A NOTE ON ATTRIBUTES DESCRIBING AND MEASURING THE POLYCENTRIC DEVELOPMENT POTENTIAL – A REVIEW OF LITERATURE

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Abstract: Even though polycentrism has gained its popularity in the late '90, it still remains a fuzzy concept; its meaning is elusive because of the lack of a consensus regarding its definition no matter the scale of analysis. The scientific literature provides studies that approach this theme both from a normative and analytical point of view; the former case refers to polycentrism as a spatial planning vision promoted by policy documents and academic literature, while the latter addresses the concept as an analytic construct providing a way to study the spatial organizational patterns of different networks. In this paper, we propose a common classification of the attributes that define the potential of an area to become a polycentric system and of the spatial variables used to measure polycentricity.

Keywords: polycentric development, governance, identity, functionality

I. INTRODUCTION

Polycentrism, respectively polycentricity are acknowledged as a central objective for spatial planning in Europe (Gloersen, 2007), thus having a frequent occurrence in academic and policy literature for more than fifteen years. Nevertheless, despite its widespread usage it still remains an elusive concept which implies a lack of consensus regarding its meaning - it rather offers a framework for debates concerning urban planning and development in a multiscale context. It not only means different things to different people, but also offers more perspectives when it is applied at different spatial scales (Davoudi, 2007).
Before attempting to characterize the features that could allow identifying a region as having potentialities for polycentric development, we may consider the terminology on which it is based. The word ‘polycentrism’ is both used in European official documents regarding urban planning and strategies and in academic approaches, which points to a normative interpretation rather than an analytical one – the suffix “-ism” being a proof in this respect (Green, 2007; Vandermotten, et al., 2008). “Polycentricity” refers to any spatial structure following a polycentric pattern, whereas “polycentrism” represents a form of ideology based on the concept of polycentricity (Vandermotten, et al., 2008).

The third concept – polycentric development – has a threefold approach: (1) a normative planning strategy which can be applied to different scales – metropolitan, national, transnational (Albrechts, 2001; Davoudi, 2003), (2) a spatial process resulting from the diffusion of urban functions (often high-order) from major cities to smaller nearby centres (Kloosterman & Musterd, 2001; Hall & Pain, 2006) and (3) a resulting spatial configuration of urban areas associated with concepts like ‘urban region’, ‘mega-city-region’, ‘metropolitan area’, ‘global city region’ (Meijers, 2005). In other words, one talks about polycentrism, measures polycentricity and observes in the territory the polycentric development.

In the past fifteen years these concepts have become popular in academic literature. Many of the contributions have focused on defining the terms according to academic and policy debates - the latter being inspired by official European and national research agenda-settings (Dieleman & Faludi, 1998 – cited by Meijers, 2007; Kloosterman & Musterd, 2001; Krätke, 2001; Davoudi, 2003, 2007; Parr, 2004; Shaw & Sykes, 2004; Hein, 2006; Baudelle, 2007; Vandermotten, et al., 2008), on the relevance and the potential application to different urban systems (Bailey & Turok, 2001; van Houtum & Lagendijk, 2001; Meijers, 2005, 2008; Riguëlle et al., 2007; Zonneveld & Waterhout, 2007; Criekingen et al., 2007; Franz & Hornych, 2010), and on identifying different approaches of the concepts in empirical studies (Albrechts, 2001; Meijers & Romein, 2003; Green, 2007; Cowell, 2010; Vasanen, 2012; Burger & Meijers, 2012).

As a result of its ambiguity, as mentioned above, the literature provides multiple approaches and measurement methods in order to assess the polycentric development potential of an area, but it does not provide a specific clarification regarding the attributes that could be measured and the appropriate methods that are to be used.

This article investigates the polycentric development potential using a literature review by classifying different studies’ reported variables, identifying common relevant attributes between studies that both define and measure polycentricity, grouping them into categories and summarizing the main literature elements.
II. MATERIALS AND METHODS

For this review, we selected a range of papers from individual publisher websites; the studies include peer-reviewed journal papers, working papers and projects. We have paid attention to 19 articles and eight projects (the latter addressing especially to policy makers); while the functionality of a system is the most analyzed attribute, there are also studies that are focused on highlighting other aspects that define an area’s potential to become a polycentric urban region. Table 1 shows the studies reviewed.

<table>
<thead>
<tr>
<th>Study</th>
<th>Case study</th>
<th>Level of granularity</th>
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<tbody>
<tr>
<td>Meijers 2005</td>
<td>Randstad - 14 cities</td>
<td>Mezoscale (intraregional)</td>
</tr>
<tr>
<td>Meijers 2008</td>
<td>42 WGR Dutch regions</td>
<td>Mezoscale (NUTS 3)</td>
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<td>Bailey &amp; Turok 2001</td>
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<tr>
<td>Albrechts 2001</td>
<td>Flemish Diamond</td>
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<tr>
<td>Burger &amp; Meijers 2012</td>
<td>42 WGR Dutch regions</td>
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<td>Vasanen 2012</td>
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<tr>
<td>Riguelle et al. 2007</td>
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</tr>
<tr>
<td>Green 2007</td>
<td>4 hypothetical settlements</td>
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</tr>
<tr>
<td>TAPAS (Transformation of porous landscape), 2008</td>
<td>4 Metropolitan Regions: Amsterdam, Helsinki, Manchester, Rhine-Ruhr</td>
<td>Mezoscale (intraregional)</td>
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<tr>
<td>van Houtum, H., &amp; Lagendijk, A. 2001</td>
<td>Rhur area, Basque Country</td>
<td>Mezoscale (intraregional)</td>
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<tr>
<td>Franz &amp; Hornych 2010</td>
<td>East German 'Saxony Triangle'</td>
<td>Microscale (intraregional)</td>
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<td>Burger et al. 2013</td>
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<td>Macroscale (LAU 2)</td>
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<td>Meijers et al. 2007</td>
<td>14 European countries</td>
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<td>Pâtru-Stupariu et al. 2011</td>
<td>North-East Region</td>
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<td>Cowell, 2010</td>
<td>San Francisco Bay, Emilia-Romagna, Randstad</td>
<td>Mezoscale</td>
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<td>Zonneveld &amp; Waterhout 2007</td>
<td>Netherlands</td>
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<td>Van Criekingen et al. 2007</td>
<td>Flemish Diamond &amp; Walloon Triangle</td>
<td>Mezoscale</td>
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<td>Governi &amp; Salone 2007</td>
<td>Campania, Emilia-Romagna, Piedmont</td>
<td>Mezoscale (intraregional)</td>
</tr>
<tr>
<td>Rota 2007</td>
<td>48 European cities</td>
<td>Mezoscale</td>
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</table>
### III. ATTRIBUTES DESCRIBING THE POLYCENTRIC DEVELOPMENT POTENTIAL

In order to identify the potential of a region to become a polycentric system, first should be made clear the elements that define it; in other words some commune attributes should be found, that will allow various groups of local, regional and national actors (local entrepreneurs, stakeholders, policymakers) to conceive, identify themselves and further develop the region in question, regarding the fact that European official documents promote this planning policy as an a-priori view valuable to adopt.

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**Table**

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<th>Study</th>
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<tbody>
<tr>
<td>Cattan 2007</td>
<td>Partner cities in Socrates/Erasmus 2000</td>
<td>Macroscale</td>
</tr>
<tr>
<td>ESPON 1.1.1 2005</td>
<td>UE 27+2</td>
<td>Macroscale</td>
</tr>
<tr>
<td>ESPON 1.4.3 2007</td>
<td>UE 27+2</td>
<td>Macroscale</td>
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<tr>
<td>ESPON FOCI, 2010</td>
<td>UE 27+2</td>
<td>Macroscale</td>
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<td></td>
<td>Bratislava, Budapest, Ljubljana, Prague, Wien</td>
<td>Microscale (intrametropolitan)</td>
</tr>
<tr>
<td>ESPON POLYCE 2012</td>
<td>Greater Region (Luxembourg, Belgium, Germany and France) &amp; Upper Rhine (Switzerland, France)</td>
<td>Macroscale</td>
</tr>
<tr>
<td>ESPON METROBORDER 2010</td>
<td>France, Germany - Basel, Strasbourg, Karlsruhe</td>
<td>Mezoscale (intraregional)</td>
</tr>
<tr>
<td>ESPON CAEE 2010</td>
<td>Barcelona, Dublin, Lyon, Manchester</td>
<td>Mezoscale (intrametropolitan)</td>
</tr>
<tr>
<td></td>
<td>8 Mega-City Region: South East England, Randstad Holland, Central Belgium, Rhine-Ruhr, Rhine-Maine, Northern Switzerland, Paris Region, Greater Dublin</td>
<td>Mezoscale (intraregional)</td>
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**Fig. 1** Attributes describing a polycentric urban region
A departure point to identify the attributes that describe the polycentric development potential is given by van Houtum and Langenduk (2001), who assume that a region is identifiable as being polycentric by three congruent interpretative dimensions: strategic, cultural and functional from which derive three types of identity and also the three main attributes that can be used to describe and measure the potentialities of a region in question – governance, territorial functionality and culture and identity (figure 1).

The strategic dimension implies a voluntary development of a geo-strategy, which aims at the strengthening of both the external positions of the region and internal interdependencies (Romein & Meijers, 2003), in order to create a common perspective and objective for a certain area (van Houtum & Lagendijk, 2001). By reviewing the literature we have found that this dimension is often replaced with the regional organizing capacity thus making it more approachable when analyzing the administrative and institutional framework of an area. This represents the ability to regionally co-ordinate developments through a more or less institutionalized framework of cooperation, debate, negotiation and decision-making in pursuit of interests at the regional scale (Meijers & Romein, 2003).

The territorial functionality is defined by economic, political and social linkages and ties between the cities involved (van Houtum & Lagendijk, 2001; Romein & Meijers, 2003). Polycentric urban systems tend to be ‘open’ and multi-layered complexes of nodes, networks, flows and interactions of global, regional and local scales (Albrechts, 2001). The stronger these linkages and interdependencies are, the more meaningful becomes the region as a coherent functional entity being more likely to adopt a regional planning approach.

The third attribute – culture and identity – refers to the creation of an entity defined by shared history, values, norms that allow the emergence of a feeling of belonging together.

Even if the scientific literature does not specifically mention about the morphology of a system as a separate dimension that defines a polycentric region (academic papers usually take it into consideration together with the functional attribute), this paper will analyze it as a fourth attribute. The morphological dimension addresses the size and territorial distribution of urban centers across the territory, whereas the latter considers the functional relations between the centers.

All these dimensions or attributes represent in fact umbrella terms that gather keywords that are to be followed when analyzing the potential of a region to become a polycentric system.

III.1. Territorial functionality attribute

The most common analyzed attribute in the studies that were reviewed is the territorial functionality. Considering its high occurrence the studies provide
various interpretations of this attribute all leading to the idea of cooperation/connections which is expressed in different contexts.

According to Evert Meijers (2005, 2007) a polycentric urban region is defined by synergies, that can be both horizontal and vertical, the latter being an expression of territorial functionality. These are generated by complementarity given by the differentiation in the economic roles of cities, in urban facilities, in business and residential milieus coupled with regional demand (Meijers, 2005). The statement is also a starting point of the research work conducted by Franz and Hornych (2010). Cowell (2010) tries to quantify the complementarity in the economic profiles of cities and the synergies that are thus generated. Maintaining the idea of complementarity the same author (Meijers, 2008) is exploring the level of functional polycentricity by taking into consideration the provision of cultural, leisure and sports amenities.

The functional attribute is also defined by the existence of a single labour market area which is an indicator of the strength of commercial interdependencies between businesses (Bailey & Turok, 2001).

There are also several approaches that are based on network analysis. Burger and Meijers (2012) take into consideration the importance of centers of a polycentric urban region; hence the functionality is given by centrality meaning the relative importance of centers (the part of its importance that can be ascribed to the provision of goods, services and jobs in excess to those demanded by the center’s own inhabitants – Ullman, 1941; Preston, 1971; Barton, 1978; Marshall, 1989 – cited by Meijers, 2012). Vasanen (2012) approaches this attribute as the connectivity of individual centers to the whole polycentric system rather than as functional relations between the centers, obtaining thus an image of how intensely each element of the system is connected to the entire entity. Green (2007) analyses the functional attribute in terms of network topology and topography, namely is trying to reveal the functional connections between the elements of a polycentric system.

Another way of defining the attribute in question is by highlighting the linkages that exist between urban centers and subcenters - located in suburban fringes (Riguelle, et al., 2007). Burger et al. (2013) stress the importance of multidirectional functional links which establish the extent to which a region operates as a polycentric system.

The same idea is to be found in the TAPAS project (Transformation of porous landscape) 2008, which evaluates the socio-economic conditions that create the premises of an integrated polycentric entity (labor market, infrastructural patterns, flows of information and capital). The economic dynamic is transposed in indexes that are used to assess the functionality of region as a polycentric entity (Pătru-Stupariu et al., 2011).
Other researchers have oriented their work toward the idea of cooperation and partnerships; it is the case the countries involved in the 5\textsuperscript{th} or 6\textsuperscript{th} Framework Programme which show that network hierarchies are not as fixed as suggested by “traditional” urban analysis. Rota (2007) concludes that the “\textit{intention to pursue polycentrism by favoring a network of centers of excellence as catalysts for backward areas, appears to be potentially more effective}”. The second example is the work of Cattan (2007) on partner universities in SOCRATES/ ERASMUS programme. The study shows that students’ mobility between European cities forms a polycentric urban network in which interconnection and integration patterns are both reticular and symmetrical (Cattan, 2007).

Because polycentricity is a common vision incorporated in territorial development plans, ESPON has constantly analyzed this matter in several projects. Regarding the functional attribute, the studies can be divided into two categories: (a) the first one includes the first projects that have approached this theme (ESPON 1.1.1 \textit{Potential for polycentric development in Europe} and ESPON 1.4.3. \textit{Study on urban functions}) – the attribute is analyzed from the perspective of a common labor market which delineates functional urban areas; and (b) the second group which analysis the functional attribute from a relational perspective, namely flows and nodes (POLYCE, METROBORDER, FOCI).

To sum up all the visions on territorial functionality, van Houtum and Lagendijk (2001) reduce the whole analysis to some keywords, namely cooperation, complementarity, accessibility, connectivity and flows.

### III.2. Morphological attribute

In many studies the authors associate usually the functional attribute with the \textit{morphologic} one; whereas the former refers to flows and nodes, the latter takes into consideration hierarchies and territorial structures (Bailey & Turok, 2001; ESPON 1.1.1., 2005; Nissen, 2008; POLYCE, 2012). If functionality is associated with centrality, morphology is given by nodality (balance in the size distribution or absolute importance of center) as Burger and Meijers (2012) conclude in their study; it can be expressed by its size and the range of functions it offers.

### III.3. Governance attribute

As mentioned afore there are two types of synergies that describe the potential development of a polycentric region: horizontal and vertical. Whereas the latter are assigned to functional attribute, the former represent a keyword for the governance attribute. As Meijers (2005) concludes, horizontal synergies derive from co-operation (regional organizing capacity or frameworks for co-operation and their functioning).
Regional organizing capacity is another important attribute assessing the potential of polycentric development of a region. Its feasibility is determined by voluntary geo-strategies that emerge before the actual reality of interdependency which can lead to internal synergetic advantages (van Houtum & Lagendijk, 2001); it results from associational structures able to deal with the complex, multi-scalar interplay of trends and forces that is urban dynamics (Romein & Meijers, 2003). As a result, the governance attribute is often associated with the analysis of:

- government’s tiers and institutional arrangements (Bailey & Turok, 2001; Zonneweld & Waterhout, 2007; Governa & Salone, 2007; Franz & Hornych, 2010; Cowell, 2010; Burger, et al., 2013),
- formal and informal cooperation networks, public-private partnerships, cooperation between public and private actors and stakeholders (Nissen, 2008; IGEAT (coord.), 2010; Université du Luxembourg (coord.), 2010);
- common planning strategies, aims and aspirations, complementarity in decision-making process (ESPON, 2012).

There is another category of researchers that have analyzed different polycentric urban systems and have concluded that the organizing capacity is either a marketing project (with polycentricity mainly thought of as a territorial marketing tool - (Van Criekingen, et al., 2007) or a simple image, vision or discourse, as they led to no actions (Albrechts, 2001).

III.4. Culture and identity attribute

The perception of urban structure and content represent the fourth attribute analyzed in this paper. This takes into consideration aspects relating to culture and identity, both transforming a polycentric system into an entity in the consciousness of inhabitants and different urban actors – politicians, companies, stakeholders. The elements that create the feeling of belonging together are shared values, norms, beliefs, customs, political preferences, territories and identities. A shared identity has a threefold approach; it includes the consciousness of each inhabitant, the local/collective identity and regional identity. All the actors involved should accept that they live and function in a space that extends beyond the local scale, to the entire polycentric system. The existence of a regional identity helps to generate societal support, including that by major stakeholders, for a regional planning approach (Romein & Meijers, 2003).

When analysing this attribute for Central Scotland region, Bailey and Turok (2001) conclude that “while it has a strong external identity based on its physical geography, there is no unifying culture or shared identity among residents which is unique to the area”.

The aforementioned attributes present a high level of interdependency; strong functional links can be associated with high levels of interactions, all
facilitating the construction of a common identity and as well the interactions among different decisional levels and actors.

IV. ATTRIBUTES MEASURING THE POLYCENTRIC DEVELOPMENT POTENTIAL

Beside these keywords that are supposed to be followed when analyzing the potentialities of an area to become a polycentric system, the scientific literature also provides methods that are used to measure polycentricity. In this paper we try to categorize the spatial variables into main classes in order to simplify assessing a system’s degree of polycentric development across different studies. In spatial analysis several methods measure attributes in each category. For our literature review, we propose the following classification:

1. **Demography** defined by the number of inhabitants, population density and population mobility. Usually these variables are used to analyze the morphological aspects of a region;

2. **Economic structure** – used to create a general idea upon the level of development of cities that form a system and to identify their potential specialization. It includes variables like the structure of economic sectors, the number of employees and commuters flows;

3. **Economic performance** – provides a more accurate image regarding the specialization of cities. These variables are used to analyze the functional polycentricity of a system - number of projects, employees in research and development, number of enterprises;

4. **Cultural innovation** – this group of variables shows if a city is part of a system and how well integrated is, by highlighting the links between different entities. It includes variables like number of patents, number of business incubators, number of exchange students (e.g., ERASMUS students), top 500 universities in the world;

5. **Accessibility** is the product of a system’s elements and transport network. As this category usually implies the use of real flow data, their availability depends on the aggregation level (NUTS3, LAU2 etc.) - time distance, connectivity, centrality/nodality, connectivity fields, number of passengers/airport, shopping trips, journeys to school, business travel;

6. **Decision-making and organizational systems** – is an umbrella term characterized by variables describing various aspects of political, administrative and other organizational levels being important when discussing the system of governance in different regions. Variables included in this category are: top 100 FIRE sector (finance, insurance, real estate) companies, top 500 European
companies, organizations, associations, national and international administrative functions.

A researcher chooses the data for its study according to its availability, resulting a variety of outputs that analyze the potentialities of polycentric development from different angles, reducing thus comparability between different polycentric systems. This can be seen in figure 2, with the number of variables per category in each study.

![Fig. 2 Variables per category in reviewed studies](image)

V. CONCLUSIONS

In this study we took an inventory on one hand of aspects that highlight the main features of polycentric development (and implicitly a region’s potentialities to become a polycentric system) and on the other hand of spatial variables and the appropriate methods used to measure and assess the level of polycentric development; all the preferences found in the scientific literature were categorized and became part of a classification.

The proposed classifications can be used in several ways; first it can serve to structure the data available to researchers. Secondly they can represent the basis for future discussions and decisions about variables that are to be included in an analysis, because they offer information about the changes of final outputs by including / excluding some data.

Reviewing the scientific literature four attributes that define the polycentric development have been identified; the territorial functionality has the highest occurrence both in academic studies and projects. The choice of analyzing one of
the fourth dimensions and of using a certain method instead of others is strictly
dependent on the geospatial data available to researchers.

Even though polycentricity is defined by four dimensions/attributes, the
concept can be reduced to one single keyword – interdependencies which can be
analyzed from two points of view:
- as symbiotic relations that appear between some of the elements of a
  system (cities can collaborate because they share a common objective, but
  it does not necessarily mean that they have the same visions); processes
  like suburbanization, metropolization, functional complementarity can
  create the premises for the relationships in question;
- as relations of cooperation seen as an expression of governance.

As the “beauty is in the eye of the beholder” (M. Wolfe Hungerford), the
extent to which a region is considered to be polycentric depends on the “eye of the
researcher” and on the lens through which is perceived.

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