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Optimal Allocation of Public Service Centres in the Central Places of Functional Regions

Samo Drobne*. Marija Bogataj**

* *University of Ljubljana, Faculty of Civil and Geodetic Engineering, Jamova cesta 2, SI-1000 Ljubljana, Slovenia (Tel: +386 1 4768 649; e-mail: samo.drobne@fgg.uni-lj.si).*

** *Mediterranean Institute for Advanced Studies, Vrtojba, Mednarodni prehod 6, SI-5290 Sempeter pri Gorici, Slovenia (e-mail: marija.bogataj@guest.arnes.si).*

Abstract: In the European Union, Member States and their regions are responsible for planning, funding and administration of public services, which should be based also on smart city tools. How smart is a city could be evaluated also by its ability to produce favorable conditions to get urban operators actively involved into spatial innovation dynamics, also to develop the innovative public logistics networks. The method presented supports local authorities and state government's decision on optimal allocation of regionally based public services. The article is presenting the method for optimal coverage of the state territory with functional regions, where smart city is a center of the activities, and optimal allocation of services influence city growth. Sets of functional regions were modelled using the *Intramax* method. An optimal regionalization on number of functional regions is presented where the optimal number is chosen according to the cost of services. The case study for Slovenian regionalization for eldercare is presented.

Keywords: region, functional region, central place, optimal allocation, service, eldercare.

1. INTRODUCTION

1.1 Formal political region and functional region

How smart is a city could be evaluated also by its ability to produce favourable conditions to get urban operators actively involved into spatial innovation dynamics, also to evaluate which public services are best to be located in the city and what is the optimal functional region which will be covered by these services. Different services in a city as a central place of a region have different optimal size of the territory covered by them. While a formal region is understand as an area having the same characteristics (at least one) and also well-defined border, a functional region is based around something (local labour market (LLM) areas, around their central places, utilities around sources or destination point, even pizza delivery area can be understood as a functional area) and its borders could be fuzzy and changing in a time horizon. Therefore, functional region is an area that is made up of different elementary spatial units (ESUs, e.g. communities, municipalities) that are linked and function as a unit. The participating ESUs could change in a time horizon. Functional region is organized around one or few central places. Dependent on number of functions, which are concentrated in central places, such central places create a highly stratified network of cities. Regarding economic and social cohesion of European Union (EU) regions, which are the main goal of European Spatial Development Perspective (ESDP 1999), the regional state-of-art and especially future development, must be studied as the base for further economic and political decisions. Here, the regions became a subject of complex, open, dynamic nonlinear system of transparent functional connections between smaller and larger territorial areas.

Many researchers (e.g. Ball, 1980; Casado-Diaz, 2000; Tomaney and Ward, 2000; Laan and Schalke, 2001; Andersen, 2002) showed already that the standard administrative regions covering territory of European Member States used as basic entities for policy making, resource allocation, and research do not provide meaningful information on actual conditions of a particular areas. As such, there has been a move towards functional regions. A functional region is defined as a region characterised by its agglomeration of activities and by its intra-regional transport, information and communication infrastructure, facilitating production and services, therefore a large mobility of people, items in production processes and final products, but also enabling services within its interaction borders, which is rarely well defined.

In industrial society, the basic characteristic of a functional region is the integrated labour market, in which intra-regional commuting as well as intra-regional job search and search for labour demand is much more intensive than the inter-regional counterparts. Consequently, the identification and delineation of functional regions are commonly based on the conditions of local labour market. Based on this perception, Smart (1974) delineated functional regions and this "industrial" approach is accepted in the recent literature (OECD, 2002; Cörvers et al., 2009; Casado-Diaz and Coombes, 2011), while the economic shocks like the nowadays' economic crises require reconsider the labour market perception. In the post-industrial society, intensity of flows of workers and flows of items decline and intensity of services in a functional region is progressing.

A number of regionalisation procedures for delineation of functional regions have been suggested in the literature. A recent review of different approaches and methods is in Casado-Diaz and Coombes (2011). Methods for delineation of functional regions can be divided into rule-based (Coombes et

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al., 1986; Coombes and Bond, 2008) and hierarchical methods (Smart, 1974; Masser and Brown, 1975, 1977; Masser and Scheurwater, 1980; Slater and Winchester 1978; Slater, 1981). There were developed several methods to determine functional areas/regions, that can be used for statistical purposes to analyse different aspects of labour market performance (Smart, 1974; Combes et al. 1986; Casado-Diaz, 2000; Van der Lann and Schalke, 2001; Newell and Papps, 2001; Karlsson and Olsson, 2006; Mitchell and Stimson, 2010; Landréa and Håkansson, 2013) and other socio-economic aspects (Green et al., 1986; Tomaney and Ward, 2000; Baum et al., 2008; Karlsson et al., 2008), to evaluate the administrative regions (Slater, 1976; Anderseen, 2002; Nel et al., 2008; Cörves et al., 2009), to analyse functional urban regions (Shimizu, 1975; Sykora and Muliček, 2009; Drobne et al., 2010; Manley, 2014), for analyses and applications of transport policy (Krygsman et al., 2009), to analyse housing market areas for housing policy (Goetgeluk and de Jong, 2007; Brown and Hincks, 2007), to analyse commodity market areas (Brown and Pitfield, 1990), to analyse telephone communication patterns (Fischer et al., 1993), to enhance economic development (Freshwater et al., 2013) – but only some of them have been developed for study the location problems and opportunities of services (Shortt et al., 2005; Drobne and Bogataj, 2014). The optimal delineation of functional regions for individual services or group of services has not been subject of scientific investigation.

The location-allocation models which try to answer the question where optimally locating a set of facilities and how to allocate resources are part of colourful and ever growing body of literature also given in the review papers of Rahman and Smith (2000), Plastria (2001), Klose and Drexl (2005), Revelle and Eiselt (2005), Sahin and Süral (2007), Revelle et al. (2008), and Farahani et al. (2010). About optima location and allocation of services have wrote Harper et al. (2005), Mestre et al. (2015) and many other researchers. Specific problems of servicing elderly has been considered in Cromley and Shannon (1986), Johnson et al. (2005) and in others. However, as far as the authors know it, there is no literature that couples both problems: location-allocation problem of facility location and the problem of optimal delineation of the functional regions. In this paper a method for delineation of functional regions servicing elderly like developed by Drobne and Bogataj (2014) is coupled by a general location-allocation model for servicing in the functional regions on the special way using *Intramax* method. Here we are looking for such allocation of activities in the potential centres of functional regions, and delineation of these functional regions, that the costs of communication between city as a central place and other areas in the functional region, and other costs of services (including investments) would be minimal, when the functional regions are covering the area of a state as tessellations.

1.2 From the classical tradition of location theory to the post-industrial smart city

Higher fix costs of public service activity A in a central place influence lower number of central places k an a broader territory of a country where A would be placed. Therefore, some "expensive" activities will find optimal location in less central places and some "cheaper" in more. Therefore, the tendencies of growth in modern city decline from the pure Tinbergen's description of spatial allocation of production activities. Tinbergen (1968) explained how the smallest towns and villages produce certain goods, let us say type TYA goods. The next largest towns produce type TYA and TYB goods. They satisfy the demands of their own population and they export goods of TYB to smaller central places and villages. Larger towns manufacture three kinds of goods, TYA, TYB and TYC for their own population, exporting TYC and so on. The market area as a functional region of the goods is a result of the competition of spatial oligopoly of central places at different levels of centrality. If some central places of a certain level are stronger than others, their market area grows and attracts customers from other central places. Models of spatial games can describe this process, like presented by Bogataj and Usenik (2005). The authors also presented that the same competition appears in the strategic logistics of supply chains. Activity cells need to find an optimal level of central place to benefit the appropriate structure of human resources, subventions and other fiscal policies, and lower production or distribution costs.

In post-industrial age among the factors influencing urban and regional growth, importance of services is growing and influence of production is declining. The answer to the question where to locate services, especially public services like schools, hospitals and eldercare is given in the next chapter, where α and β are subject of negotiation.

2. THE DELINEATION OF 21ST CENTURY LOCAL LABOUR MARKET AREAS AND FUNCTIONAL REGIONS

2.1 Intramax procedure

To follow the ideas of functional regions as a local labour market areas (Casado-Diaz and Coombes, 2011), delineation could be made as described in the first part of this chapter. Let us consider the labour commuter as a person in employment whose territorial unit (ESU, e.g. community, municipality) of workplace is not the same as territorial unit of residence. To analyse functionally delineated regions as LLM areas, the groupings have been arranged using the *Intramax* method, which belongs to the methods of hierarchical clustering.

Regionalisation procedures based on hierarchical clustering were initially developed in the 1970s and 1980s, and were introduced as alternatives to the more ad hoc methods. The methods include Markov chain techniques of Brown and Holmes (1971), as well as the strategy of Masser and Brown (1975, 1977) and Masser and Schuerwater (1980), which is based on refinements to Ward's (1963) hierarchical aggregation procedures.

The objective of the *Intramax* procedure is to maximise the proportion within the group interaction at each stage of the grouping process, while taking account of the variations in the row and column totals of the matrix. In the grouping process, two ESUs are grouped together, for which the objective function is maximised (Breukelman et al., 2009):