly facilitated by having a vision for the city centre, based on the views of the city core interest groups. The principles of sustainable development are not necessarily the driving factors for entrepreneurs, nor do they need to solve local government finance, congestion or transport system problems. Although business people are not necessarily experts in urban and traffic planning, they are an essential city core interest group.

In its most basic form, establishing a line of communication can mean visiting the stores located on the main shopping street. It would be very dangerous to assume that the most vocal interest group member should represent and reflect the opinion of all of entrepreneurs.

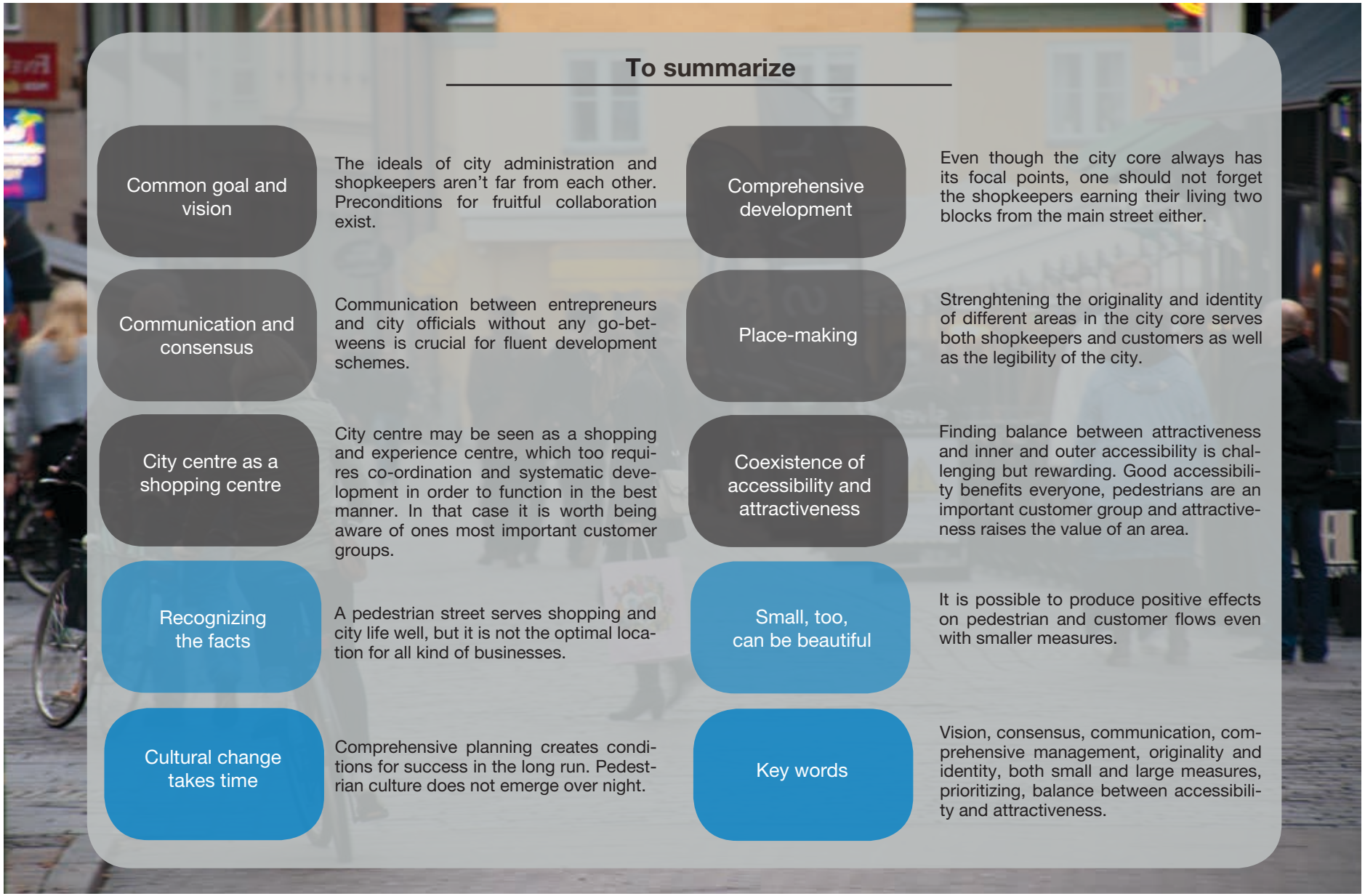
Pedestrian culture development takes time

Based on the survey, cities with a successful and established pedestrian street tend to view improvements in the pedestrian environment more positively. Good examples bring good publicity, and good experiences do not go unnoticed among the other entrepreneurs in the area. However, good examples in other cities do not necessarily convince everybody that a pedestrian street would work in their own city. This is particularly true in the case of earlier negative experiences with pedestrian streets. In general, respondents with a negative outlook on pedestrian areas think that pedestrian streets only attract substance misusers. Possible reasons for the negative views expressed in "young" pedestrian cities may be that the pedestrian centre is still looking for its identity or that feeder services and winter maintenance are not implemented properly. A pedestrian centre can be seen as a self-developing ecosystem, and a pedestrian culture is not created overnight.

Figure 20, 21, 22 ja 24. *Carnaby Street in Soho, London. Small boutiques in the back alleys area easily found thanks to shopping maps displayed in the area. Marketing and branding have been centralized in the benefit of all of the shopkeepers.*


WELCOME TO
CARNABY STREET


Boots
Soccerscene
American Apparel
Lyle & Scott
Aqua
Pure
Regent News
BEAK STREET
You are here
Ramasqua
The Hide Out



To summarize

Common goal and vision

The ideals of city administration and shopkeepers aren't far from each other. Preconditions for fruitful collaboration exist.

Communication and consensus

Communication between entrepreneurs and city officials without any go-betweens is crucial for fluent development schemes.

City centre as a shopping centre

City centre may be seen as a shopping and experience centre, which too requires co-ordination and systematic development in order to function in the best manner. In that case it is worth being aware of ones most important customer groups.

Recognizing the facts

A pedestrian street serves shopping and city life well, but it is not the optimal location for all kind of businesses.

Cultural change takes time

Comprehensive planning creates conditions for success in the long run. Pedestrian culture does not emerge over night.

Comprehensive development

Even though the city core always has its focal points, one should not forget the shopkeepers earning their living two blocks from the main street either.

Place-making

Strenghtening the originality and identity of different areas in the city core serves both shopkeepers and customers as well as the legibility of the city.

Coexistence of accessibility and attractiveness

Finding balance between attractiveness and inner and outer accessibility is challenging but rewarding. Good accessibility benefits everyone, pedestrians are an important customer group and attractiveness raises the value of an area.

Small, too, can be beautiful

It is possible to produce positive effects on pedestrian and customer flows even with smaller measures.

Key words

Vision, consensus, communication, comprehensive management, originality and identity, both small and large measures, prioritizing, balance between accessibility and attractiveness.

Sources

[1] Drennen, E. 2003. *Economic Effects of Traffic Calming on Urban Small Businesses*. San Francisco State University, Department of Public Administration.

[2] Wooller, L. 2010. *What are the economic and travel implications of pedestrianising a roadway in Takapuna's shopping precinct*. Auckland University of Technology.

[3] City of Copenhagen. 2012. *Copenhagen City of Cyclists. Bicycle Account 2012*.

[4] Henton, D. & Walesh, K. 1998. *Linking the New Economy to the Livable Community*. The James Irvine Foundation.

[5] Local Government Commission. 1998. *The Economic Benefits of Walkable Communities*. Local Government Commission, Center for Livable Communities.

[6] Department for Transport. 2011. *Creating Growth, Cutting Carbon. Making Sustainable Local Transport Happen*.

[7] TSU & David Simmonds Consultancy. 2003. *The Effect of Urban Quality Improvements on Business Location – Technical Note 5 Final Report*. Transport Studies Unit, University of Oxford. David Simmonds Consultancy, Cambridge.

[8] Montgomery, J. 2003. C*ultural Quarters as Mechanisms for Urban Regeneration. Part 1 & 2*. Journal of Planning, Practice & Research.

[9] Hass-Klau, C. 1993. *A Review of the Evidence from Germany and UK*. Transport Policy, Vol. 1, No. 1, pp. 21-31.

[10] Sandahl, J. & Lindh, C. 1995. *Impact of improving the attractiveness of town centres.* Transport Policy, Vol. 2, No. 1, pp. 51-56.

[11] Santasalo, T. & Heusala, H. 2002. *Erikoiskauppa kaavoituksessa*. Tuomas Santasalo Ky, Helsinki.

[12] Ryan, B. 2003. *Economic Benefits of a Walkable Community*. Center for Community Economic Development, University of Wisconsin-Extension.

[13] Wright, L. & Montezuma, R. 2004. *Reclaiming public space: The economic, environmental and social impacts of Bogota's transformation.*

[14] CABE Space. 2005. *Does Money Grow on Trees?* Cabe Space.

[15] Kumar, S. & Ross, W. 2006. *Effects of Pedestrianisation on the Commercial and Retail Areas: Study in Khao San Road, Bangkok*. World Transport Policy & Practice, Vol. 13, Issue 1, pp. 37-50

[16] Whitehead, T., Simmonds, D. & Preston, J. 2006. *The Effect of Urban Quality Improvements on Economic Activity*. Journal of Environmental Management, Vol. 80, Issue 1, pp. 1-12.

[17] Cortright, J. 2009. [WWW] Walking the Walk: How Walkability Raises Home Values in US Cities. Available at: http://www.ceosforcities.org/research/walking-the-walk/

[18] Genecon. 2010. *Research and Evaluation of Public Realm Schemes*. Available at: http://www.integreatplus.com/sites/default/files/genecon_public_realm_evaluation_sheffield.pdf

[19] Rush, N., Actman, L., McMahon, P. & Renski, H. 2010. [WWW] Street Redesign for Revitalization – West Palm Beach FL. Available at: http://www.walkinginfo.org/pedsafe/casestudy.cfm?CS_NUM=16

[20] Yiu, C. 2011. *The Impact of Pedestrianisation Scheme on Retail Rent – an Empirical Study in Hong Kong*. Journal of Place Management and Development, Vol. 4, No. 3, pp. 231-242.

[21] Transport for London. 2011. *Town Centre Study 2011*. Transport for London, Mayor of London.

[22] Söderholm, D. 2008. *The Commercial Structure of Pedestrian Streets and Shopping Districts - Three Cases From Finland*. University of Helsinki, Department of Geography.

[23] Kalenoja H. & Tiikkaja H. 2013. *Tampere Regional Travel Survey 2012*. Passenger traffic survey. Tampere region, Tampere 2013.

[24] Kalenoja, H. 2010. *Jyväskylä Regional Travel Survey, 2009*. Detailed report 1: Passenger traffic survey. City of Jyväskylä. ELY Centre, Central Finland. Regional Council of Central Finland.

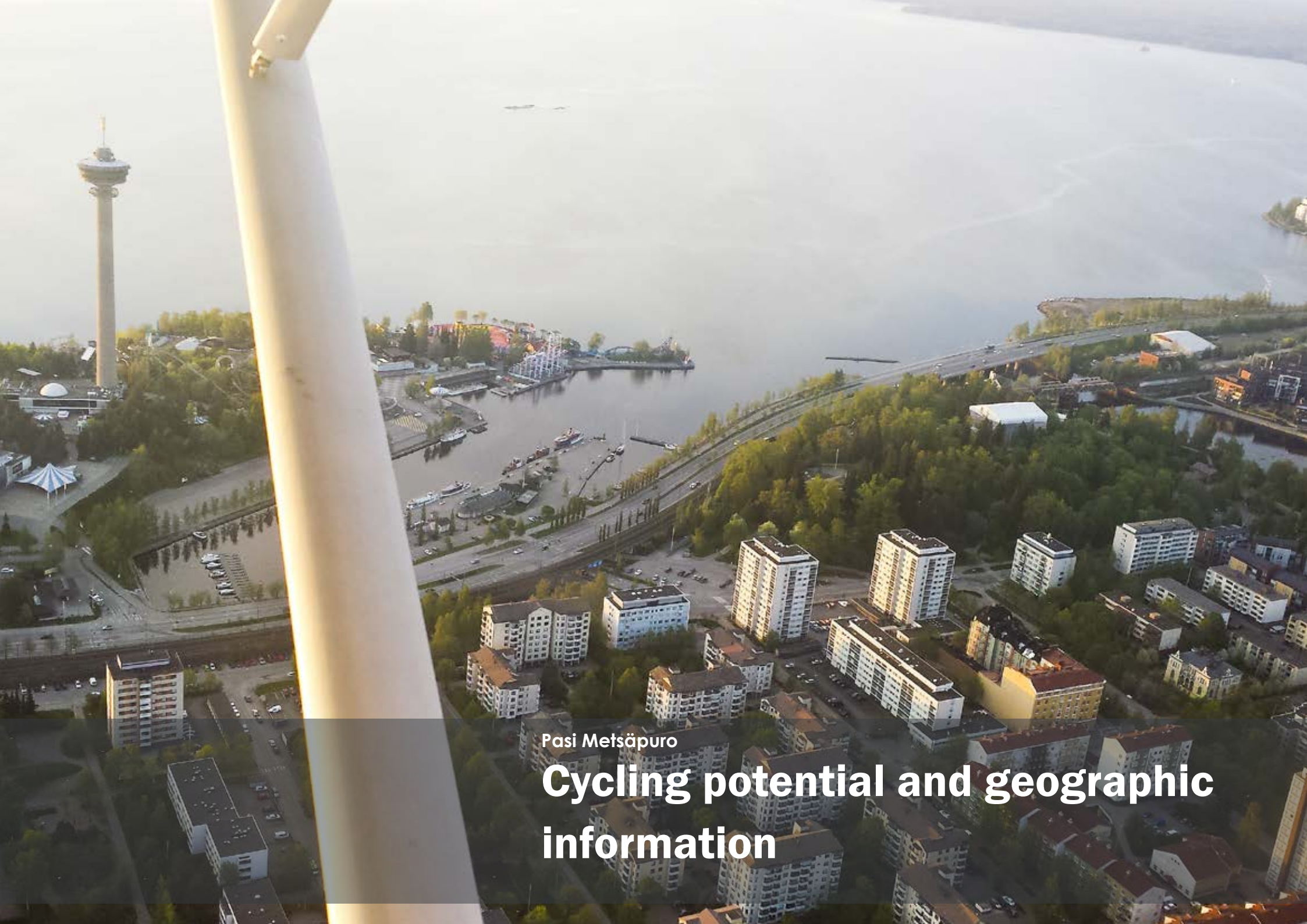
[25] Kalenoja, H. 2010. *Oulu Regional Travel Survey, 2009*. Detailed report 1: Travel survey. Oulu region. ELY Centre, North Ostrobothnia. Ministry of Transport and Communications.

[26] Thull, J. & Mersch, M. 2005. *Accessibility and attractiveness – key features towards central city revitalisation – a case study of Christuchurch, New Zealand*. Journal of the Eastern Asia Society for Transportation Studies, Vol.6, pp. 4066-4081.

[27] Sauter, D. 2009. *Das Limmatquai vor und nach der Neugestaltung. Aufenthaltsnutzung, Fuss- und Veloverkehrsaufkommen im Vergleich der Jahre 2004-2005-2008*. Stadt Zürich, Eine Dienstabteilung des Tiefbau- und Entsorgungsdepartements.

Part II
VITALITY FROM CYCLING

4



Pasi Metsäpuro

Cycling potential and geographic information

Why is analysis of cycling potential so important?

Main routes to where the potential users are

The best cycling cities in Europe all have a top-notch cycling infrastructure. A good cycling infrastructure consists of a safe, logical and hierarchical cycleway network, functional cycle parking, clear signage and high-quality services. The good thing about the cycling infrastructure in these cities is a result of decades of transport policy promoting fluent urban traffic.

A well-implemented cycleway network is hierarchical and serves the users as efficiently as possible. This means that the cycling connections are implemented and maintained with care to where the demand is the greatest (Dill, 2004). The core of a cycleway network consists of a main route network connecting the most important destinations. The main network must be supported by a lower level regional network. The regional network channels cyclists together from various destinations and directs them onto the main routes. The main routes ensure that the major cyclist flows can move fluently.

Information on decisions promoting sustainable mobility

For a long time now, transport policy has been dominated by motor traffic. Therefore, the cycleway network has been developed where it has been easy to build. The emphasis of transport policy is slowly being transformed to promote walking, cycling and public transport. This has also brought on a change at the level of principles. Cycleway networks are no longer designed as by-products of motor traffic. Instead, the tendency is to plan cycleway networks where the demand is.

An analysis of cycling potential reveals areas with demand for high-quality cycling conditions. At the same time, the analysis reveals those areas which are not so relevant from a cycling point of view, providing information that can be used when allocating resources.

Like walking, cycling as a mode of transport is usually a fairly unknown territory for cities. The traffic models used as basic information when planning the routes, for instance, are typically only prepared for passenger traffic and public transport. Traffic models for cycling are still relatively rare. The municipalities usually have a good overview of the quality of the cycling infrastructure, but precise route-specific information is often lacking. Some municipalities, of course, do conduct condition surveys on their transport network. In some municipalities, cyclist flows are counted, but the systematic utilisation of the results is still in its infancy. When analysing cycling potential, new information is gathered by collecting data from various sources and then combining it, for example.

Fig. 1. *Typically short and regular, journey to school is a potential cycling journey. ('s-Hertogenbosch, the Netherlands)*

There are many determinants of bicycle use

There are several factors determining the use of bicycles as a mode of transport, and these have been studied by Rietveld and Daniel (2004, Figure 1), among others. Individual factors, like significance of gender, age, activity and income level are important when studying the cycling potential. Income level, for example, correlates with vehicle ownership and therefore has an impact on the mode of transport chosen. Age can affect physical fitness. Here, activity refers to the individual habitual travel behaviour determined by the location of the work or study place and the domiciles of friends and relatives. Socio-cultural factors determine, for example, how one views the importance of cycling on a national level. In the United States, for instance, cycling is not considered a part of everyday mobility but more of a recreational activity (Pucher et al., 1999). In India, on the other hand, the amount of cycling is strongly related to social class. According to a study carried out in Delhi, the share of cyclists out of all transport modes in the high income group is only a few per cent compared to that of almost 40% in the low income group (Tiwari, 2002).

There are also costs involved in cycling, referred to in a broader sense as travel impedance. Cycling travel impedances include, for example, financial costs (purchase of the bicycle), travel time, level of comfort and feeling of safety, and physical strain of cycling. In cycling, travel time is determined by factors such as the geometry of the terrain and the structure of the city. In some advanced cycling cities in the Netherlands, the city has been divided into sectors between which free access is possible only on foot or by bicycle. Cars have to use the ring road to get from one sector to another. Thus, the travel time by bicycle is competitive when compared to that by car. Another important factor is comfort, determined by factors such as the quality of the cycling infrastructure, weather conditions and topography. The risk of accident and feelings of safety are partly individual factors, but the day and time in question and urban infrastructure also matter. (Rietveld & Daniel, 2004)

Besides improving the infrastructure, a local authority can make cycling more attractive by other means, such as making the city structure more compact or by regulating the cost of private motoring. To improve cycling, it is important that costs should be lower than that of private motoring. This way, cycling would be an attractive, comfortable and quick mode of transport as opposed to cars.

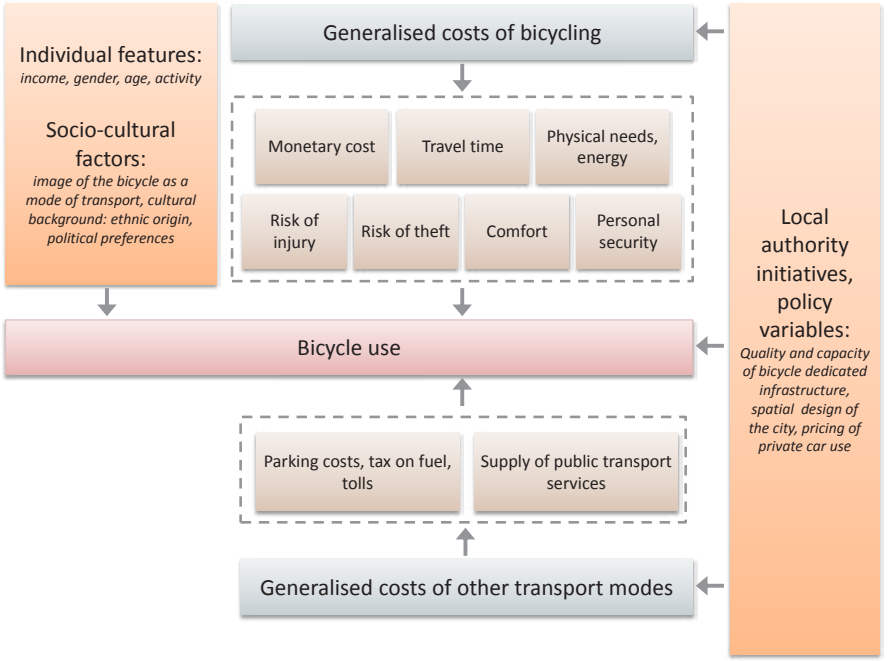


Fig. 2 *Besides individual determinants, bicycle use is determined by factors like political will and the travel impedance of cycling and other modes of transports. (From Rietveld & Daniel, 2004)*

Short journeys are potential cycling journeys

Pedestrian and bicycle journeys, though typically relatively short in length, are made in great numbers. According to the Finnish National Travel Survey, 32% of all journeys are made on foot or by bicycle. In kilometres, however, they represent only about 5% of distance travelled each day. (Finnish Transport Agency, 2012). Based on the Tampere region travel survey, as a mode of transport, cycling is at its most popular on journeys to work, school or place of study. The combined share of walking and cycling of all shopping and pleasure- and hobby-related journeys is over 40%. (Kalenoja et al., 2012, figure 3)

Cycling is a significant mode of transport, especially among school children. Cycling retains its significant role among the younger working population, but the share of cycling as a mode of transport clearly starts to diminish after the age of 30. Among the elderly, the share of cycling is less than 5%, but the share of walking as a mode of transport is respectively higher than among the working population. (Kalenoja et al., 2012, Finnish Transport Agency, 2010; Figure 4)

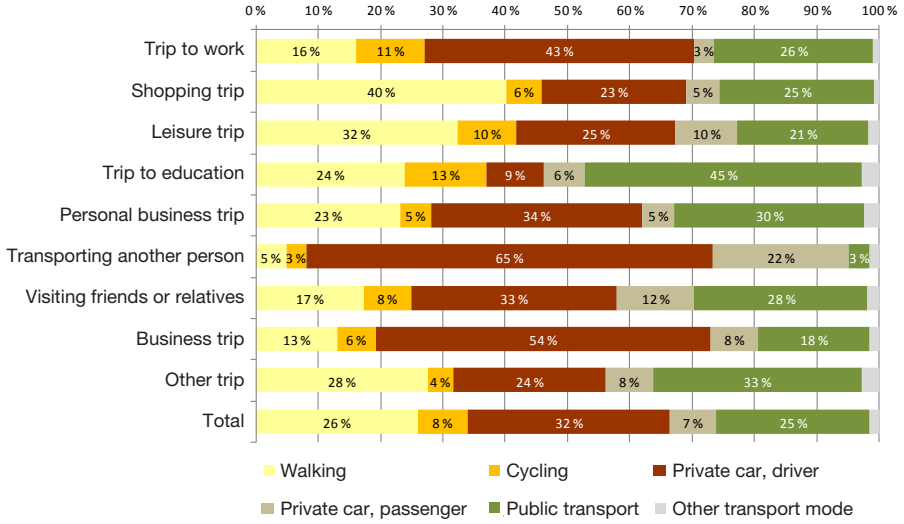


Fig. 3. *Transport mode ratio of journeys to Tampere city centre by travel group. (Kalenoja et al., 2012)*

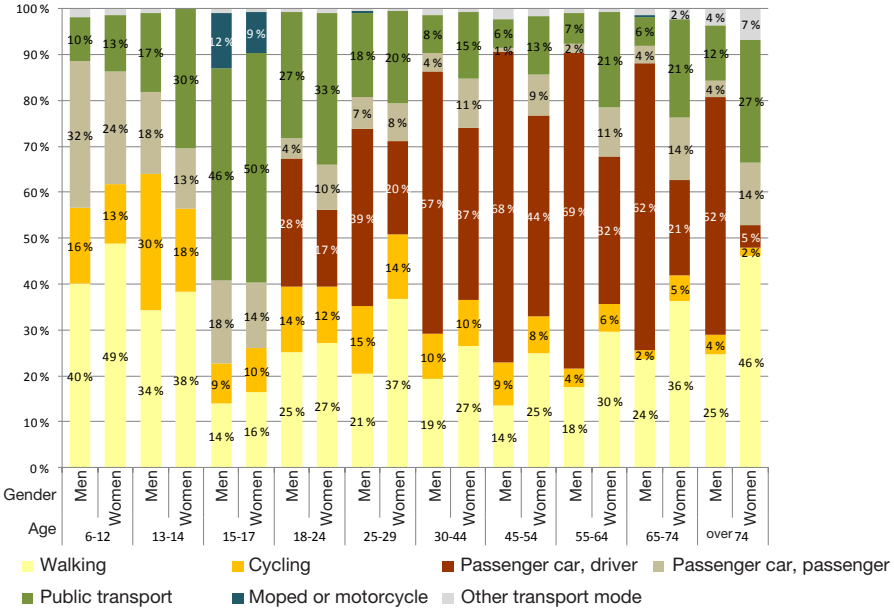


Fig. 4. *Example of the transport mode ratio of Tampere residents by age group. (Kalenoja et al., 2012)*

Hilliness is a significant travel impedance

Topography is a major factor in the attractiveness of cycling. Steep or long gradients are often perceived to be difficult to cycle up. Longitudinal gradient usually refers to a per cent value that indicates the steepness of the slope on the route section in question. A longitudinal gradient of 2%, for example, means that the difference in altitude over 100 metres is two metres.

The Finnish pedestrian and cycleway planning guide recommends that longitudinal gradient should not exceed 3%. Longitudinal gradient is a major factor decreasing the attractiveness of cycling. For some cyclists, even a longitudinal gradient of 5% means that they have to walk their bicycle on the slope. (Finnish Road Administration, 2008). The impact of longitudinal gradient on the attractiveness of cycling has been studied. According to a study analysing journeys to and from work, the flexibility factor between longitudinal gradient and journeys to work is –0.839. Therefore, a 10% increase in hilliness decreases journeys to work by 8.39%.

Level of research

Cycling potential has been studied from various perspectives. Most of the studies are conducted regionally from the point of view of cycling potential and studies analysing the accessibility of specific destinations. On the following pages, some of the cycling potential evaluation methods described shortly above are looked at in more depth.

- To evaluate the share of the daily journeys that could be cycled or walked, a method developed in London was used to analyse travel survey material gathered between 2005 and 2007. Potential cycling and walking journeys were evaluated based on criteria such as travel length, day and time or age of the traveller. The study concluded that the share of cycling and walking out of all modes of transport in London would increase by up to 50% if half of the potential cycling and walking journeys were to be cycled or walked.
- The Cycling Potential Index developed in the UK reveals cycling latency. The method acknowledges three factors, namely the topography, the socio-demographic structure of the area, and the mean length of journeys to work. The method can be used, for example, to evaluate the potential usage of an existing or planned cycleway.
- The Cycle Zone Analysis developed in Portland, United States, is used to create regional models of cycling potential. It can be used to provide versatile information on the conditions and potential of cycling. The method can, for instance, provide a city-wide map of potential cycling areas that can be used when allocating cycling infrastructure investments and so on.
- The Bikeshed Analysis can be used to evaluate the accessibility of various destinations by cycling based on the travel impedance according to the cyclist's energy consumption. Factors contributing to energy consumption are hilliness, air resistance, rolling resistance of the tyres, speed and the combined weight of the bicycle and the cyclist. The method has been used in the United States in Montgomery County, Maryland, where cycling accessibility areas were formed based on the planned light railway stations.

Bikeability – quality index for cycling conditions

The Bikeability Index is a quality index for cycling conditions, and it can be used to evaluate cycling potential. Based on the analysis, it is possible to create maps that describe potential cycling areas, similar to a heat map. The index is composed of the following five sub-factors (Winters, 2011):

1. Amount/density of cycleways
2. Separation of cycling from motor vehicle traffic
3. Connectivity of the cycleways to the rest of the traffic network
4. Topography, or slope of terrain
5. Land use and accessibility of destinations

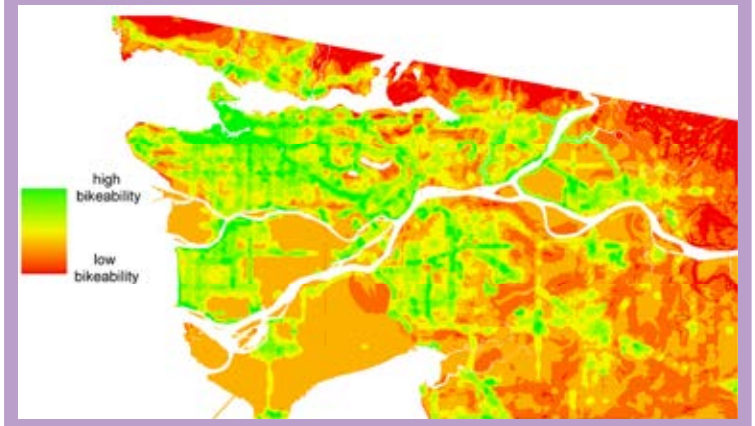


Fig. 5. *Example of Bikeability Index analysis of the Vancouver metropolitan area in Canada. Green areas represent high-quality cycling potential conditions, yellow represents average quality and red represents low quality. (Figure: Winters, 2011)*

Analysis of cycling potential in London

Huge potential for cycling or walking journeys

London aims to have a 5% cycle mode share by 2026, a fourfold increase to that of 2001. As a base for the target, the daily potential cycling journeys in London have been evaluated. The material for the analysis was travel survey material gathered in London between 2005 and 2007. The material was studied for cyclable journeys that are made using some other mode of transport. (TfL, 2010)

Potentially cyclable journeys were determined based on factors like travel length, day and time and age of the traveller. Furthermore, potential journeys that were estimated to take over 20% more time by cycling than by the original mode of transport were ruled out. Out of the 18.5 million daily journeys, 6.1 million were made by cycling or on foot, and the number of potential cycling journeys was 4.3 million. If all current and potential journeys were made on foot or by bicycle, it would mean 10.4 million journeys in total, bringing the share of the combined mode of cycling and walking up to 56% instead of the current 33%. (TfL, 2010)

Currently, two-thirds of cycling journeys made in London take place within the inner city, but more than half of the potential journeys are located in the suburban areas. Therefore, there is significant potential for promoting cycling in suburban areas, and this can be activated by building good cycleways, for example. (TfL, 2010)

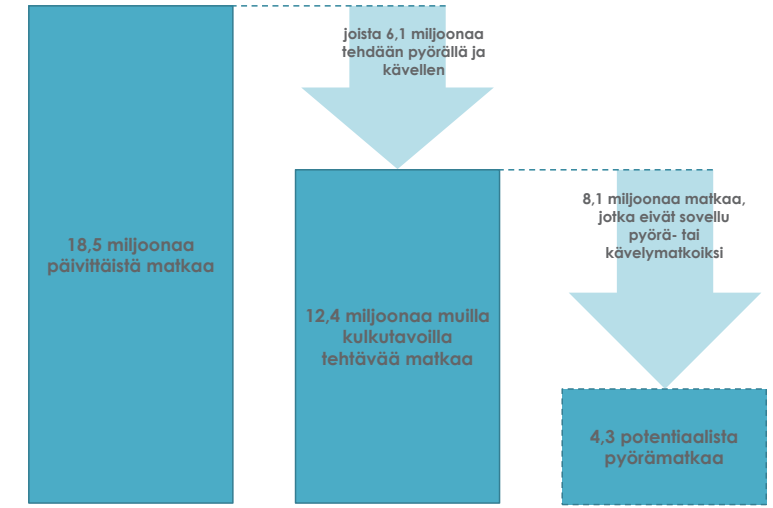


Fig. 6 (above). *According to the potential analysis, 10.4 million of the 18.5 million journeys made in London could be made by cycling or walking. (Original figure: TfL, 2010)*

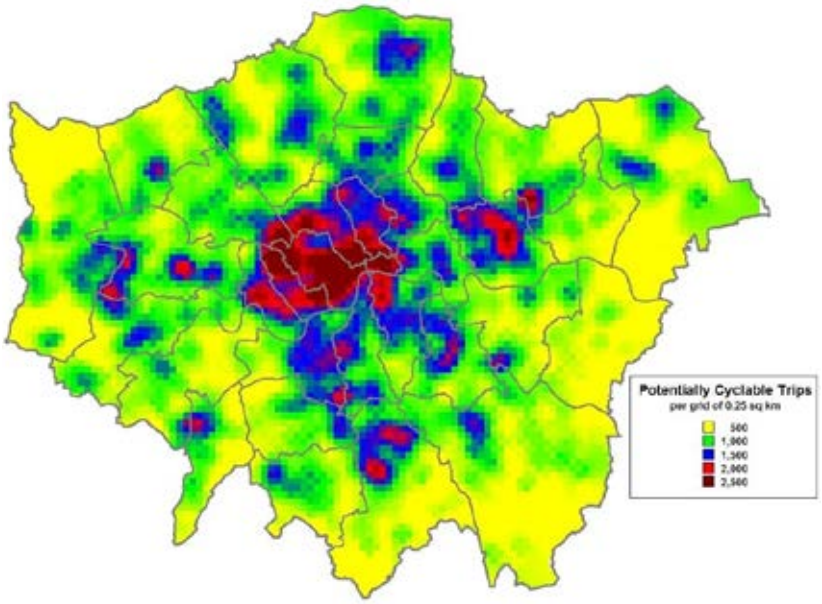


Fig. 7 (below). *Origins of potential cycling journeys. Most cycling journeys start in Central London, but the number of potential cycling journeys in the suburbs is also significant. (Figure: TfL, 2010)*

Important findings from the London survey

- Out of all journeys made by motor vehicles in London, 4.3 million could have been made by bicycle, which would be 23% of all journeys. If all the potential cycling journeys were made by bicycle, the combined transport mode share of walking and cycling would be 56%.
- Two-thirds of the potential cycling journeys are made by passenger cars.
- Out of the journeys, 40% are shopping and recreational journeys. Approximately one-quarter of the potential journeys are work-related.
- Out of the potential cycling journeys, 3.5 million would have lasted 20 minutes or less by bicycle.
- Central London is a major hub of origin and destination points for potential cycling journeys.
- 54% of potential cycling journeys take place within outer London, the incorporation of which requires large-scale investment in cycling infrastructure.
- The typical London cyclist is male, aged between 25 and 44, and has a good income. Typical travellers on the potential cycling journeys consist of women, people from ethnic minorities, young people, the elderly and people on low incomes.

Fig. 8 (above). *Since 2010, London has had a cycle hire system, currently offering 8,000 bicycles for hire at 600 docking stations.*

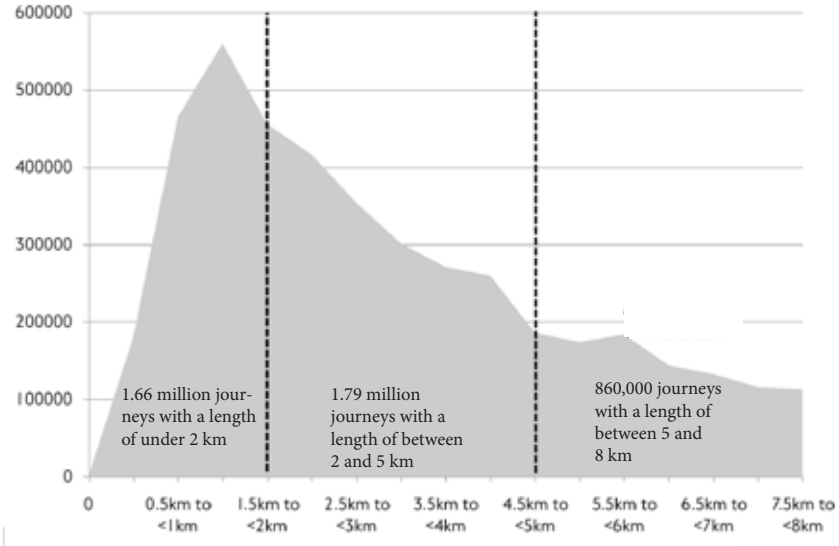


Fig. 9 (below). *Out of the potential journeys, 3.45 million, or 80%, are under 5 kilometres in length. With an average speed of 15 km/h, the cycling time for this average journey is 20 minutes maximum. (Figure: TfL, 2010)*

Cycling Potential Index

Analysis reveals hidden potential

The cycling potential index developed in the UK provides a method, based on objective and numerical data, for analysing the geographical potential of cycling. The analysis can be used to give recommendations based on which investments should be allocated. With the method, it is possible to calculate a national cycling index allowing comparison between different districts or even cities. (Steer Davies Gleave, 2010)

The cycling potential index considers the following three factors: topography, socio-demography and mean length of the cycling journeys. The method is designed to determine hidden potential, with less attention paid to the current infrastructure. The areas are compared to each other by ranking them by each of the three factors. If there are, for example, 30 cities in the comparison, the best city gets 30 points per section and the worst one gets one point. (Steer Davies Gleave, 2010)

Flat cities have greater potential

Topography is evaluated based on the SRTM (Shuttle Rada Topography Mission) data provided by NASA in a regular grid of altitudes at a 90-metre resolution. The cities are compared by determining the differences in the topography of the city regions. From a cycling potential point of view, it is only natural that flat city regions top the survey and receive higher points than hilly city regions. (Steer Davies Gleave, 2010)

Users based on socio-demographics

The analysis utilises the MOSAIC dataset, which divides consumers into different groups based on socio-demographics. The MOSAIC dataset includes information like household size, income, employment and car ownership. For the analysis, the consumer groups are classified into the following five cycling potential categories: very low, low, average, high and very high. (Steer Davies Gleave, 2010)

Distance is a factor in potential cycling to work

Besides hilliness, the length of the journey is an important factor in cycling potential. According to the London travel surveys, the share of cycling journeys drops considerably when the journeys are in excess of 5 km. However, journeys of up to 8 km are considered cyclable. The regional potential of cycling to work has been evaluated by comparing the ratio of journeys to work with a distance under 8 km (distances as the crow files) to all journeys to work. Also from this point of view, the areas with the shortest distances to work have the greatest potential for cycling. (Steer Davies Gleave, 2010)

Fig. 10. *The MOSAIC dataset consists of the following six components: demographics, socio-economics and consumption, financial measures, property characteristics, property value and location. (Figure: Steer Davies Gleave, 2010)*

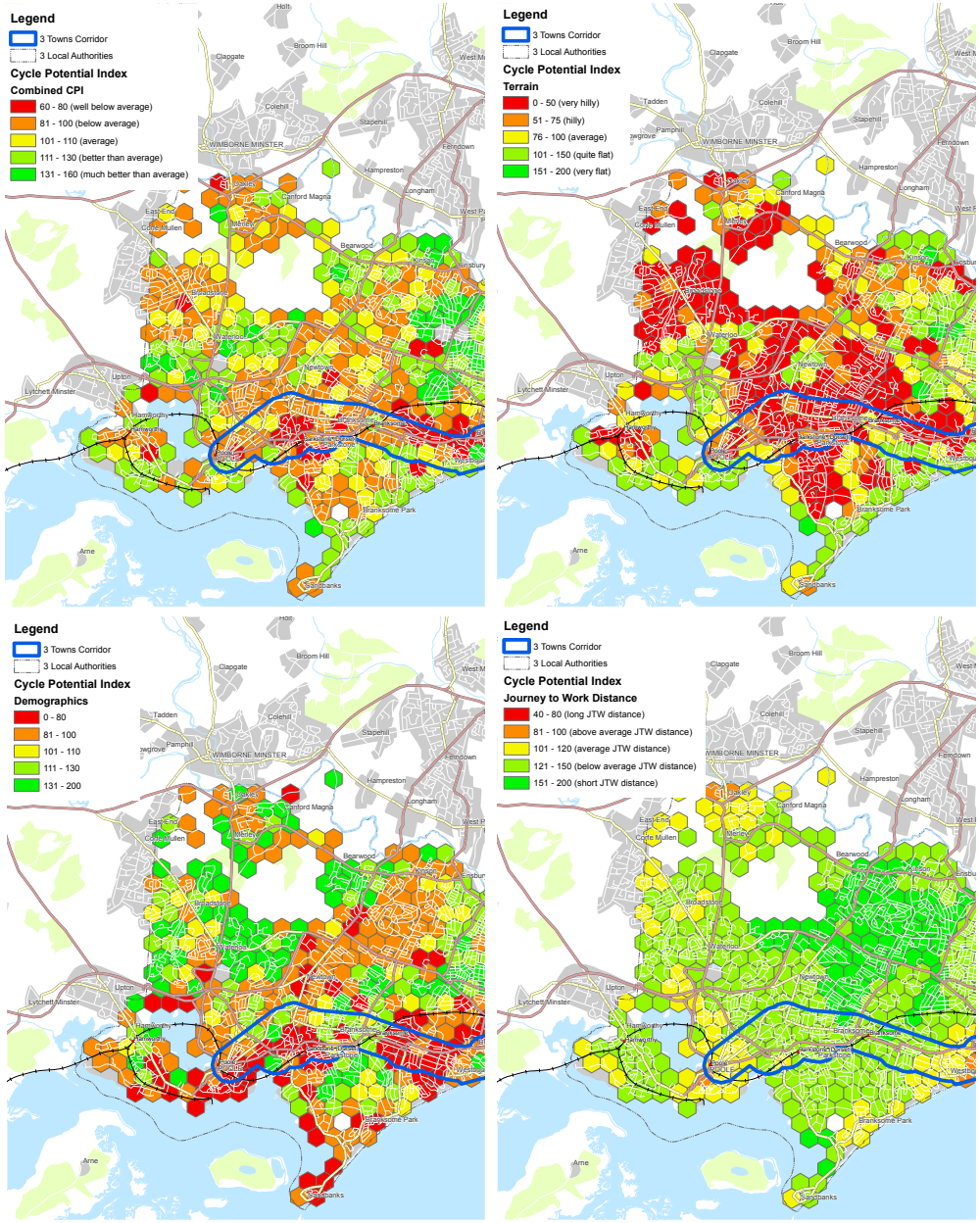


Fig. 11. *The figure in the upper left-hand corner presents the cycling potential index in hexagonal areas. The red areas have the lowest and the green areas the highest cycling potential. The yellow areas indicate average potential. The potential index consists of three factors: terrain (above right), demography (bottom left) and distance to the workplace (bottom right). (Figures: Steer Davies Gleave, 2011)*

Cycle Zone Analysis

Versatile information on regional cycling potential

The Cycle Zone Analysis developed in Portland, United States, is used to create regional models of cycling potential. In the method, the wider area to be analysed is divided into zones that are seen as homogeneous from a cycling condition viewpoint. The aim is to produce versatile information on the cycling conditions and potential. When the analysis is performed on a city- or region-wide basis, it provides an overall picture of cycling conditions and, at the same time, reveals the areas with the highest potential for cycling. This way, it can be used to support decision-making when allocating resources for cycling condition improvements. (Geller, 2008)

A time series analysis is also possible, provided that there is enough historical data available on the area. This would provide information indicating the development of the cycling conditions of the city over time. It enables the determination of the actions that have promoted cycling potential. The credibility of the method can be reviewed by calculating the cyclist flows from various areas and comparing them to the potential indicated by the method. (Geller, 2008)

Wider use of material

The Cycle Zone Analysis consists of the following three parts: zone analysis, intersection quality index and bikeway quality index (Figure 12). The zone analysis determines factors like topography, road network connectivity and land use (Figure 13). The intersection quality index mainly determines safety of the intersections, including the number of lanes to be crossed and the control method used (traffic lights, stop signs, obligation to give way). The bikeway quality index considers factors like the surface type, lighting, signage/marking and parking. It is important to take different factors into account, as studies have shown that the built environment has a significant impact on bicycle use (Winters, 2010).

Fig. 12. *The Cycle Zone Analysis evaluates cycling potential based on three different sectors. (Figure: Fadum & Patterson, 2010)*

Residential & Employment Density (residents and employees per hectare)							
0 - 3	1G	2G	3G	4G	5G	6G	7G
3 – 9	1F	2F	3F	4F	5F	6F	7F
10 – 24	1E	2E	3E	4E	5E	6E	7E
25 – 49	1D	2D	3D	4D	5D	6D	7D
50 – 99	1C	2C	3C	4C	5C	6C	7C
100 – 199	1B	2B	3B	4B	5B	6B	7B
200 +	1A	2A	3A	4A	5A	6A	7A
Land Use Mix (% Commercial, Institutional, or Mixed Commercial-Residential)	40 +	20 – 40	10 – 20	6 – 10	4 – 6	2 – 4	0 - 2

Ratings Scale	
Violet	Highest (8)
Indigo	(7)
Dark Blue	(6)
Light Blue	(5)
Green	(4)
Yellow	(3)
Orange	(2)
Red	Lowest (1)

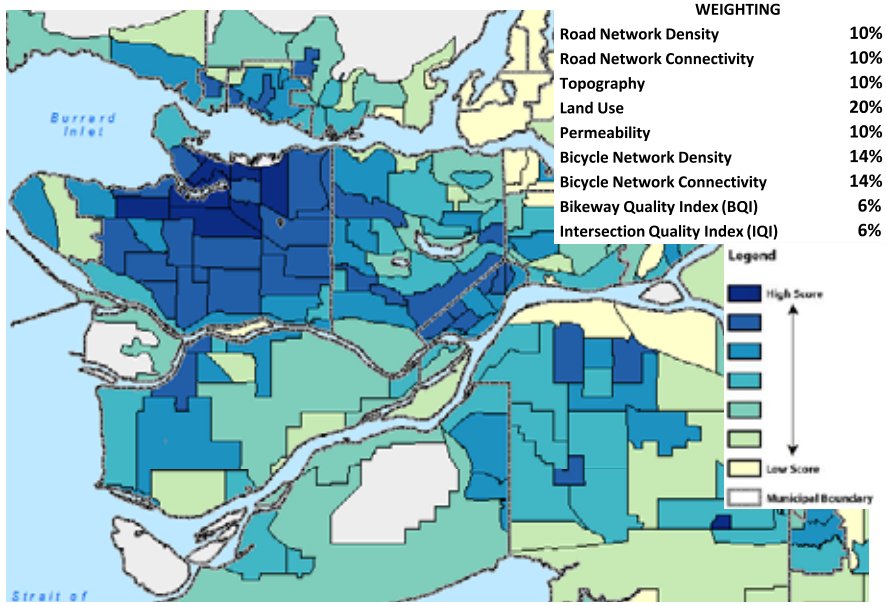
URBANSYSTEMS.

Fig. 13 (left). *Example of the way the information on residential and employment density has been combined with land use mix and then classified to evaluate cycling potential. The cycling potential of an area can be high if the area in question has a high residential and employment density and a land use mix that promotes shopping or personal business trips or journeys to work. (Figure: Fadum & Patterson, 2010)*

Fig. 14 (below). *Map of the Vancouver area cycling potential analysis performed using the Cycle Zone Analysis. Blue areas have high cycling potential, light yellow areas the lowest. In case of a need to emphasise a certain factor, the method allows changes to the way the different factors are weighted, such as the impact of land use. (Figure: Fadum & Patterson, 2010)*

Support for planning the strategic investment allocation

The strength of the Cycle Zone Analysis is the wide information base and well-founded compilation of the data. The new information provided by the method can shed light on the strengths and weaknesses of the various areas (Figure 14). Among other things, this enables different kinds of investments to be allocated more precisely to the areas. The analysis can, for instance, show that although an area has a high cycling potential, there are also many dangerous intersections there. On the other hand, the analysis can be used as a basis for prerequisites and actions needed to develop a low potential area into a higher cycling potential area. The above-mentioned cases are just a few examples where the method provides ample facts to facilitate decision-making.



Bikeshed Analysis

Topography and attractiveness of cycling

Travel costs are an important criteria when selecting a transport mode, and not all costs are measured financially. This explains the use of the term "travel impedance", which can include factors like travel time, feelings of insecurity, heavy physical stress or bad weather.

The Bikeshed Analysis considers hilly terrain by determining the energy needed for cycling. Using this method, it is possible to create accessibility areas with a certain amount of energy. Accessibility areas are typically determined by distance (such as a distance of one kilometre), but in the Bikeshed Analysis the method is to define the areas based on energy consumption (such as 10,000 joules). Therefore, the method includes not only the distance but also the topography.

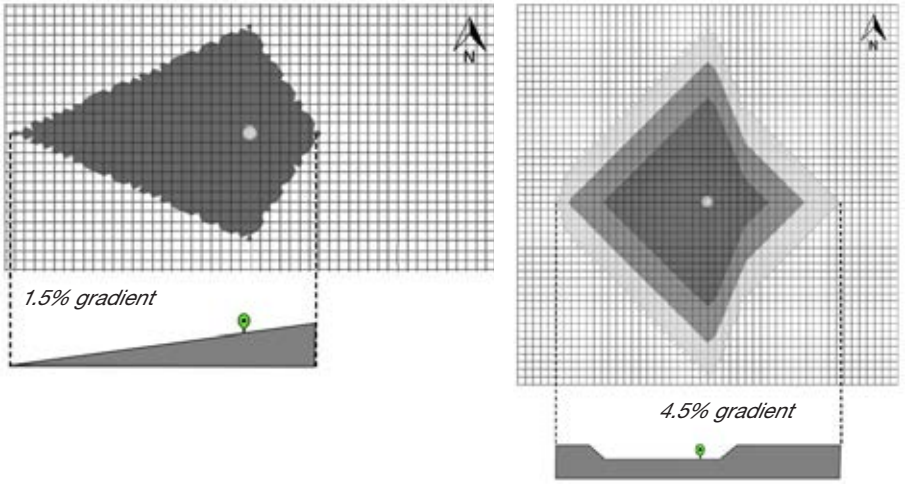


Fig. 15. *The principle based on which accessibility areas are created using the Bikeshed Analysis. In the graph, the grey area represents the area on the fringes of which it is possible to cycle from the centre point using a certain amount of energy. In the example on the left, there is a 1.5% uphill slope to climb when travelling to the east, but in the north-south orientation the terrain is flat. The downhill slope to the west means that the accessibility area using the same amount of energy is larger than that when travelling to the east. The figure on the left also shows the optimal location for a public transport terminal. When the terrain in front of the terminal is flat (towards the west, south or north), it has a larger accessibility area than when it is hilly (towards the east).*

Energy consumption depends on many factors

In the Bikeshed Analysis, the travel impedance used is the calculated energy consumption of the cyclist. The energy consumption is calculated based on a formula that includes topography, air resistance, rolling resistance of the tyres, speed and the combined weight of the bicycle and the cyclist. The impact of topography on the cyclist's energy consumption is significant. The following examples indicate the energy consumed on a one-kilometre cycling journey:

- flat terrain: 7,050 joules
- 1% uphill slope: 14,900 joules
- 2% uphill slope: 22,700 joules
- 5% uphill slope: 46,300 joules

Five different methods to create accessibility areas

The Bikeshed Analysis used five different methods to create accessibility areas. The first method uses the distance as the crow flies, the other the street distance in the network. The two were used in the study as the reference points with no consideration to the other factors. The third method considered the gradient but not the directionality. This means that all slopes are considered as uphill slopes. Consequently, the accessibility area of the third method is always smaller than that of the others. The fourth method considers both the slope and the directionality. This means that, for example, the accessibility area is different depending on whether the direction is to or from a public transport stop. In the fifth method, the accessibility areas were determined as in the fourth method, with the exception of also including the intersections. The intersections were included because they are likely to force the cyclist to stop and then accelerate back to the travel speed, requiring the use of extra energy. The five different accessibility areas created based on the methods are presented in Figure 16.

Multiple potential applications

The Bikeshed Analysis allows hilly environments to be taken into account in a new way, and for its impact on the travel impedance of cycling to be systematically calculated. Consequently, the method has multiple potential applications. In the original study, the method was used to locate accessibility areas for light railway stations. Other applications could include evaluation of the accessibility areas for a cycle hire system, or determining the travel impedance for a cycling route guide. Using energy consumption as the travel impedance in cycle traffic models would make the models more realistic compared to those using only the distance of travel. Energy consumption calculation could be used when creating recreational routes or to categorise the cycling routes into light or demanding routes.

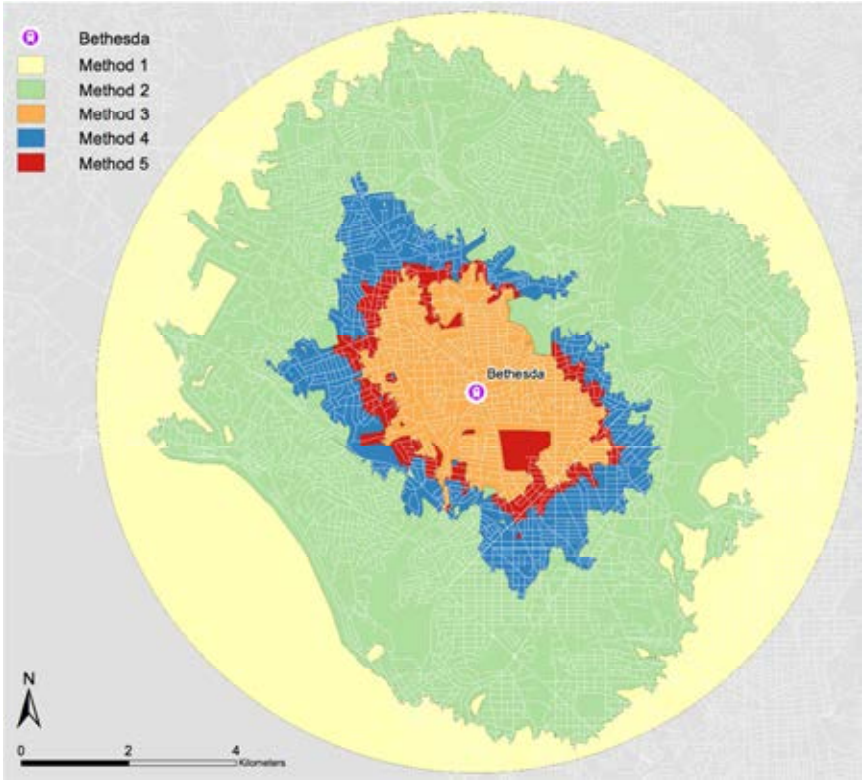


Fig. 16. *Bikeshed Analysis accessibility areas determined based on an energy consumption of 50,000 joules. When travelling as the crow flies, this amount of energy would allow for approximately seven kilometres of cycling on flat terrain.*

Potential analysis for cycling to work

Mapping journeys to work

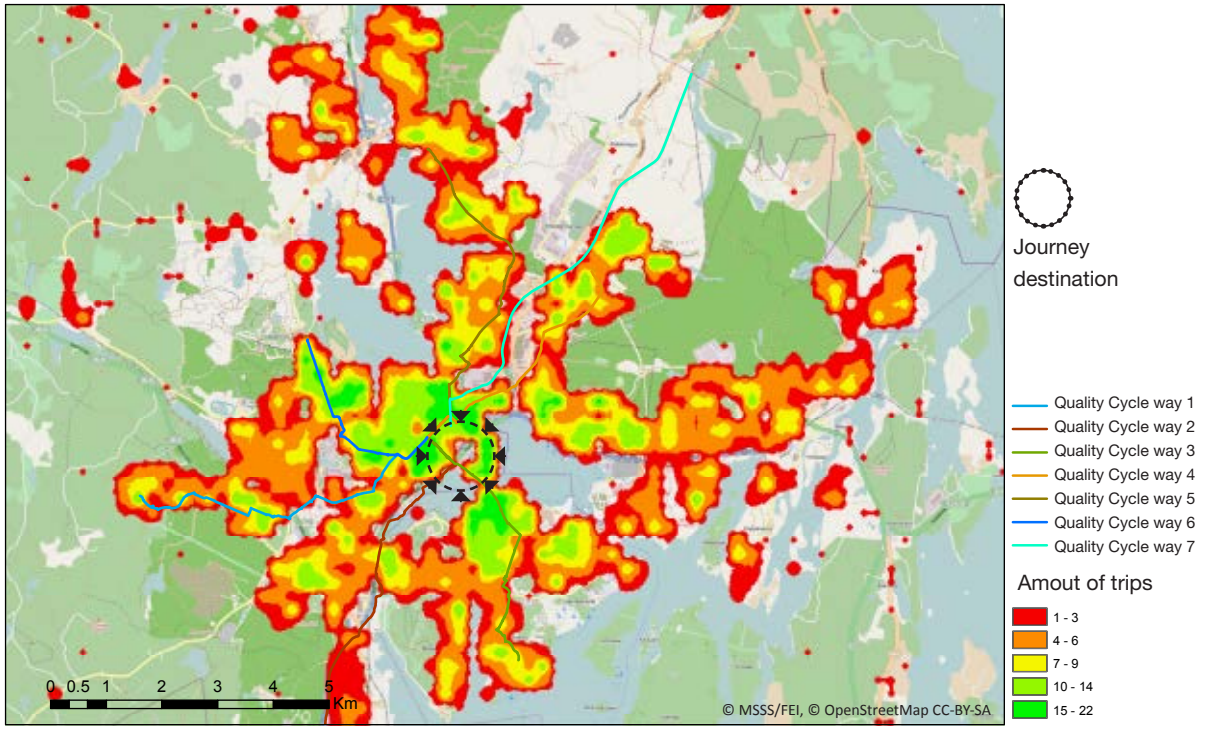
In the advanced European cycling cities, high-quality main cycling routes control the main cyclist flows. In the starter cycling cities, the cycling infrastructure is often poor in quality and lacking in route hierarchy. Using the journey to work potential analysis, it is possible to illustrate the directions of the journey to work flows and to analyse major journey to work routes. The method can also be used to detect missing connections by comparing the modelled network to the current cycleway network.

Material used

The method utilises the Monitoring System of Spatial Structure (MSSS) data provided by the Finnish Environment Institute. The MSSS database contains data describing varying urban structure characteristics in a form of geographic information. The material is generated into 250 x 250-metre grid cells containing information on population, workplaces, journeys to work, buildings and places of business, for example. Collected in time series, the material makes it possible to generate regionally and periodically comparable information. (FEI, 2013)

The journey to work potential analysis utilises the MSSS data system material in placing the journeys to work. The analysis for the City of Jyväskylä described here used the journey to work information from the end of 2009. The information is compiled from Finnish Tax Administration data and presented in a table where each row describes a single journey to work. The row indicates the grid coordinates for the individual's place of residence and work. Data for grids with only five journeys to or from them is hidden from the material. This means that precise data from sparsely populated areas is not available. However, as the analysis focuses on the main commuter traffic flows, it does not have a significant impact on the reliability of the study.

In order to be able to analyse the routes used on journeys to work, the journeys must be mapped on the road and street network. This was done using the Digiroad data material, which contains national road and street network geometry data and diverse characteristics data such as road numbering, speed limits and traffic flow information (Finnish Transport Agency, 2013). The Digiroad material contains geometry data for separate walking and cycling routes, but not for the cycling networks and pavements located by the roads or streets. Consequently, the basis for the potential analysis model also includes the road and street network, with the exception of main motor vehicle routes.



Description of the method

In the first stage of the method, the journey to work flows to the employment areas are described (Figure 17). In the application part, city-specific employment areas have been selected to produce, in a form of a "heat map", a presentation of the areas in which the journeys to work to the employment area originate from. The colours on the map describe the number of journeys originating from the area. With the current main routes also described in the map, it is possible to determine the missing main route-level connections.

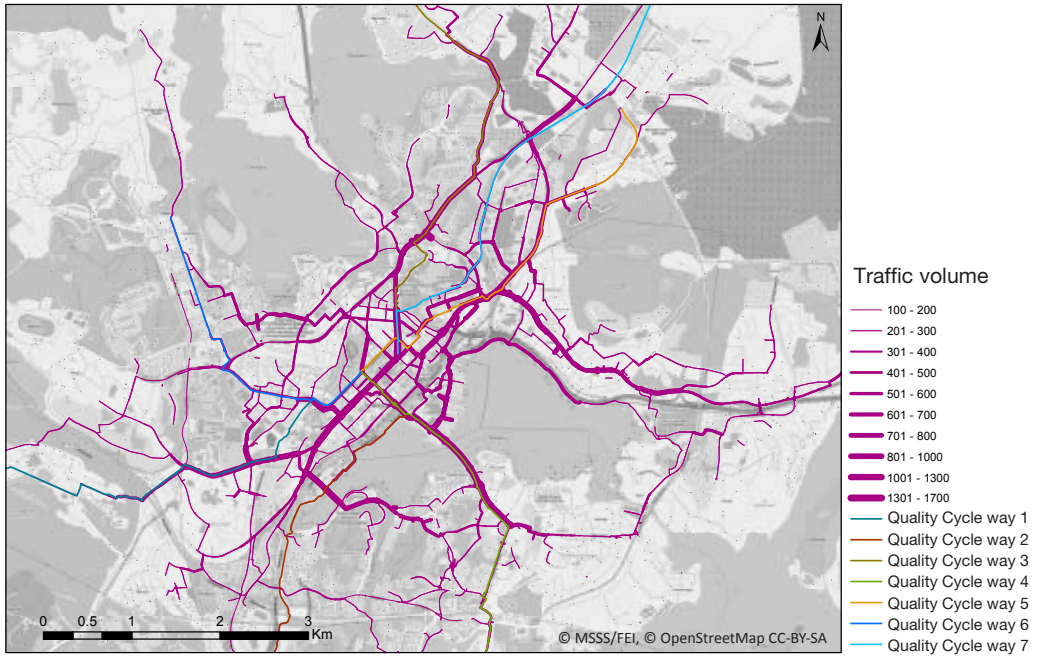
In the second stage, the journeys to work are mapped on the road and street network using the shortest possible route. When all potentially cyclable journeys to work (under 5 km in length) have been mapped, they are connected in to a traffic model describing the potential traffic flows. The model is visualised by using a thicker line to describe route sections with higher potential traffic flows (Figure 19).

In practice, the analysis produces a model describing the intensity of the traffic flows in cases where all journeys to work that are under 5 km in length would be made by cycling and using the shortest possible route. Therefore, the method provides a good overview of an optimal cycleway network from the point of view of cycling to and from work.

Fig. 18. *In addition to the national road and street network geometry data, the Digiroad data material contains a range of diverse characteristics data, such as road numbering, speed limit and traffic flow information. The Digiroad material is used to map the journeys to work on the road and street network. (Finnish Transport Agency, 2013)*

Fig. 17 (left). *A heat map of origins of journeys to work to Jyväskylä city centre. The biggest number of journeys (more than 10 journeys per 250 x 250 m map grid) to the centre originate from the green and light-green areas.*

Fig. 19. *A model describing the potential journey to work cycling flows in Jyväskylä. The model includes all routes under 5 km in length using the shortest possible route.*



Sources

Dill, J. 2004. Measuring Network Connectivity for Bicycling and Walking. July 8, 2004, TRB 2004 Annual Meeting.

Fadum, S., Patterson, B. 2010. Cycling Analysis in Metro Vancouver. Urban Systems Ltd.

Geller, R. 2008. Cycle Zone Analysis (CZA): A New Bicycle Transportation Planning Tool. International Symposium on Walking and Biking.

Hiroyuki, I., Tingstrom, M. 2013. A New Approach in the GIS Bikeshed Analysis with Consideration of Topography, Street Connectivity, and Energy Consumption. Transportation Research Board Annual Meeting 2013. Paper #13-1774.

Kalenoja, H., Tiikkaja, H. 2012. Tampereen kaupunkiseudun ja Pirkanmaan liikennetutkimus 2012. Henkilöliikennetutkimus. Tampereen teknillinen yliopisto.

Liikennevirasto. 2013. Digiroad kansallinen tie- ja katutietojärjestelmä . http://www.digiroad.fi/

Parkin, J., Wardman, M., Page, M. 2008. Estimation of the determinants of bicycle mode share for the journey to work using census data. Transportation. January 2008, Volume 35, Issue 1, pp 93-109.

Pucher, J., Komano, C., Schimek, P., 1999. Bicycling renaissance in North America? Recent trends and alternative policies to promote bicycling. Transportation Research Part A 33 (7/8), 625–654.

Rietveld, P., Daniel, V. 2004. Determinants of bicycle use: do municipal policies matter?, Transportation Research Part A: Policy and Practice, Volume 38, Issue 7, August 2004, Pages 531-550, ISSN 0965-8564.

Steer Davies Gleave. 2010. cycling potential index. 8 s.

Steer Davies Gleave. 2011. Bournemouth Three Towns Corridor - Cycle Potential Index. 17 s.

SYKE - Suomen Ympäristökeskus. 2013. Tietoa yhdyskuntarakenteesta. http://www.ymparisto.fi/ykr

Tielaitos 2008. Kevyen liikenteen suunnittelu. Tiehallinto. Tie- ja liikennetekniikka. Helsinki 1998. 152 s.

Tiwari, G. Urban Transport Priorities: Meeting the Challenge of Socio-economic Diversity in Cities, a Case Study of Delhi, India, Cities, Volume 19, Issue 2, April 2002, Pages 95-103, ISSN 0264-2751.

Transport for London. 2010. Analysis of Cycling Potential. Mayor of London. 55 s.

Winters, M., Brauer, M., Setton, E. E., Teschke, K. 2010. Built Environment Influences on Healthy Transportation Choices: Bicycling versus Driving. Journal of Urban Health: Bulletin of the New York Academy of Medicine, Vol. 87, No. 6.

Winters, M. 2011. Improving Public Health Through Active Transportation: Understanding the Influence of the Built Environment on Decisions to Travel by Bicycle. Doctor of Philosophy Thesis Work. The University Of British Columbia, Vancouver.

5

Kalle Vaismaa

Good examples for cycling circumstances

Solutions for cycleways

TWO-WAY CYCLEWAYS

From home to the centre

Figures 8 and 9. *In Copenhagen, this two-way cycleway runs separate from vehicular traffic.*

Figures 10 and 11. *Separated high quality cycle and footways in Odense. In the figure on the right, the transport modes are separated in two levels and with stylish light poles illuminating both routes.*

Figure 12. *A straight and fast cycleway from the eastern part of Odense to the centre.*

Figure 13. *Pedestrian separator lane in Odense. The exercise equipment on the right is available throughout the year.*

Figure 14. *A good quality cycleway in 's-Hertogenbosch. Pedestrians can also use the route.*

Figure 15. *A high quality connection from the residential area to the centre. Cars can use the cycleway to access the driveways, but through traffic is prohibited. (Breda)*

Figure 16. *An example of street space allocation in a residential area. Different transport modes are separated, with the emphasis on the cycleway. The four-metre wide route is straight and fast. (Breda)*

Figure 17. *The two-way cycleway running by the pedestrian area and through Odense city centre.*

Figure 18. *A rail is an excellent solution where space is limited. A good quality cycleway can be built on a fairly narrow strip. (Copenhagen)*

Figure 19. *A two-way cycleway running in the middle of a boulevard in Rijen, the Netherlands.*

Figure 20. *This street has been converted into a one-way street by turning the other lane into a two-way cycleway. (Tilburg)*

On the way to work or school

Figures 21 and 22. *In the Netherlands, the cities have high quality cycleways leading to the industrial and other employment areas (figure: above from Nijmegen, below from Houten).*

Figure 23. *Pedestrians and cyclists use separate lanes even in parks. (Copenhagen)*

Figure 24. *Asphalt surfacing can also be used in forest environments. Asphalt surfacing offers the best cycling comfort. (Nijmegen)*

Figure 25. *The main cycling route from Nijmegen central station to the university. The 4.5 metres wide route makes it possible to overtake without using the opposite lane.*

Between cities

Figure 26. *In the Netherlands, cities are often connected by separate cycleways facilitating safe long-distance cycling. The cycle highway between Breda and Etten-Leur is one of the finest in the Netherlands. Even in the countryside, it is of better quality than the road that runs alongside it. A dream for all cyclists cycling to work or for pleasure.*

Figure 27. *Cycling highway from Delft to the Hague. The surface material selected is not ideal, but other than that the comfort and pleasure of cycling are top-notch.*

Figure 28. *Cycleway running along the river bank from Tilburg to the east toward the city of Breda. Due to the low number of pedestrians, they are allowed to use the cycleway, eliminating the need for a separate pedestrian path.*

Figure 29. *In the Netherlands, mopeds are allowed to use the cycleways wherever roads have high speed limits. The aim is to have separate routes for pedestrians. (Breda)*

Figure 30. *The flat ground next to railway tracks often provides an excellent location to build a cycle super highway. (Nijmegen)*

Cycling bridges

Figure 31. *The elegant new cycling and pedestrian bridge built next to the old railway bridge in Nijmegen. The bridge provides a high class river crossing for cyclists travelling from the residential area to the city centre.*

Figure 32. *To improve the competitiveness of cycling, this vehicle bridge in Delft was converted into a cycling and pedestrian bridge.*

Figure 33. *An exemplary separation of cyclists and pedestrians in a railway underpass. (Tampere)*

Figure 34. *This combined cycling and pedestrian bridge in 's-Hertogenbosch has been built in a style similar to the railway bridge next to it.*

Route intersections

Figures 35 and 36. *After the cycleway ends, the cyclists continue along a parallel mixed traffic street.*

Figure 37. *The point from which cyclists leave the two-way cycleway and enter a mixed traffic street. (Tilburg)*

Figure 38. *The point where the two-way cycleway becomes a one-way cycleway should have clear street markings. (Copenhagen)*

Two-way route on a street



Figures 39, 40 and 41. *One-way cycleways are usually the best option on central streets. Two-way cycleways can be used to enable turning around to travel in the opposite direction without unnecessary street crossings. If only one side of the street is developed, the two-way cycleway is a good solution (figure on the left). Likewise, if the route is mainly two-way and busy, short sections should not be converted into two one-way routes (figures in the middle and on the right). A one-way cycleway can, however, be used on the opposite side of the street.*

Figure 42. *A section of the roadway has been separated to create a two-way cycleway. The structural barrier made of kerb stones, bollards and chains protects children on their school journeys. Pedestrians and cyclists have separate lanes.*

Figure 43. *In 's-Hertogenbosch, a one-way cycleway was converted into this two-way cycleway so that children do not need to cross the road on their way to school. The cycleway gets narrower further down the route to allow space for the trees.*

ONE-WAY CYCLEWAYS

Best solution for population centres

Figures 44 and 45. *In Copenhagen, split kerb stones are often used to separate general traffic streets from the one-way cycleways. Split kerb stones are also used to separate the pavement from the cycleway. Due to the daily flow of approximately 40,000 cyclists on Nørrebrogade (figure above), the one-way cycleways are four metres wide on both sides of the street.*

Figure 46. *On many streets, the one-way cycleway is a safer alternative to a cycle track. (Odense)*

Shifting space from cars to bicycles

Figure 47. *An example of a high quality one-way cycleway: the other lane of the roadway is converted into a one-way cycleway with a structural barrier separating it from the roadway. (’s-Hertogenbosch)*

Figure 48. *The roadway was made narrower to allow sufficient space for the one-way cycleways on both sides the street. The pavements are also wide enough. (The Hague)*

Google Street View

Figure 49. *By making the street narrower and restricting the on-street parking, it would be possible to have one-way cycleways on Uudenmaankatu in Hyvinkää.*

Visual presentation of the street: Tiia Ruutikainen

Figure 50. *The function of the street can be changed by removing motor traffic from one lane and converting the space into a high quality one-way cycleway on both sides of the street (Uusikatu, Oulu, concept image).*

Visual presentation of the street: Juuso Iivonen

Separator lanes for safety

Figures 51 and 52. *If the traffic flow increases, the cycleway should be separated from the vehicular traffic with a separator lane. (Copenhagen)*

Figure 53. *A one-way cycleway behind a row of parked cars on the street. The cycleway runs unobstructed alongside the on-street parking. (figures: left from Copenhagen, right from Odense).*

Figure 54. *A one-way cycleway running alongside a residential collector street. (Breda)*

Figures 55, 56, 57 and 58. *Barrier elements can be used to separate a cycleway from the roadway. It is safer than separation by street markings only. (figures: upper left corner from Mexico City, upper right corner from Tilburg, bottom left corner from Vancouver, bottom right corner from Vancouver)*

Cycleways and bus stops




Figures 59, 60, 61 and 62. *A one-way cycleway can be directed to pass the bus stop from the front or the rear, depending on the space available and also on the bus schedules. (Copenhagen)*

Cycleways on pavements

Figure 63. *Sometimes it is necessary to designate part of the pavement for cyclists. Cycling and pedestrian safety can be increased by using distinctly different surface materials. One-way cycleways allow sufficient space for pedestrians on both sides of the street.*

Figure 64. *On Overgade in Odense, mixed traffic could be a safe option. For cycling comfort, however, designated cycleways separated by smoother surface material than the historical cobblestone surface of the rest of the street is a good solution – especially due to the busy cyclist flow on the street.*

CYCLE LANES

Good planning is essential

Figures 65 and 66. *In the Netherlands, the cycle lanes are straight. Cyclist do not need to navigate between parked cars, for instance. Motorist opening their car doors can cause hazardous situations, but this is rarely serious enough a problem to prevent the building of the cycle lane. The intensity of the vehicle flow and the driving speeds used have a far greater influence on safety. (figures: left from Delft, right from Nijmegen)*

Figure 67. *Due to the busy bicycle traffic on the street, the cycle lane takes up more space from the street surface than the roadway. The wider the lane, the safer it is for cyclists. (Odense)*

Figure 68. *Contrary to the figure, cycle lanes should be straight with no curves to accommodate on-street parking.*

Figure 69. *The cycle lane in the figure is not safe because heavy vehicles use it as a short cut.*

Figure 70. *On busy streets with heavy traffic, a one-way cycleway is safer than a cycle lane. The safety of a cycle lane can be increased by making it sufficiently wide and using street markings to create a safety zone for the cyclists. (Ghent)*

On narrow streets

Figure 71. *The Netherlands have advisory cycle lanes for cyclists. Cars are allowed to use the lanes in order to avoid oncoming traffic. Advisory cycle lanes are used when the street is too narrow for cycle lanes, but cyclists nevertheless need a designated space due to busy car traffic or high driving speeds.*

Figure 72. *In the Netherlands, advisory cycle lanes are also used on the roads. Designated space helps to decrease the feeling of insecurity experienced by the cyclist due to heavy farm-bound traffic, for example. (Rijen)*

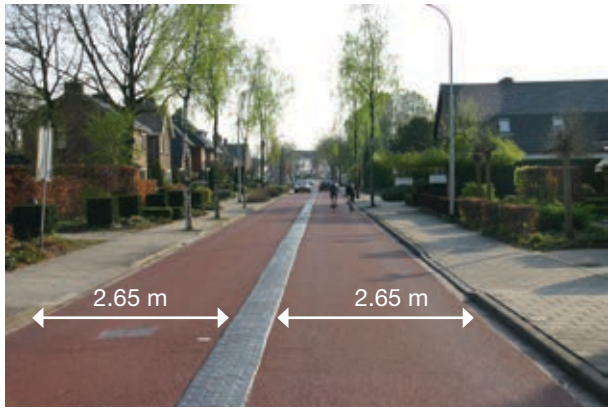
Figure 73. *Colour can be used to make the advisory cycle lanes easier to notice. (Tilburg)*

BICYCLE BOULEVARDS

Figure 74. *Bicycle boulevards are an excellent solution with several benefits. Cyclist can be directed to fast short cuts via quiet streets, away from the busy motor traffic. Also, the implementation of the boulevard does not require extra space. This two-way street in Tilburg city centre has been converted into a bicycle boulevard. Two-way motor traffic is still allowed, but through traffic is not.*

Figure 75. *This street running through a residential area was converted into a bicycle boulevard. (Delft)*

Figures 76 and 77. *This access lane in 's-Hertogenbosch has been converted into a bicycle boulevard.*



Figures 78, 79 and 80. *The main streets of this newly developed Nijmegen residential area were built as bicycle boulevards.*

Figures 81 and 82. *In Houten, the city street network is largely based on bicycle boulevards shared by cars and bicycles.*

SLOW STREETS

Figure 83. *The narrow streets of this Delft residential area accommodate mixed traffic. To facilitate cycling, cyclists are permitted to cycle against the one-way traffic.*

Figure 84. *Distinctive street hierarchy in Delft.*

Figure 85. *In the Netherlands, some cities have opted to bring down the speed limits on the residential area streets with speed bumps, chicanes or other structural means located every 75 metres. (Delft)*

Figures 86 and 87. *Cycling comfort can be increased by applying traffic calming devices for vehicular traffic only. Cyclists can bypass the devices. The cycle lanes in figure on the left are of the advisory cycle lane type. (Delft and Copenhagen)*

Figure 88. *Pleasant access street in Rijen.*

Figure 89. *In the Netherlands, horizontal deflections are used to slow down driving speeds on the access roads. (Rijen)*

Figure 90. *Planting can be used as traffic calming devices, adding simultaneously to the comfort of the street space. (Odense)*

Figure 91. *Elegant new residential area in Odense. Streets are curvy in order to slow the traffic down. This makes the streets safe for children to play on, increasing the utilisation rate.*

Figure 92. *Planting adds comfort to the streets and slows the traffic down. (Freiburg)*

CYCLING AGAINST THE TRAFFIC ON ONE-WAY STREETS

Figure 93. *It is advisable to permit cycling against the traffic on one-way streets. It makes cycling faster and easier by eliminating unnecessary detours. (Ghent)*

Figure 94. *Cycling against the traffic on a one-way street with a cycle lane. (Vienna)*

Figure 95. *To improve safety, advisory cycle lanes can be used on one-way streets, permitting cycling against the traffic. (Breda)*

Figure 96. *Street markings for the cyclists riding against the traffic in a Copenhagen intersection.*

Figure 97. *Intersections are potentially problematic on one-way streets permitting cycling against the traffic. One good solution is to use a traffic divider to separate the cyclists from the oncoming vehicular traffic. This prevents the motorist from blocking the cyclist's way. (Vancouver)*

CAR-FREE STREETS

Figures 98 and 99. *In Delft, cycling conditions have been improved by limiting or prohibiting vehicular traffic on the narrow city centre streets.*

Figure 100. *The pleasant and safe main street of Houten city centre. Cars are not allowed on the main street.*

Figure 101. *Banning vehicular traffic allows for the implementation of high quality cycleways in the city core. The width of the motor vehicle streets is usually quite adequate for this (Lappeenranta, Kauppakatu, concept image).*

Visual presentation of the street: Juuso Iivonen

Figures 102 and 103. *Comfortable cycling conditions in 's-Hertogenbosch city centre. The figure on the left shows cyclists using roadways formerly reserved for cars. The figure on the right is from the pedestrian street with designated space for cyclists, albeit shared with the pedestrians.*

Figures 104 and 105. *Delft (left) and 's-Hertogenbosch (right) use automatic bollards to restrict access by cars to the city core. Cyclists can bypass the island with ease. The bollards are equipped with thermoswitch-controlled heating to ensure proper operation in cold conditions.*

Figure 106. *In the University of Utrecht campus centre, the traffic routes consist of cycleways, bus streets and pavements.*

Figure 107. *Construction work on the ring road around Odense city centre in 2012. The aim was to limit vehicular traffic through the centre. To avoid differences in levels, the cycleway runs along the cut.*

Solutions for intersections

Safety and smoothness first

Figures 108 and 109. *Where a left turn is hazardous for cyclists, the two stage turn is a good solution. As with the advanced stop line, the stop line for the cars should be located five metres prior to the stop line for the cyclists. Contrary to the advanced stop line, the cyclists turn left by first continuing straight through the intersection and then crossing the intersection again. (Figures: above from Breda, below from Odense)*

Figures 110 and 111. *At intersections, cycleways or lanes can be built to run separate from the vehicular traffic (figures: above from Breda, below from the Hague)*

Figures 112 and 113. *In the Netherlands, intersections are usually designed so that cyclists do not need to cross the roadway. Cars cross the cycle lane when turning to the right. (Delft)*

Figure 114. *Cars are not allowed to turn on the bicycle boulevard diverging to the right. The island is there for the cyclist coming from the bicycle boulevard. (Tilburg)*

Figure 115. *Advanced stop line for cyclists turning onto the intersecting cycleway. (Tilburg)*

Figure 116. *Right turn on red for cyclists in Odense. Cycleway passes the traffic lights.*

Figure 117. *Right turn on red for cyclists indicated on a signal support. (Delft)*

Figure 118. *A sign warning the motorist turning right of the cyclists going straight on. (Delft)*

Clearly indicated obligation to give way

Figures 119 and 120. *A cycling highway crosses a collector street. Motorists give way to the cyclists.*

Figure 121. *An exemplary pedestrian and bicycle crossing. (The Hague)*

Figure 122. *The cyclist's obligation to give way is also marked clearly on the islands. (The Hague)*

Cyclists giving way to other cyclists

Figure 123. *At intersections, cyclists adhere to similar rules to vehicular traffic. Markings for getting into the correct lane and the obligation to give way are clear. Pedestrians use the pedestrian crossing. (Delft)*

Figure 124. *At this dangerous intersection with poor visibility distance, cyclists coming from the intersecting cycleway are obliged to give way. (Delft)*

Figure 125. *A cycleway intersection alongside general traffic streets. The intersecting streets have one-way cycleways. Cyclists coming from the left must give way to the cyclists going straight ahead. Those turning left have a separate lane. (Odense)*

From side street to cycleway

Figure 126. *Cyclists coming from the side street have straightforward and clear access to the cycleway. When crossing the main street to turn to the side street, cyclists must give way to the vehicular traffic. (Delft)*

Figure 127. *On quiet intersections cyclists follow the same rules as motorists. The intersecting collector street has cycleways on both sides. (Odense)*

Grade separations

Figure 128. *The slope to the cycleway underpass is not as steep as that to the roadway. There is no need for the cycleway underpass to be as high as the roadway underpass.*

Figure 129. *In this Nijmegen cycleway underpass, the steepness of the slope has been minimised (max 4%) by building a long ramp to the underpass and by raising the roadway (0.8 m). Pedestrians have a separate route in the underpass under the roadway.*

Figures 130 and 131. *Grade-separated cycleway intersection. The ramp on the left leads down to an intersecting cycleway. The gentle slope increases cycling comfort. Signs are used as per regular road traffic. (Odense)*

One-way roundabouts

Figure 132. *A separate one-way cycleway has been found to be the safest solution on roundabouts. (Nijmegen)*

Figure 133. *A one-way cycleway joins a roundabout next to a road-way. The barrier between the road-way and the cycleway prevents the motorists from using the cycleway as a short cut. (Odense)*

Figure 134. *A two-way cycleway joining a one-way cycleway on a roundabout. The solution works. It is similar to the one used by the cars on the roundabout. (The Hague)*

Figure 135. *Straight cycleway bypassing a roundabout. Cyclist turning left use the roundabout. When on the roundabout, cars and cyclists share the same roadway. (Odense)*

Two-way roundabouts

Figure 136. *Smooth two-way cycling on a roundabout made possible through good designing. Good visibility distances and clearly marked cycling directions facilitate navigation on the roundabout and improve the safety of the cyclists. ('s-Hertogenbosch)*

Figure 137. *A two-way roundabout cycleway changes into a one-way cycleway. Due to the high cyclist flows to and from the university, parts of the roundabout cycleways have two-way traffic. Good design ensures that the solution works properly. (Nijmegen)*

Figure 138. *The cycleway encircling the roundabout has been raised above the level of the roadway. Two-way traffic is indicated with clear street markings and traffic signs. The motorist's obligation to give way is also clearly indicated. ('s-Hertogenbosch)*

Figure 139. *The obligation to give way to cyclists already on the roundabout is marked clearly. The guidance and warning surface for people with visual impairments is applied on the cycleway crossing. ('s-Hertogenbosch)*

Parking solutions

Figure 140. *Black Sheffield cycle stands in the Delft city centre's pedestrian square.*

Figure 142. *Bicycle parking in Delft city centre.*

Figure 141. *Lockable bicycle boxes in a Delft residential area.*

Figure 143. *Sheffield cycle stands by a store entrance in the Delft pedestrian area.*

Figure 144. *Parking bays converted for bicycle parking (London).*

Figure 145 *In Odense, designers have come up with elegant covered parking stands for bicycles. The stands have a stylish lighting system, too.*

Figure 146. *The entrance to the street-level stores has been moved into a bay providing covered bicycle parking by the door. (Utrecht)*

Sources

[1] CROW, 2006. Design manual for bicycle traffic. English translation in 2007. Record 25. CROW. Ede, the Netherlands, pp. 18–22.

[2] Cycling Embassy of Denmark, 2012. Collection of cycling concepts 2012. Cycling Embassy of Denmark. Copenhagen, Denmark, p. 57.

[3] Kouri, Pekka, 1993. “Keskusta-alueiden pyöräliikenneverkot”. Licentiate thesis. Tampere University of Technology. Tampere, Finland.

[4] I-CE, 2009. Cycling-Inclusive Policy Development. A Handbook. Interface for Cycling Expertise, Deutsche Gesellshaft für Technische Zusammenarbeit. Utrecht, the Netherlands, pp. 70–73.

[5] PRESTO, 2010. PRESTO Cycling Policy Guide. Cycling Infrastructure. http://www.PRESTO-cycling.eu/en/. Accessed 29 December 2011. pp. 8–9

[6] I-CE, 2009. Cycling-Inclusive Policy Development. A Handbook. Interface for Cycling Expertise, Deutsche Gesellshaft für Technische Zusammenarbeit. Utrecht, the Netherlands, pp. 59-62.

[7] CROW, 2006. Design manual for bicycle traffic. English translation in 2007. Record 25. CROW. Ede, the Netherlands, pp. 30–33, 60–66.

[8] Van Goeverden, Kees & Godefrooij, Tom, 2011. The Dutch Reference Study. Cases of interventions in bicycle infrastructure reviewed in the framework of Bikeability. Delft University of Technology, Department of Transport & Planning. Delft, the Netherlands.

[9] CROW, 2006. Design manual for bicycle traffic. English translation in 2007. Record 25. CROW. Ede, the Netherlands, pp. 26-38.

[10] Furth, Peter G., 2012. Bicycling Infrastructure for Mass Cycling: A Transatlantic Comparison. John Pucher & Ralph Buehler (ed.): City Cycling. Massachusetts Institute of Technology, pp. 105–139.

[11] Copenhagenize Design Co., 2013. The Copenhagenize Bicycle Planning Guide. 19 April 2013. http://www.copenhagenize.com/2013/04/the-copenhagenize-bicycle-planning-guide.html. Accessed 6 August 2013.

[12] Van Goeverden, Kees & Godefrooij, Tom, 2011. The Dutch Reference Study. Cases of interventions in bicycle infrastructure reviewed in the framework of Bikeability. Delft University of Technology, Department of Transport & Planning. Delft, the Netherlands, pp. 87–88.

6

Kaisa Karhula

Best practices for cycle path winter maintenance processes

Winter maintenance in Finland

Street maintenance is the responsibility of the municipality

In Finland, the law states that maintenance and public sanitation of streets and certain public areas are the responsibility of the municipality. The owner of a plot has a duty to take care of the maintenance of the pavement next to plot by keeping it clear of snow and taking care of gritting and salting, for example. Figure 1 presents the responsibilities related to street maintenance. It is also possible for the municipality to take over the maintenance of the pavements belonging to the plot owner. [1]

According to the law, the municipality has the right to prioritise the streets to be maintained. This makes it possible to give priority to the maintenance of more significant transport routes. The maintenance classification should be performed separately for vehicle traffic, and footways and cycle paths. According to the Maintenance and Public Sanitation Act, the roads must be kept in a satisfactory condition for traffic. However, the Act does not define a specific level for the quality of the maintenance, leaving this the responsibility of each respective municipality. [2]

Therefore, it is the task of a municipality to organise the maintenance as well as to define the level of quality and the actions and measures to meet this level. Hence the criteria of time limits, snow thickness or the methods to be used, for example, can vary significantly between cities. The importance of winter maintenance of cycle paths and footways also varies between cities.

According to the Maintenance and Public Sanitation Act, the roads must be kept in a satisfactory condition for traffic. However, the definition of the level of quality is the responsibility of the municipality.

Street maintenance and sanitation responsibilities

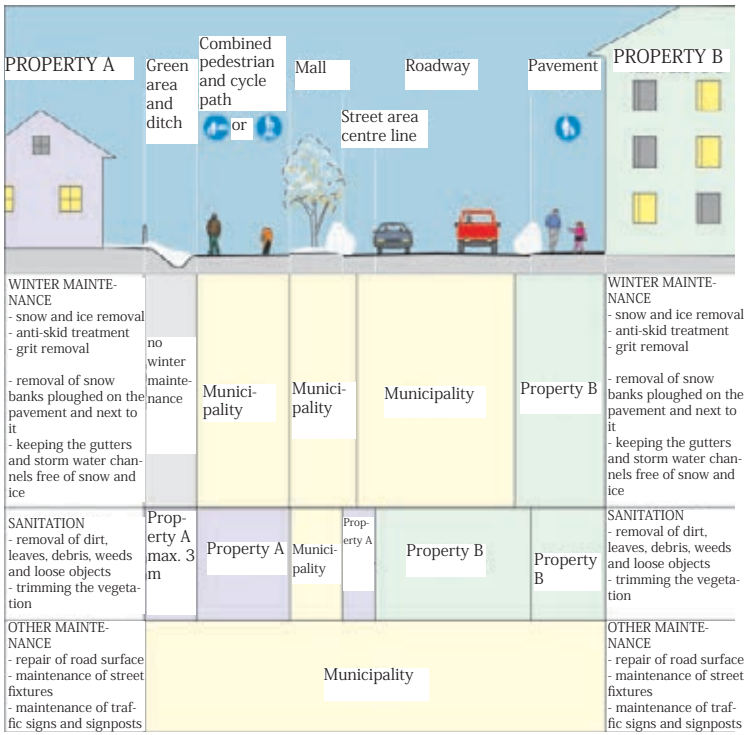


Fig. 1. *Street maintenance responsibilities. In principle, pavement maintenance is the responsibility of the property owner, and the municipality takes care of the other traffic routes. [3]*

Challenges in cycle path winter maintenance

Winter maintenance is one of the most important means available for controlling cyclist and pedestrian volumes during the winter months. The number of cyclists can be increased by keeping the routes free from snow and ice. Cycling usually declines during the snowy winter period: in the summer time, there can be up to 10 times more cyclists on the roads. Although the snow conditions in many Finnish cities are challenging, the number of cyclists can be significantly increased by improving winter maintenance. Cycling is also possible in winter as long as winter maintenance is used to create sufficient conditions for it. [4] [5]

Fig. 3. *The excess snow ploughed from the road often piles up on cycle paths and footways located next to the road.*

Fig. 2. *Snow ploughed on cycle path makes safe movement difficult and encourages cyclists to use the road instead.*

Fig. 4. *In winter maintenance, intersections are often problematic. The snow tends to pile up at the ends of the pedestrian crossings, making them more difficult to use for pedestrians and cyclists.*

Implementation of the study

Example cities

In order to find the best cycle path winter maintenance practices, four Nordic example cities were selected: Copenhagen, Denmark; Linköping and Umeå, Sweden and Oulu, Finland. The material was collected by separately interviewing the employees responsible for maintenance in each respective city. In all cities, the winter maintenance of cycle paths and footways has been prioritised, and various practices are used to maintain a high-quality network of cycling and pedestrian routes throughout the year.

Copenhagen's winter maintenance processes are among the most effective. The city lives up to its cycling city reputation in summer and winter, as the efficient and proactive use of salt prevents the cycle paths from icing over, keeping the cycling conditions safe throughout the year. Linköping has set stringent quality requirements for the city's 90-km long main cycle path network. Snow coverage of 1 cm is enough to send the combined snow sweeping/salting vehicles into action to clear the cycle paths of snow and to prevent the road surface from freezing over. In Umeå, the snow conditions are challenging. To ensure a good level of quality, the City has subsequently decided to maintain the streets in the city centre area itself. Oulu is probably the best-known cycling city in Finland. Thanks to good winter maintenance, cycling is a quick and efficient alternative to motoring, even in the winter time.

The methods used to achieve a high winter maintenance quality in the example cities differ. The winter maintenance process and methods used are adapted to the city-specific characteristics and weather conditions. A common feature for all of the cities is that they appreciate the cyclists' needs and prioritise these in their winter maintenance processes.

Fig. 5. *Example cities in Finland, Sweden and Denmark.*

Winter conditions in the example cities

Winter maintenance is mainly organised based on the weather conditions, which vary from city to city. In Copenhagen, there is not a lot of snow in the winter, but slipperiness often causes problems. In Oulu and Umeå, the ground may be covered with snow for more than 150 days of the year. This means that ploughing and snow storage become critical factors. In Linköping, the winter conditions are somewhere in between those of the other cities. See Table 1 for winter conditions in the cities studied.

	Linköping	Umeå	Copenhagen	Oulu
Inhabitants	147,334 (2011)	117,294 (2012)	549,050 (2012)	190,847 (2013)
Length of winter	75 days of snow coverage (on average, 1961–1990)	150 days of snow coverage (on average, 1961–1990)	Cold season 21 Nov –22 Mar	160–175 days of snow coverage (on average, 1981–2010)
Mean temperature	Approximately 6 degrees (yearly mean temperature, 1961–2011)	Approximately 3 degrees (yearly mean temperature, 1965–2011)	The highest daytime temperature: below 6 degrees (on average, 21 Nov–22 Mar)	2–3 degrees (annual mean temperature)
Snow depth	20 cm (on average, 15 Feb 1981–1990)	50–60 cm (on average, 15 Feb 1981–1990)	6.8 cm (greatest depth on average, 8 Jan)	40–60 cm (on average, 15 Mar 1981–2010)

Table 1. *Winter conditions in the example cities. [6] [7] [8] [9] [10] [11] [12]*

Linköping

Umeå

Copenhagen

Oulu

Winter maintenance processes in example cities

One step at a time toward objectives

Efficient and effective winter maintenance requires a well-planned maintenance process. Each part of the process must function seamlessly together to ensure a route that is safe and easy to navigate. Each study city has worked out their winter maintenance differently, but the level of cycle path and footway maintenance quality has been raised to a high level in all of them. It is even higher than that applied to road maintenance. See Table 2 for some key figures related to winter maintenance in the example cities.

With regard to winter maintenance, it is particularly important that the City upholds the set quality requirements and that the high winter maintenance levels are adhered to. Because it is seldom possible to achieve the high-quality standards with respect to the whole route network, Linköping and Umeå, for example, have prioritised a network of routes to be maintained at a particularly high maintenance quality level. The network is used to inform the citizens of the routes that are suitable for pedestrians and cyclists throughout the year, regardless of the weather. Cyclists and pedestrians must be assured that the route is always going to be safe to use.

It is wise to start improving the quality of winter maintenance through small actions rather than trying to raise the quality level of the entire network immediately. For example, by selecting one of the most heavily-used cycle paths and then promising to keep it in good condition, it is possible to show the inhabitants what a high level route at its best can be like. This way, you can attract more people to engage in winter cycling.

In Umeå, for example, the maximum snow coverage on the prioritised cycle path network was previously 2 cm. However, the City soon realised that keeping up that quality level was too challenging, and the snow limit was raised to 4 cm. The citizens have been happy with this change, because they now know what kind of winter maintenance quality level to expect. Even with the raised snow limit, the high-quality winter maintenance in Umeå makes cycling easy.

Quality criteria must be set so that the stated quality level can be maintained throughout the entire winter.

	Linköping	Umeå	Copenhagen	Oulu*
Snow ploughing times per winter	100, class I cycle paths 25, class II cycle paths (on average)	30, class I cycle paths 15, class II cycle paths (on average)	29, cycle paths 9, footways (2011/12)	36, in total class I and II routes (2012)
Anti-skid treatments per winter	100, class I cycle paths 25, class II cycle paths (on average)	19, class I and II cycle paths (on average)	29, class A cycle paths 9, footways (2011/12)	16, in total class I and II routes (2012)
Amount of snow removed per winter	200,000–300,000 m^3 (on average)	162,520 m^3 (2011/12)	In an average winter, snow removal is not required	approximately 300,000 m^3 (including footways in the city centre)
Budget per year	Footways and cycle paths approximately 2.4 million in EUR (20 million in SEK)	Total budget approximately 4.1 million in EUR (about 35 million in SEK) Cycle paths approximately 0.8 million in EUR (about 7 million in SEK)	Total budget 4.7 million in EUR (35 million in DKK), Cycle paths and footways not separated	EUR 720,000 per year, class I pedestrian and cycle routes EUR 550,000 per year, class II pedestrian and cycle routes
Cycle paths, km	Ca. 560 km (including the prioritised 90 km long network) (2012)	67 km, prioritised routes 171, other cycle paths and footways (2012)	358 km (2012)	600 km (2012)

Table 2. *Key figures related to the winter maintenance of the study cities.*

** The number of times City of Oulu snow ploughs and anti-skid treatments are employed and the amount of snow removed only include maintenance actions carried out by Oulu technical public utility (TEKLI), not outside contractors.*

Linköping

Prioritised 90-km cycle path network

In total, there are approximately 560 km of cycle paths and footways in the Linköping city area. Out of that, approximately 90 km belong to the prioritised cycle path network. The network is designed to connect the most important business areas, the university, schools and the city centre to the residential areas. The winter maintenance requirements are higher for the prioritised network than on other cycle paths. The snow limit is 1 cm, and maintenance is carried out using a combination of sweeping and salting. Thanks to the prioritised network, the residents can rest assured that certain routes will be easily accessible for cyclists and pedestrians throughout the winter.

The general snow limit on Linköping's street plan is 3 cm (except for the local streets belonging to the 'lokalvägnät' where it is 5 cm) for cycle paths and roads alike. Time limits have been placed to prioritise the winter maintenance criteria of the city centre and travel centre areas. The city centre must be clear of snow within 6 hours and the travel centre within 3 hours after the snowfall has stopped.

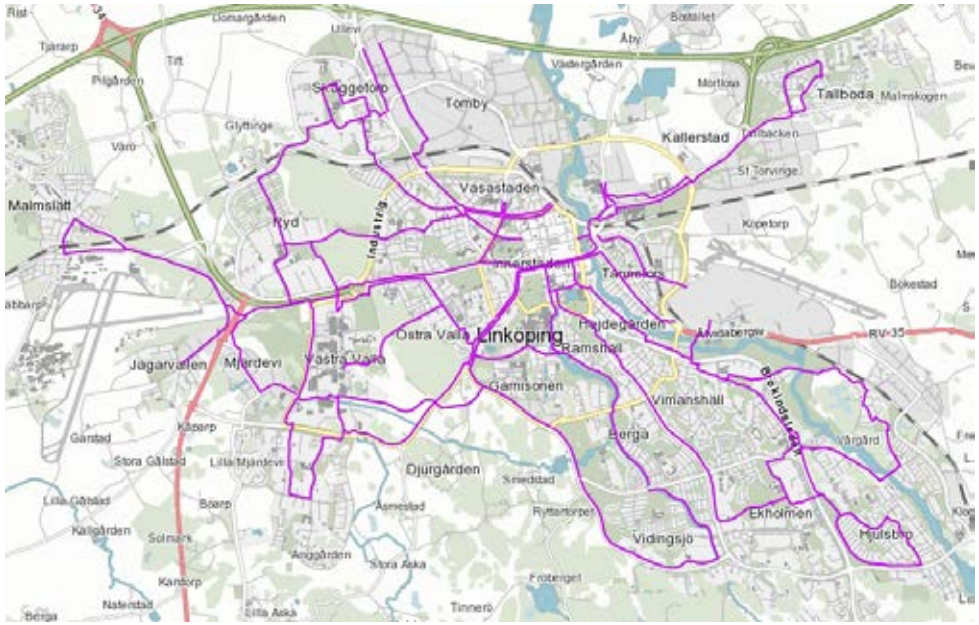


Fig. 6. *The snow limit for Linköping's prioritised 90-km cycle path network is 1 cm. [13]*

Maintenance requirements

Prioritised 90-km cycle path and footway network

- Snow limit 1 cm
- Work must be completed within 4 hours from when the snow limit is reached
- Work methods used are sweeping and salting. If the temperature falls below –10 degrees, salt cannot be used. When the snowfall is heavy, plough is used instead of sweeping.

Other cycle path and footway network

- Snow limit 3 cm
- Work must be completed within 8 hours from when the snow limit is reached
- Methods used are ploughing and sanding

Works contracts

There are seven contract areas in Linköping, and six contractors. The works contracts are awarded for five years at a time. The contract period is designed to be long enough to make it worthwhile for the contractors to invest in new equipment, for example. The contracts are mainly based on geographical areas, with the exception of the prioritised 90-km cycle path and footway network, the maintenance of which has been given to a single contractor, even though the network passes through several separate contract areas. This way, only one contractor has had to acquire the special sweeping and salting equipment required. A continuous contract area also ensures that the quality remains uniform throughout the route.

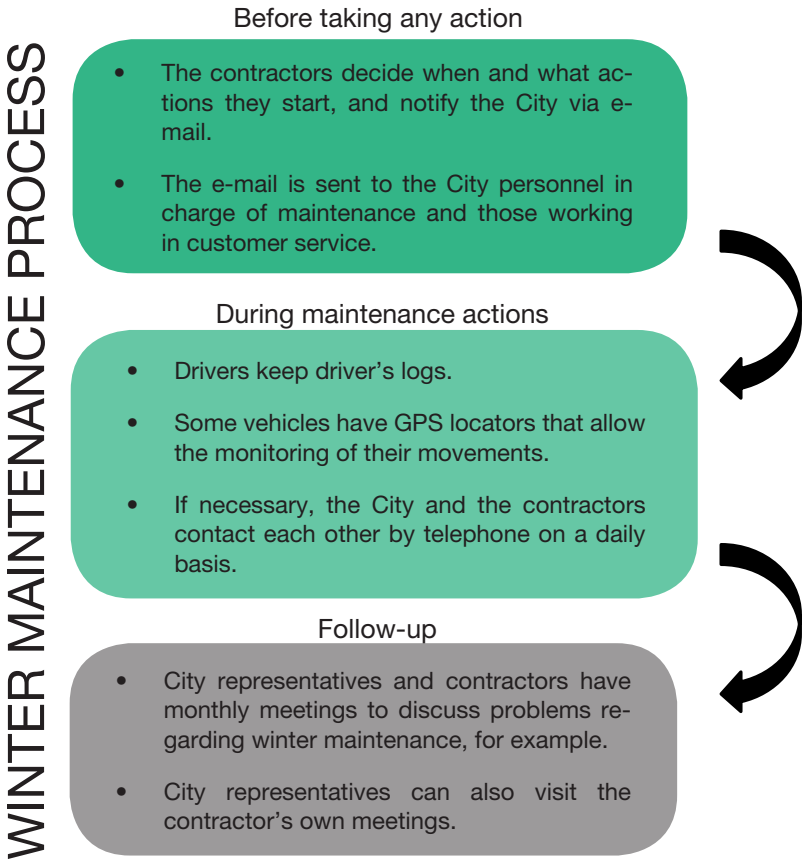
The contractors decide themselves when they start the maintenance, but they are required to send an e-mail notification before starting each action. This is to make sure that the city personnel in charge of the maintenance are aware of the status of the street network. An e-mail will also be sent to the City's customer service centre so that they are able to answer any questions regarding the winter maintenance.

Figures 7 and 8. *The prioritised cycle path network is maintained using a method that combines sweeping and salting. During heavy snowfall, ploughing is used instead of sweeping.*

Working dialogue with the contractors

When necessary, the City is in contact with the contractors on a daily basis. In their monthly meetings, the City and the contractors discuss the work carried out and any problems that may have arisen. Sometimes the City personnel in charge of the maintenance take part in contractor meetings and meet the drivers themselves. This way, they have the opportunity to discuss important matters at the grassroots level and, on the other hand, to hear the views and comments of the drivers regarding winter maintenance.

Some contractor equipment has GPS locators, enabling the City to monitor the maintenance actions. The GPS locators make it easier to track where the driver has been at any given time and to verify that all routes are cleared as agreed. The locator also provides detailed location information on possible road surface failures or other problems reported by the driver. The City's goal is to have GPS locators available on all contractor equipment.



Pavement maintenance

In Linköping, pavement maintenance is the responsibility of the property owner. However, not all property owners carry out their duties in accordance with the required level, which can cause problems – especially in the city centre. Therefore, the City initiated a project which aimed to get the property owners to purchase winter maintenance services for their respective pavements from the contractor managing the area. This way, the pavements could be maintained at the same time as the other parts of the routes, thus improving quality levels. The method was tested during winter 2012–2013 on one street section, and the results were promising.

Fig. 9. *In Linköping, the heating system keeps the pedestrian areas clear of ice.*

Fig. 10. *In Linköping, as is the case with Finnish cities, pavement maintenance is the responsibility of the property owner.*

Umeå

Prioritised cycle path and footway network

There is a total of approximately 240 km of cycle paths and footways in Umeå. Of these, 67 km belong to the prioritised cycle path and footway network, which has more stringent winter maintenance quality requirements. The prioritised network connects all residential areas to the university, hospital and the city centre. Most of the residents work or go to school within these areas, so good connections are important.

The City has drafted a winter maintenance quality declaration, which guarantees that the main streets will be ploughed after a 4–6 cm snowfall, and the prioritised cycle paths after a 4 cm snowfall. On the other cycle paths and footways, the snow limit is 6–8 cm. On the prioritised network, the goal is to carry out proactive anti-skid treatment.

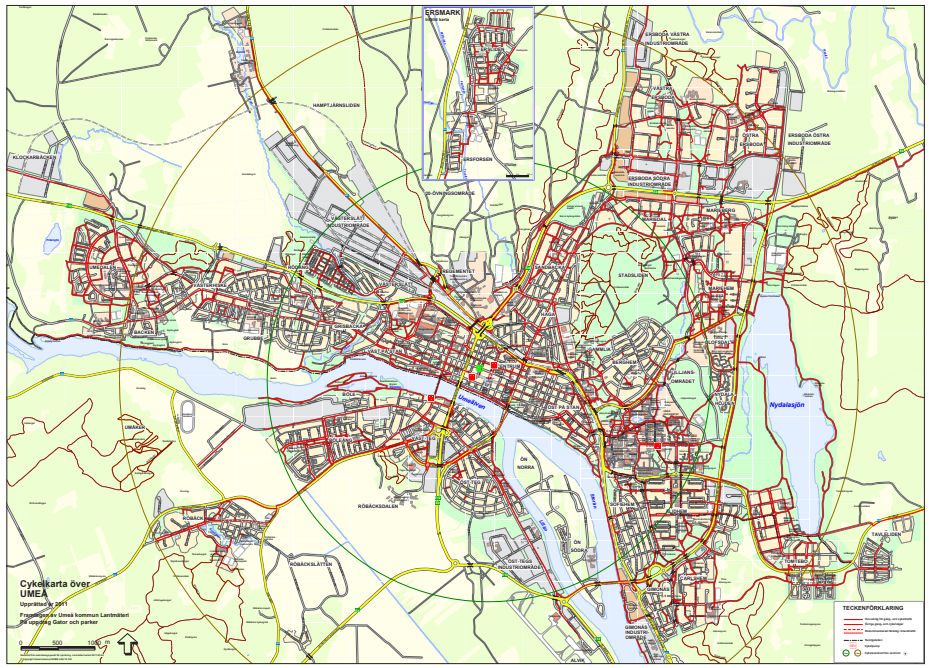


Fig. 11. *In Umeå, the prioritised cycle path and footway network extends to different parts of the city. Other cycle paths complement the network. [16]*

Warm wetted sand

In the warm wetted sand method, sand is mixed with hot water before applying it to the road surface. This makes the sand stick more effectively to the surface, providing higher traction than in normal sanding. In particular, this method is suitable for conditions where the temperature is below –1 °C. [14]

The method was introduced in Umeå in 2006 and during the winter of 2011–2012 the properties of the method were studied by VTI (Statens väg- och transportforskningsinstitut) [15]. The warm wetted sand was found to be more effective than normal sand but slightly more expensive. The efficiency of the method, however, cuts the number of sanding times required. Therefore, there was no significant increase in total costs after introducing the method in Umeå.

Maintenance requirements

Prioritised cycle path and footway network

- Snow limit 4 cm
- Anti-skid treatment should be carried out proactively
- Methods in use are ploughing and warm wetted sanding

Other cycle path and footway network

- Snow limit 6–8 cm
- Anti-skid treatment is applied when ice is detected
- Methods used are ploughing and sanding

Works contracts

In Umeå, the City itself is responsible for winter maintenance in the city centre. The maintenance of the other city areas have been awarded to an outside contractor with a 3-year works contract. The contract can, however, be extended by a further 2 years. Allthough it is more expensive for the City to maintain the city centre itself than using an outside contractor, the City wants to invest in the quality of the maintenance. It is possible to guarantee high quality and invest in small details by using your own personnel than by using an outside contractor.

External contractor decides on the actions they take independently, but they must contact the City before starting any actions. Subsequently, the City always has two employees on standby to receive the notifications from the contractors and to control the maintenance work. In order to manage the maintenance more efficiently, the City aims to take more responsibility for decision-making regarding, for example, when the actions should commence.

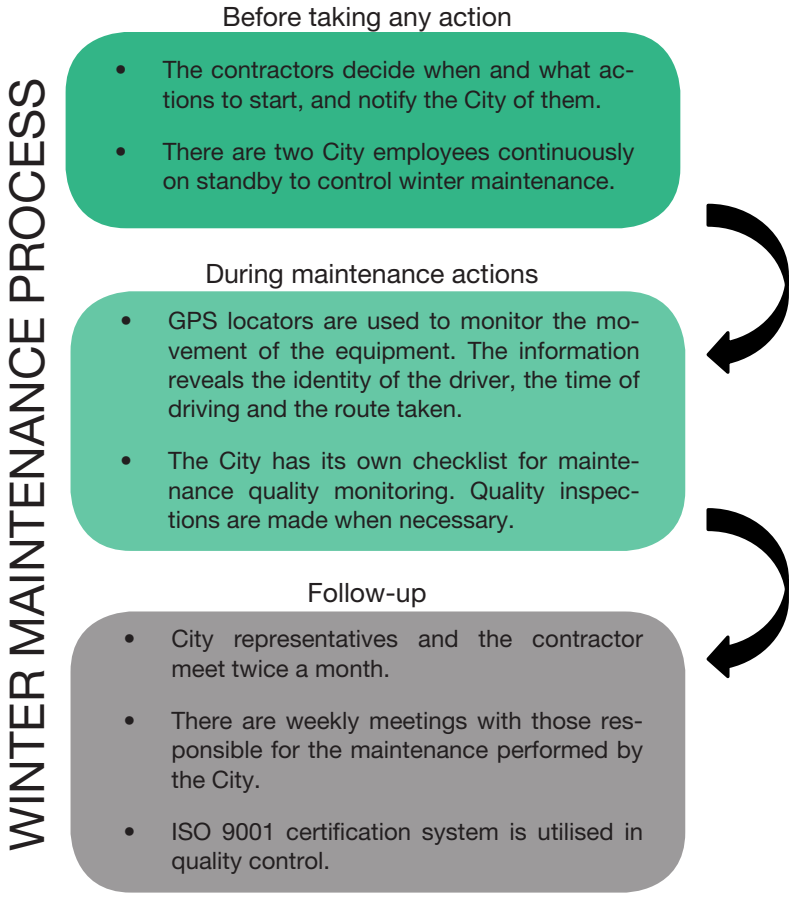
Figures 12 and 13. *In Umeå, the prioritised network is used to separate the cycle path network from other traffic in most locations, including the city centre.*

GPS locators make monitoring easier

The street and park department at the City of Umeå uses the ISO 9001 certification, with which the quality of the winter maintenance is monitored and evaluated. A GPS tracking system helps with quality control and devices have been installed in the equipment of both the City of Umeå and the contractor. The system makes it possible to track the movements of the maintenance equipment along the road network, and to identify the driver and the time of day. In particular, this makes it easier to monitor the actions carried out by the contractor and, on the other hand, to locate problematic areas on the map.

Furthermore, the City and the contractor also meet twice a month in the winter time. In order to bring up any problems and to be able to address them as soon as possible, there are weekly meetings with those responsible for the maintenance performed by the City.

Fig. 14. *The City of Umeå has opted to build green areas between the cycle paths and footways and the road, and use them for snow storage.*



De-icing system

In Umeå, the most important cyclist and pedestrian underpasses and bridges are heated. Heating is used to ensure that these locations are safe to move in. In some locations, the motive has been to minimise the risk of winter maintenance damage to a particularly expensive surface material.

The heating system utilises district heating circulating water. De-icing systems cost 2.5–3 times more compared to the traditional maintenance methods, but the benefits they offer are deemed to outweigh the higher costs.

Copenhagen

Continuous cycle path network

In Copenhagen city centre, the street space is usually divided into three parts: road, one-way cycle path edged with kerb stones, and pavement. There is a total of 358 km of cycle paths, and they are kept free from snow by sweeping or, in case of heavy snowfall, ploughing. The main method of anti-skid treatment is salting, and the aim is to use it proactively on the cycle paths. Like Linköping, Copenhagen also uses combined sweeping and salting equipment.

The three different maintenance classes in use in the city are A, B and C, of which class A is of the highest quality. All cycle paths belong to class A, and all pavements to class B. The snow limit for classes A and B is 2–3 cm. The roads may belong to class A, B or C. Class C routes are cleared of snow only after the higher class routes have been cleared.

The quality of Copenhagen's winter maintenance is based on proactive salting. The aim is to apply salt to the cycle paths before they freeze, which ensures safe cycling, regardless of the weather.

Fig. 15. Copenhagen has a comprehensive cycle path network that is separated from both motor and pedestrian traffic. [17]

Maintenance requirements

Class A (cycle paths)

- Snow limit 2–3 cm
- The aim is to keep the routes clear of ice at all times
- Methods used are sweeping/ploughing and salting

Class B (pavements)

- Snow limit 2–3 cm
- The aim is to clear any ice from the routes by applying anti-skid treatment with a few hours delay
- Methods used are sweeping/ploughing and salting

Works contracts

There are 40 different contractors operating citywide in Copenhagen. The contracts have been determined route-specifically, and the number of routes per contractor can vary. The duration of the contracts is four years. The route-specific contracts help to minimise quality issues when moving from one contract area to another, and the quality is even across the whole street network.

The contractors have agreed that the last contractor to arrive at a road junction clears the junction area of snow. This way, everybody knows whose responsibility it is. The City has also taken over some junction areas belonging to private roads that otherwise would not be under the City's maintenance responsibility. This is to ensure a high maintenance quality level throughout the city and on the main cycling routes.

The decisions regarding the winter maintenance actions in Copenhagen are made by the City. Winter maintenance is managed from a control room, from where things like weather conditions and sending orders to contractors to undertake actions are monitored. Thanks to the control room, dozens of contractors can be managed easily and in a systematic manner.

In Copenhagen, the last contractor to arrive at a junction is required to clear the junction area of snow.

Control room

The entire maintenance responsibility of the City of Copenhagen is controlled around the clock from the control room. There are always two duty officers monitoring the weather and making decisions on winter maintenance actions. The control room receives information from ten measurement locations around the city. Among other things, the points provide information about the amount of salt and traction on the routes' surfaces. Around-the-clock monitoring allows for high-quality winter maintenance, thanks to proactive salting.

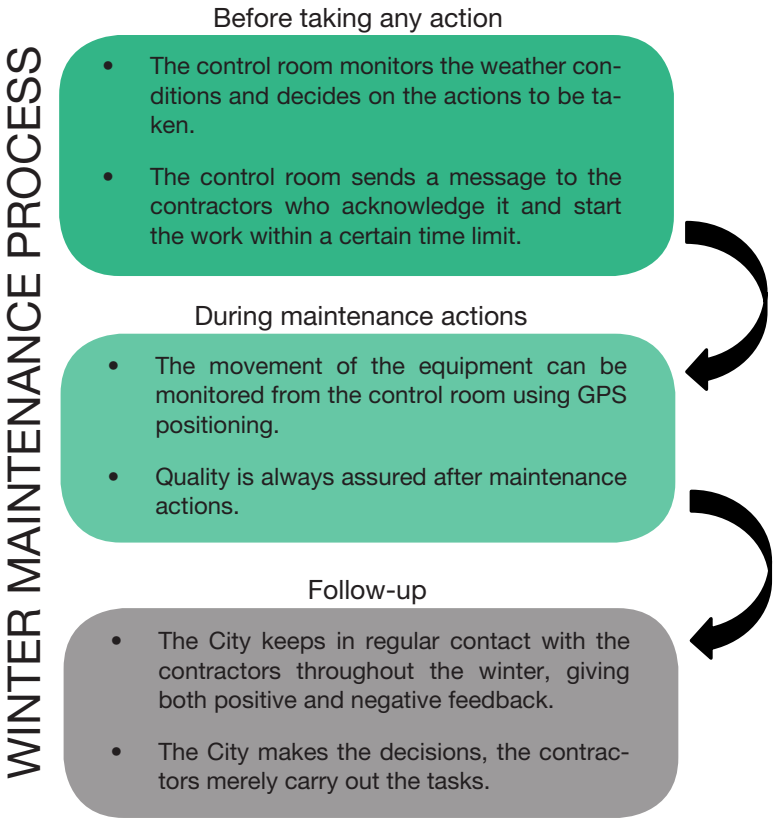
The duty officers can contact the contractors directly and instruct them on what actions should be taken. On the class A routes, the contractors have 45 minutes to start work after acknowledging the notification. On class B routes, the deadline is 1 h 15 min and on the class C routes it is 1 h 30 min. The movement of the contractors can be monitored via GPS locators.

Continuous monitoring

The City of Copenhagen has three employees who are responsible for monitoring the quality of the winter maintenance. Quality control takes place every time the equipment is on the move.

At the beginning of the winter the City has a meeting with all the contractors to explain the maintenance procedures. However, the City and the contractors exchange information continuously throughout the winter. The City aims to provide the contractors with both positive and negative feedback when necessary. The idea of the feedback is to let the contractors know that they are subject to constant supervision.

Fig. 16. *A salted and swept route offers good traction, making cycling safe and easy.*



Oulu

A separate and straightforward cycle path network

There are approximately 600 km of cycle paths in Oulu, the winter maintenance of which has been divided into two quality classes. On the class I cycle paths, the snow limit is 2 cm, and the routes are to be ploughed by the end of the following workday. In case of continuous snowfall, the snow limit is 3 cm. The snow should be ploughed before the following morning and afternoon rush hours at 7 am and 4 pm, respectively. If there is snowfall after 6 pm, it does not need to be ploughed before 7 am the following morning, unless the snowfall is in excess of 8 cm. On the class II cycle paths, the snow limits are 3 cm and 5 cm in case of a continuous snowfall. Slush should be removed from the cycle paths and footways when it reaches 3 cm on the class I routes and 5 cm on the class II routes. [18]

In general, the anti-skid treatment used on the cycle paths is ploughing and sanding. At certain locations, separate permission can be granted for the use of salt in spring and autumn. The ploughs use perforated blades so as not to create a slippery surface.

At the beginning of 2013, Oulunsalo, Haukipudas and Kiiminki merged with the City of Oulu, which is now also responsible for their winter maintenance. In this study, however, we only concentrate on the winter maintenance of Oulu proper.

Maintenance requirements

Class I

- Snow limit 2 cm, 3 cm during snowfall
- The aim is to keep the routes clear of ice at all times
- Ploughing and anti-skid treatment is carried out before 7 am and 4 pm. After 6 pm, the snow does not need to be ploughed unless the accumulated snow coverage thickness is over 8 cm.
- Methods used are ploughing and sanding

Class II

- Snow limit 3 cm, 5 cm during snowfall
- The aim is to clear any ice from the routes by applying anti-skid treatment with a few hours delay
- Ploughing and anti-skid treatment is carried out after the maintenance of the class I routes
- Methods used are ploughing and sanding

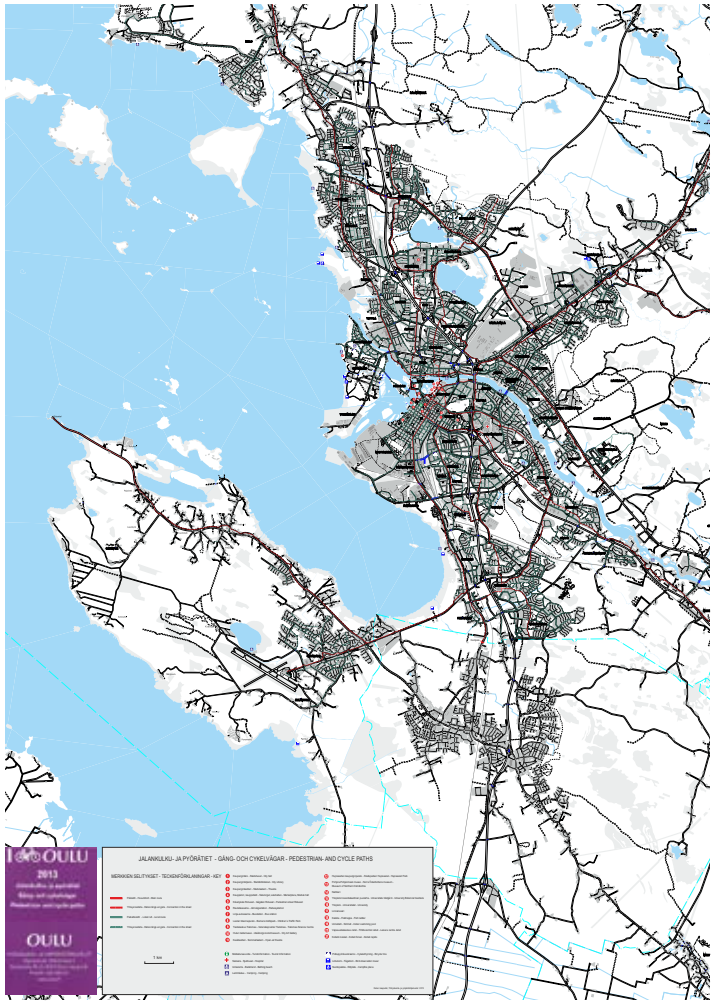


Fig. 17. *In Oulu, the cycle path network runs separate from the vehicle traffic, making winter maintenance easier and more efficient. [19]*

Works contracts

There are eight regional maintenance areas in Oulu proper, four of which are managed by the Oulu technical public utility (TEKLI). The other areas have been given to outside contractors. There are four outside contractors with four-year works contracts. The contract periods overlap so that all contracts do not expire at the same time. Therefore, one contract is tendered each year. As a result, contractors who lose the contract this year can bid for a maintenance contract in another area the following year.

The contractors decide themselves when to start the maintenance actions. However, the City contacts the contractors via telephone or e-mail to discuss actions when necessary. The monthly meetings between the City and the contractors cover issues such as what actions have been carried out, and feedback regarding maintenance.

TEKLI

The Oulu technical public utility, or TEKLI, began its operations in early 2008. As a public utility, it offers maintenance and building services, machine and transport services, and real estate and logistics services. A management board subordinate to Oulu City Council is responsible for the operations and viability of the department. At the moment, TEKLI is responsible for the maintenance of four contract areas. [20]

Fig. 18. *De-iced footways facilitate the use of bicycle racks in the winter, and covering the racks facilitates winter maintenance.*

Fig. 19. *In Oulu, the ploughed surface must not be left slippery, so the ploughs must use a perforated blade.*

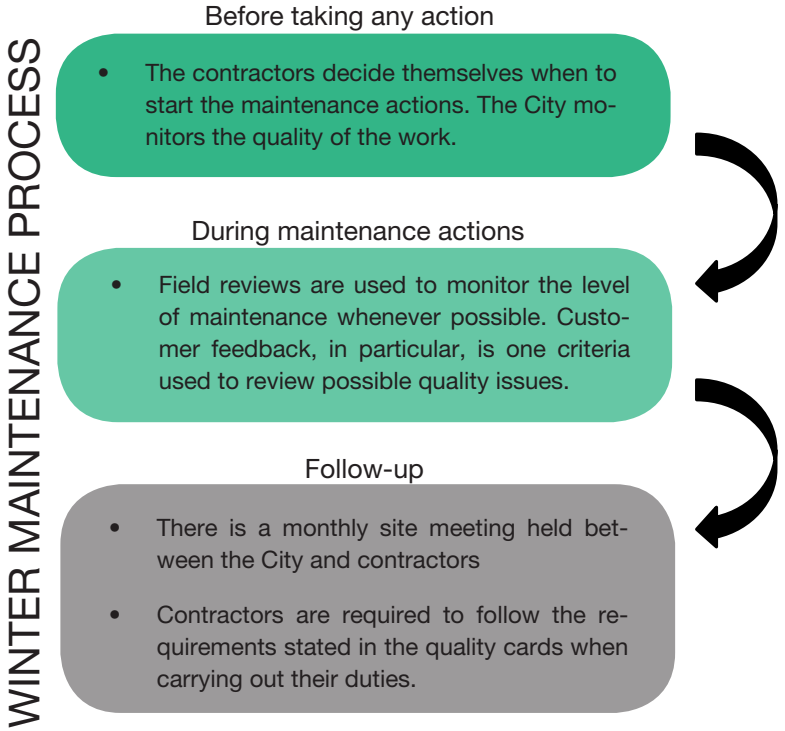
Follow-up

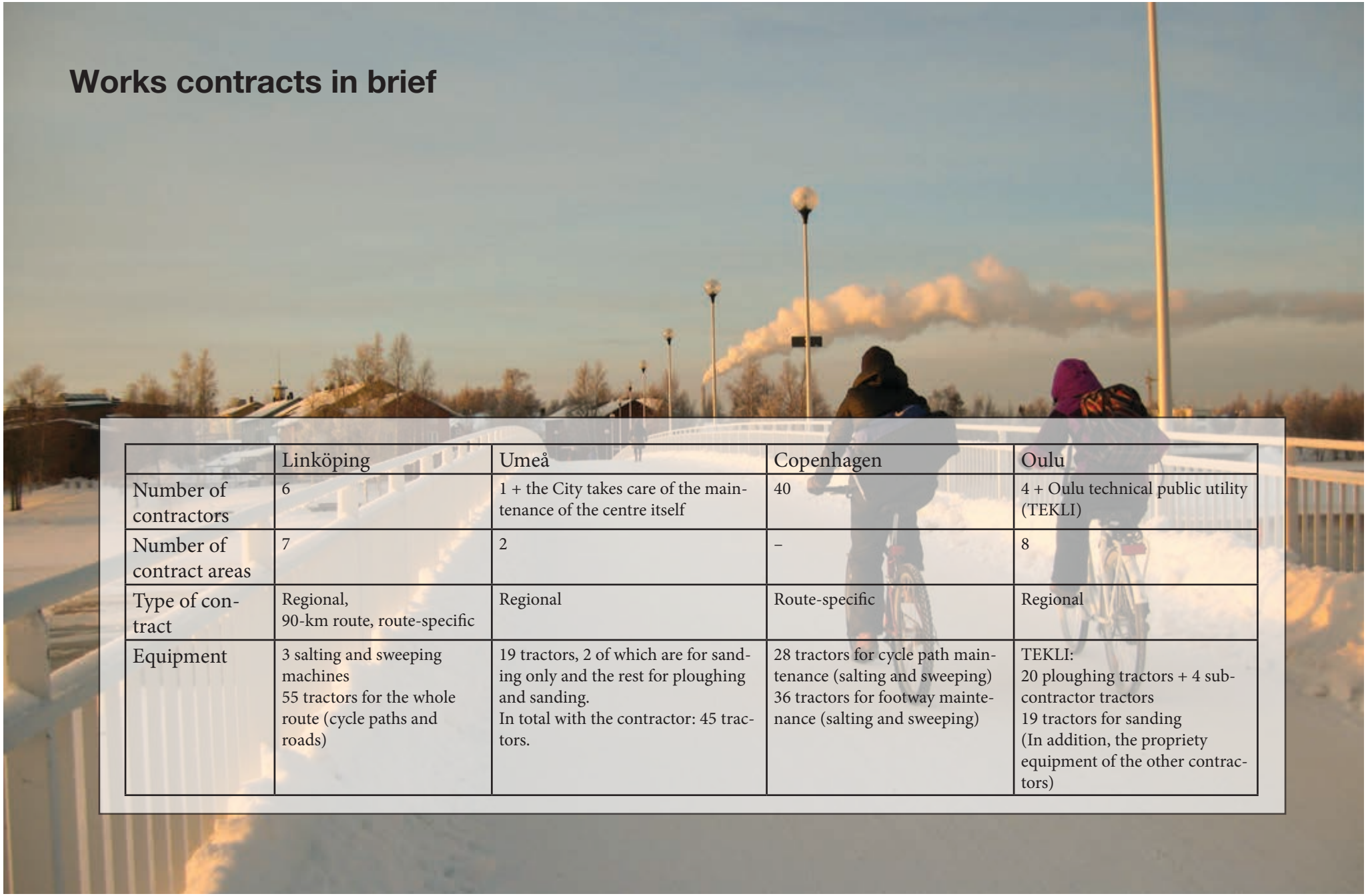
The contractors are not obliged to notify the City of the actions they carry out in real time, but the quality of the maintenance is monitored via inspections and field reviews. Inspections apply to TEKLI, too. The contractors must follow the winter maintenance criteria stated in the quality cards. Among other things, the cards specify the snow and time limits, the grade of sand to be used and the properties of the ploughing equipment.

The City also has a browser-based information website for saving contract-related documents such as works contracts, ploughing logbooks and quality cards. This facilitates communication between the City and the contractors and ensures that all parties have the same information at their disposal.

During 2013, Oulu implemented a GPS tracking system for ploughing and sanding equipment for a new area contract. The goal is to extend the use of the GPS system whenever new work contracts are concluded.

Fig. 20. *Junctions are often left unattended, especially where contract areas meet at a junction. With proper maintenance, however, it is possible to ensure safe crossing for cyclists and pedestrians alike.*





Works contracts in brief

	Linköping	Umeå	Copenhagen	Oulu
Number of contractors	6	1 + the City takes care of the maintenance of the centre itself	40	4 + Oulu technical public utility (TEKLI)
Number of contract areas	7	2	–	8
Type of contract	Regional, 90-km route, route-specific	Regional	Route-specific	Regional
Equipment	3 salting and sweeping machines 55 tractors for the whole route (cycle paths and roads)	19 tractors, 2 of which are for sanding only and the rest for ploughing and sanding. In total with the contractor: 45 tractors.	28 tractors for cycle path maintenance (salting and sweeping) 36 tractors for footway maintenance (salting and sweeping)	TEKLI: 20 ploughing tractors + 4 subcontractor tractors 19 tractors for sanding (In addition, the propriety equipment of the other contractors)

Communication with stakeholders

Linköping – dialogue is the key to success

In Linköping, the City and the contractors are engaged in an open dialogue. Both parties give feedback and contact each other by e-mail or phone on a daily basis during the winter when necessary. Although there are occasional winter maintenance quality problems in Linköping at junctions and contract area borders, for example, these issues are easily addressed through dialogue. An open, working dialogue ensures that issues can be solved quickly and easily by a single call, if necessary.

Besides the contractors, the City is in contact with various stakeholders during the winter. The public transport operator, for example, is informed in good time of any winter maintenance problems. This way, the operator can take the conditions into account and inform customers of any possible changes due to winter maintenance.

Umeå also informs its citizens

In Umeå, contractors are obliged to notify the City before starting any maintenance actions. The City utilises the information provided by the contractor efficiently to inform citizens. The web pages of the City contain continuously updated information about winter maintenance, including locations and what is happening next. This way, the citizens can check for themselves exactly when the streets nearby will be ploughed. This reduces the amount of calls to the city customer service centre and maintenance team. If the City's customer services centre receives calls related to maintenance, the callers can be referred to the web pages, which often provide an answer to the problem.

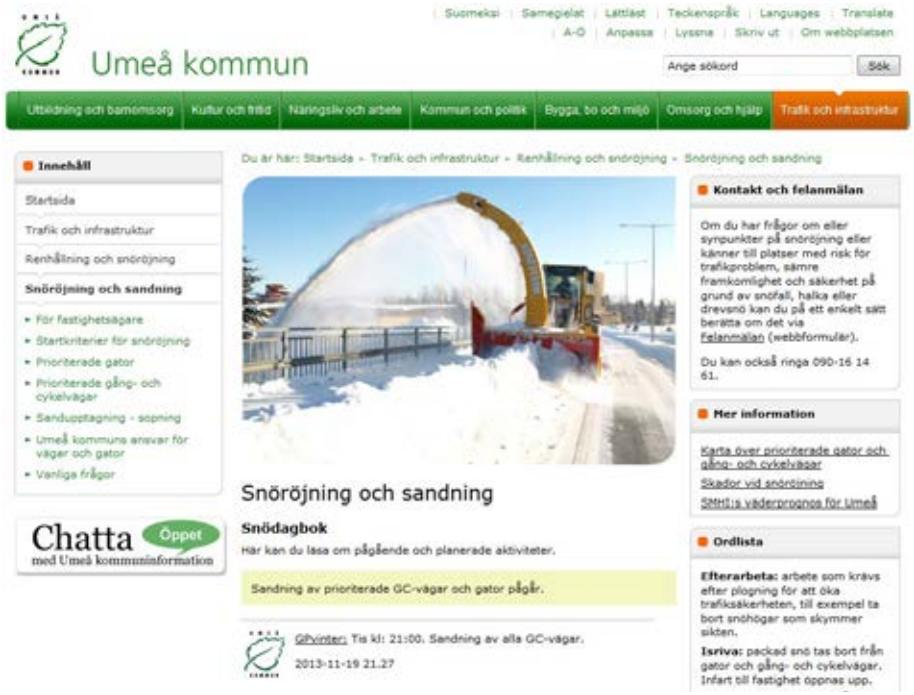


Fig. 21. *The City of Umeå website provides an easy way to check what is going on with regard to maintenance. The electronic form makes it possible to give feedback regarding any winter maintenance problems and to indicate the problem areas on the map. [21]*

Winter maintenance into consideration in road network planning

The basis for winter maintenance is created during the planning stage

To facilitate efficient and easy-to-operate winter maintenance, the routes must support winter maintenance. Maintenance is easier when the routes are separate from other traffic, as in Oulu and Umeå. When the snow is ploughed from the road, it doesn't accumulate on the cycle paths and footways. A separate, uniform route is easy to plough and sand without the need to worry about other traffic.

Observing the requirements of snow logistics

The space requirements for snow logistics are often ignored when planning areas and streets. If there is no storage space for snow next to or near the streets, the ploughed snow must be transported elsewhere. This can increase winter maintenance costs significantly. In Umeå, the aim is to leave a 3-metre wide safety strip between the cycle paths and footways and the road for easy storage of the ploughed snow. In Copenhagen, there is always a half a metre of space left between the road and the cycle path for snow storage. This way, there is no need to transport snow during an average winter. Besides space for snow storage, the planning must take into account the melt water flows in the spring.

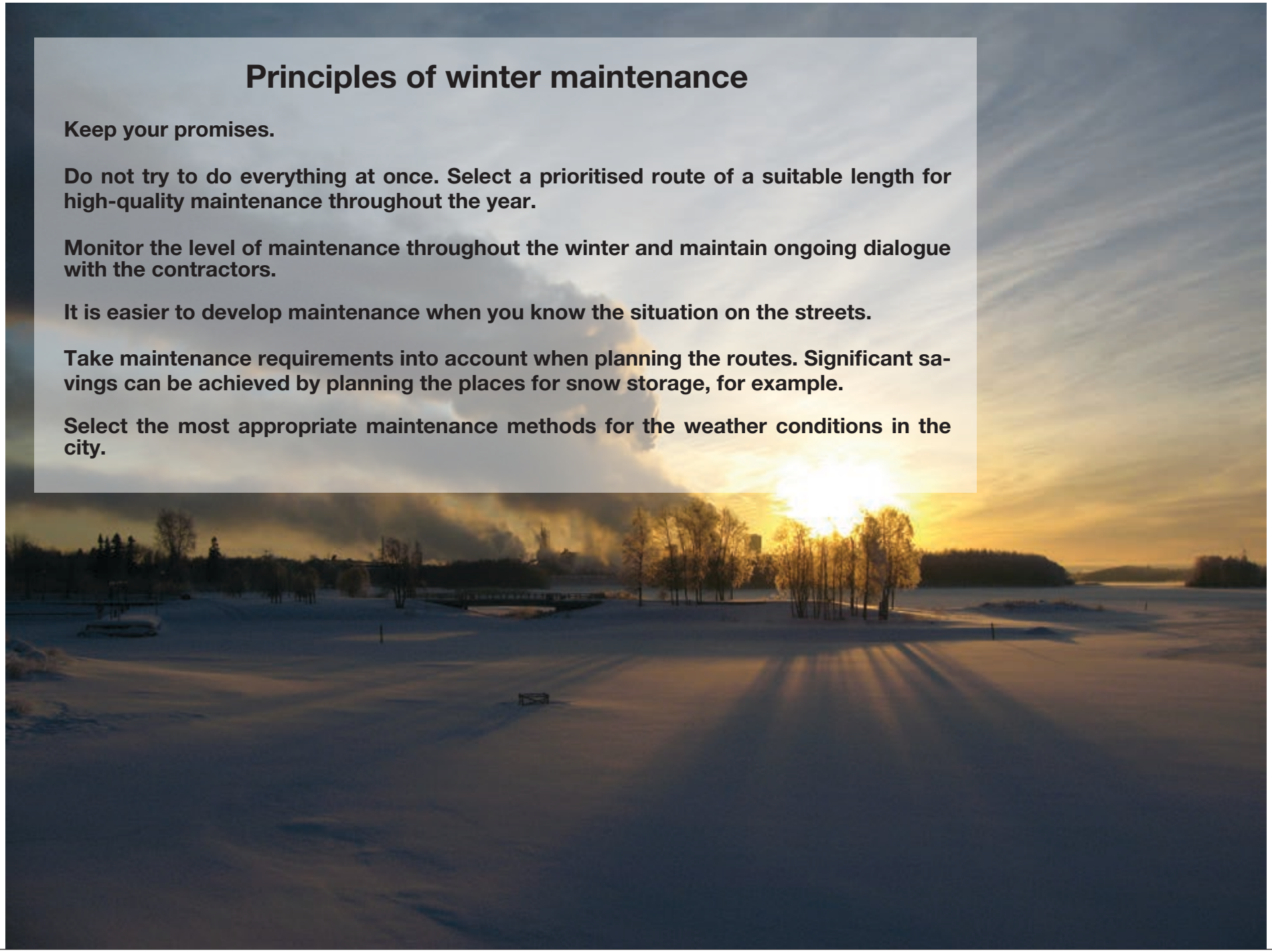
Figures 22 and 23. *When the route is separated from the other traffic, maintenance is easier. That is one of the reasons for the high-quality winter maintenance found in Oulu and Umeå.*

Aiming for minimum snow removal

In Umeå, snowfall during the winter is heavy, and removal of snow increases costs. Hence the desire to minimise the need for snow logistics. In residential areas where there are two pavements, one is used to store snow. This means that pedestrians may have to use the road or the pavement on the other side for some distance. This is not considered a problem, since the traffic is light and slow-moving.

Fig. 24. *In Copenhagen, planners have added a half-metre wide space for snow between the cycle path and road, eliminating the need to transport snow during a normal winter.*

Fig. 25. *Using appropriate machines for the routes guarantees consistent quality. (Copenhagen and Linköping)*



Principles of winter maintenance

Keep your promises.

Do not try to do everything at once. Select a prioritised route of a suitable length for high-quality maintenance throughout the year.

Monitor the level of maintenance throughout the winter and maintain ongoing dialogue with the contractors.

It is easier to develop maintenance when you know the situation on the streets.

Take maintenance requirements into account when planning the routes. Significant savings can be achieved by planning the places for snow storage, for example.

Select the most appropriate maintenance methods for the weather conditions in the city.

Sources

[1] Kunnossapitolaki, 1978: *Laki kadun ja eräiden yleisten alueiden kunnossa- ja puhtaanapidosta*. 31.8. 1978/669.

[2] Kuntaliitto, 2007. *Katujen kunnossa- ja puhtaanapidon laatutaso ja väylien luokittelu*. Suomen Kuntaliitto. Kuntatalon paino. Helsinki, 2007.

[3] Ympäristöministeriö, 2005: *Kadut kuntoon: Vastuut kadun kunnossa- ja puhtaanapidosta muuttuivat 1.11.2005*. Ympäristöministeriön esite, marraskuu 2005. Soprano Oyj. Ympäristöministeriö ja Kuntaliitto. p. 5

[4] Liikenne- ja viestintäministeriö, 2003: *Talvipyöräilyn laajuus, sen esteet ja motiivit sekä terveysvaikutukset*. Liikenne- ja viestintäministeriön Jaloin hanke. Helsingin kaupunki, Oulun kaupunki, Rovaniemen kaupunki ja Tiehallinto, Oulu 2003.

[5] Bergström, Anna, 2002: *Winter maintenance and cycle paths*. A PhD thesis in English. Royal Institute of Technology, Stockholm. Stockholm 2002.

[6] Ilmatieteenlaitos, 2013: [WWW] Ilmatieteenlaitoksen viralliset kotisivut. www.ilmatieteenlaitos.fi (25 May 2013)

[7] City of Copenhagen, 2013: [WWW] Statistikbanken. http://www.kk.dk/da/om-kommunen/fakta-og-statistik/statistik-og-historie/statistikbanken (29 May 2013)

[8] Linköping Municipality, 2013: [WWW] “Statistik Årsbok för Linköping”. http://app.linkoping.se/statdok/sabok/innehall.htm (29 May 2013)

[9] Oulun kaupunki, 2013: [WWW] Oulun kaupungin viralliset Internet-sivut. www.ouka.fi (29 May 2013)

[10] SMHI, 2013: [WWW] Swedish Meteorological and Hydrological Institute’s website at www.smhi.se (25 May 2013)

[11] Umeå Municipality, 2013: [WWW] Umeå Municipality statistics, population. http://www.umea.se/umeakommun/kommunochpolitik/fakta-omkommunen/statistikochanalyser/befolkning.4.3c34d75c1292984ed9680001542.html (29 May 2013)

[12] Weatherspark, 2013: [WWW] Average weather for Kastrup near Copenhagen, Denmark. https://weatherspark.com/averages/28823/Kastrup-near-Copenhagen-Capital-Region-of-Denmark (25 May 2013)

[13] Linköping Municipality, 2012: [WWW] “Linköpings karta, Sopade och saltade cykelbanor”. Available at http://kartan.linkoping.se (7 October 2013)

[14] Norem, Harald, 2009: *A winter maintenance strategy for roads based on climatic factors*. VTI report 630A, published in 2009.

[15] Niska, Anna. 2013. *Varmsandning på gång- och cykelvägar, Utvärdering i Umeå av för- och nackdelar med metoden*. VTI rapport 796. VTI 2013.

[16] Umeå Municipality, 2013: [WWW] Cycling map on Umeå Municipality’s website. Available at www.umea.se (7 October 2013)

[17] Københavns kommune. 2013. Cykelkort København, Cycling map Copenhagen. Københavns kommune, Teknik- og Miljøforvaltningen. 4. udgave. 2013

[18] Oulun kaupunki, 2013: Kunnossapidon ohjeelliset laatukortit.

[19] Oulun kaupunki, 2013: “Jalankulku- ja pyörätiet 2013” map. Oulun kaupunki, Yhdyskunta- ja ympäristöpalvelut.

[20] Oulun tekninen liikelaitos, 2008: Toimintakertomus 2008. Oulun tekninen liikelaitos. Available at http://oulu.ouka.fi/tekli/tiedostot/Tekli_Toimintakertomus_08.pdf (11 October 2013)

[21] Umeå Municipality, 2013: [WWW] Snöröjning och sandning. http://www.umea.se/umeakommun/trafikochinfrastruktur/renhallningochsnorojning/snorojningochsandning.4.bbd1b101a585d7048000173733.html (16 October 2013)

Interviews:

City of Copenhagen, Kim Sørensen – person in charge of maintenance, 14 December 2012

City of Linköping, Lise-Lotte Johansson – person in charge of maintenance, 5 December 2012

City of Oulu, Kai Mäenpää – head of maintenance, 20 February 2013

City of Oulu, Minna Komulainen – maintenance supervisor, 20 February 2013

Oulu technical public utility, Ilmari Kyllönen – works manager, 29 April 2013

City of Umeå, Marie Frostvinge – traffic planning manager, 12 December 2012

City of Umeå, Torbjörn Sandberg – street operations manager, 12 December 2012