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Functional diversity and urban form

Measuring accessible diversity of economic activities in Stockholm

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ABSTRACT

Despite a general recognition of diversity as an important factor in urban planning and design to create liveable and attractive cities, the role of urban form and spatial structure on supporting or hindering such diversity is often less studied. The presented study suggests a quantitative analysis to measure *functional diversity* as a complement to other qualitative approaches. The suggested method has a 'location based' approach rather than an 'area based' one (Berghauser Pont and Marcus, 2014). In this method diversity is measured among accessible 'uses and functions' from a specific location. This answers the question of: what kind of diversity is within reach from one specific location 'through' the street network? Functional diversity is measured using different diversity measures that are applied on accessible activities within different distances. The study is also exploring a set of spatial and socio-economic properties and their possible effect on the measured diversity. The chosen properties are based on different studies developed within space syntax theories and methods as well as other criteria such as those introduced by Jane Jacobs (1961).

KEYWORDS

Diversity, Mixed use, urban form

1 INTRODUCTION

Diversity and its importance for cities and their liveability, attractivity (Jacobs, 1961; Montgomery, 1998; Fainstein, 2005; Grant, 2002; Talen, 2006b), as well as economic vitality (Glaeser et al., 1992; Florida, 2008) is not a new notion for urban planners and designers. Jane Jacobs with her critiques of the increasing homogeneity in cities (Jacobs, 1961) was one of the most influential people who redirected the attention to the need for diversity for more than sixty years ago.

Despite being a central concept among urban designers, diversity is an elusive notion, where concepts like mixed-use, multi-functionality and diversity partly overlap and partly contradict each other, which can lead to rather indistinct debates (Talen, 2006b; Fainstein, 2005; Fainstein, 2000; Vaughan, 2015). The problem is, on the one hand, that what is meant by diversity often is poorly defined and, on the other hand there is a lack in common methodologies when it comes to measuring diversity in cities, which makes it difficult to do comparative studies (Sardari Sayyar and Marcus, 2013). The implemented approach in this study is chosen with the attempt to quantify what is here called 'functional diversity'. This is different from other concepts like mixed use which usually focus on few major functions in cities. The term is chosen to widen the scope of analysis to different types of uses that can vary according to main focus of studies. A set of different properties of urban form is also chosen to be tested to explore their potential influence on measured functional diversity. Finding such essential factors can be useful in urban planning and design practice to create vital and attractive cities.

Diversity could be defined differently by urban planners and designers (Fainstein, 2005). Some might focus on building or property level while others focus on neighbourhoods. Jane Jacobs argued for a mix of primary and secondary functions in order to reach such diversity and vital public life on street as well as neighbourhood level (Jacobs, 1961). She was also suggesting three other factors of urban environment necessary for development of diversity: small blocks, buildings of different ages, and a concentration of people.

2 RELATED THEORIES AND EARLY STUDIES

During the recent years there has been much more focus on trying to test and compare different methods and measurement to better understand concepts like land use mix on different scales (Song et al., 2013; Jiao et al., 2021), as well as searching for the influential factors of built environment that may affect the developed diversity (Ye and Van Nes, 2014; Mahmoudi Farahani et al., 2017; Song et al., 2013; Jiao et al., 2021; Bobkova, 2019; Bobkova et al., 2019; Bobkova et al., 2017; Sardari Sayyar and Marcus, 2013). Another major line of research focuses on social diversity and how it is influenced by the built environment such as Emily Talen and her research on looking into existing diverse neighbourhoods to understand the influential factors of built environment (Talen, 2010; Talen, 2006a; Talen, 2006b; Talen and Ellis, 2002).

The space syntax theories and methods enables the studies to take into account the configurative aspects of the built environment (Hillier and Hanson, 1984). Furthermore the later developed theories like *natural movement* and *movement economy* (Hillier, 1996a; Hillier, 1996b; Yamu et al., 2021) facilitates exploring the importance of movement on land use distribution in cities. Last but not least looking into *spatial sustainability* and *centrality as a process* (Hillier, 2009; Hillier, 1999) introduces even more theories and methods to study the spatial structure of urban centres in cities. Looking into retail and urban centres as well as mix of uses along high streets and their spatial contexts which are studied by different researchers like Hillier and Chiaradia et al.

(Hillier, 1999; Chiaradia et al., 2012; Chiaradia et al., 2009) and Laura Vaughan (Vaughan et al., 2010; Vaughan, 2015) give a valuable ground to shape the structure for the analysis and a set of studies to compare.

3 DATASETS AND METHODS

In order to measure functional diversity different diversity measures (Entropy index, Simpson diversity index, and Neighbourhood Diversity index) are applied whereas the results from one of them, the so called 'Entropy index[1]' is presented here. The difference here is that the analyses are used to measure *accessible diversity* in configurational terms using Place-Syntax Tool developed at KTH (Ståhle et al., 2005; Berghauser Pont et al., 2019) rather than diversity within a specific geographical area. Analyses start by searching for a number of functions or uses that are accessible *through* the street network, from address points or street segments as origins, within a specific distance as illustrated in figure 1. It is argued that what is captured here is how spatial form structures 'people and things' in the space (Bobkova et al., 2017) which results in a 'location based' analysis rather than 'area based' (Ståhle, 2008; Berghauser Pont and Marcus, 2014). This method is argued to capture 'functional diversity' that is what diversity is accessible from specific location. This answers the question like: what kind of diversity is within reach from one specific location through the street network? The analyses permit comparing accessible diversity on different scales.

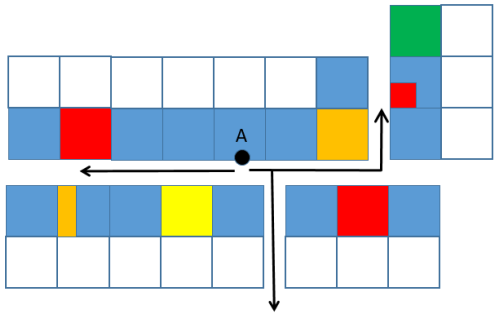

Figure 1: Illustration of accessible diversity from point A, as origin, through street network within a metric distance. Different colours represent different uses or functions that could be retail, restaurant, institutions or more.

The data for the analyses includes all types of uses, both primary and secondary, on a detailed level which is represented on address points for the city of Stockholm. The analyses have the possibility to be applied at different distances, either metric or topological distance. This eliminates the issue of predefined geographical units for the definition of functional diversity or mix.

1 $$Mixed-use\ entropy = -1 \times \left(\frac{\left(\sum_{i=1}^{k} p_i \times \ln(p_i) \right)}{\ln(k)} \right)$$

First, the number of accessible urban activities is analysed, including retail, restaurants and other services within short walking distances. The results are suggested to represent clusters showing different urban centres in the city. Next, in order to measure functional diversity different measures are applied to measure diversity among accessible retail shops which are divided into six groups: food, clothing and accessories, culture and leisure, information and communication equipment, home furnishing, other household goods.

The superimposed maps of both accessible urban activities and accessible diversity of retail with integration and betweenness maps at different radii are used to find visual correspondence between configurative properties and the mix and cluster of urban activities. In the next phase other additional factors such as accessible population density and access to other economic activities are also analysed and compared to find correspondences. As part of the presented project it has been tried to reformulate Jane Jacobs' criteria in a more operational form and then to test them to see their influence on the existing diversity (table 1).

Table 1: Refinement of Jane Jacobs' criteria and the tools to measure them.

Jacobs' criteria	**Redefinitions**	**Tools**
Short blocks	Integration and Betweenness	Configurative network analysis
Concentration of people	Accessible population	Accessible attraction analysis
Buildings of different ages	Accessible plots	Accessible attraction analysis
Mix of primary uses	Accessibility to other economic activities Accessible day and night population	Accessible attraction analysis

4 INITIAL FINDINGS

The first set of the analyses (figure 2) shows the number of accessible urban activities within a 150 meters walking distance from each activity as the origin. The analysis illustrates clusters of accessible activities in the inner city and in the southern part of Stockholm that vary in size. The image shows a large difference between the city and the southern part in the number of accessible activities. Furthermore differences are found between different neighbourhood centres in the southern area and how the size of the clusters change or not by expanding the reach. The images are much more illustrative compared with maps created from analysing the intensity of activities within a superimposed grid system that does not take into account the spatial structure underneath.

Figure 2: Number of accessible urban activities including retail, restaurants and service within 150 m walking distance (attraction accessibility analysis).

Different radii and distances have been used in the analyses where visual comparisons of the maps are done between the accessible activity maps and the spatial analyses, integration and betweenness, maps. One example is presented in figure 3. The visual comparison of the maps are quite useful to gain a preliminary understanding about possible relations between spatial properties and the location of urban activities. The images presented here can be interpreted as a distinct sign of the inner city as a self-organising (market driven) economic systems with the highest concentration of activities, that partly can be explained by variations in pedestrian accessibility, and the outer city as a planned (publicly or privately) centres, that rather can be explained by infrastructural investments and marketing, with lower concentration of urban activities.

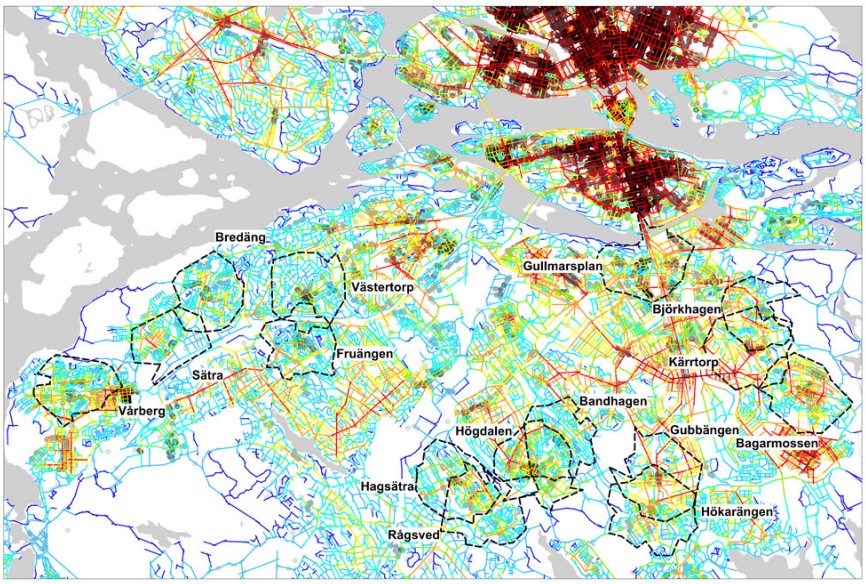

Figure 3: Overlap of integration analysis within 7 axial steps and accessible urban activities within 250. The image shows some of the focus areas in the southern part that are chosen for later studies.

In order to illustrate the accessible functional diversity, segments are chosen as origins and activities are defined as destinations. A number of different walking distances are analysed. The reason to choose segments as origins is to illustrate which street segments might be experienced as having access to a higher diversity. This is argued to be important both for the people living along such streets, and for the activities located along these streets. Figure 4 shows an example of accessible diversity of retail shops (six groups) within a short walking distance (150 m) using entropy index. The highest accessible diversity of retail shops is found in the inner city of Stockholm, and in the southern area there are a few nodes that have a relatively high accessible diversity.

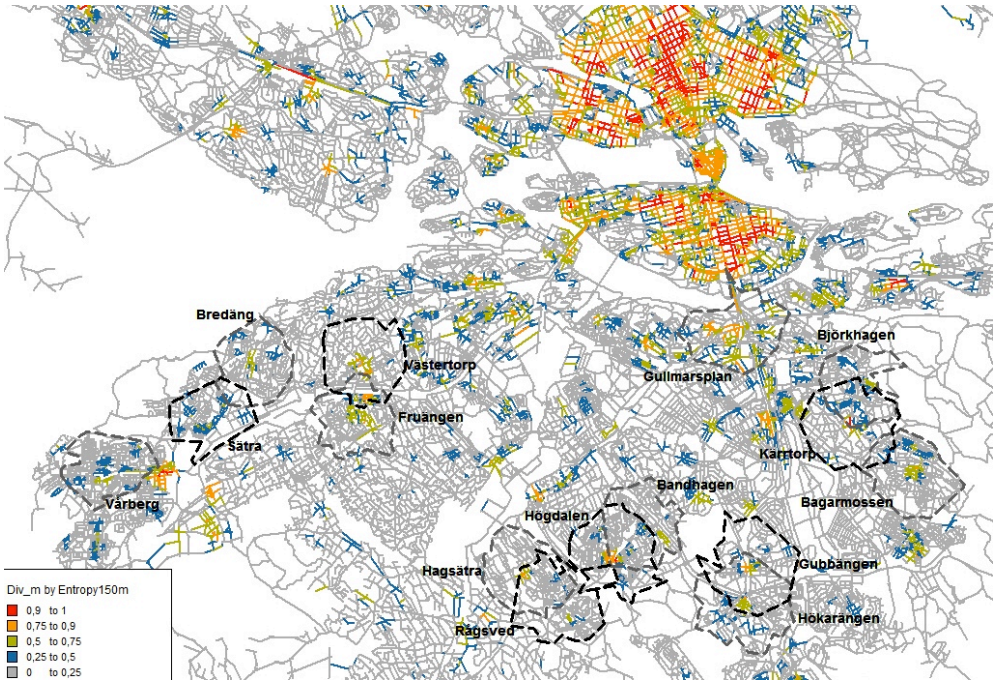

Figure 4: Accessible diversity of retail activities within 150 m walking distance from street segments in central and southern Stockholm. Grey illustrates the lowest diversity and red the highest.

The early results of the statistical analyses show the importance of the accessible population and proximity to other economic activities for both accessible intensity (number) and diversity of activities (Sardari Sayyar and Marcus, 2013).

5 CONCLUSIONS

The presented study has applied a selection of available measurements to quantify the concept of diversity as accessible functional diversity. The method explored in the study has the potential to be used to measure all kinds of diversity within different land uses, socio-economic aspects and even ecological diversity. The quantitative approach of the studies makes it possible to do comparative studies between various areas with different spatial structures and create illustrative maps as valuable tools for both researchers and practitioners. This may increase the understanding of influential properties of urban form for development of a diverse/mixed city. The results of the studies are in line with prior studies of retail centres (Hillier, 2009; Chiaradia et al., 2012; Vaughan, 2015) while in this study it is suggested to use a ‘location based’ approach

to functional diversity rather than an area based. The importance of intermediate scales area is also highlighted as parts of the results concerning neighbourhood centres in addition to local and global scales. The analyses of the next stage of the studies will be more compared and modified according to Hillier (Hillier, 1999), Chiaradia et al. (Chiaradia et al., 2009; Chiaradia et al., 2012) and Vaughan's studies (Vaughan, 2015; Vaughan et al., 2010). This will help to compare the centres and their spatial properties as well as their role in a larger system. Finally it will be interesting to even explore the existing social life at the level of street or neighbourhood centres for some of the cases. Other recent studies concerning mixed use and different measures are also widening the possibilities to explore the diversity of uses on different levels by applying different methods.

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