

NEW URBAN CENTRES IN THE NETHERLANDS

PIETER VAN DER HEIJDE

*Faculty of Social and Behavioural Sciences, University of Amsterdam, Netherlands.
E-mail: pvdh@stedplan.nl*

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ABSTRACT

Over the last 50 years, intense urbanisation has taken place in the Netherlands. This has resulted in the development of many polycentric urban regions, which consist of historic core centres, other historic centres as well as new urban centres (NUCs). Focusing on NUCs in Dutch city regions, this paper presents the results of a research project analysing the number and spatial structure of NUCs, examines their functional composition and explains the different types of centres that exist. The paper also analyses the level of centrality of the NUCs. The main finding is that functional composition is related to the type of area in which NUCs are built: district centres, villages, new towns, transition areas or university areas. With a character that is much narrower than that of core centres, the NUCs house a lower diversity of functions, fewer facilities serving an area larger than central districts, and a limited number of public transport modes.

Key words: New urban centre, the Netherlands, Randstad, polycentric, core centre, definition

INTRODUCTION

The Dutch Environmental Assessment Agency (PBL 2011) expects that population and employment in Dutch urban areas will continue to grow in the coming decades. This is expected to be most pronounced in the Randstad (seven million inhabitants), an urbanised region in the west of the Netherlands that includes the cities of Amsterdam, Rotterdam, The Hague and Utrecht. Also in the urban areas outside the Randstad, it is expected that the demand for development of available land will increase.

In the Netherlands, like in many other urbanised countries, polycentric urban networks have developed. Lambregts (2009) defines a polycentric metropolitan region as an urban region characterised by multiple centres. Research carried out by Burdock *et al.* (2005) examining development on the periphery of

European cities shows that the formation of polycentric networks is most pronounced in Paris and in the Randstad (London was not included in this research). The Randstad's polycentric pattern is partly inherited from the past, due to the fragmented political and administrative structures that have prevailed in this area (Dieleman & Faludi 1998; Meijers 2005). But it is also the result of urban and regional planning. During the post-war period, all levels of government – from local to national – exerted a strong influence on spatial planning in the country. The national government planned new towns and housing developments on the edges of existing urban areas. Since the 1980s, government policy has become more market oriented. The current (right of centre) government has even decided to decentralise spatial planning and give much more responsibility to the provinces (Ministerie van Infrastructuur en Milieu 2011).

Historic core centres are no longer the clear centre of activity in a city region. In the Netherlands an urban mosaic has taken shape, composed of urban environments with different urban qualities (PBL 2010). This phenomenon has been described as post-suburbia (Kling *et al.* 1991; Bontje 2006) or *Zwischenstadt* (Sieverts 2001), and is characterised by an increase in multi-functionality in terms of employment, leisure and educational functions. Whether it represents a diffusion of urban functions in the form of urban sprawl, or also a clustering of urban functions in new urban centres (NUCs), depends whether we define NUCs as centres of employment or as activity centres (Davoudi 2003).

In her article analysing the concept of polycentricity, Davoudi (2003) notes that polycentricism means different things when applied to different spatial scales. She distinguishes between three forms of polycentricism. The first, intra-urban polycentricism, deals with multiple centres in one city region. The second, inter-urban polycentricism, relates to an area with multiple cities. These are called polycentric urban regions (PURs). The third type, inter-regional polycentricism, is a combination of various PURs. At the intra-urban level, polycentric urban networks are composed of core centres, other historic urban centres and NUCs.

Most previous research on polycentric networks has focused on the inter-urban scalar level, while in Europe little empirical research considering the intra-urban level has been conducted. The existing literature is unclear about the number and function of NUCs in Europe. Additionally, much of the literature about polycentric networks deals with housing, employment and mobility; and devotes considerably less attention to services. This paper attempts to contribute to the body of knowledge regarding polycentric networks in Western Europe at the intra-urban level. Focusing on NUCs in Dutch city regions, it analyses the number and spatial structure of NUCs, examines their functional composition and explains the different types of centres that exist. The emphasis is on the service function of the centres within these networks. The paper also analyses the level of centrality of the NUCs. This is especially interesting against the background of the policy of the

Dutch national government, which from the 1970s until 2010 has emphasised the position of city centres rather than the development of NUCs. As a result of this policy, it is expected that compared to historical city centres the centrality level of NUCs will be lower. Barnett (2002) states that, over time, NUCs evolve into areas with a composition of functions similar to those found in historic urban centres. Despite the recent restrictive government's policy, it is expected that NUCs, over time, will increasingly come to resemble core centres.

DEFINING NEW URBAN CENTRES (NUCs)

At present there is no generally accepted definition of an NUC. Garreau (1991) emphasises office and retail space. He introduced the concept of 'edge cities' in an American context. These are areas, located far from the traditional centre in places where 30 years earlier no city was present, and now contain enormous office and retail floor space. Edge cities have more jobs than residents. Such a scale of development differs from a European (and certainly Dutch) context. A European definition is presented by Bontje and Burdack (2005), stating that Europe's edge cities are located closer to the city centre than in the United States and have more residents than jobs.

Other researchers see NUCs as having high concentrations of employment, which distinguishes them from other areas (see Giuliano & Small 1991; Garcia-Lopez & Muniz 2008). Although urbanisation and economic development are closely intertwined (Henderson & Venables 2009) this emphasis on the working function does little justice to the service function of centres, nowadays one of their most important characteristics. Moreover, consumer amenities are becoming increasingly important in all types of places (Glaeser 2005). In European city centres, the traditional presence of urban functions such as retail, cafes, public services, religion, healthcare facilities and culture means that these have a central role in providing services for the surrounding city (area). In this context Van Engelsdorp Gastelaars (2001) uses the concept of centrality level. He believes the centrality level depends on the number of different functions that an area fulfils for its surroundings, and the catchment area that it

serves. Although he does not specifically focus on NUCs, there is no reason to believe that such characteristics would not be applicable in the case of NUCs. In light of these considerations, the definition of NUCs used for this research is not based on the level of employment in the centre, but rather on the multi-functionality and level of services there. This is pre-eminently what distinguishes these centres from their surrounding residential and employment areas. This research defines NUCs as: the largest concentrations of city-centre functions in an urban region containing multiple functions as well as services for an area larger than the district of the centre itself where, in the past, there was no urban centre present.

THE DEVELOPMENT OF NUCs

Anas *et al.* (1997) state that NUCs are the result of centripetal and centrifugal forces at play in the original centre. Centripetal forces have to do with the facilitation of interaction, profiting from the attractive public environment, cost savings on public services and reduced costs of doing business. Centrifugal forces, which pull development away from the centre, include shortages of development land, congestion, pollution, and the attractiveness of other locations. Henderson and Venables (2009) states that urban diseconomies and other cost factors reduce the benefits of agglomeration, helping to limit the size of cities. According to Abdel-Rahman and Anas (2003), the formation of NUCs is an important way for cities to accommodate a larger economic base, making growth possible. But developing NUCs is only possible with considerable effort. Anas *et al.* (1997) state that an NUC has to reach a certain size and critical mass to be viable. As cities become larger, the critical size for NUCs decreases. This relates to an increase of the centrifugal forces of the core centre. Once a new centre has reached a critical mass, it has a self-reinforcing effect as the location becomes more attractive for businesses (Gaschet 2002).

Henderson and Mitra (1996) showed that the distance to the city centre is vitally important for the location of an NUC. This is the result of property developers who aim to maximise land yields, which vary depending on the distance to the centre. For companies, locating

closer to the centre means more efficient information exchange but also higher land prices and commuting costs. In the European context, NUCs develop as a result of the interplay between private parties and government. Property developers seek to maximize the return on their investment, which leads to a search for economies of scale or savings in development costs (Guy 2007). Planners seek to influence patterns of development in order to achieve wider goals they consider to be the public interest.

The process of transformation from a monocentric city region into a polycentric network is one that requires time. Frequently, the old spatial hierarchy remains intact for a long time. This raises the question of how 'urban' the periphery can become. The way to develop true urban networks is not self-evident. Critical enablers include new transport networks, diffused concentrations of residential and employment areas and NUCs with differentiated services. In the interests of future development of urban regions in the Netherlands, it is essential to examine the spatial and functional composition, as well as the centrality, of the NUCs in these polycentric networks-in-the-making. For the government, this offers an opportunity to readjust the future process of urban development.

The next part of this paper describes the research design. After, the results of the research are presented. The spatial dispersal and location of NUCs are described. The subsequent parts analyse the functional composition and the level of centrality of NUCs. The paper ends with several conclusions.

RESEARCH DESIGN

Limited research has been done on the spatial distribution and functional composition of NUCs at the intra-urban scale in the Netherlands. Van der Heijde and Hoppenbrouwer (2005) carried out a spatial and functional analysis of eight NUCs in the Randstad. Apart from this latter study, however, only case studies have been described: Salet and Majoor (2005) analysed the development of the Amsterdam South Axis and Bontje and Burdack (2005) studied two NUCs in the Randstad (Amsterdam South Axis and Schiphol

Airport). Because of this lack of empirical research and academic studies encompassing multiple regions in the Netherlands, for this analysis an explorative approach has been selected. This paper is based on research carried out by the author between 2010 and 2011, involving an inventory of the spatial and functional characteristics of NUCs, core centres and other historic centres in the Netherlands. The focus is on all the 22 city regions of the Netherlands as defined by the Dutch Central Bureau of Statistics (Statistics Netherlands 2011). The inventory was put together through desktop research and field research. Data was analysed concerning population, office space and retail. Visual inspections of new areas were carried out. And at least three municipal civil servants were interviewed from every city region, along with eight academics at the larger universities.

As no standard criteria exist to determine which areas can be considered NUCs, three criteria were derived from the author's definition of NUCs. The first criterion is related to multi-functionality. Priemus *et al.* (2000) define multi-functional land use as the combination of different socio-economic functions, while De Wilde (2006) sees it as the use of space in the second, third and fourth dimension, with the condition that functions are used independently and separate from one another. The second dimension refers to functions located next to one another. The third dimension relates to the vertical combination of functions. The fourth dimension relates to the multiple use of space at different moments in time. Multi-functionality, in this research, focuses on the second dimension – locating functions next to each other. Hoppenbrouwer and Louw (2005) state that combinations of two functions can be considered as multi-functional use of space. For the purposes of this research, to avoid the problem of considering too many areas as NUCs, two threshold values have been used to identify multi-functionality. First, an area must have at least three different city centre functions out of the following: retail; office; leisure; government; healthcare; education and other services. As housing and transport are present in almost all NUCs, these functions were not taken into consideration. The threshold for classification as

multi-functional was further raised by applying the following minimum requirements: for retail, an area must have a 5,000 m² rentable floor space before retail is considered to be one of the area's functions; for recreation and healthcare facilities, five small facilities or one large facility must be present; for offices, a 10,000 m² gross floor area and for government and education, at least one large institution.

The second criterion relates to the catchment area. Cross-district services must be present, meaning that the new urban centre serves a catchment area beyond its own boundaries. In the case of retail, having more than 12,000 m² of rentable floor space means it is servicing an area beyond its own district (Bolt 2003). For this research, an extra threshold has been created with a requirement of at least 15,000 m² rentable floor space for a centre to be considered an NUC. Smaller concentrations of retail facilities are only regarded as NUCs if more than six cross-district or three city/regional-level services are present. Having these services means that a centre fulfils a cross-district function.

The third criterion for an area to be considered a new urban centre is that no pre-existing urban centre is present. Given the post-war suburban expansion in the Netherlands, the end of the Second World War is used as a cut-off point when selecting NUCs. In this paper, centres that were built before 1945 are called 'core centres' (for example the core centres of Amsterdam and Utrecht) or other 'historic centres' (for example Delft, Zaandam and Soest). Core centres and other historic centres before 1945 already served an area larger than their own districts.

To be considered an NUC for the purposes of this research, an urban area has to satisfy all the three above-mentioned criteria. Before an inventory of the NUCs could be made, the boundaries of a new centre had to be delineated. The transition of functions (from a commercial function to a residential neighbourhood, for instance) and the morphology (form and construction) were used to establish the borders of NUCs. These elements demarcate areas with different spatial and functional characteristics. From this perspective, adjacent large scale office locations or residential areas were not considered part of a NUC.

NUMBER AND SPATIAL STRUCTURE OF NUCs IN THE NETHERLANDS

Based on the definition of NUCs and the criteria outlined above, in 18 of the Netherlands' 22 city regions one or more NUCs could be identified. As shown in Table 1, 68 NUCs are identified in total, with an additional 14 planned or in development (although development of some of these new areas has been delayed due to the current economic situation). No existing or planned NUCs were found in the four city regions of Tilburg, Apeldoorn, Leeuwarden and Sittard/Geleen.

However, 17 areas do not qualify as NUCs because of their limited variety of functions or the presence of a limited number of cross-district or city-level functions. Had stricter criteria been set (for instance, that an urban area contains four different functions in addition to housing and transport, and at least four city or regional level functions), as many as 40 of the 68 areas in Table 1 would not have been considered an NUC. This means that the centrality level of 28 (41%) of the NUCs is quite stronger than the other 40 (59%).

A strong positive correlation was found between the number of residents in a city region and the number of NUCs located or planned/under construction ($N = 22$, correlation 0.93, confidence level 99%). NUCs are primarily located in Amsterdam, Rotterdam and The Hague – large city regions in which an average of 12 NUCs either exist or are being developed. Some 37 per cent of the total number of NUCs are located in these three city regions. This is logical as 40 per cent of the residents of all Dutch city regions reside there. In medium-sized regions, there are only three NUCs on average and in small regions only one. Some city regions deviate from the average. Tilburg (pop. 294,000), for example, has no NUC, while the smaller urban region of Zwolle (pop. 176,000) has three, and one more planned. Why the difference? One explanation is that while Tilburg's city region actually contains three urban centres, these lack sufficient functional variation or contain too few cross-district functions to be classified as NUCs for the purposes of this research.

Even though the 68 NUCs in the large city regions are distributed in concentric circles

around the core centres (Figure 1), this does not mean that the urban centres located the farthest from the historic core centre have been developed most recently. Indeed, many former growth centres developed in the 1980s are the ones located farthest away from the historic core centres. More recently, many NUCs have been developed in existing urbanised areas. The majority of the NUCs are located in the centre of residential areas and are, therefore, not located near the national motorway network, which runs tangentially to cities.

FUNCTIONAL COMPOSITION OF NUCs

In terms of functions, a distinction can be made between housing, transport, retail, offices, leisure, healthcare, education, government and other services. The threshold values discussed earlier are used here. In 79 per cent of Dutch NUCs, the functions of transport, residential, leisure and retail were present. In two thirds, government and healthcare functions were also identified. Educational facilities and offices were, combined with other functions, seen in about half of all NUCs.

Different types of NUCs developed in different periods – It is noteworthy that the functional composition is clearly related to an area's period of development. This can be explained by examining NUCs based on the original function of the areas where they came into being. In this way a differentiation can be made between district centres, villages, new towns, transition areas, university areas and other places.

Table 2 shows the percentage share of each function in the different types of NUCs, each of which were developed in different periods, and have a particular functional composition. For instance, district centres from the 1960s to 1970s have the usual functions of housing, transport and leisure. Retail is present in all of these centres. Government, healthcare and educational facilities in two thirds of them, and offices in 41 per cent of them. During the 1970s many villages developed into NUCs; however, the absence of educational facilities and offices (present in only 18% of these centres) is striking. The new towns developed in the 1980s have a functional composition broadly comparable with that of the district centres developed

Table 1. Existing and planned/under construction NUCs in 22 Dutch city regions (2011).

Region	Population (Statistics Netherlands 2011a)	Existing NUCs	Planned NUCs/ NUCs under construction	Names of NUCs
Amsterdam	1,515,000	13	3	Amsterdam Zuidas, Amsterdam South East Centre, Amsterdam Osdorp, Amsterdam Plein '40-'45, Amsterdam North Boven 't Y, Purmerend Centre, Purmerend Station East, Schiphol, Hoofddorp Centre, Amstelveen Centre, Almere Centre, Almere Haven, Almere Buiten, Amsterdam Science park, Amsterdam IJburg Centre, Amsterdam Polderweggebied
Rotterdam	1,161,000	12	2	Rotterdam Alexandrium, Rotterdam Zuidplein, Rotterdam Kop van Zuid, Rotterdam Erasmus Medical Centre, Rotterdam Hoogvliet, Capelle Centre, Hellevoetsluis Struytse Hoek, Barendrecht Centre, Barendrecht Carnisse, Spijkenisse Centre, Ridderkerk Centre, Maassluis Koningshoek, Krimpen aan den IJssel Crimpenhof, Schiedam Schieveste
The Hague	1,017,000	7		The Hague Nieuw Laakhaven, The Hague Scheveningen, The Hague Leyweg, The Hague Leidsenhage, Rijswijk In den Bogaard, Zoetermeer Stadshart, Naaldwijk Centre
Utrecht	606,000	5	2	Utrecht Uithof, Utrecht Kanaleneiland, Nieuwegein Centre, Houten Centre, Maarssen Bisonspoor, Utrecht Leidsche Rijn Centre, Utrecht The Wall
Haarlem	412,000	1		Castricum Centre
Eindhoven	409,000	3	1	Veldhoven Centre, Geldrop Centre, Valkenswaard Centre, Best Centre
Arnhem	355,000	3		Arnhem Kronenburg, Arnhem Presikhaaf, Dieren Centre
Groningen	349,000	2	1	Groningen Zernike, Haren Centre, Euroborg
Leiden	336,000	3		Leiden LUMC, Leiderdorp Centre, Noordwijk Centre
Enschede	314,000	4		Enschede Go-Planet, University of Twente, Enschede South, Oldenzaal Centre
Breda	316,000	2		Ettel-Leur Centre, Oosterhout Centre
Tilburg	294,000			
Dordrecht	282,000	3	2	Zwijndrecht Walburg, Papendrecht Centre, Sliedrecht Centre, Dordrecht Leerpark, Dordrecht Gezondheidspark
Nijmegen	281,000	3	1	Nijmegen Heyendaal, Beuningen Centre, Malden Centre, Nijmegen Citadel Waalsprong
Amersfoort	279,000			
Heerlen	252,000	1	1	Amersfoort Vathorst Centre
Apeldoorn	212,000			Brunssum Centre
Den Bosch	193,000	1		Den Bosch Paleiskwartier
Maastricht	180,000	2		Maastricht Brusselse Poort, Maastricht AZM
Zwolle	176,000	3	1	Zwolle South, Zwolle Hanzeland, Heerde Centre, Zwolle Voorsterpoort
Leeuwarden	161,000			
Sittard/Geleen	151,000			
Total	9,251,000	68	14	

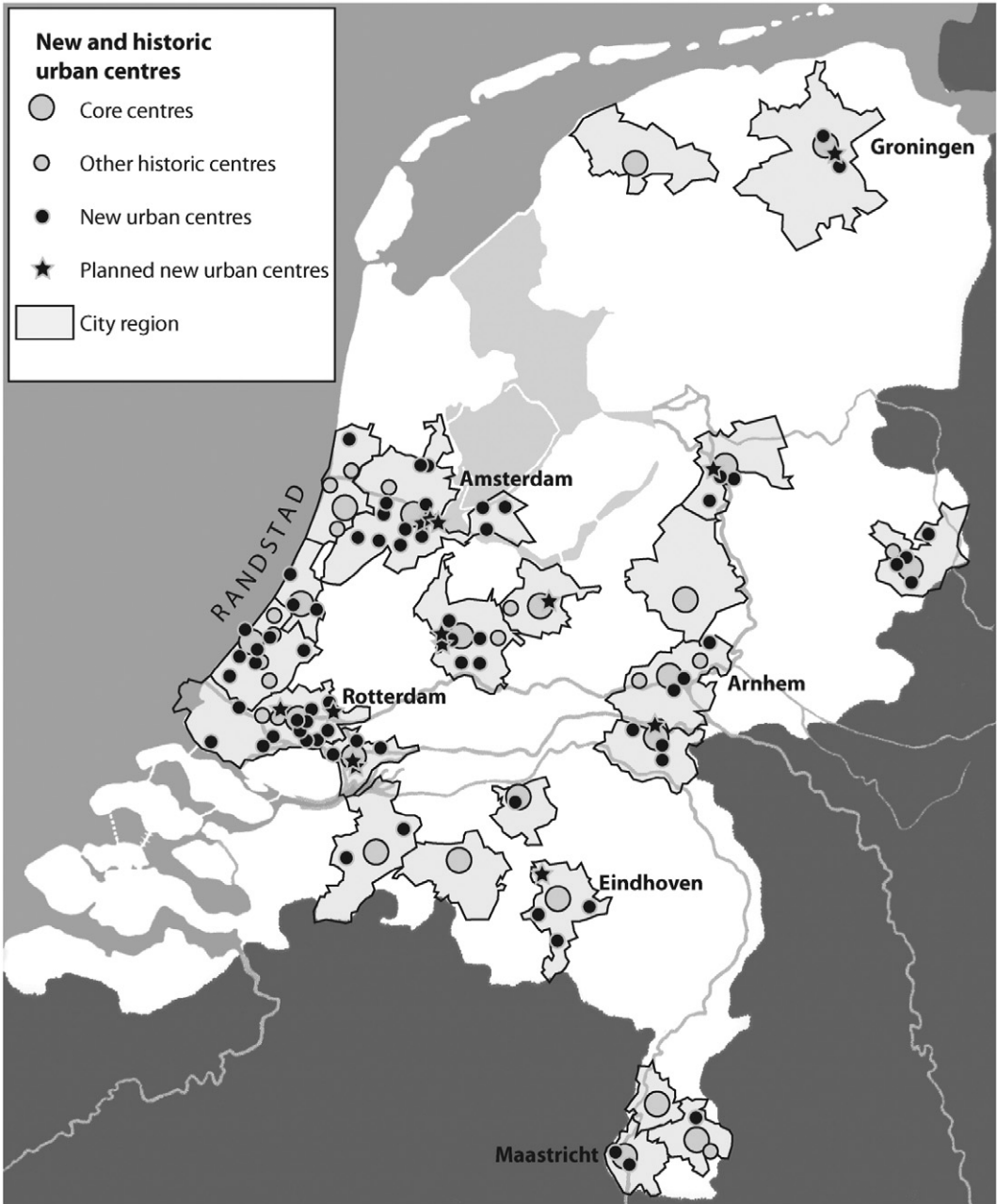


Figure 1. Core centres, other historic centres and new urban centres in Dutch city regions.

in the decades prior. More recently, the 1990s saw NUCs built at university campuses. These are characterised by the absence of retail and government functions. In addition, NUCs have

recently been developed in transition areas. In most of these NUCs there is an absence of retail. Given their short distances to the core centres, this absence can be considered an

Table 2. *Functional composition of different types of NUCs in the Netherlands (2011).*

Main period of development	1960s–1970s	1970s	1980s	1990s	1990s	1990s	1960–2011	Before 1940
Type of NUC	District centre	Village	New town	Transition area	University area	Other	All NUCs	All core centres
Number of NUCs	18	22	12	6	7	3	68	17
Transport (%)	100	100	100	100	100	100	100	100
Housing (%)	100	100	100	100	71	33	91	100
Retail (%)	100	100	100	17	0	67	79	100
Leisure (%)	88	100	100	83	86	100	97	100
Offices (%)	41	18	50	100	71	100	46	94
Healthcare (%)	59	50	67	50	86	33	64	88
Education (%)	65	18	67	83	100	67	57	100
Government (%)	71	77	75	100	0	0	65	100

Table 3. *Retail Floor space (m²) in the 17 urban centres analysed in the Netherlands (2011).*

	Average area (m ²)	Average area in the Randstad (m ²)	Average area outside the Randstad (m ²)
Core centres	142,900	150,700	137,400
Other historic centres	32,400	35,200	23,700
NUCs	26,200	31,500	16,600

indication of government policy, which seeks to protect the position of retail in the central core. The comparison between all NUCs and all core centres shows that in the NUCs fewer functions are present. In particular, offices and educational facilities are seen less often in NUCs.

Functional composition is also affected by an area's distance to the core centre (not shown in the table). Areas further away from the centre tend to have more leisure, retail and government functions, and fewer functions of education and offices. This can also be explained by the different types of NUCs, described above, that were developed at different distances from the core centres.

Analysis of the different functions provided in NUCs – For transport, all Dutch NUCs have at least one bus connection. However, in 36 per cent of NUCs this is the only form of public transport, and 57 per cent have no train station. Regarding facilities, daytime hospitality facilities (such as cafes) are present in 91 per cent of NUCs, a library in two thirds, a theatre, sports hall or fitness centre in just over one third

(37%), and a cinema in one quarter. Housing is present in 91 per cent of the NUCs, with 52,500 units, mostly flats, in total. On average, there are only 772 housing units in each new urban centre. The limited number of houses can be explained in part because adjacent large-scale residential areas were not considered part of the new centres.

In total there is 1.76 million m² of retail space in the NUCs – 6 per cent of the total retail space in the Netherlands. Of the NUCs, half have a retail floor area of less than 25,000 m², one third between 25–75,000 m² and only 5 per cent more than 75,000 m². The average retail floor space in the 68 NUCs is 26,000 m² – considerably less than the average of 143,000 m² (Locatus 2011) in the core centres of the 17 urban regions analysed (Table 3). Retail space in NUCs outside the Randstad is considerably lower (47%) than in NUCs inside the Randstad, although the floor space in the core centres of these urban regions outside the Randstad is only 9 per cent smaller than in the core centres inside the Randstad. One explanation for this Randstad/non-Randstad difference is that in

Table 4. Office floor space (m²) in the 17 urban centres analysed in the Netherlands (2011).

	Average area (m ²)	Average area in the Randstad (m ²)	Average area outside the Randstad (m ²)
Core centres	381,300	631,100	206,400
Other historic centres	30,700	29,100	35,200
NUCs	50,700	62,200	29,400

1993 the national government allowed large retail at a limited number of urban nodal points. As part of this programme, extensive retail development took place in the urban centres of Amsterdam South East, Den Haag Laakhaven and Alexandrium in Rotterdam. Given that all these centres are located in the Randstad, this may explain why the average retail space in the NUCs within the Randstad is higher.

Government administration is present in two thirds of the NUCs. The relatively high percentage can be explained by the fact that a number of villages and new towns are also municipalities meaning that government offices are located in the new centre. Furthermore, district centres in the large cities are also home to district-level government facilities.

Healthcare facilities are present in 64 per cent of the NUCs and educational facilities in 57 per cent. One third of NUCs have secondary schools, 22 per cent have higher vocational education and 18 per cent have universities. The latter finding (18% having universities) can be explained by the fact that campuses, developed when universities relocated from the central city to the edge of the city, have gradually evolved into NUCs.

The total office floor space in the 68 NUCs is 2.8 million m² (based on inventories), which represents 6 per cent of the total office space in the Netherlands (Bak 2011). This percentage is low, considering that core centres hold 15 per cent of the total office space in the Netherlands (Bak 2011). The average floor space of offices in the 68 NUCs is approximately 51,000 m² – considerably less than the average of 381,300 m² found in the core centres of the 17 urban regions (Table 4). But, in the other historic centres the office floor space is considerably smaller than in NUCs, just 30,700 m² on average. Interestingly, more office space is

present in NUCs inside the Randstad. The difference cannot be explained by the economic structure: the share of service sector industries in the city regions of the Randstad (86%) is comparable to those in the rest of the country (84%) (Statistics Netherlands 2011b). The most important explanatory factor is that in some of the NUCs in the Randstad, large amounts of office space are located. The Amsterdam Zuidas is the largest of these centres.

Finally, it is striking that there is a strong positive relationship between the period of development and the average area of office space (N = 68, correlation 0.99, confidence level 99%). The amount of office space realised in the NUCs developed in the 1990s was especially high (156,800 m² on average).

LEVEL OF CENTRALITY

Centrality is used as a concept to classify the NUCs. The level of centrality depends on each centre's number of functions and its catchment area. Using these criteria, the level of centrality in the NUCs was compared with that of the core centres. Furthermore, the accessibility of the areas was considered, as this is of primary importance for urban centres (see Arends *et al.* 2002).

The first determining factor when considering the level of centrality is the number of functions. To be classified as a new urban centre, at least five functions (housing, transport, and three other functions) are required from the eight possible functions. The average number of functions is 5.9 – fewer than the 7.8 seen in the core centres of cities (Table 5). Yet the number is somewhat higher than in other historic centres. NUCs with seven or eight functions are only found in one quarter of the centres. In most cases these are located in the

Table 5. *Functional diversity of the 17 urban centres analysed in the Netherlands (2011).*

Type of centre	Number	Functional diversity
Core centres	18	7.8
Other historic centres	16	5.5
NUCs	68	5.9

large city regions: Amsterdam, Rotterdam and The Hague.

The distance in kilometres from an NUC to a core centre was found to have little influence on the number of different functions located there (correlation 0.44, confidence level 95%). In the Randstad, the number of functions is somewhat larger than in the rest of the country (correlation 0.5, confidence level 95%). However, among NUCs no significant relationship was found between the period of origin and the number of functions. This could be the result of restrictive government policy, which inhibited the development of some functions in the NUCs developed in the 1950s and 1960s.

Catchment area is the second determining factor when considering the level of centrality of NUCs. The average Dutch NUC contains four cross-district and city/regional-level services, considerably lower than in the core centres where there are at least eight city-level services, and more than 30 in the core centres of Amsterdam and Rotterdam.

Besides the level of centrality, the accessibility of the NUCs was compared with those of the core centres. The absence of a train station in over half the NUCs is surprising. This deviates considerably from the core centres which are, without exception, served by multiple forms of public transport, typically including an intercity train station. Generally, NUCs are well connected to the road network. Some 82 per cent of the NUCs are situated on one or more urban main roads.

CONCLUSION

Since 1950, a polycentric urban system of core centres, other historical centres and new urban centres has developed in many Dutch city

regions. This pattern is most noticeable in the heavily urbanised area of the Randstad. As mentioned previously, NUCs are defined as the largest concentrations of city-centre functions in an urban region containing multiple functions as well as services for an area larger than the district of the centre itself where, in the past, there was no urban centre present. A strong positive relationship has been found between the number of residents in a city region and the number of NUCs. It is evident that larger cities have more centres.

Many Dutch NUCs are located in residential areas. This is due to the fact that these NUCs were originally built to service new housing development. Consequently, a considerable portion of the NUCs provide services – most notably shopping and leisure services – to their surrounding areas. Furthermore, many NUCs are home to government functions as well as healthcare and educational facilities. Offices are present to a much lesser extent.

NUCs have other functional characteristics than core centres. This is the result of a more limited number of functions and fewer cross-district and city/regional-level services than core centres. This means the level of centrality of NUCs is less than that of core centres. Accessibility by public transport is also more limited. These functional differences between NUCs and core centres mean that there is still a considerable hierarchy of functions present in the polycentric urban networks in the Netherlands. Nevertheless, urban areas do seem to be evolving from monocentricity to polycentricism. This is in line with the outcomes of the INTERREG IIIB Polynet research project, which examined the development of polycentric regions in northwest Europe, and concluded that areas in the Randstad were found to be mildly polycentric and that this polycentricism was intensifying (Burdock *et al.* 2005).

It is not surprising that the functional composition of NUCs differs from that of core centres. These NUCs are, after all, less than 60 years old. What is striking is that at present the number of functions in the earlier NUCs is not higher than in the NUCs developed in later decades. This suggests that more recent government policies to revitalise core centres have inhibited functional diversity in the earlier NUCs. Another explanation is that the number

of functions is related to the type of new centre (district centre, village, new town, transition area and university area) each of which was developed in a separate period with different functional characteristics. For example, the oldest generation of NUCs, the district centres, were built as service centres for surrounding residential areas, and their distance to the national motorway network made them less attractive for the location of offices. Given this complex reality, it is uncertain whether or not NUCs will develop into centres with the same functional characteristics as the core centres.

Together with core centres and other historical centres, NUCs help form a polycentric structure of Dutch urban areas. With urbanisation expected to increase, government at national or provincial level could consider strengthening this structure by further concentrating urban functions into NUCs. This would improve the centrality level of NUCs and, combined with better access to NUCs by train, would improve the 'urban' character of the periphery. That would be a contribution to the building of compact and sustainable urban areas.

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