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THE EFFECTS OF NEW BYPASS ROADS ON SMALL NORWEGIAN TOWNS

SPACE SYNTAX AND LAND USE ANALYSES OF JESSHEIM, ASKIM, GOL AND HOKKSUND

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ABSTRACT

What happens with small towns when the main through transport route is replaced outside them? In this research project the consequences of bypass roads on four Norwegian small towns have been investigated, focusing on the location pattern of shops and urban functions. The small towns analysed are Gol, Hokksund, Jessheim and Askim. By combining space syntax analyses with the registrations of shops and urban functions, we have analysed the before and after situation for bypass roads in the four small towns.

As *the theory of the natural movement economic* process state, the spatial configuration of the street and road network influence the mobility flow, and thereby the dispersal of shops. Shops tend to locate themselves along the most spatially integrated streets, where also most people move, because they need to be in an optimal location to reach as many potential customers as possible.

The results show that shops and other commercial related functions follow the most globally integrated streets. If the integration values changes, the shops will move towards these new most integrated streets. Moreover, property owners tend to invest in high-density buildings along the most integrated streets. Even though the municipality and the conservation authorities try to hold this process back in areas with historic important buildings and high quality agricultural ground, the spatial and economic drivers are difficult to control due to Norwegian's strong property rights.

If the integration does not change in the town as an effect of the bypass road, the shops will not move. Based on the generalisations of the analyses makes possible to predict the consequences bypass roads will have on other Norwegian small towns.

Space syntax has previously been used to research how changes in street grids affect cities all over the world, but it has not been used to research how bypass roads affect Norwegian small towns. The results show that spatial and economic forces are closely interrelated in Norwegian too.

KEYWORDS

Space Syntax, Small towns, bypass roads, centrality, economic development

1. INTRODUCTION

In many small settlements in Norway the main road is a national transport route running through the local centre. On the one hand, the local economic development of the small settlements depends on the through travellers as customers. On the other hand, other problems such as heavy loads of vehicle transport, traffic safety, noise, pollution and the quality of street life for pedestrians are affected (Transportøknonomisk institutt 2012, p. 260). Since the 1960's several settlements have placed the trough traffic route outside their centres through new bypass roads. Yearly, 1-10 new bypass roads are implemented and opened for traffic in Norway, and several settlements are considering to implement new bypass roads (Transportøknonomisk institutt 2012, p. 90). Several actors from various settlements are concerned about how these new bypass roads affect the economic life, and the commercial activities of local centres (Multiconsult 2009, p. 16). Therefore, the impacts of bypass roads on local centres is very actual in Norway, and we therefore investigated how new bypass roads affects commercial activities and the social life in the centres of small settlements.

Every small settlement exists on to have a viable trade and industry, and a good population base. During the last year the focus has been on to strengthen their local centres as trade and social meeting place for the inhabitants. However, during the last two decades, several settlements' centres are struggling to survive due to strong competition from large out of town shopping malls located along the motorways (Tennøy et.al 2015, p. 5). It leads us to the following research questions:

How is the development of the settlement affected when placing the main road from its centre around the whole settlement? If the spatial configuration is affected on various scale levels, will the new bypass road affect the location pattern of commercial activities or the location of the settlement's existing centre? To what extent is the research results valid for other cases through the analyses of four cases in Norway?

At present, there are some research results on how road building changes the location pattern of commercial functions. In 1995 Falleth et.al carried out a research on how new bypass roads affect the land use of towns in Norway (Falleth et.al, 1995). The focus of this inquiry was only on the involved actors and not on the changes in land use as an effect of the new bypass road. Besides, the spatial parameters are lacking in this research project for understanding the physical drivers for changes in land use as an effect of the new bypass road. However, the authors observed that new enterprises located themselves at the junctions where the bypass road tangents the settlements (Falleth et.al, p. 69).

In 2002, van Nes investigated the effects of inner and outer ring roads in large cities and towns. She analysed 8 towns and cities with the traditional axial analyses method and compared the results with the location pattern of shops. As her results show, shops located themselves along the highest integrated streets. If the ring road change the dispersal of integration values of the street network of a town or city, shops will relocate themselves along the streets and roads with the highest integration values (van Nes 2002). Her research empirically supports Bill Hillier's theories on the natural movement economic process (Hillier et.al 1993), stating that the spatial configuration affects the flow of movement and the location of economic activities. Van Nes' research on ring roads focus only on highly urbanised areas. How ring road change urban areas depends on how the ring road is connected to its vicinity, and the type of street network the ring road is imposed upon. The more broken up the local street network is, the more the integration values are dragged towards the ring road (van Nes 2002).

Shortly after, van Nes (2003) conducted analyses of various new road proposals for the Norwegian town Tønsberg. Most of the road proposals are located outside the town's centre, whereas one of them goes through the town centre. Later van Nes and Stolk (2012) analysed two road proposals for the Dutch city Leiden. Both cases show that when new roads drag all the integration values on a global scale away from existing town centres towards potential new areas, interests for new investment start to occur in these new areas. These research results are also in accordance with the theory of the natural movement economic process; commercial activities locate themselves along the highest integrated roads.

In this context, we analysed four settlements in Norway where a new bypass road has been implemented. Our hypothesis is then as follow:

Shops and commercial activities locate themselves along the spatially highest integrated streets on a local as well a global scale, according to figure 1 upper left. If a new bypass road affects this optimal location for shops and commercial activities, one can presume that shops will relocate themselves along the new highest integrated streets or roads. Most roads during the last 50 years are planned in accordance with the national road dimensions requirement, which is heavily influenced by the Buchanan report ideology from the 1960's (figure 1 upper right). However, as research has shown, economic and commercial activities tend to seek for the most optimal location for reaching as many customers as possible. The only thing that can influence the most optimal location of enterprises are a strong planning system, political and organisatoric constraints (Figure 1, below). Norway has strong private property rights. If a land owner sees possibilities for high economic benefits as an effect of a spatial configurative change of the mobility network, he or she will use this opportunity. The only thing that can block this opportunity is a rigid or strong planning system (van Nes 2017).

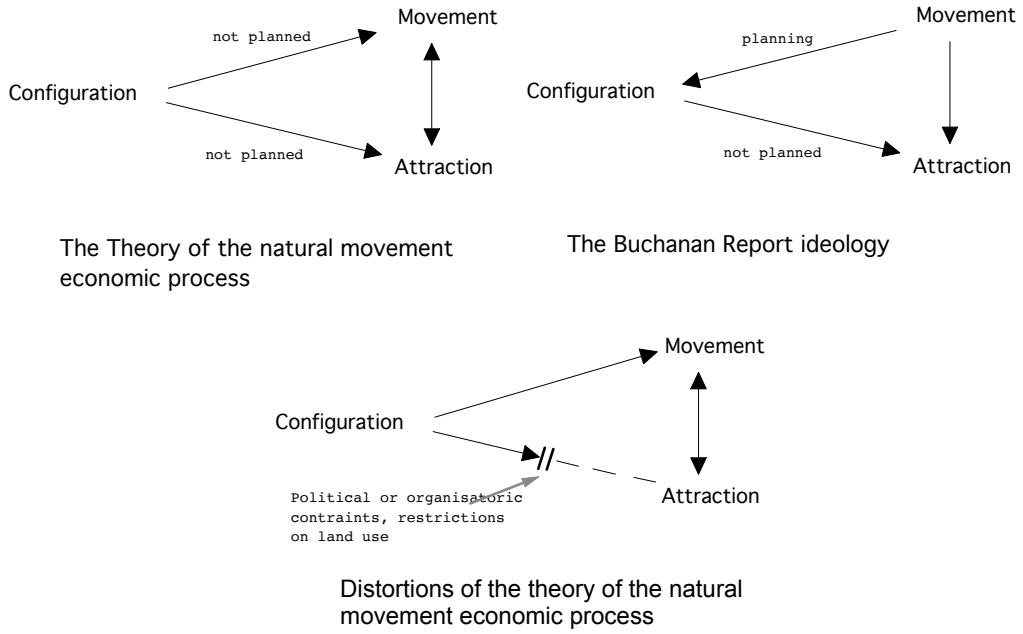

Figure 1. Theories (left), ideologies (right), and understandings (below) on the relationship between road building, movement, attraction and planning system.

2. DATASETS AND METHODS

The following four cases are chosen: Gol, Jessheim, Hokksund and Askim. All cases located in the Østlandet area (South eastern part of Norway), along main routes leading from Oslo towards Sweden (Askim), towards the city of Bergen (Hokksund and Gol) and towards the city of Trondheim (Jessheim). These roads have a large amount of through traffic, both for short and long distances. Moreover, all these small settlements have a railway station, where the stations for Askim, Hokksund and Jessheim is used for commuters travelling to Oslo (for about 40-60 minutes train travel), and long-distance travellers travelling to either Oslo or Bergen (Gol and Hokksund).

The settlements in Norway are named "tettsted" in Norwegian, which mean "dense place". The settlement density is rather low in Scandinavian countries in comparison to rest of Europe. Most dwellings in Norwegian settlements outside the cities and town centres consist of mostly single-family houses. During the last years row houses and apartments have been constructed close to the local centre. A joke exists on naming these settlements as "spredtsted", which mean "sprawled place", because it is in line with their urbanisation pattern. Some of these settlements have got a status as a town, whereas others have the status as village.

Outside the large cities in Norway, the private car ownership is high. Almost everyone obtains a driving licence when turning 18 years. Most movement routes in these settlements are roads, such as dwelling road ("boligvei"), main road ("hovedvei"), motorway ("motorvei"). Only a couple of streets

exists in these settlements, such as for example main street ("storgata") and station street ("stasjonsgata" or "Jernbanegata").

The following spatial analyses were carried out: Global segment integration analyses, angular choice with a high and a low metrical radius. The global segment integration analysis shows the *to*-movement potentials and the two angular choice analyses shows the *through*-movement potentials for pedestrians and for car traffic.

For the information about the location pattern of shops and commercial functions before and after implementation of the bypass roads, old and new maps, old telephone books, field work, old and new municipality plans and documents were used. Information about population and income for the past and present situation are found at the central bureau of statistics.

Through old and new plans from the various municipalities we got an overview over the economic drivers for that these four settlements exist. Small settlement in Norway are woundable for large changes. Therefore, we wanted to investigate how replacing the main routes for transport from *through* to *around* the settlements affect their local centres.

3. RESULTS

For all four cases the spatial forces affect where investment takes place. Where the new bypass road affected the integration of the street network in existing centres, the location pattern of shops was affected too.

3.1 Gol

Gol is the main shopping and administration centre for the long valley Hallingdal. Gol is located down in the valley, surrounded by mountains, some of them 1000 meters above the sea. The municipality has 4578 inhabitants, where 2881 lives in the settlement. Two of the main routes over the mountains towards Western Norway runs through Gol. These main routes connect Western Norway with Eastern Norway. The rail line between Oslo and Bergen runs through the Hallingdal valley and has a station in Gol. Gol is located 169 km from Oslo and 307 km from Bergen. It takes 2 hours and 30 min to travel to Oslo by car, and 3 hours and 6 min by train. It takes 4 hours and 15 minutes to travel to Bergen by car and 3 hours and 42 minutes by train. Often the roads above the high mountains towards Bergen are closed in the winter during the winter storms.

Through history, Gol has always been a junction between the two main routes over the mountains and to Oslo. The settlement has developed at this junction around the bridge "Heslabrua" crossing over the river in the valley. In 1909 the railway between Oslo and Bergen was opened, and a shop and hotel was opened in Gol. In the 1930's the settlement grew, and at the end of the 1960's a high school was opened. As the settlement grew, the number of shops and service functions increased. In 1997 a large shopping centre with 20 shops was opened (Asplan Viak 2017, p.13). Gol is now a popular tourist and vacation resort for hiking in the mountains and winter sport. Several people from the Oslo as well as Bergen area have cottages in the mountains.

In 1975, before the bypass road was opened, Gol had 3699 inhabitants. In 2016 Gol had 4578 inhabitants. The income from shopping was 91961NOK (2016 value) per year per inhabitant in 1975 and 146582NOK per year per inhabitant in 2016, which is an increase of 59% (Statistisk sentralbyrå 1977 and 2018).

All through traffic went through the settlement. As the private car ownership grew, an effect was that already in 1964 the first plans for a bypass road was made. The resistance from shop owner and property owners was high against this road. A new proposal was made in 1969 and in 2017 the new bypass road was finished (Haakenaasen 1980).

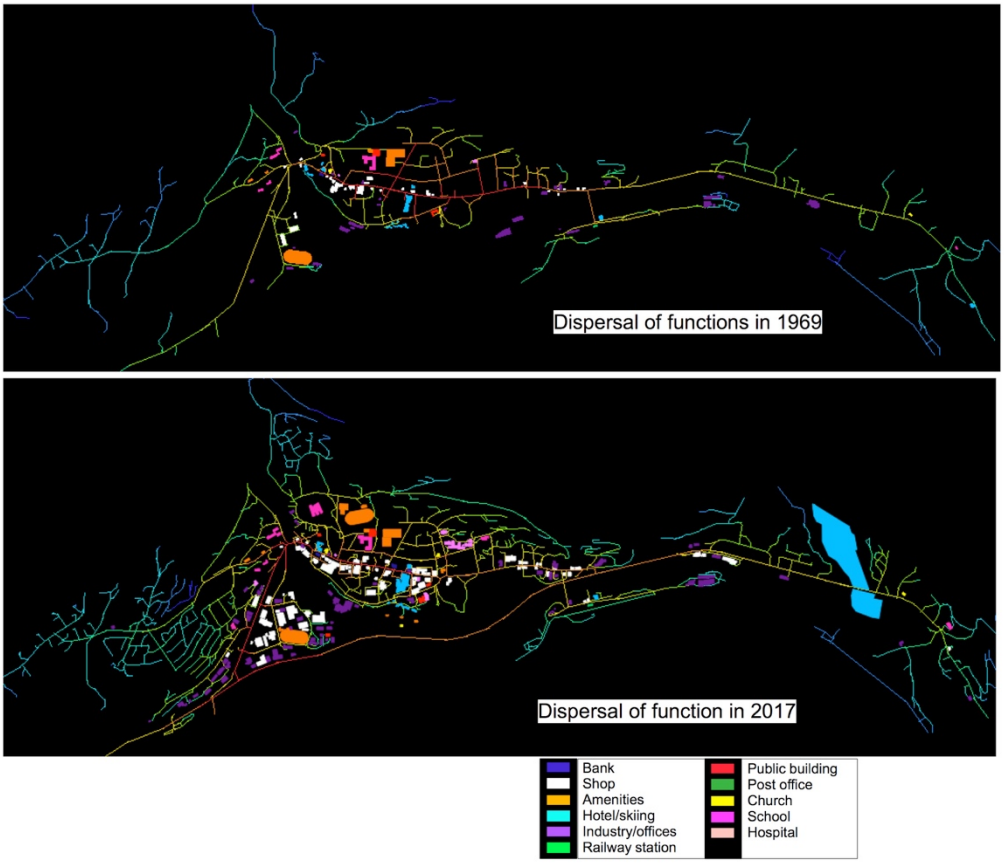

Figure 2 The change of functions in Gol with global segment integration analyses from 1969 and 2017.

Figure 2 shows the dispersal of function in Gol from 1969 and 2017 with a global segment integration map. In 1969 all the shops (coloured in white) are located on the highest integrated street, running between the railway station and the bridge. All long-distance traffic went through this street.

In 2017 the integrated core has moved towards the western side of the bridge. The number of shops (coloured in white) has increased, and the centre has now moved towards the new core. Several car-based shops are located on the western side of the bridge, and the old individual shops are still located on the eastern side of the bridge.

Whereas the segment integration analysis shows the to-movement potentials, the angular choice analyses shows the through movement potentials. Figure 3 shows that the old centre has both the highest values on the angular choice analyses with both high and low metrical radius. The new car based shops are located along the streets with the highest integration values on global level.

The settlement is connected to the new bypass road at two places in figure 3. Later on, in 2017, a third direct connection from the old centre towards the bypass road has been made. When adding this link to the global integration analyses, the to-movement potentials shifts towards this new junction, but there are no changes in the angular choice analyses. Already a large car-accessories shop (Biltema) has got permission from the municipality to establish themselves at this third junction.

When revealing the municipality plans and legal documents throughout the years, pressure for establishing shops has been on all the three junctions since the bypass road was opened. At the industrial area located at the eastern junction, restrictions for establishment of shops are prohibited with purpose to protect the existing old centre (Gol kommune 2006). Seemingly, the spatial forces seem to overrun the municipality plans on a long-term due to the strong property rights in Norway.

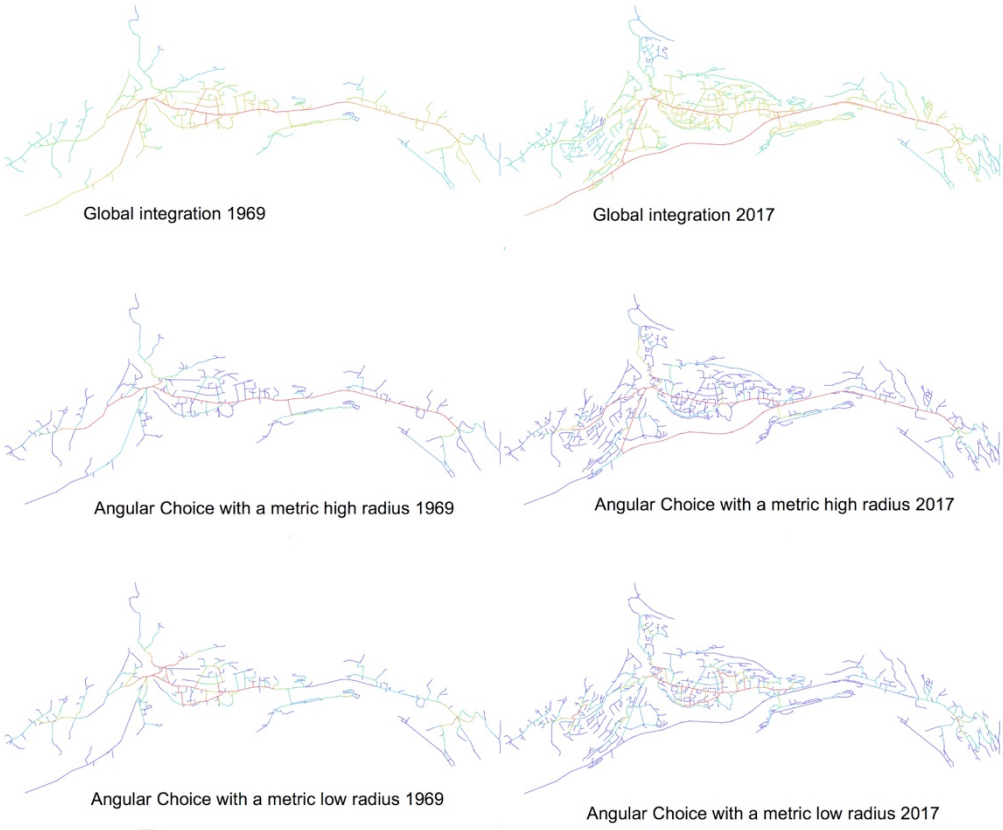

Figure 3 Space syntax analyses from Gol from 1969 and 2017

Figure 3 shows various space syntax analyses from Gol from 1969 and 2017. On a global scale, the new bypass road and the old main route through the centre has the highest values in the segment analyses and the angular choice analyses. However, the old main route has also the highest local values in the angular choice analyses with a low metrical radius (500 metres). Therefore, various individual pedestrian based shops are located in the old centre and only car-dependent shops are located along the main routes that have only high values on the high metrical radiuses (5000 metres).

3.2 Hokksund

Hokksund is the administration and shopping centre of the municipality Øvre Eiker. Currently, 8138 people are living there. Since 2002, the settlement has got status as a town. Hokksund is located at a junction where three valleys are intersection, surrounded by mountains of 600 meters above sea level. The large river Drammenselva separates the towns in two parts. Two main routes are intersection in Hokksund, a main route from east to west Norway, and a route towards southern Norway. The same accounts for the railway. The town has a station with trains running on the southern line as well as on the east-west line in Norway. Hokksund is located 63 km west from Oslo and 18 km west from Drammen. It takes 55 minutes to travel to Oslo and it takes 15 minutes to travel to Drammen by both car and train.

The existence of the town is related to transport, first on the river, then by train and now the roads. The dominant transport mode has influenced the location of its centre throughout the history (Guttu et al 1992 p. 15). In 1989 the new bypass road was opened, leading all long distance through traffic outside the town centre. This new bypass road was moved from the northern side to the southern side of the river Drammenselva. A lot of pressure for establishment of new firms and shopping malls took place, just before and after the new bypass road was opened.

When revealing the income from shopping per capita from before and after the bypassroad, it has decreased with 23%. In 1988 it was 66 493 NOK per inhabitant (in 2018 values) and in 2017 it has 51269 NOK.

The main road between Oslo and Kongsberg went through Hokksund. The heavy through traffic contributed to affect the urban life in the town centre. During the 1970's and 1980's, several traffic restructurings was done. However, these changes affected the vitality of the centre (Guttu et al 1992 p. 27). Some roads were closed for through traffic, and the effect was that several shops lost their customers and closed down. At the end of the 1980's a shopping mall was opened south of the town centre, in which affected the individual shops in the town centre. Most of them closed down.

During the 1990's a lot of resources was put into upgrading the old town centre for making the streets as a pleasant place to stay rather than driving though it with large speed from the settlement towards the bypass road. These improvements had a positive effect on shops and street life in the old centre. Currently, the municipality is making a plan to upgrade the old town centre to be an attractive reginal centre for establishment of firms, services and shops. The policy is that all these new functions should be located within a radius of 1 km from the railway station with purpose to reduce transport by private car. Conversely, the municipality have planned some new dwelling areas for single family houses far outside the centre for attracting new inhabitants. These new dwelling areas contributes to urban sprawl and private car dependency.

Figure 4 shows the dispersal of functions with the global integration analyses from 1988 and 2017. As can be seen on the figure, there is a slightly shift of the white pattern of shops towards the new bypass road. The large shopping mall in the south was just opened in 1987, when the plans of the new bypass road was on the table. Some new shops are located along the main route from the town's northern parts towards the bypass road.

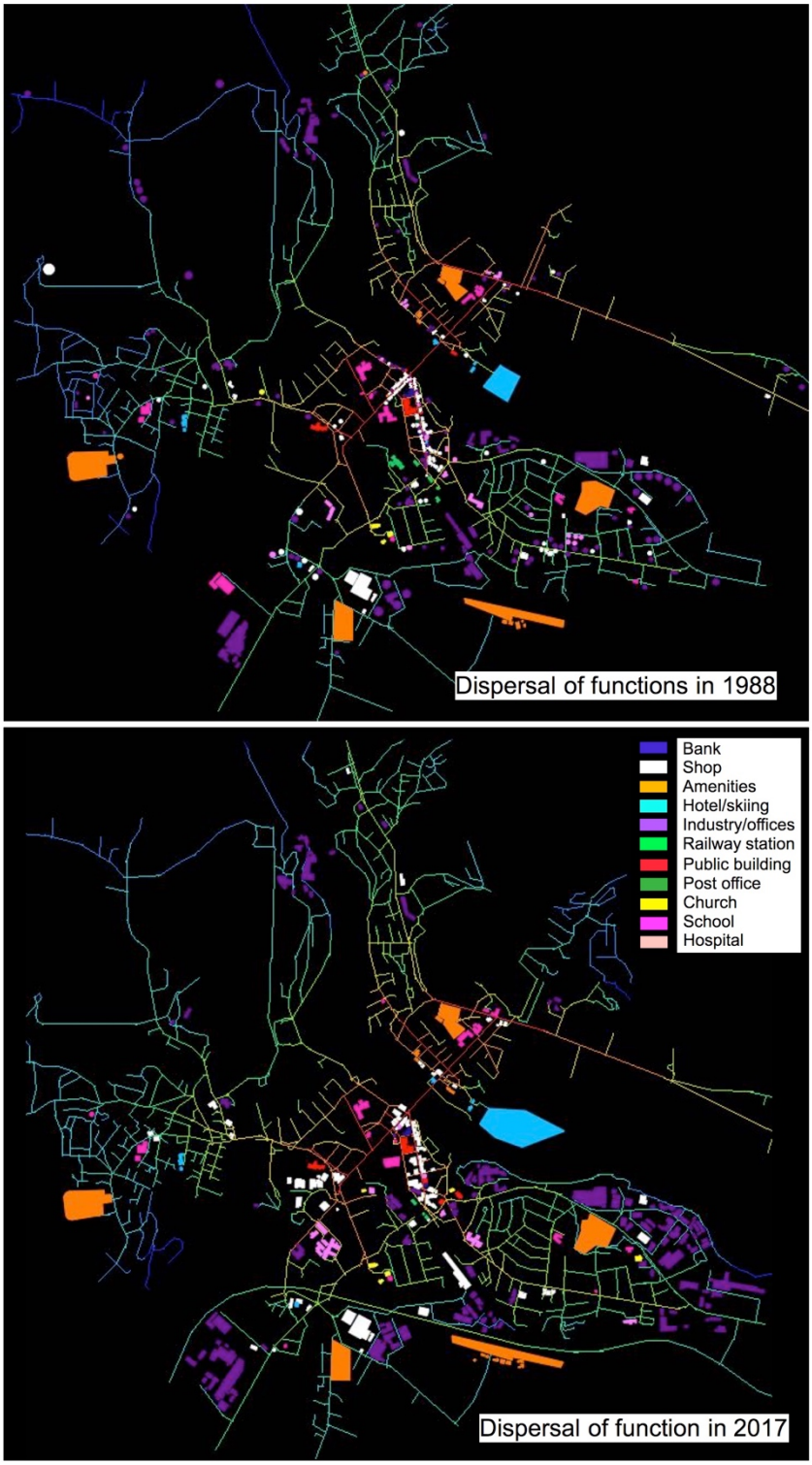

Figure 4 The change of functions in Hokksund

The private car ownership is high in Hokksund, in which implies that a large amount of daily travels is done by car. All the traffic from the northern part of the town have to cross the river and travel through the old centre for reaching the new bypass road. Therefore, the integration is still high in the

old town centre. When making a space syntax map for the whole region, the regional core will probably be on the junction to the new bypass road.

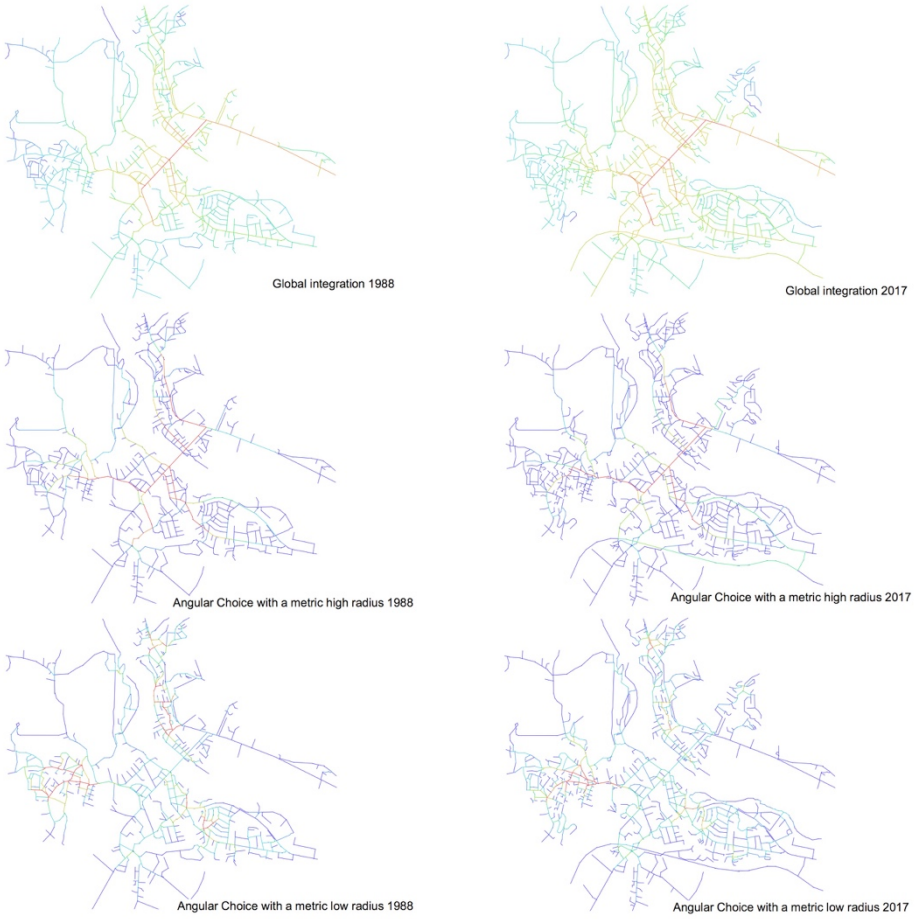

Figure 5 The change of spatial integration on various scale levels in Hokksund

Figure 5 shows the various space syntax analyses of Hokksund before and after the bypass road. The only changes that are shown are that the to-movement potentials are moved toward the new bypass road in the south. No changes can be seen in the angular choice analyses. Thanks to the only connection over the river to the northern part contribute to keep the high integration values in the old town centre.

3.3 Jessheim

Jessheim is the administrative centre of Ullensaker municipality. It is currently the fastest growing municipality in Norway, due to that Oslo Airport opened in 1998, 4 km away from Jessheim centre (Halvorsen 2014). Jessheim got the town status in 2012, and has 15 367 inhabitants.

Jessheim's existence is and has always been related to through traffic. The first main connection to Trondheim was established after 1600, and Jessheim is located on the first rail connection between Oslo and the town Eidsvoll, opened in 1854. Many old buildings are located along the old main route through the town. Several inhabitants earned their income on hotel, restaurants and handwork related to through travellers (Ullensaker kommune 2012, p. 4). The settlement grew around the main road and the railway station. In 1979 the highway E6 was placed outside the settlement's centre. At that time Jessheim had 16 755 inhabitants. However, the settlement continued to grow. After the opening of Oslo's new airport in 1998 to present, the population increased from 19 120 to 34 189 inhabitants (104%). New shopping centres and industrial areas are established.

Jessheim is located 42 km north from Oslo. It takes 35 minutes to travel to Oslo by car and 39 minutes by train. Several commuters to Oslo and the airport are living in Jessheim.

When revealing the income from shopping per capita from before and after the bypassroad, it has increased with 187%. In 1978 it was 75 917 NOK per inhabitant (in 2017 values) and in 2017 it was 218 257 NOK. At present, Jessheim has the highest income per inhabitant in Norway.

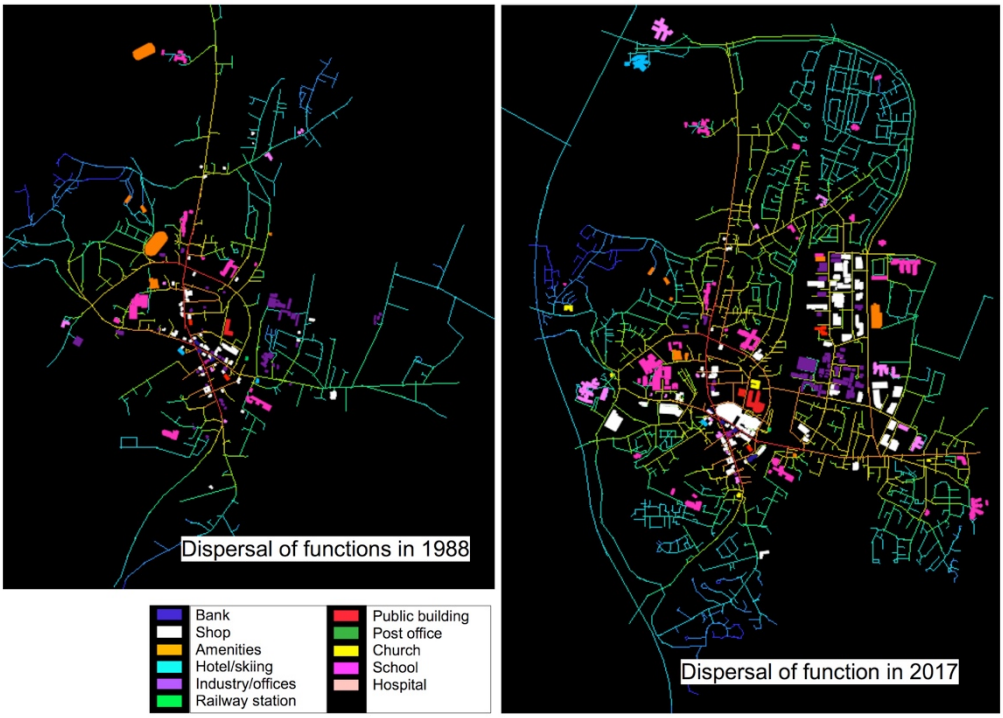

Figure 6 The change of functions in Jessheim

Figure 6 shows the dispersal of functions in Jessheim from 1978 and 2017 with the global integration analyses. The new bypass road is located far outside the settlement. No changes can be found in the dispersal of integration values and the location of the centre. The old centre located along the old main road is not affected at all. Probably the growth occurred close to the main centre.

The municipality tries to protect the historical core with its old tiny wooden buildings through protection plans. There is pressure on these areas for investment, and according to these plans all new buildings have to adjust themselves to these old buildings. Simultaneously, the municipality make plans to facilitate the population growth. Jessheim is popular for young couples with children who cannot afford the high dwelling prices in Oslo. Still the municipality works to improve the public transport for solving congestion problems and private car dependency.

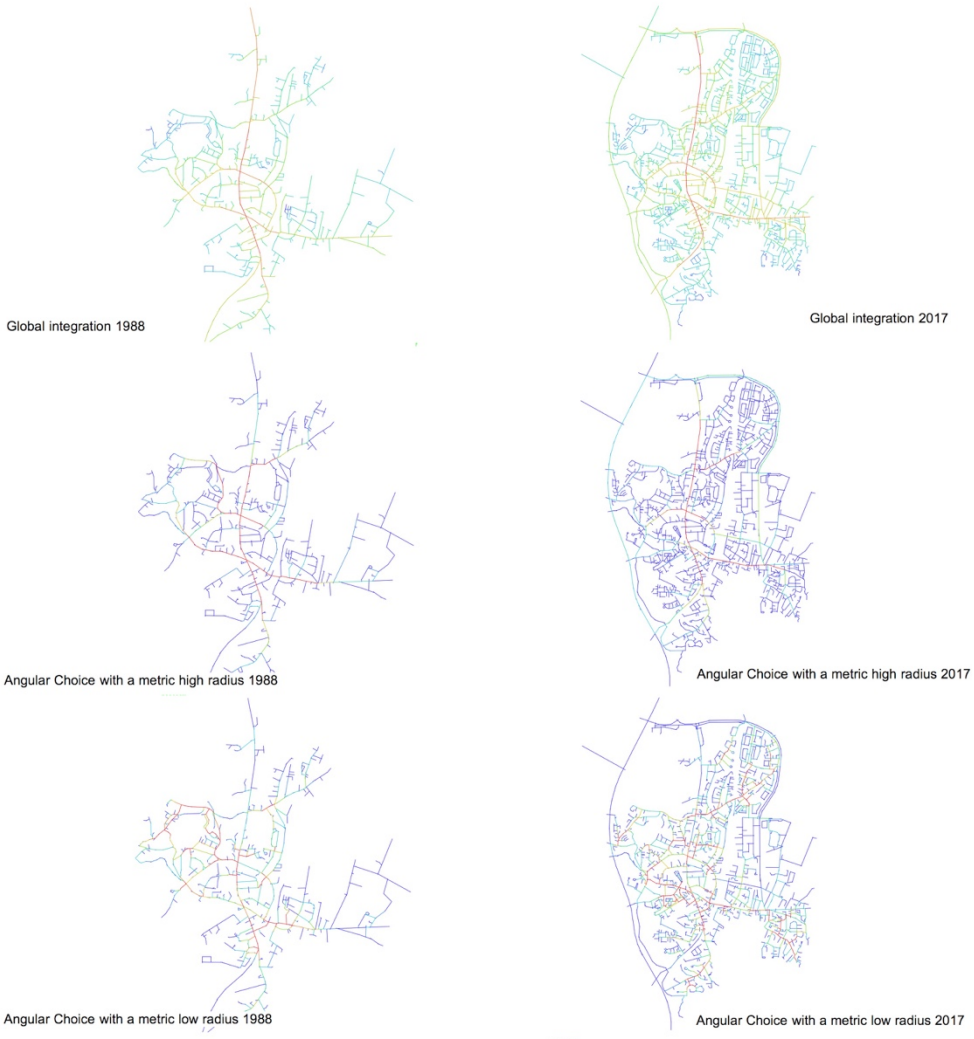

Figure 7 The change of spatial integration on various scale levels in Jessheim

Figure 7 shows the various spatial analyses of Jessheim. As can be seen on the figure, the new bypass road did not affect Jessheim at all on all scale levels. The centre has the most integrated streets and roads in 1978 as well as in 2018.

3.4 Askim

Askim is located east of Oslo, on the main road towards Stockholm. Norway's largest river, Glomma is the municipality's western boarders. In 1855 the first bridge was constructed over Glomma towards Oslo. In 1882 the rail bridge was constructed over Glomma, and Askim got connected to Oslo by train. In the beginning of 1900's Askim started with the production of electric water power from the strong streams of Glomma. In the 1920's the rubber factory opened, and later the insulation factory was opened. A settlement grew up around these production activities, surrounded by farm land.

Askim's shopping centre grew up along the main road, where it crosses the railway. As the traffic grew, the settlement's centre suffered from congestions and heavy car traffic. During the 1970's the discussion of a new bypass road started, due to the extreme congestions in the town centre. In 1983 a new road link was placed outside the centre, and the old rail crossing was closed for through traffic. The centre got two dead-end streets in its centre. The effect was that several shops moved to shopping centres close to the eastern junction of this new bypass road. In 1991 the rubber factory closed down. Due to the rubber factory's location is directly accessible from the eastern junction, the building was transformed to a shopping centre in the 1990's. After a couple of years, the crossing over the rail

tracks was opened for saving the old town centre from empty shopping buildings. Askim got the town status in 1996 (Askim Kommune 2012).

Askim is located 58 km east from Oslo. It takes 47 minutes to travel to Oslo by car and 57 minutes by train. Askim is also a home for commuters to Oslo. In 1983 Askim had 12 302 inhabitants, and in 2016 it was 15 615.

When revealing the income from shopping per capita from before and after the bypassroad, it has increased with 0,6%. In 1983 it was 77 058 NOK per inhabitant (in 2017 values) and in 2017 it has 77 536 NOK.

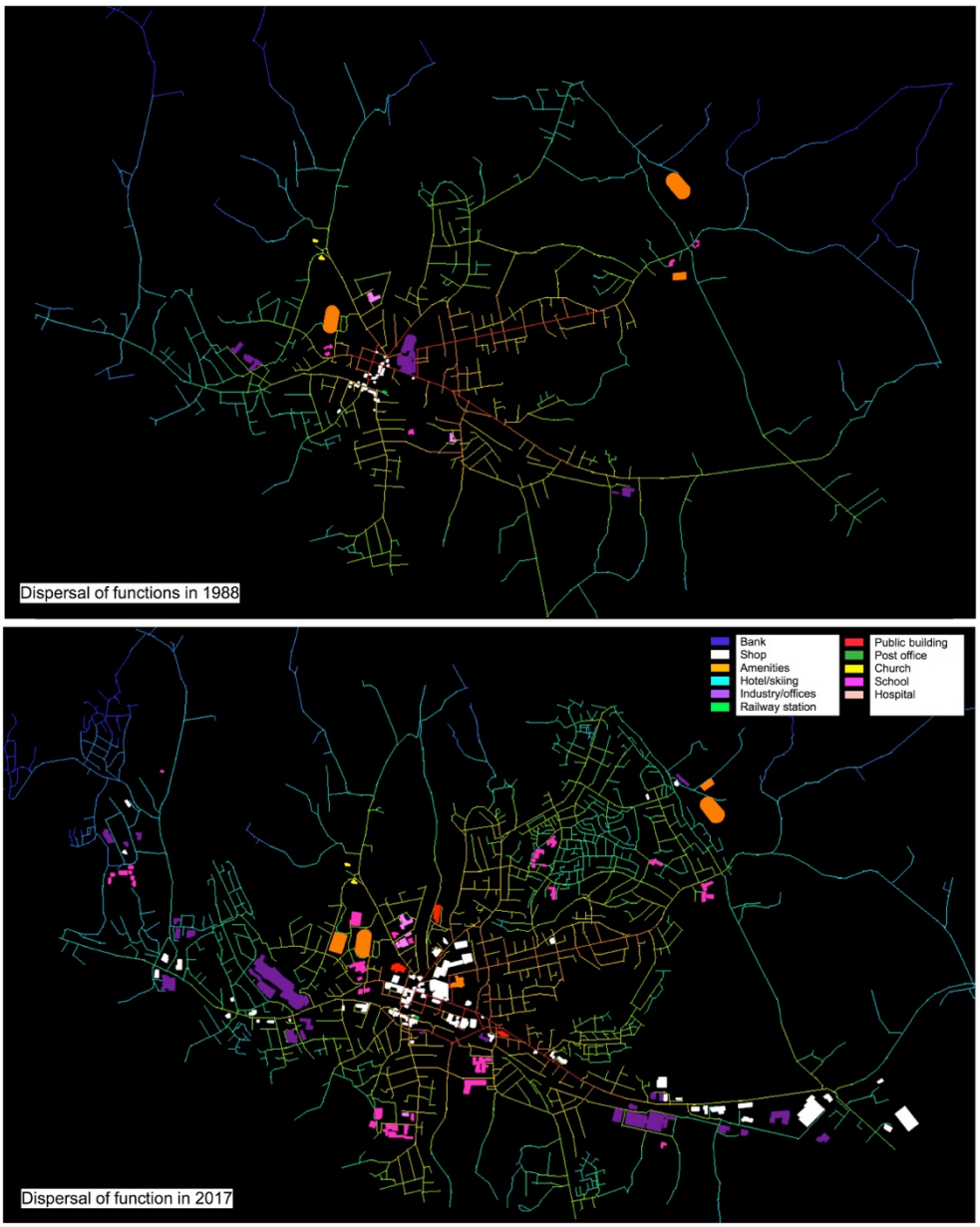

Figure 8 The dispersal of functions in Askim in 1983 and 2016 with global integration.

Figure 8 shows the dispersal of functions with a global integration analyses of Askim. As can be seen on the figure, the town centre moved slightly east-ward as an effect of the new bypass road. The old

large buildings from the rubber factory (coloured in purple in the 1983 analyses) is transformed to a shopping centre (coloured in white) in the 2016 analyses.

Figure 9 The change of spatial integration on various scale levels in Askim

Figure 9 shows the results of the various spatial analyses of Askim from 1983 and 2016. In the global segment integration analyses and the angular choice analyses with a high metrical radius, the centre has moved eastward. In the angular choice analyses, the local street network is broken up. The streets with the highest values are located inside a dwelling area with low through movement potentials. In general, the old main routes had few connections to their side streets. Therefore, Askim is very sensitive to a change of the main route. Luckily, the new main route has few direct connections to its vicinity, in which saved Askim's centre.

4. CONCLUSIONS

The analyses of the four Norwegian cases show that new bypass roads can change the spatial configuration of the street and road network and the location of local centres. In two of the cases, the settlements' centre moved slightly as an effect of the change in the spatial configuration. In the other two cases, the new bypass road did not affect the spatial configuration of the settlements at all. The effect was no change in the location pattern of shops.

In all four cases, the shops and commercial activities are located along the globally highest integrated streets or roads. According to the theory of the natural movement economic process, shops locate themselves along the highest integrated streets on various scale levels. The local food shop and the bakery depend on high integration values on local scale, such as the local angular choice analyses with low metrical radius. Car-based shopping malls depends on high values on the angular choice analyses with a high metrical radius as well as on the global integration analyses. As soon as there is a shift of these values, it affects the location pattern of shops.

Most car based commercial activities prefer to locate themselves at the junction where the new bypass road tangents or is connected to the local settlement. The purpose is to catch the through travellers from the motorway, as well as being accessible by the settlements' inhabitants. In line with the angular choice with a high metrical radius, shops prefer to locate themselves along the routes with the highest spatial integration values. Where the integration change on local as well as global levels, the location pattern of commercial activities are affected too.

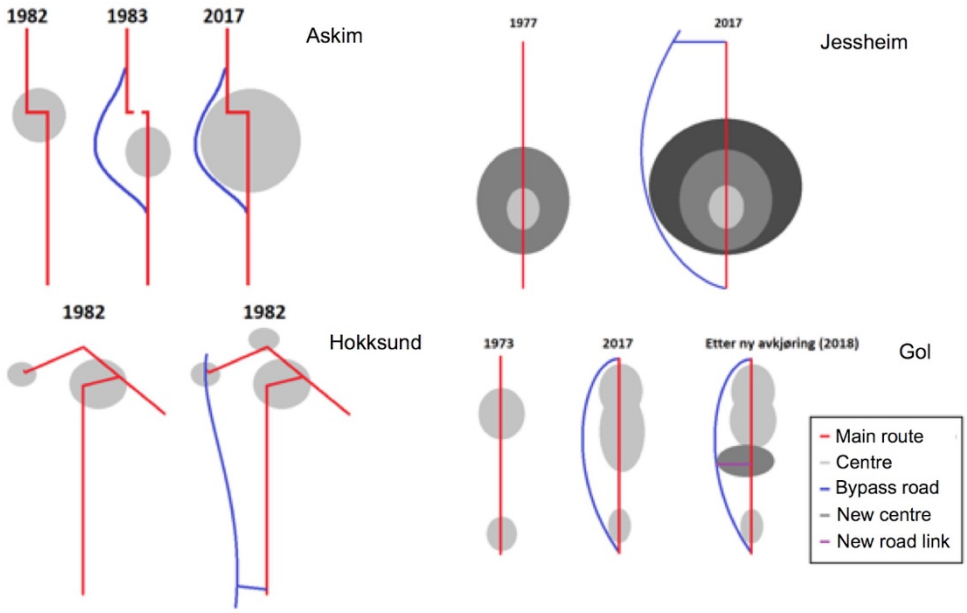

Figure 10. Principles on how bypass roads affect the towns Gol, Hokkssund, Jessheim and Askim

How sensitive are small settlements to new bypass roads? Figure 10 shows some schematic principles on how the bypass road affected these four Norwegian settlements. In the case of Askim, the combination of the new bypass road and closing the old main route for through traffic had a very negative effect on the town centre. Shops closed down. In a short time-span, this main route was re-opened for saving the economic vitality of shops in the town centre. However, new shops established themselves at the eastern junction of the bypass road. The best access to Askim centre is from that eastern junction, even though when people are arriving the town from west.

In the case of Jessheim, the new bypass road had no effect at all at the town centre. All new development took place around the existing centre. Moreover, all new streets are well-connected to the old centre, in which strengthened its local catchment area. The new bypass road for Hokksund contributed to the establishment of a shopping centre between the old centre and the junction of the new bypass road. The only crossing over the river contributes to the other half of the settlement contributes to keep the economic vitality in the old centre alive. In the case of Gol, the new bypass road contributed for an establishment of a new centre with car-based enterprises, next to the old centre. Currently, pressure starts to occur at the newly established junction.

How new bypass roads affect small settlements depends on two things; firstly, how the new bypass road is connected to the existing settlement, and secondly, on how the spatial configuration is on the local street network. The location of the junctions in relation to the new bypass road and the existing centre affect the spatial integration of the whole settlement.

Small settlements with existing small centres are extreme sensitive to the location of new bypass roads. In particular, in places where the private car is the main transport mode, new bypass road can destroy old small town centres. It all depends on how the new bypass road is connected to the existing local road structure. Planning and implementation of them has to be done with care. The analyses of these four cases show that the space syntax method is useful for making impact assessments of

alternative solutions for new bypass roads. As world-wide research results have shown, space syntax has high degree of predictability regards the location of commercial activities (van Nes 2017).

Norway has a weak planning system on regional level. At present, there is high competitions between municipalities to attract large shopping malls along the motorways. Large shopping malls create jobs and income for the municipality. This practice is not in line with the Norwegian national policies on coordinating transport and land use planning in a sustainable manner. The national policy is to protect and densify inside existing urbanised areas, and stop the urban sprawl into the countryside. However, it is difficult to implement these policies in the Norwegian country side, due to high degree of private car ownership, high degree of private car dependency, combined with low frequencies on public transport, on train as well as bus services. Therefore, the spatial forces on the mobility network are the drivers for economic development. As this inquiry shows, space syntax is a useful tool to predict the economic consequences of existing centres in the planning of new bypass roads.

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