CENTRALITY AND ECONOMIC DEVELOPMENT IN THE RIJNLAND REGION:
social and spatial concepts of centrality

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Abstract
In urban research, spatial and social concepts of centrality are being distinguished. From a spatial point of view, metrical centrality implies that something is located in the middle of an area. However, metrical and topological centrality are not equivalent. In research where space syntax methods are applied, topological centrality implies that something is spatially integrated in an area. From a social point of view, cultural centrality characterises an urban area in terms of a concentration of e.g. historically or artistically relevant artefacts. Likewise, urban areas can be central in terms of their economic relevance, e.g. shopping areas, concentrations of enterprises. These two kinds of societal centrality do not have to coincide either.

According to the theory of the natural movement economic process, centralities of a spatial order support centralities of a social order. However, political forces and organisational constraints can overrun the spatial forces. In order to set out the difference between various types of centralities and political forces as well as organisational constraints, the Dutch region Rijnland in the Randstad can serve as an example. As regards metrical centrality, this region has a central, strategic location in the Randstad metropolitan area with several potentialities for investment and development. In spite of its metrically central location and all its opportunities, Rijnland benefits less from investment and economic development than the other four cities in the Randstad (The Hague, Amsterdam, Rotterdam and Utrecht). As configurative spatial analyses show, the region's street and road net are poorly inter-connected with its highways and its various local centres understood in social terms. The inter-national highway through the region is located on the edge of the region's most urbanised area.

The region consists of several local centres functioning independently of one another. Leiden city is a strong cultural centre. However, the region lacks a strong economical centre. Even though there are potentialities for developing a new economical centre in the region, a development of this kind is constrained by political forces, organisational conditions, conflicting interest of 3 municipalities and strong national protection plans. Comparable studies of Amsterdam, Rotterdam and The Hague show that vital economical centres depend on a location along a highway with an easily accessible city centre and on a surrounding locally inter-connected street grid. Thus, economic centrality is heavily dependent on topological centrality. Cultural centrality is not sufficient for attracting investors to a region. It has to be supplemented by an inter-connected and highly integrated street and road net on a national, regional and even local scale.

Keywords:
Centrality
Economical development
Political and organisational forces

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Introduction

In urban research, spatial and social concepts of centrality are being distinguished. From a spatial point of view, *metrical* centrality implies that something is located in the middle of an area. However, *metrical* and *topological* centralities are not equivalent. In research where space syntax methods are applied, topological centrality implies that something is spatially integrated in an area. From a social point of view, *cultural* centrality characterises an urban area in terms of a concentration of e.g. historically or artistically relevant artefacts. Likewise, urban areas can be central in terms of their *economic* relevance, e.g. shopping areas, concentrations of enterprises. These two kinds of societal centrality do not have to coincide either.

According to the theory of the natural movement economic process, centralities of a spatial order support centralities of a social order. However, *political forces* and *organisational constraints* can overrun the spatial forces. In order to set out the difference between various types of centralities and political forces as well as organisational constraints, the Dutch region Rijnland in the Randstad can serve as an example.

**Metrical and Topological Centrality**

As regards *metrical* centrality, Rijnland with its Leiden city has a central, strategic location in the Randstad metropolitan area with several potentialities for investment and development. Like Amsterdam, it is closely located to Schiphol International airport. Moreover, two main highways are passing through the region. All inter-city trains stop at Leiden central station. Leiden's historic centre with its old styled brick stone buildings, churches, forts, museums, art galleries, canals and bridges is quite large. It is even larger than the historic centre of The Hague. One of the oldest universities in the Netherlands is located in The Hague that is known to be the centre of the chemistry knowledge. Furthermore, Leiden is also located close to the sea and to the protected agricultural area of the Randstad, named “the green heart.”

In spite of its metrical central location and all its opportunities, Leiden benefits less from investment and economical development than the other four cities in the Randstad (The Hague, Amsterdam, Rotterdam and Utrecht). The region offers several areas waiting for investment and development. In comparison with its neighbouring cities Amsterdam and The Hague, few international and national companies put investment in Leiden. Culturally and historically, the city has a lot to offer. However, investment and economic growth has stagnated. Why is Leiden not as developed as Amsterdam, Utrecht, The Hague and Rotterdam? To what extent can a configurative analysis of the street and road net contribute to identify Leiden's economical stagnation?

In the first instance, some definitions of centrality seem to be necessary. Walter Cristaller's central place theory attempts to illustrate how the provisions of goods relate to a town centre and its surrounding areas. Christaller assumes that central places are distributed over a uniform plane of constant population density and purchasing power. People travel to the closest centre in order to purchase their desired goods or services. Presumably, customers act rationally in the way transportation cost is reduced in order to reach the closest centre (Christaller 1972). If Leiden has such a metric central location in the Randstad area, why is it not such a vital economical centre like The Hague, Rotterdam, Utrecht and Amsterdam?
In studies on built environments, metric centrality implies that something is located in the middle of an area with the shortest metric distance to all other points in that area. Sometimes temporal aspects like time use for travel are taken into account. Obstacles like traffic-junctions, bad street quality and a broken up street net influences the temporal aspects of metric centrality.

If Rijnland has the most metric-central location in the Randstad area, maybe it has the least topological central location. In addition, its topological weak centrality can be described in terms of the high number of times one has to change directions when travelling from the highways to its various centres. In the first instance, Leiden's city centre and the region's village centres are not directly connected to the highway net at all. One has to travel a certain distance on regional roads before the highways are reached. Moreover, the local street net in Leiden's city centre is messy and broken up in comparison with the ones in Amsterdam, Rotterdam and The Hague. One tends to get easily lost when walking around in the centre of Leiden. Only Leiden's two main shopping streets Haarlemmerstraat and Breestraat are easily to find. Thus, topological centrality can be described in terms of the configurative structure of the road and street net.

**Economical and Cultural Centrality, Political and Organisational Constraints**

Metrical and topological centrality deals with spatial issues of a built environment. Other concepts of centrality are required in order to describe the social and economic activities taking place inside urban centres. In general, one can distinguish between economical and cultural centrality.

An economic centre is defined to be the urban areas where trade, shopping and finances take place. The aim for these kinds of activities is to be both in a metrical and topological central position to all potential customers. As research has shown, their optimal position depends on the configurative structure of the street net. The theory of the natural movement economic process demonstrates how a street grid's configuration determines the flow of human movement and the location pattern of shops. The location of shops and flow of human movement can influence each other, though not the configuration of an urban grid (Hillier et. al. 1993). Figure 1, left side, shows the relationship between configuration, attraction (the location of economic activities) and movement. It explains how a built environment function independently on planning processes as regard the location pattern of shops, human movement through the urban network and the configuration of the street grid.

If a centre's optimal position changes through changes on a street net, the location of this centre is likely to change too (Hillier 1999). Therefore an economic centre is heavily dependent on a street
structure, in which relates to topological centrality. Accessibility to potential customers is at issue.

However, political forces, interests' conflicts and organisational constraints can overrun the generative power of the street grid's topological structure. A strong planning system on national and regional level can prevent the stimulation of investment and economical development in certain areas. Likewise, planned strategies, regulations and socio-political constrains can allow or restrict interventions at strategically located places. A street grid's spatial forces can thus be overrun by politically accepted plans, interests' conflicts among property owners and their neighbours, and a too complex bureaucratic planning organisation on municipality, national and regional levels. So far, these issues are not sufficiently considered in studies on spatial configurations and urban centrality. In this respect, the Rijnland region presents a case of this kind. Figure 1, right side, shows how such obstacles can distort the natural movement economic process in cities.

Cultural centrality is a broader issue than economic centrality. Places where one has a large concentration of historic important buildings and monuments from the past are defined to be cultural centres. The artefacts' meaning and the tradition related to them could be understood from the technical, social, cultural and economical activities that took place in the past (Moudon 1997, Rossi 1983). Cultural centrality can be many folded, as for example religion centres, art and craft centres, historical trading centres or education centres. In the case of Leiden, the historical city centre had a strong position due to its old university and art and crafts. These activities from the past mostly have left monuments over like for example a set of buildings and a street pattern. Intact historical centres function as a magnet for cultural activities like museums, art and crafts, tourism, concerts, performances etc. All these activities with their artefacts seem to create the atmosphere and sense of a particular place (Lynch 1990, Norberg-Schulz 1980 & 1995, Rossi 1983).

In many ways, cultural centres contribute to create a city's image. As often presumed, a strong city image attracts investors into a city or region. However, evidence or precise understandings and explanations of this phenomenon are lacking.

What are then the spatial features of the economic and cultural centres? How does the metrical and topological structure of a region's street net influence these two main types of centres? To be more precise, to what extent functions an urban centre in itself with all its monuments and images as an attractor for investment, and to what extent encourages or limits a street net's topological structure urban investments? It the following sections some answers on these questions will be discussed with examples from the spatial configurative analyses.

**The Spatial Analyses of Rijnland's Street and Road Net**

Rijnland's weak topological centrality and its potentials for economical investment and growth can be identified through the spatial configurative analyses of its street and road net. Figure 2 shows a global integration analysis of the whole Rijnland Region. It shows thus where its most topologically central area is located - in which is at the highway A44 and the western parts of Leiden centre. The black dots represent the location of national and international companies. As can be seen from the figure, the region is divided up in several municipalities. Some of the highest integrated areas are located on the edges of two or three municipalities.
Compared with Rotterdam, The Hague and Amsterdam, as shown in figure 3, the Rijnland region's topological central core is located outside any of the region's centres. The globally integrated ZuidAs in Amsterdam is directly connected to the city's main route net as well as the local street net. Almost 90% of the foreign directed investment in the Randstad takes place in Amsterdam, most of them located in the ZuidAs area (Rocco & van Nes 2005). There is high inter-connectivity between the highway A10, the main routes through the city and the local street net at the ZuidAs. As shown in the global integration analyses of Rijnland, the most integrated area is the Bio-science Park located along the highway A44. The main route through the northern part of Leiden city belongs to the 10% most globally integrated streets. At present, most national companies are located along it (Rocco & van Nes 2005).

Being well connected to all other streets in their direct vicinity is a condition for vital local shopping streets. In comparison with Amsterdam and The Hague, the local integration with a radius like 3 is low throughout the whole Rijnland region. When increasing the radius to 5 and 7, the results start to correspond with the location pattern of shops. Several local configurative measurements have been carried out, such as radius-radius integration, area integration, integration gradient and angular integration with various radiuses. Figure 4 shows a radius-radius integration and area integration analysis of the region.

Figure 2: Global integration of the Rijnland region with the location of the national and international firms and the municipality boarders
The location pattern of shop, as shown in figure 5, follows the radius-radius integration analysis, whereas the degree of vitality in terms of variation in choices and types of shops depends on the area integration of the surrounding areas. The higher area integration, the livelier the shopping street is in terms of number of people in streets and variation in types of shops.

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An angular analysis combined with a local integration highlights the main routes through the region. As shown in figure 6, a local angular total depth analyses highlights the most vital shopping streets in the region as well as the streets where most of the larger companies are located. The highly trafficked street Breestraat and the lively shopping street Harlemmerstraat imply the highest local angular integration values. Since most streets in Leiden centre are curved, they tend to have relatively low values in the axial analyses. In this respect, Leiden’s most lively shopping streets turn out to be the most integrated in the local angular analyses.

In comparison with the other analyses where Alphen a.d. Rijn has highly segregated streets, its main streets are highlighted in the local angular analysis.

The topological analyses of the street net demonstrate how the region consists of several self-contained local shopping centres rather than one large economic main centre. Each municipality in the region has its own shopping centre. Generally speaking, there are two types of shopping areas in the region. One is the old historic town centre consisting of one or two linear shopping streets, while the other one in the clustered car based shopping centre. The first one is pedestrian- or bicycle- based, while the other one is car-based (van Nes 2005). The old historical villages consist of pedestrian based linear shopping...
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Figure 5:
Location pattern of shops

Figure 6:
Local total angular depth of Leiden

The region's main cultural centre is Leiden's historical centre. As regards its degree of economic vitality, this centre consists only of two main shopping streets and some small local shopping streets and shopping centres. Most companies are located along the highly globally integrated road in front of the railway. Through city growth, the topological centre of Leiden has moved away from the historic city centre towards the Bio-science Park.

The Bio-science Park is located between Leiden centre and A44. Its local street structure is broken up and badly connected to its vicinity. It might explain as to why the Bio-science park area at present is barely used. A stimulation of investment and economic growth in this area...
depends on an effective well-connected local infrastructure to all areas in the vicinity. Seemingly, vital economic centres depend not only on high global integration, but also on a well integrated and well connected local street net.

Since the international highway A4 brings flows of transport between Amsterdam, Schiphol airport, The Hague, Rotterdam, Antwerp and Brussels, proposals are made to create economical "hubs" along A4 at Leiden's eastern side. However, these nodes are located on the edge of the most urbanised parts of the Rijnland region. Furthermore, there exist no effective direct connections to Leiden's city centre from A4, or between the highways A4 and A44 through Leiden. Inter-accessibility and inter-connectivity is at stake on all scale levels.

**Rijnland's Central Topological Location in the Randstad-Holland**

At present, there exists no space syntax software with the capacity analysing the street and road structure for the whole Randstad area. Therefore, some model studies are made in order to demonstrate Rijnland's weak topological centrality in relationship with the other four cities in the Randstad.

Figure 7 shows an integration analysis model of a group of towns located around an empty space connected to a highway net in five different ways. Here in this context the empty space is the protected agricultural area “the green heart.” How does each town’s degree of connectivity to the highway net affect their centres? In the case A, the...
highway is located outside the town. It is the most segregated town in this example. This illustrates the case of Leiden and its relationship to the highway A4. In case B, the highway goes through the town and is well connected to all its streets. The centre is located along this main road. In cases C and E, the highway goes through the towns and both towns have also a ring road. The most integrated core is on the well-connected parts of the ring road to the town and highway itself. An example on this is the ZuiderAs in Amsterdam. It is located on the A10 and is well connected to the city of Amsterdam. In the case of D, the highway functions as an outer ring road. The integration is on the ring road itself and the potentialities for economic development will be on the junctions between the ring road and the main routes to the towns. Examples on this are the ring roads in Rotterdam and Utrecht.

If one wants to increase the global integration of town A, then one has to make direct connection to the highway from the town's centre. A ring road or a direct road connection into the town centre (like for example The Hague) can encourage it. The local integration is more or less the same in all towns.

Conclusions - Rijnland's Weak Topological Centrality

As configurative spatial analyses show, the region's street and road net are poorly inter-connected with its highways and its various local centres understood in social terms. The inter-national highway A4 through the region is located on the edge of the region's most urbanised area.

The topological spatial structure of Rijnland's street net is disconnected between the regional and the local scale in the following way: The two highways pass only through the region without any connection to its centres. The inter-regional road system is spatially broken up and effective east-west connections are missing. An effective well-connected main route street net through the region is missing at several parts. On a local level, the historical centre has a spatially broken up street structure, which is disconnected from the global network. There are only two successful main streets functioning as vital shopping streets for Leiden.

The region's most integrated core, located at the Bio-science and Valkenburg areas, has potentialities for becoming a centre for economic development on a regional level. However, it lacks effective connections to the A4, Leiden centre and the railway station. Furthermore, this core is located on the edge of the municipalities Leiden, Valkenburg and Oegstgeest. In order to stimulate economic development in the Rijnland region, it requires agreements and cooperation between these three municipalities. As it is at present, there are conflicting interests. Some of the municipalities want to be a part of the large metropolis in the Randstad, while others prefer to protect their image being a small settlement in the agricultural Dutch landscape.

One can ask as to why economic development has not taken place earlier at the west and east nodes, due to their strong spatial potentialities. The answer might be in the way the powerful Dutch planning system's laws and rules and local democracy can overrun the generative power of the street net's potentialities for economic development. In the case of Rijnland the region's most integrated core is located on the edge of 3 different municipalities where each of them has conflicting political and economical interests. Furthermore, protected green belt areas and green buffers stated in national policy documents limit expansions and development on the potential nodes along the highways A4 and A44. In general, strong planning policies
at all levels seems to restrict the natural movement economic process at all spatial scale levels.

The spatial structure of the network and the region's division of several independent municipalities contribute to the region's fragmented settlement structure, where the local centres are poorly interconnected with one another throughout the region. An economic vital main centre, like for example as the Zuid As in Amsterdam is missing. After all, the location of firms occurs in centres with both high global and local angular total depth integration, while the location pattern of shops follows the local angular total depth and local integration. If the aim is to increase investment in the region, the challenge is to make attractive centres with a street net with both high global as well as local integration. Inter-connectivity is at stake in Rijnland.

**Suggestions or Challenges for Street and Road Net Improvements**

In order to make a street and road structure optimal for stimulating economic growth in the region, the main challenge is to improve connectivity between A4 and A44 with high accessibility to Leiden centre.

For years several suggestions are made and discussed by the Leiden municipality for a new road link between A4 and A44 located at the south-western part of Leiden centre. These suggestions are analysed with the help of space syntax method. The analyses shows how a new road link between A4 and A44 depends on direct connections to the city centre as well as the east and west nodes - if one wants to increase the global integration in Leiden centre.

However, these suggestions are already throughout discussed for years by decision-makers. Experiments on other alternative solutions have been tried out. Figure 8 shows global integration analyses of four strategic principles of improvement of the link between A4 and A44. Strategy one shows the municipality's proposal to upgrade existing roads or streets through Leiden. This alternative will increase the global integration in the area around the street Kennedylaan - Churchilllaan in which can stimulate economic growth inside this area. As it is at present, the area is poorly connected to the city centre and the railway station due to the rails tracks. Strategy two suggests making the connection to the city centre as short as possible and to link it to the main route from the city centre to the west node. This solution contributes to increase the integration in the historical city centre and the west node, which might contribute to investment in the areas around the central station and the Bio-science Park.

Strategy three suggests making a direct connection between the highways at the south-western part of Leiden, and a direct link into Leiden centre. As can be seen in figure 8, this road link drags the global integration away from the other road link suggested in the first alternative. Both Leiden centre and the west and east nodes will benefit from an increase of the global integration in their cores, although the weight is put on the east and west nodes. In order to increase the vitality of both nodes on a national level, one can make a direct tunnel between these nodes. As shown in strategy four, the east and west nodes imply the highest global integration values. Nevertheless, Leiden centre and the area around the central station will have weak global integration values. Local integration will be the same in all four suggested strategies. It can be increased by a well-connected local road net inside the new east and west nodes.

It is not enough encouraging new development facilitating city and economic growth at Leiden's west and east nodes along the highways.
by only making land available for development. Lively economical centres seem to depend on topological shallow inter-connectivity between the local street net, the main routes network and the highway network. This implies few changes of directions from the highway net to the local street net. Inside the nodes itself, encouraging street life implies a well-connected street net with an integrated use of pedestrians, bicycles and vehicles. This can generate attractive lively urban centres facilitating economic development for all types of firms, retail and shops and attractive dwelling areas.

As the global integration analysis has shown, the Valkenburg area and Bio-science park at the western node has a global strategic central position in the region. In order to maximise the potentialities of their location with purpose to stimulate investment, a new street net must also be locally integrated. Making a street net well connected to the areas in the vicinity, the highways and Leiden centre seems to be essential. Furthermore, there exist potentialities for restructuring the street structure and to increase the built mass' density of the Bio-science park area.

Most proposals for an effective east-west connection are suggested at the southern side of Leiden. However, at present several national and international companies are located on the north side of Leiden centre. Therefore effective east-west connections between A4 and A44 on the north side of Leiden centre can not be neglected. When taking both links into account, it will then contribute to make a ring road encircling Leiden centre. In order not to drag the global integration out of the city centre, accessibility to Leiden centre can not be forgotten. In what ways new routes around Leiden centre can contribute to investment in the Region depends on how these routes are imposed and connected to the existing street and road net. Interconnectivity and accessibility is at issue (van Nes 2002).

In order to reveal the possibilities for a ring road encircling Leiden centre, two strategies have been analysed. One is the highway or motorway styled ring road with few connections to the existing street net, and the other is the boulevard ring road with many connections to the street net in the vicinity. As the analyses shows in figure 8, the highway ring road has the advantage improving the accessibility between the west and east nodes, while the latter one might stimulate to a location of firms, retail and shops along the north and south parts of this ring road. As research has shown, economic centres tend to locate at the highest integrated nodes of ring roads. It all depends how a ring road is imposed upon and connected to the existing street net (van Nes 2002). In the case of Leiden, the challenge is to improve the accessibility from a ring road to the city centres and the east and west nodes.

What kind of strategy can be suggested in order to stimulate economic investment in the Rijnland region? From a spatial point of view, improvements need to be done on the region's topological centrality. In the first instance, accessibility and inter-connectivity of its road and street net on a local as well as a national scale needs improvement. The east and west nodes and Leiden centre must be easily accessible from the two highways.

From an organisational and political point of view, the region consists of several local centres functioning independently of one another. Creating new nodes without taking interests conflicts into account is doomed to fail. At present Leiden city is a strong cultural centre in the region. However, the region lacks a strong economical centre. Even though there are potentialities for developing a new economical centre at the region's most globally integrated core, a development of this kind is constrained by political forces, organisational conditions,
conflicting interest of 3 municipalities and strong national protection plans. Therefore, resources have to be put into negotiation processes in order to reach a common agreement of all involved participants, organisations, municipalities and governmental institutions. Otherwise, spatial improvements have to be implemented on places with a low level of interest conflicts.

As comparable studies of Amsterdam, Rotterdam and The Hague show, vital economical centres depend on a location along a highway with an easily accessible city centre and on a surrounding locally interconnected street grid. Thus, economic centrality is heavily dependent on topological centrality. Cultural centrality is not sufficient for attracting investors to a region. It has to be supplemented by an interconnected and highly integrated street and road net on a national, regional and even local scale, combined with a common agreement

Figure 8:
Global integration of six strategic principles of improvement in Leiden
with various involved parties, common development visions with municipalities, regional and national authorities.

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