449

The natural route choice of bicyclists in urban areas

Snail-trailing bicyclists in Bergen centre

OLE MARTIN BOLSET, ANDERS KAMPENHØY, AKKELIES VAN NES, WENDY TAN,

WESTERN NORWAY UNIVERSITY OF APPLIED SCIENCES, BERGEN, NORWAY

ABSTRACT

The significance of the bicycle as a form of transport are becoming a part of the traffic management in enhancing sustainable mobility means in cities. The aim of this study is to reveal the natural route choice for bicyclists in the Norwegian city Bergen through snail trailing. Obtained data through the observations contributes to an overview of the cyclists' actual route choices through the city centre.

The registered cycle routes in Bergen's city centre are compared with the results from space syntax analyses, the survey and the literature review. We could therefore conclude which cycle routes we believe should be improved with bicycle facilities, and which type of facilities should be built on the various sections. As the results show, bicyclists avoid steep hills and traffic lights. The cyclists route choice follows the integrated main routes with the highest values on the angular choice analysis with R=n. We believe that applying this first-hand data into current planning practice can contribute to increasing the bicycling as transport mode in Bergen´s city centre.

KEYWORDS

Bicycle routes, Angular choice, Snail-trailing, topography, traffic lights

1 INTRODUCTION

The significance of the bicycle as a sustainable transportation mode are becoming a part of the traffic management in large cities. The Norwegian city of Bergen who wants to describe itself as a cycling city, and who wants to be a model for sustainable transportation development, seems to have a long way to go. The city is far from reaching its strategic goals when it comes to increasing bicycle use and changing the population´s transport and travel habits to reduce the city´s climate emissions.

Bergen Municipality has in collaboration with the Norwegian Public Roads Administration and the consultancy firm Asplan Viak prepared a strategy for improving bicycle routes in Bergen 2010-2019. In this cycling strategy, the following three main goals are set:

1. It should be attractive and safe to cycle for everyone in Bergen,
2. the bicycle share in Bergen should increase to at least 10 percent of all journeys during the period,
3. and the main road network for bicycles should be completed by 2019 (Stavenes, et al., 2009).

However, these goals have not been achieved, as central parts of the main road network have not undergone any changes in the last ten years, and the proportion of bicycle journeys in Bergen was below average, at 3 per cent of all journeys in 2013/14 (Hjorthol, et al ., 2014, p. 30). With these observations, as well as statements from Bergen municipality about uncertainty about the goal of 10 percent bicycle share to be continued, we assume with strong certainty that this goal has not been achieved (Erstad, 2018).

Do then the current cycle routes in Bergen centre represent the route choices made by the cyclists in reality? Will cyclists choose the shortest route over simpler and more energy-saving routes? Will cyclists choose the shortest route over safer routes in terms of traffic? Are the criteria on which the proposal for a bicycle network in the city centre areas is based on the right criteria to emphasize? Will more people choose to use the bicycle as a means of transport if the municipality plan bicycle routes according to the bicycle flow patterns that exist today? How do cyclists deal with the current difficulties, such as steep hills and traffic lights in the centre of Bergen?

What we want to achieve is to study the cyclists' natural route choices in Bergen city centre. This is done by snail trailing (van Nes and Yamu 2021) or tracing the routes of 200 random chosen bicyclists through Bergen city centre.

The following methods were chosen: Literature review, survey and observations. In this short paper, we will present the results from the observation study and to compare the results with the space syntax analyses, the plan proposals for new bicycle routes and topography.

2 MAIN ASPECTS FROM THE LITERATURE REVIEW

Research on cycling in urban areas show that the physical condition of the built environment has a major impact on people's choice of bicycle as a form of transport in the urban environment. Heinen et al. (2010, p. 61) describe the urban form and infrastructure as decisive factors in the built environment. The distance relationship between the activities emerges as a factor that is always considered when the individual makes his choice. Along with distance, the time savings and the basis for efforts also emerge as arguments for choosing other modes of transport. Among other things, it appears that bicycle commuters often have a shorter distance to the workplace than other commuters (Cervero, 1996, p. 371). This, together with human physical abilities, will have an impact on cyclists' travel distance (van Wee, et al., 2006, p. 117). Research shows that satisfactory distance completed by bicycle varies between genders. Studies conducted by Garrard (2008, p. 57), show that women often cycle shorter distances than men to the workplace. Furthermore, the size of the city often has a decisive factor in the number of cyclists. Among other places in the Netherlands, research has shown that it is in the small towns that the number of cyclists is greatest, where the goal is to reach other modes of transport such as buses and trains (Martens, 2004, p. 291). The research of Keijer and Rietveld (2000, p. 227) also shows that the bicycle is most often used as a means of transport to reach its destination within the ratio from 0.5 km to 3.5 km.

The network structure in a city will also have its impact and influence at a distance when it comes to cycling. A denser street and road network will be less suitable for motorized traffic as the distances will again be smaller (Southworth, 2005, pp. 249-250). The compact city with high building density and short distances makes it easier for people to move around by bicycle. In compact cities car ownership is low, whereas the bicycle usage is highest (Pucher & Buehler, 2006, pp. 276-277). The degree of function mix in a city also has a major impact on the choice of cycling as a mode of transport with proximity to service facilities such as shops, restaurants, work, schools and hospitals (Cervero, 1996, p. 375).

The natural environment such as the topography, weather conditions and climate change are also factors that influence the individual's choice of mode of transport. Landscapes with steep slopes require a greater physical effort by the individual cyclist (Heinen, et al., 2010, p. 67). Research on use bicycles use in varied terrain conducted in the city of York in the UK, shows that steep terrain in bicycle facilities has a negative impact on bicycle use. In the city of York, which is a city with little topography, 13.1% in bicycle share was measured against other modes of transport. In the city of Bradford, which is characterized by being rugged and having varying terrain, the city measured only 0.8% bicycle share against other modes of transport (Parkin, et al., 2008, p. 106). In contrast with the commuting bicyclist, the recreational cyclists prefer challenging terrain (Moudon, et al., 2005, p. 258). In addition, varying terrain will automatically lead to downhills as a gain for the result of cycling uphill (Stinson & Bhat, 2004a, p. 9).

Regards the season of the year, research has shown that cycling as a mode of transport is most common in the summer (Stinson and Bhat 2004b, Nankervis, 1999). Research in Sweden shows that the number of cyclists decreases in colder environments, and that the cyclist's travel distance by bicycle is reduced to 10 km on winter roads from 20 km on summer roads. Car travel on winter roads also increased by 27% on winter travel as a negative counteracting development (Bergström & Magnusson, 2003, p. 649). Large variations in the daily weather conditions affect also bicycle. usage.

Although rain is one of the most negative influencing factors, temperature fluctuations also show up (Nankervis, 1999, p. 428).

Using the bicycle is a cheap form of transport (Heinen, et al., 2010, p. 74). Comparisons of data and research conducted in the USA and Canada show a clear connection between revenues, increased petrol prices and the use of cars as a mode of transport (Pucher & Buehler, 2006, p. 277).

The bicycle is acknowledged for shorten the travel time for short distances in urban areas. The longer the travel time and the so-called discomfort on the transport journey, the easier it is to choose another mode of transport than the bicycle. Especially when the bicycle as a mode of transport is three times less comfortable than other modes of transport, it is clear that time and effort largely play an important role (Wardman, et al., 2007, p. 343). Discomfort and longer travel distances will be factors that affect the amount of use of a bicycle as a form of transport, even though some individuals strive for challenges that require greater effort (Heinen, et al., 2010, p. 75).

Costs, travel time and effort all have an impact on the individual's choice of bicycle as a mode of transport. An increase in transport costs for public transport and car use will have a positive impact on increased bicycle use. Overall, we can also say that not only the actual value of the cost, but also our personal well-being in everyday life influence on the decision of transport mode (Heinen, et al., 2010, p. 75).

A continuity of bicycle route network and a separate cycle path from vehicle transport will also have a positive effect on cyclists. Likewise, traffic lights and intersections have a negative impact on cyclists (Stinson & Bhat, 2004a). Signage, light regulations and systems that stop the network structure as a regulator of traffic can to a large extent create an irritating factor for cyclists (Fajans & Curry, 2001, pp. 28-31). Time use is a relevant factor for cyclists, and delays via red lights and stop signs will lead to higher time use. Furthermore, Stinson and Bhat (2004a, p. 9) have found that cyclists clearly prefer good, even surfaces on their cycling facilities.

Bicycle infrastructure must be seen in the context of safety. The objective safety will be measurable in actual incidents that occur on the road. The subjective safety will thus relate to the individual's experience of safety in the traffic picture (Heinen, et al., 2010, p. 63).

3 DATASETS AND METHODS

We used the GPS watch ‘Suunto 3 Fitness’ to record our data. After the observations, we have registered data such as estimated age, gender and type of cyclist. The data was further registered in the app ‘Suunto’ and later synchronized in "Strava" to be able to prepare analyses in the software ArcGis. All observations were performed by bicycle, for optimal participation in the given environment.

We used eight entry points into the city centre as a starting point to follow a random chosen cyclist into Bergen city centre. The observations were performed in six days in February 2019, from 07.30 to 17.30. The observations were not carried out during holidays, public holidays or other major events in the cityscape to avoid sources of error in the result. The purpose of the observations is to reveal the actual route choice of cyclists and to reveal to what extend these routes correspond with the existing and planned new bicycle routes. Figure 1 (top) shows the steps we used. Below shows the existing and the planned new bicycle routes for Bergen.

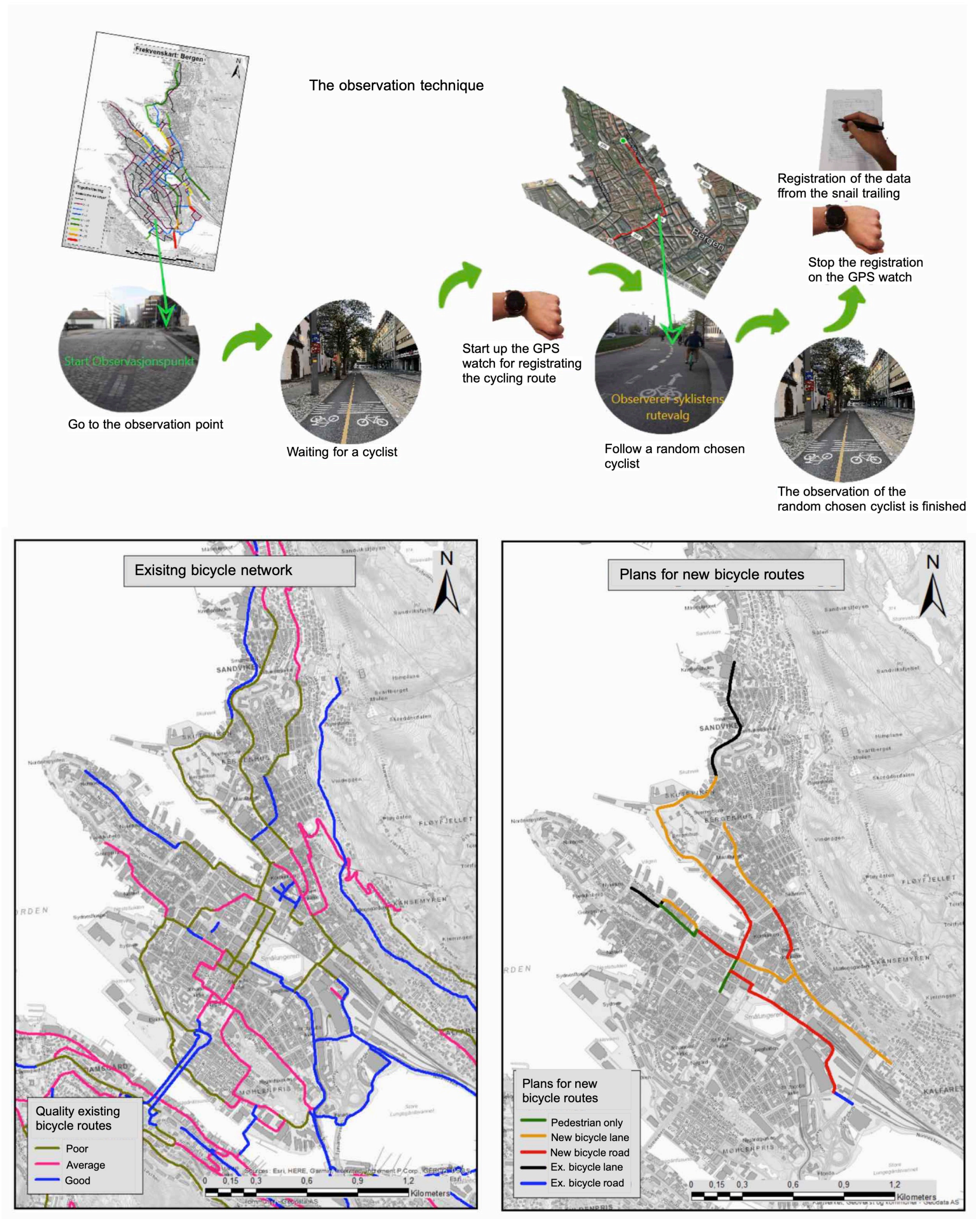

Figure 1: Observation techniques for snail-trailing cyclists (top), map showing the quality of the existing bicycle routes (left), map showing existing plans for new bicycle routes (right)

The first idea was to transfer the GPS coordinates from "Strava" to ArcGis. This should be done by first converting the GZ file to a GPX file, and then converting it to a SHP file. We could thus enter the SHP file as data in ArcGis. Test trials of this were performed, for 3-4 observations, but some problems occurred. The GPS coordinates were not as accurate as desired. This meant that every single observation had to be edited. The choice then fell on editing each individual route manually, as this would be timesaving, easier and more structured to implement.

What is important when performing a frequency analysis in ArcGis is that each individual observation line, which runs in the same street, must be on top of each other. This must be completely for ArcGis to be able to count how many lines are on top of each other. Then we can show a value for each street segment, which is equal to the number of times cyclists have cycled through this street segment.

To solve this, the dataset Elveg was used. Elveg is a data set that is well suited for transport planning and route planning (GeoNorge, 2018). The purpose was to use this dataset as a base map. The lines in Elveg, which correspond to the observation route, were marked, then copied. The next step was to paste these lines into a separate map layer, which we called "Bicycle Routes". The lines were copied one observation at a time, pasted into the map layer «Bicycle routes», and given the same 'TrackID' as the same observation had received in the excel sheet with details from each observation.

4 RESULTS

In total we cycled over 400 km on the bike divided into 120 observations from our 8 observation points. Figure 2 shows the results from our observation compared with the topography (left) and the frequency map (right). As it appears in the high-frequency map, we see that the observation points at southeast of Bergen come out poorly in the analysis. Topographically, we see that the observation points come out poorly based on the that the cyclist must cross the steep hill Nygårdshøyden.

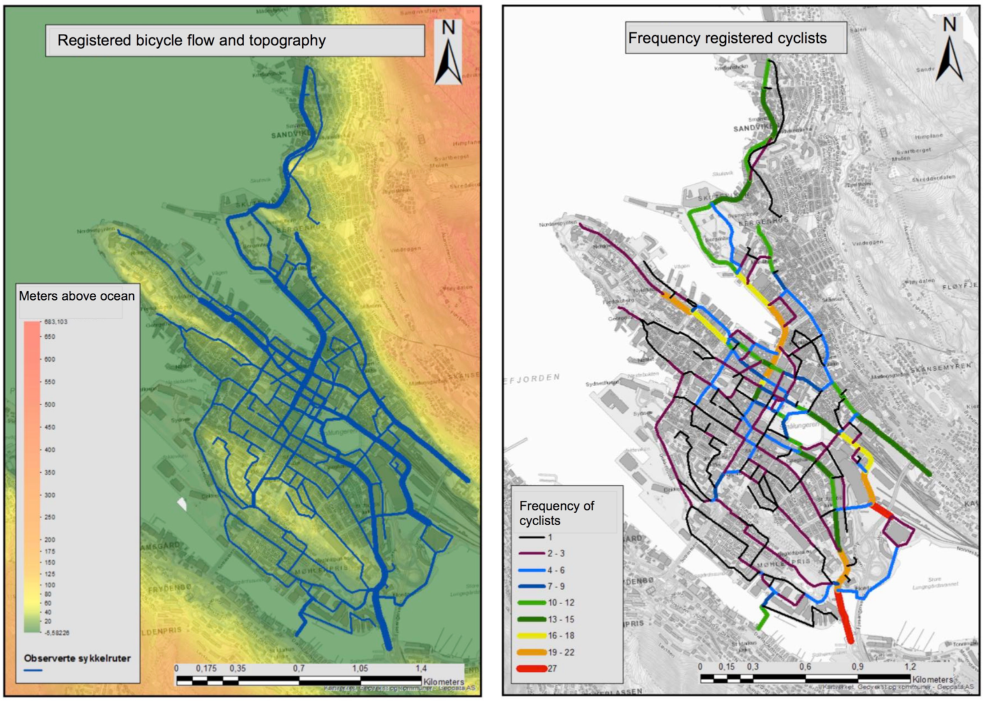

Figure 2: Registration of bicycles correlated with topography (left) and registered frequency (right)

Based on our observations, we see that cyclists largely avoid challenging terrain where this is possible. Although topography has a negative impact, Heinen et al. (2010, p. 67) also describe that cycling in challenging topographic terrain can also be a form of relaxation as physical activity. It is also described that an uphill will lead to a downhill. We clearly see the positive effect of topography from the cycle routes following the landscape which give the cyclist higher speed as a positive gain for having cycled uphill at an earlier time.

Traffic light regulations often create an annoying factor in cyclists in term of time and energy use. Based on our observations, we see that cyclists choose to avoid traffic lights. The traffic lights create dangerous situations for the actual and experienced security. This is something we largely recognize in streets where cyclists often ignore the red lights at pedestrian crossings.

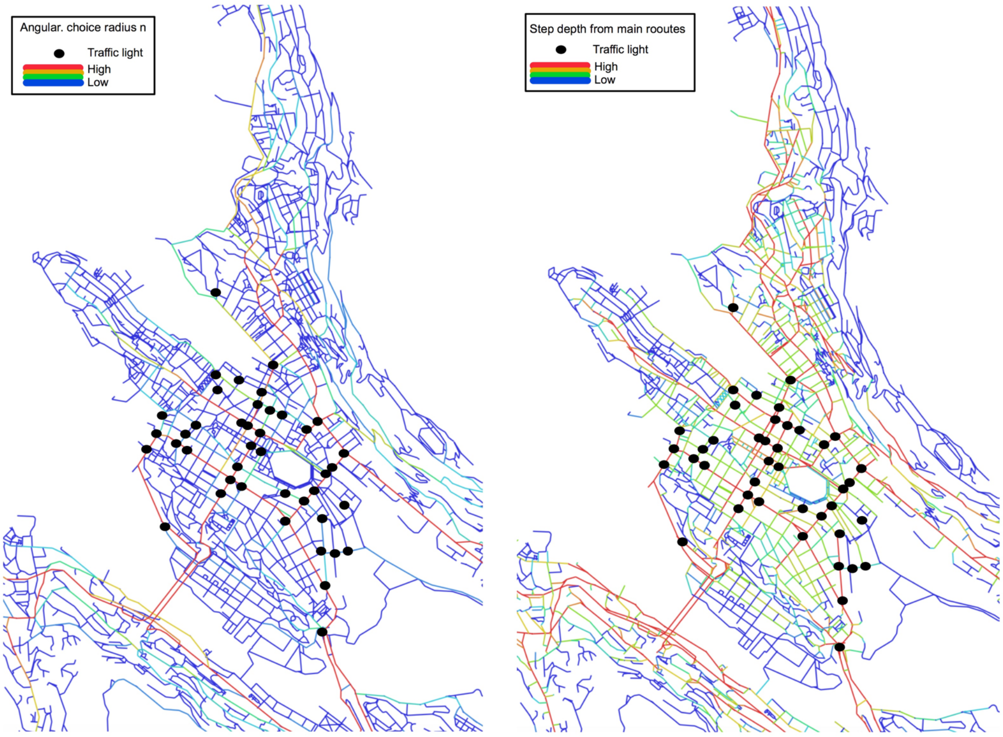

Figure 3: Angular choice (left) and angular step depth from main routes analyses (right) of Bergen centre with the location of traffic lights

Figure 3 shows an angular choice analysis with a high metrical radius (left) and an angular step depth analysis from the main routes (van Nes 2021) with the location of traffic lights. The red lines show the highest integrated main routes. In line with our observations, bicyclists follow the highest integrated routes. Wherever an integrated main route is obstacled by too many traffic lights and a too steep hill, it affects the route choice of the cyclists.

5 CONCLUSIONS

Which cycle routes should then be developed with cycle facilities, and which cycle facilities should be prioritized? Seemingly, enhancing new bicycle routes and to improve the existing ones requires to consider the topography, the degree of spatial integration (angular choice with a radius = n) of the main routes, and to have as few as possible traffic lights on the route.

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