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Article

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Driving factors of formation, development, and change of spatial structure in metropolitan areas: A systematic review



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ABSTRACT

In the last decades, there have been many articles on the spatial structure of metropolitan areas, but a study for explaining driving factors of changes in the spatial structure of metropolitan areas has remained unknown so far. To fill this gap, the article explains the driving factors of these changes using a systematic review method. To this end, 115 peer-reviewed scientific articles published from 1999 to 2019 were carefully analyzed. According to the results, 4 main dimensions including contextual and intrinsic, incentive and disincentive, developmental, and transformative were identified in this regard. This article argues that spatial structure subject to the driving factors have undergone vast changes over the past two decades, and the metropolitan areas have been shifting from concentrated and compact patterns toward decentralized and dispersed patterns.

1. Introduction

Cities and metropolitan areas are considered to be the main elements of the spatial structure in the post-industrial period (Scott, 2001). Gradually, with increasing population density and activity in these areas, population and activity are shifting out of large cities, which has led to the formation of sub-centers of activity and settlement in different patterns of spatial structure (Kloosterman & Musterd, 2001; Burger, Goei, De van der Laan, & Huisman, 2011; Dadashpoor & Alidadi, 2017). Changes in the relationships between metropolises and peripheral territories are often associated with economic, cultural, and social developments (Dadashpoor & Ahani, 2019a; Burger et al., 2011). On the one hand, metropolitan areas, as the main elements of the global urban hierarchy containing hard and soft infrastructure, have concentrated multicultural lives, talents, and capacities in a production network consisting of several interconnected nodes (Scott, 2001), on the other hand, with increasing density, high land prices, and environmental pollution in the main centers (Richardson, 1995), these areas have led to intertwined and complex processes of decentralization and restructuring (Champion, 2001).

Many scholars believe that the development and change of spatial structure in metropolitan areas is a process dependent on factors that shape these areas (eg, Kloosterman & Lambregts, 2007). Empirical evidence suggests that various driving factors affect the spatial structure of metropolitan areas. Spatial structure results from the interaction of driving factors subject to the local, regional, national, and global scales. Some researchers consider demographic, social, and cultural factors to be the cause of change (i.e. Catalan et al., 2008; Arribas-Bel & Fernando, 2014; Finka, 2010). Other researchers have introduced economic factors as influential factors in the spatial structure of metropolitan areas. For instance, Sýkora et al. (2009), Veneri and Bungalassi (2012), Zhong, Lin, Zhou, and Chen (2018), Li and Liu (2018), Meijers and Burger (2010), and Kwon and Seo (2018) believe that economic

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performance is highly effective on the formation of strong sub-centers outside the main core and subsequently the formation of polycentric patterns. Some also consider geographical factors to be effective in the shaping of spatial structure (i.e. Meeteren et al., 2016; Hassan, 2011). Some studies point out that institutional factors such as macro policies (i.e. Dadashpoor & Alidadi, 2017; Sweet et al., 2016; Burger et al., 2014; Lee & Shin, 2012; Kloosterman & Musterd, 2001), rules and regulations (i.e. Sinclair-Smith, 2015), and incentives and disincentives (i.e. Hajrasouliha & Hamidi, 2017; Li & Monzur, 2018) influence the formation of spatial structure.

With these in mind, many empirical studies show that spatial structure is evolving under the influence of various factors, but no study has yet been made for classifying and explaining the driving factors effective on the spatial structure in metropolitan areas. To fill this gap, in this article, an attempt has been made to classify and explain the driving factors, affecting the formation, change, and development of spatial structure in metropolitan areas. To achieve the above-mentioned goal, the main question is what driving factors affect the spatial structure of metropolitan areas?

The paper is structured into five sections. The second section presents the methodology of the research and shows how we obtained the findings through the systematic review method. In the third section, driving factors of formation, development, and change of spatial structure in metropolitan areas are identified and categorized. The fourth section is followed by a discussion. Finally, the article ends with the synthesis of findings and the conclusion based on our main objective. A further study is also proposed to complete this study.

2. Materials and methods

This study systematically reviews the driving factors of formation, change, and development of spatial structure in metropolitan areas. The systematic review method was conducted in four steps: collecting, assessing, extracting, and explaining the data.

In the first step (collecting the data), only the scientific studies published in peer-reviewed journals from 1999 to 2019 were selected and the book chapters, private and public reports, and the conference papers were excluded due to the lack of access to all documents. The dominant subject focus was on the studies in the field of driving factors of spatial structure in metropolitan areas. Thus, the articles that only focused on the spatial structure without pointing to the driving factors, as well as the studies on the urban scale were excluded. To this end, first, the research problem was presented and then, to answer the research major question, the related keywords such as (spatial structure, spatial pattern, polycentricity, monocentricity, dispersion); driving factor (driving force, factor, cause, reason, determinant, mechanism) and scale (metropolitan area, urban agglomeration, city region, metropolitan region, megacity-region, urban region, extended urban region, extended metropolitan regions) were used to search scientific articles published in the valid scientific databases such as Elsevier's Scopus, Science Direct, Taylor and Francis, Springer & Kluwer, ProQuest, Oxford, Science Magazine Google Scholar database.

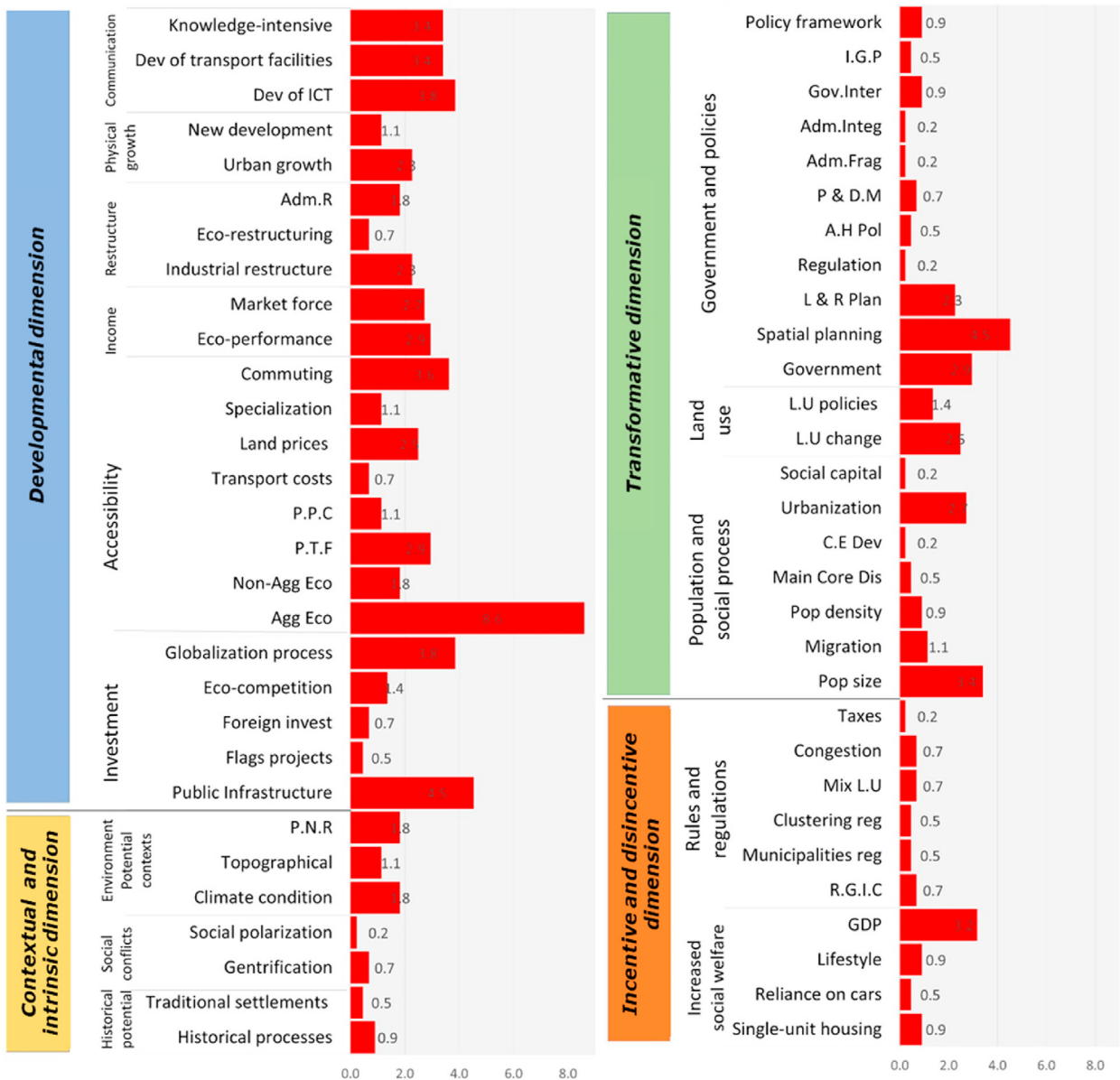
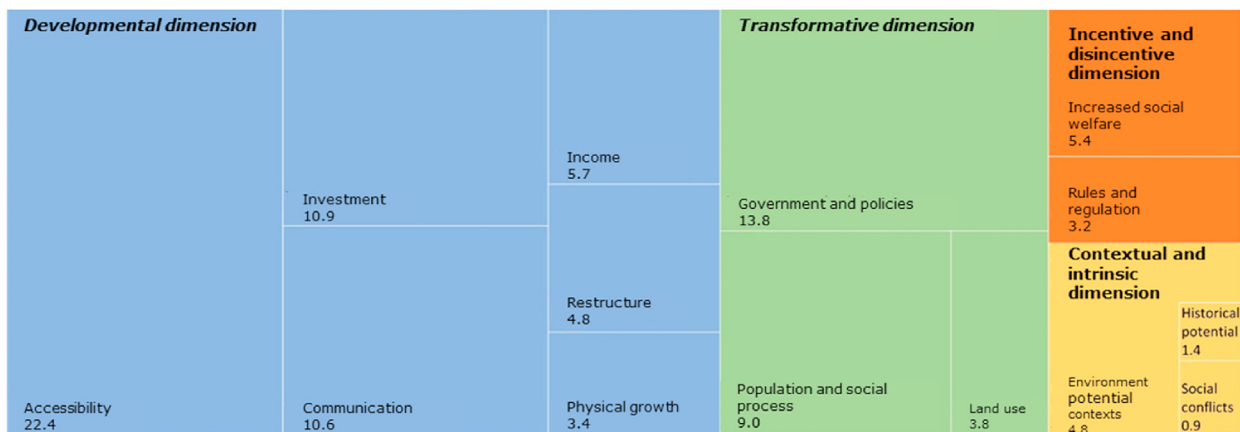
After collecting the documents, the second step (assessing the documents) was followed by two stages. Based on the search in the valid databases, first, more than 400 studies were collected. By reviewing the topics of the articles, this number reduced to 254 articles. Then, the abstracts of the remained articles were examined in terms of content, leading to the omission of 95 articles. The 44 articles were also excluded due to lack of connectivity between title, abstract, and the result as well as due to their urban and intra-urban scales. Finally, 115 articles were selected and analyzed.

After assessing the documents that were the result of a systematic review of available references, in the third step (extracting the data), a text analysis method named "open-source coding" was used. This method mostly seeks to reduce information and provide a detailed description of an issue. In this coding method, the codes were extracted from the text of the studies (first-order coding); then, the extracted codes were re-coded, leading to the formation of the concepts (second-order coding). Finally, on the concepts, another coding was conducted (third-order coding) to form categories. In the last step, the results were explained, and finally, the article came to an end with a discussion and a conclusion.

3. Results

During the last decades, the spatial structure of metropolitan areas has experienced different spatial patterns. The driving factors under the influence of centrifugal and centripetal spatial forces changed the spatial structure from concentrated to dispersed and polycentric patterns. The systematic review (Fig. 1) revealed that 4 major dimensions, 14 subcategories and 60 codes corresponding to the main categories were mentioned 442 times in 115 articles. Developmental dimension with 255 frequencies (57.7% of the total), 6 subcategories, and 23 codes, has been the most pointed forces in the studies. Among the major driving factors, investments, accessibility, income, and economic productive forces, restructuring, physical growth, and communication were the most driving factors affecting the change of spatial structure in metropolitan areas. After the developmental dimension is the transformative dimension with the frequency of 118 cases (26.7% of the total), 3 subcategories and 20 codes were the most important among the studies. Then, incentive and disincentive dimension with a frequency of 38 cases (8.6% of the total), 2 subcategories and 10 codes, and the last, contextual and intrinsic dimension with a frequency of 31 (7.0% of the total), 3 subcategories and 7 codes affected the spatial structure in metropolitan areas.

The authors in this section of the study have classified the resulting codes based on the similarities and features and how they affect the spatial structure of metropolitan areas in four major dimensions. Based on the initial review of identification codes, it was found that some driving factors are more independent of other factors and are more effective. These factors are less changeable and almost constant. Driving factors with such characteristics were placed in the dimension of "contextual and intrinsic". It was also found that some driving factors have an "incentive and disincentive dimension" which can be divided into two parts, some are influenced by internal factors and social changes, and some others are influenced by external driving forces. The third group is factors



(caption on next page)

Fig. 1. Percentage of the main categories, sub-categories, and codes of driving factors of spatial structure in metropolitan areas. R.G.I.C = Restricted growth of inner core, Dis = Disadvantages, C.E Dev = Cultural evolutions and development, L.U = Land use, L & R Plan = Local and regional planning, A.H Pol = Affordable housing policies, P & D.M = Planners and decision-makers, Adm.Frag = Administrative fragmentation, Adm.Integ = Administrative integration, Gov.Inter = Government interventions, I.G.P = Interest groups pressure, P.N.R = Proximity to natural resources, Agg Eco = Agglomeration economies, Non-Agg Eco = Non-economic agglomeration, P.T.F = Proximity to transport facilities, P.P.C = Proximity of the principal city, Adm.R = Administrative restructuring.

that cause the change of the spatial structure by creating development and were included in the “developmental dimension”. Finally, some other driving factors are categorized under “transformative dimension” that cause the change and transformation of other driving factors and also change the spatial structure of metropolitan areas (Fig. 1).

3.1. Developmental dimension

The developmental dimension includes the internal factors, driving forces, and developer, which, by creating economic, communication, and physical infrastructure, change the spatial structure in metropolitan areas. The developmental dimension includes economic factors such as income and economic productivity, public investment, accessibility, and physical factors and infrastructure development, such as communication factors, physical growth, and economic and social restructuring. Public investments in the development of service infrastructures and large-scale urban projects (Sweet et al., 2016; Smetkowski, 2018; Trapero et al., 2015; Gutiérrez & García-Palomares, 2007; Lizhu et al., 2013; Fernandez-Maldonado, Romein, Verkoren, & Pessoa, 2014; Wei et al., 2018; Hoyler et al., 2008; Smetkowski, 2013; Criekeingen, Bachmann, Guisset, & Lennert, 2007; Lan et al., 2019; Priemus, 2019; Chen et al., 2019), which has a direct influence on locating the settlement and activity, is one of the driving factors in the formation and change of spatial structure (Li & Monzur, 2018; Criekeingen et al., 2007). Criekeingen et al. (2007) indicate that large-scale urban projects undertaken by public investments play a direct role in the formation and consolidation of polycentric spatial structure. Beyond these large-scale projects, further analyses are needed to see whether other less spectacular, but still pro-active forms of public intervention, do play a role in the emergence and consolidation of polycentric patterns (e.g. granting of financial advantages or facilities for selected firms, targeted investments in site equipment).

The process of globalization and getting involved in the global network and economic competitions (Sweet et al., 2016; Trapero et al., 2015; Lee & Shin, 2012; Lizhu et al., 2013; Xigang, Jing-Xiang, & Hu, 2002; Li & Phelps, 2016; Taylor et al., 2008; Maly, 2016; Goess et al., 2016; Taubenböck et al., 2014; Kloosterman & Musterd, 2001; Sat, 2018) and foreign investments (Finka, 2010; Smetkowski, 2018; Lan et al., 2019) led to the concentration of economic activities in certain areas, based on local circumstances, and contexts (Hoyler et al., 2008; Romero et al., 2014). and have greatly changed the spatial structure of metropolitan areas. For instance, Lan et al. (2019) considered the foreign investment to be effective in the shaping of a polycentric pattern in 20 major city-regions in China.

Furthermore, the most important of effective centripetal factors is accessibility, agglomeration economies (Junliang et al., 2010; Sweet & et al., 2016; Acheampong & Agyemang, 2016; Shearmur et al., 2007; Meijers, Hoogerbrugge, & Cardoso, 2017; Nam & Kim, 2017; Romero et al., 2014; Golem & Mustra, 2013; Brezzi & Veneri, 2015; Burger et al., 2015; Lv et al., 2017; Coffey & Shearmur, 2001; Charney, 2005; Shearmur & Coffey, 2002; Meijers & Burger, 2010; Hamel & Jouve, 2008; He et al., 2019) and specialization (Champion, 2001; Goess et al., 2016; Vandermotten et al., 2008) means access to job opportunities and direct relationship with specialized manufacturers, which strongly change spatial structure. Economic agglomeration means the spatial proximity in the spatial territory of a metropolitan area and refers to a condition in which a shared space is created to agglomerate the economic enterprises for easy access to labor forces, resources, and investors. This important factor, as a centripetal force, causes spatial concentration through the agglomeration of economic activities outside the core center.

Agglomeration diseconomies such as land prices and housing (Jiang et al., 2016; Golem & Mustra, 2013; Trapero et al., 2015; Gutiérrez & García-Palomares, 2007; Lv et al., 2017; Nasri & Zhang, 2018; He et al., 2019; Guanghui et al., 2017) and increase in transport costs (Sinclair-Smith, 2015; Veneri, 2010) increase the centrifugal forces and the tendency of most of the economic enterprises to move outside the main center. With the decrease of transportation costs, the tendency to reside in suburbs and activity in out of the main center increases; and as it grows, the desire for proximity between work and residence increases. Hence, transportation costs have a significant influence on spatial dispersion or decentralization. In the 1980s in China, because of land reforms, an increase of land prices in the main center and regulations to exclude the industries from the cities, industry's tendency toward the suburbs increased, leading to the formation of industrial sub-centers outside the main center and the emergence of suburbanization and spatial dispersion (Man, Zheng, & Ren, 2011).

Some articles indicates that proximity to transport facilities (Krehl & Siedentop, 2018; Mohino, Solís, & Urena, 2017; Zeng et al., 2015; Nasri & Zhang, 2018; Criekeingen et al., 2007; Lan et al., 2019; Wang & Niu, 2019; Chen et al., 2019; Grunfelder et al., 2015; McMillen & McDonald, 1998) and principal city (Dadashpoor & Alidadi, 2017; Trapero et al., 2015;) impact on spatial structure in metropolitan areas. Commuting as the daily flow between workplace and the place of residency (Dadashpoor & Jalili, 2019; Burger et al., 2011; Mohino et al., 2017; Veneri, 2010; Brezzi & Veneri, 2015; Kauffmann, 2015; Murayama, 2000; Fujii et al., 2006; Hakim & Parolin, 2008; Acheampong & Agyemang, 2016; Ellingsen & Leknes, 2012; Grunfelder et al., 2015) is a significant part of accessibility factors. This factor dramatically modifies the spatial structure and is itself dependent on the social, cultural, economic, and political factors governing the spatial structure.

Economic performance (Meijers & Burger, 2010; Keys et al., 2007; Ellingsen & Leknes, 2012; Kwon & Seo, 2018; Criekeingen et al.,

2007; Hamel & Jouve, 2008; Lan et al., 2019; Wang & Niu, 2019; Zhang et al., 2019) have great impact on spatial structure. In fact, under influence of this factor, the level of prosperity, access to services, infrastructure development, etc., lead to the emergence of strong sub-centers with a low dependency on the core center and, consequently, the emergence of polycentric spatial structure. According to the studies, the market forces were identified as effective forces in change of spatial structure (Jiang et al., 2016; Golem & Mustra, 2013; Kauffmann, 2015; Burger et al., 2014; Acheampong & Agyemang, 2016; Lv et al., 2017; Fernandez-Maldonado et al., 2014; Wei et al., 2018). Under the market economy condition, economic enterprises choose their place by pursuing their benefit maximization. For example, market forces, instead of administrative allocations, started to affect employment distribution after China's reform and open doors policy (Lv et al., 2017; McMillen & McDonald, 1998).

In the meantime, the industrial restructuring that is affected by economic agglomeration force, in many studies, was mentioned as one of the factors influencing on the changes in the spatial structure of metropolitan areas (Bailey & Turok, 2001; Kim et al., 2018; Nam & Kim, 2017; Lizhu et al., 2013; Shearmur & Coffey, 2002; Smetkowski, 2013; Maly, 2016; Giuliano & Small, 1991; Knapp, 1998). Economic restructuring (Sweet et al., 2016; Krehl et al., 2016; Goei et al., 2010) is another economic driving factor that brings changes by the central government. For example, this factor in China caused tremendous changes to the spatial structure. Zhong, Arisona, Huang, Batty, and Schmitt (2014) considered the changes in monocentric, polycentric, and dispersed patterns resulting in economic growth and economic restructuring.

Also, according to some other studies, administrative restructuring (governmental) (Meeteren et al., 2016; Burger et al., 2014; Zeng et al., 2015; Wei et al., 2018; Hamel & Jouve, 2008; Knapp, 1998) caused an enormous transformation in the spatial structure of metropolitan areas. Among the prominent features, is economic and administrative devolution and the delegation of authority from the central government at the national level to a regional and local one.

Urban growth (Junliang et al., 2010; Salvati & Rosa, 2014; Wang & Maduako, 2018; Díaz-Pacheco & García-Palomares, 2014; Lan et al., 2019) is one of the important factors in physical changes. On the other hands, new developments (Salvati et al., 2016; Egermann, 2009; Salvati & Rosa, 2014; Veneri & Burgalassi, 2012) outside the main center such as economic development zones, development of new towns, and university towns led to the formation of new subcenters outside the main center and formation of decentralized spatial structure. This framework is based on functional complementarity among the various subcenters of the metropolitan areas and the main core and subcenters, which relates to mass transport infrastructures and large investments in these subcenters (Criekingen et al., 2007). Also, the erosion and unusuality of buildings led to the loss of the population within the urban context, reduction of population density in the main center (Salvati et al., 2016; Egermann, 2009; Salvati & Rosa, 2014), and people's tendency to move from the main center and create the new residential centers in the suburbs. This has been the current trend in most metropolitan areas of Europe over the past 20 years (Veneri, 2010).

The recent studies have focused on the role of ICT and the emergence of “new economics”, which are influential in the change of the spatial structure of metropolitan areas (Dadashpoor & Yousefi, 2018; Yousefi & Dadashpoor, 2020). One of the main factors contributing to this force is the Internet and the developments in ICT (Dadashpoor & Yousefi, 2018; Yousefi & Dadashpoor, 2020; Burger et al., 2011; Nam & Kim, 2017; Smetkowski, 2018; Romero et al., 2014; Veneri & Burgalassi, 2012; Sinclair-Smith, 2015; Xigang et al., 2002; Goei et al., 2010; Smetkowski, 2013; Maly, 2016) which leads to reduction of costs of information flows, and consequently, reduction of physical distance-derived costs in many knowledge-intensive innovation activities (without spatial dependency) (Sweet et al., 2016; Burger et al., 2011; Finka, 2010; Smetkowski, 2018; Romero et al., 2014; Golem & Mustra, 2013; Li & Phelps, 2016; Taylor et al., 2008; Ellingsen & Leknes, 2012; Hoyler et al., 2008; Vandermotten et al., 2008; Smetkowski, 2013; Criekingen et al., 2007); it also highlights the important role of information in the reduction of face-to-face communications. The widespread developments undergone or ongoing in the third millennium have been effective in the spatial structure, leading to the emergence of new spatial patterns. Burger et al. (2011) considered the relationship between changes in the spatial structure of metropolitan areas and an increase in flexibility and flow exchanges of households influential in the development of technological and transportation infrastructures.

Development of transport facilities (Catalan et al., 2008; Bailey & Turok, 2001; Krehl & Siedentop, 2018; Burger et al., 2011; Garcia-Lopez, 2010; Murayama, 2000; Wang & Maduako, 2018; Filion & Saboonian, 2019; Garcia-Lopez et al., 2017) has over time decreased the dependency of economic activities to location. Thus, the efficiency and popularity of the central business districts have decreased compared to the past and, in return, the attention and desire to suburbs (Burger et al., 2011; Garcia-Lopez, 2010) and the sub-centers has increased due to access to open space, lower land prices (Catalan et al., 2008; Jiang et al., 2016), and getting away from the disadvantages of the main center. As a result, the traditional monocentric spatial structure changed to the dispersed and polycentric one.

3.2. Transformative dimension

The “Transformative dimension”, which includes internal and external factors, causes change and transformation in the spatial structure of metropolitan areas. This dimension, on the one hand, is subject to demographic and social processes related to migration and developments arising from these changes. On the other hand, under the influence of spatial planning and driving forces from top-down, in the form of government decisions and policies, the rules and regulations of spatial planning at national, regional and local scale cause changes in the spatial structure of metropolitan areas.

Change in population size is the major demographic factor that many articles consider it to be effective in the formation and changes of spatial structure (Catalan et al., 2008; Junliang et al., 2010; Finka, 2010; Hakim & Parolin, 2008; Hassan, 2011; Burger et al., 2015; Zeng et al., 2015; Watanabe & Takeuchi, 2010; Lan et al., 2019; Cardoso, 2018; Alidadi & Dadashpoor, 2018). Some other articles based on two hypotheses of concentration and dispersion considered population density (Lizhu et al., 2013; Zeng et al.,

2015; Kwon & Seo, 2018; Manzato & da Silva, 2010; Dadashpoor et al., 2019a). According to the concentration hypothesis, with an increase in population and population density in the main center, the population tends toward sub-centers, leading to a concentrated and centripetal spatial structure with mutual relation between the main center and the sub-centers. In contrast to this hypothesis, there is also a dispersion hypothesis which considers the movements of population from the main center to sub-centers, leading to the formation of a dispersed spatial structure.

Some studies point out that the increase of the total population is not the only influential factor on demographic changes; rather, migration and population movements (Finka, 2010; Filion et al., 2004; Kloosterman & Musterd, 2001; Smetkowski, 2013) and cultural evolutions and development (Catalan et al., 2008) are other factors that alter the spatial structure. Internal migrations and demographic movements have several driving factors. These factors include main disadvantages (Catalan et al., 2008; Lv et al., 2017) such as costs of congestion, the rise in the price of land and labor, land speculation, environmental pollution, lack of development space, etc. lead to the depopulation of the metropolitan main center and the emergence of 'new cities' in the peripheral areas (Dadashpoor & Ahani, 2019a). Another driving factor behind migration and consequently the change of spatial structure is social capital. There is a strong correlation between social capital and urban growth. Sprawl in many metropolitan areas can occur due to the encouragement of migration to secondary-sized cities, which is closely related to social capital (Lan et al., 2019).

Land-use changes (Catalan et al., 2008; Hajrasouliha & Hamidi, 2017; Salvati et al., 2016; Hassan, 2011; Keys et al., 2007; Díaz-Pacheco & García-Palomares, 2014; Manzato & da Silva, 2010; Filion & Saboonian, 2019; Dadashpoor et al., 2019a; Dadashpoor et al., 2019b) were also considered to be the main factor in the physical changes and consequently the change in spatial structure. Also, land-use policies (Nasri & Zhang, 2018; Zhang & Sasaki, 2000; Garcia-Lopez, 2010; Wang & Maduako, 2018) such as land-use rules, restricting the expansion of built-up land use, zoning, privatization of open spaces, extensive land occupation in the main center and the existence of bare land outside the main center, residence followed by activities is distributed from the main center to the sub-centers, which leads to spatial dispersion.

Government and institutions (Sweet et al., 2016; Trapero et al., 2015; Houtum & Lagendijk, 2001; Burger et al., 2014; Hakim & Parolin, 2008; Lv et al., 2017; Kloosterman & Musterd, 2001; Ellingsen & Leknes, 2012; Wei et al., 2018; Manzato & da Silva, 2010; Dadashpoor & Alidadi, 2017) by imposing rules and regulations in high levels spatially control the metropolitan areas. This control in the strategic level includes national spatial planning (Dadashpoor & Saeidi Shirvan, 2019; Kim et al., 2018; Meeteren et al., 2016; Finka, 2010; Golem & Mustra, 2013; Egermann, 2009; Salvati & Rosa, 2014; Asikhia & Nkeki, 2013; Wang & Maduako, 2018; Lizhu et al., 2013; Watanabe & Takeuchi, 2010; Ellingsen & Leknes, 2012; Crieckingen et al., 2007; Priemus, 2019), is one of the main manifestations of power and control in the growth of metropolitan areas. This factor as an external driving factor affects the spatial structure in the form of top-down approaches (Bailey & Turok, 2001). Sweet et al. (2016) describe the political factor as the head of the triangle of forces (economics, governance, and globalization) that change the spatial structure. Governance in the form of managerial policies and interventions of the government (Li & Monzur, 2018; Sinclair-Smith, 2015; Guanghui et al., 2017) and decisions of the planners and decision-makers (Asikhia & Nkeki, 2013; Nasri & Zhang, 2018) have a key role in spatial structure.

One of the most effective non-governmental factors in changing the spatial structure also depends on the type of management or governance; management integration (Meijers et al., 2017; Finka, 2010) against management fragmentation (Bailey & Turok, 2001) has a direct relation to the integration and cohesion of the spatial structure. Besides, there are also effective non-governmental factors like interest pressure groups for development (Trapero et al., 2015; Lee & Shin, 2012) such as , pro-growth groups and environmental advocacy groups (Lee & Shin, 2012) affect the changes of metropolitan areas. In studies conducted, local and regional plans and policies (Hajrasouliha & Hamidi, 2017; Meeteren et al., 2016; Goei et al., 2010; Filion et al., 2004; Coffey & Shearmur, 2001b; Kloosterman & Musterd, 2001; Keys et al., 2007) such as affordable housing policies (Priemus, 2019) contain limited or developing policy frameworks (Brezzi & Veneri, 2015; Lan et al., 2019; Mariani et al., 2018; Zhang et al., 2019) were identified as one of the most important factors influencing changes in spatial structure. For example, Goei et al. (2010) state that local and regional development policies and regulations with the aim of economic decentralization and creation of urban networks contribute to the formation and changes in spatial structure.

3.3. Incentive and disincentive dimension

The "incentive and disincentive dimension" also affects the spatial structure of metropolitan areas. These areas, on the one hand, affected by incentive factors reduce population concentration and activity from the main center and spatial distribution of population and activity in sub-centers outside the main center. On the other hand, under the influence of *disincentive* factors, they prevent further concentration in the main center. This dimension includes internal factors in the form of increasing social welfare and external factors in the form of setting rules and regulations. The increased social welfare (Schmidt et al., 2017; Chen et al., 2019) includes the tendency to have single-unit housing, reliance on personal cars, lifestyle and attitudes of households, residential decision-making, retirements' migration, GDP growth/rising incomes. Some of the studies mention social and cultural changes as the driving factors of changes in spatial structure, while some other studies refer to the growth of new technologies, causing a change in lifestyle and attitudes of households (Dadashpoor & Ahani, 2019a; Catalan et al., 2008; Goei et al., 2010) and the tendency toward prosperity and access to services and residential decision-making (Champion, 2001; Keys et al., 2007; Hamel & Jouve, 2008) which reduced the desirability of living in the main center. One of the factors of change in lifestyle returns to the growth of transportation technology and increased use of personal cars (Filion, 2001; Fernandez-Maldonado et al., 2014). Another type of incentive dimension is retirements' migration who move out from the main center to suburbs to obtain a more relaxed environment away from environmental pollution. For example, Champion (2001), points out that most of these types of households prefer to live in a polycentric metropolis, rather than the monocentric one. Households' preferences in gaining more prosperity and access to services are recognized as the

main driving factor of the formation of subcenters.

Rules and regulations (Sinclair-Smith, 2015) such as municipalities regulations, rules and conventions for doing business, clustering regulation, encourage for mix-land use, the imposition of congestion (Díaz-Pacheco & García-Palomares, 2014; Salvati, Morelli, & Sabbi, 2013; Kloosterman & Musterd, 2001) and growth restriction of the main center (Catalan et al., 2008; Garcia-Lopez, 2010; Wang & Maduako, 2018), encourage to mixed-use development (Hajrasouliha & Hamidi, 2017; Li & Monzur, 2018), subsidies for new urban development (Keys et al., 2007) and subsidies for transport (Acheampong & Agyemang, 2016) are also the most important driving factors of spatial structure change in metropolitan areas.

3.4. Contextual and intrinsic dimension

“Contextual and intrinsic dimension” refers to factors that contain fixed or less changeable elements. These factors as environmental potentials, are an integral part of metropolitan areas or have been formed and completed during the historical process. Thus, it is impossible to change or delete these elements. Some of these factors are more changeable than natural and historical factors. These factors are formed and developed in social processes and under the influence of social conflicts. Due to its immutability and stability, this dimension is more effective in the formation of the main centers as the primary nuclei of residence and activity, as well as the formation of special settlement centers and changing the spatial structure of metropolitan areas.

Some studies point that historical processes (Catalan et al., 2008; Wei & Knox, 2015; Sarzynski et al., 2014; Meeteren et al., 2016; Schmidt et al., 2017), and the existence of traditional settlements (Catalan et al., 2008) have a significant effect on the spatial structure in metropolitan areas. Sarzynski et al. (2014) regarded the historical core as the driving force in the formation of a concentrated monocentric pattern in 311 US metropolitan areas and argued that the cluster is compactly developed with a notably high concentration of jobs and housing, predominantly in or relatively near the historical core.

Besides, social conflicts such as spatial segregation, gentrification, social polarization, crime growth, secular changes in social organization, and poverty create the groundwork for other factors in such a way that these contexts and environmental factors influence the intensity and influence of other driving factors in the spatial structure. Based on the dispersion hypothesis, there are driving factors that cause the formation of sub-centers and weak suburbs, which are dependent on the main center and are spatially sprawled. Following the pluralism in societies (Kloosterman & Musterd, 2001), it is the spatial fragmentation, spatial segregation, secular changes in the social system, as well as a high rate of poverty in the main center that lead to the loss of the population in the main center and formation of suburbs with socially poor population and dependent on race and religion. Some studies have also pointed to gentrification (prosperity level) of social classes (Dadashpoor & Ahani, 2019b; Catalan et al., 2008; Champion, 2001; Krehl et al., 2016) as influential on spatial structure changes in metropolitan areas. This spatial fragmentation is especially observable in metropolitan areas in Africa and Latin America.

Environmental factors are effective contextual and intrinsic factors in the formation and change in spatial structure. Proximity to natural resources (Wang & Maduako, 2018; Priemus, 2019; Salvati et al., 2016; Meeteren et al., 2016), climate condition (Dadashpoor & Ahani, 2019a; Gutiérrez & García-Palomares, 2007; Hassan, 2011; Nasri & Zhang, 2018; Dadashpoor & Saeidi Shirvan, 2019; Catalan et al., 2008) access to water, land quality, climate change (Catalan et al., 2008) and environmental and ecological gaps (Xigang et al., 2002) were mentioned as the driving factors for spatial structure changes and play a significant role in the imbalanced distribution of the population and formation of sub-centers outside the main cores. Besides, the topographical factors (slope and elevation) (Wang & Maduako, 2018; Dadashpoor et al., 2019b; Taubenböck et al., 2017; Krehl et al., 2016) exerts the highest impact on the change control and transformation of non-built lands to built-up ones. The low-elevation areas are more exposed to flooding compared to those with high elevation; thus, they are not suitable for settlement (Wang & Maduako, 2018).

4. Discussion

One of the main challenges in the field of spatial structure is to classify and explain the factors and driving forces that are effective in its formation, change, and development. The results showed that over the past century, on a global scale, the factors and driving forces have influenced the spatial structure not only in length and but also in width each other.

The spatial structure of metropolitan areas are changeable patterns, which are evolving into four major types of convergent, divergent, homogeneous, and heterogeneous. The transition from one pattern to another is influenced by various factors. Many studies consider the interaction of socioeconomic forces (Jiang et al., 2016; McMillen & McDonald, 1998), accessibility, globalization, and governance (Sweet et al., 2016). Others specify economic factors and the influence of government as the root causes of changes in spatial structure, and other factors are assumed to be a function of these root factors (Acheampong & Agyemang, 2016; Kim et al., 2018). In this paper, attempts were made to explain the driving factors that are independent of each other and also affect each other, in four incentive and disincentive, contextual and intrinsic, developmental, and transformative dimensions (Fig. 2). It was also found that most of the driving factors influencing changes in spatial structure are developmental dimensions. Investment in accessibility (transportation nodes, facilities, economic activities, and affordable housing), investment (in economic competitions, public facilities, large and public utility projects), economic productivity, restructuring (economic, managerial, industrial), development of communications and technology that are completed and developed over time are effective in changing the spatial structure.

The review also found that transformative dimension, especially government decisions, in the form of spatial planning at the national and regional levels, the determination of national regulations and government measures, the type of managerial structure (integrated or fragmented), land use regulations in upstream documents are very important and determinants on the spatial structure of metropolitan areas. The findings clearly show that poor management and managerial fragmentations cause spatial dispersion and

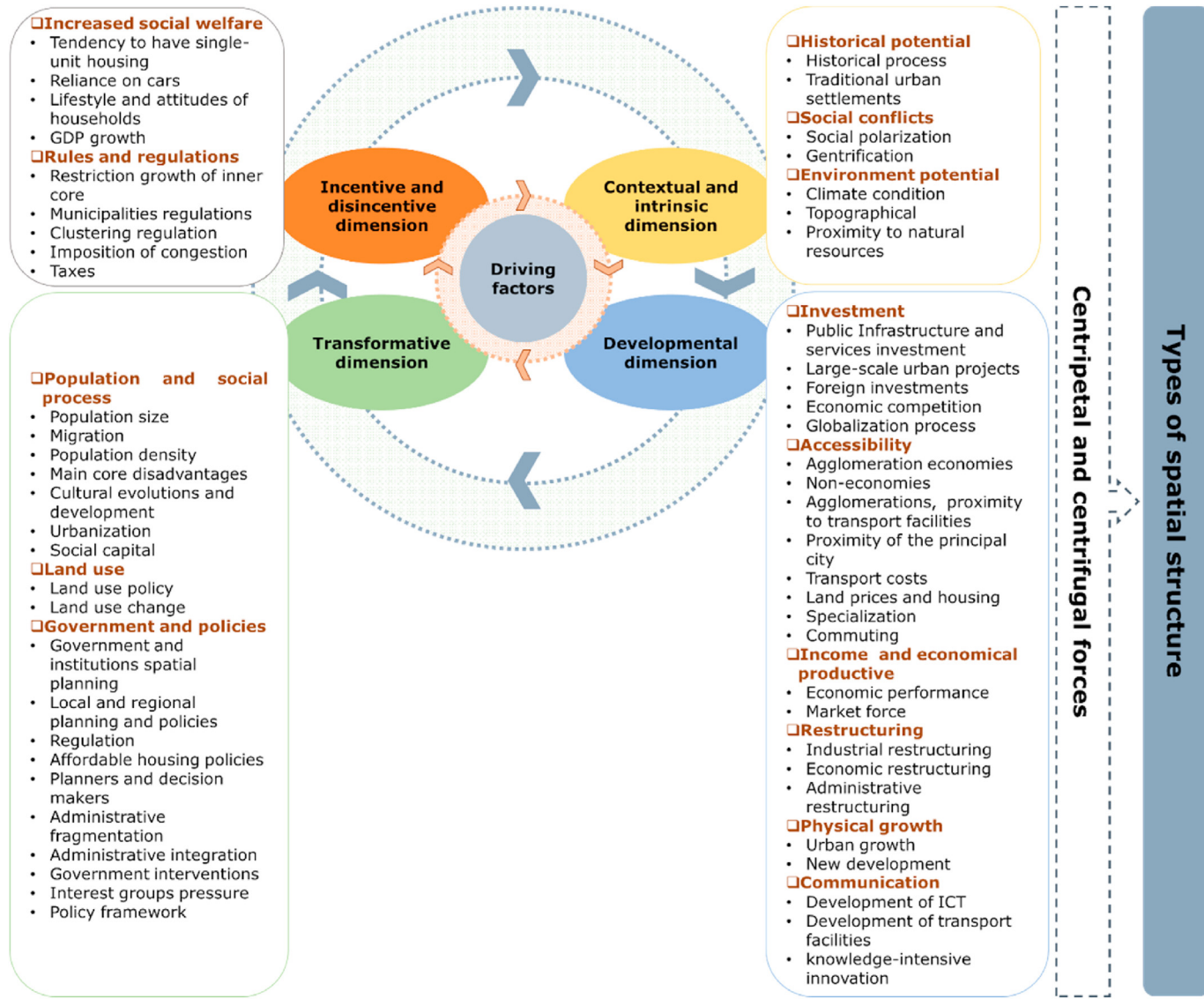


Fig. 2. Driving factors the formation, development, and change of the spatial structure in metropolitan areas.

incoherence. In contrast to the existence of futuristic spatial planning and accurate predictions of attitudes and displacements of residence and activity, causes spatial concentration, cohesion and balanced distribution of population and activity in the territorial realm of metropolitan areas.

Furthermore, economic factors, demographic changes, and social, political, institutional, physical, and environmental processes, developmental infrastructures, and globalization processes are among the main identified factors affecting the changes in the spatial structure of metropolitan areas. In this paper, as in several recent studies (Brezzi & Veneri, 2015; Costa & Lee, 2019; Hu, Sun, & Wang, 2018), the factors affecting the formation and change of spatial structure in metropolitan areas are mostly influenced by interaction and multifactorial composition. The factors that drive these forces are interacting with each other in geographical areas and at different times have a distinct effect on the spatial structure. Factors related to formal and informal rules change the spatial structure in metropolitan areas. These structures are not fixed and unchanging, but the combination of these forces itself leads to the reform of these structures. Spatial outputs of agglomeration and combination of factors and driving forces have led to the emergence of various types of spatial structure in metropolitan areas in different geographical areas, and the effect of each factor in any contextual and geographical origin has been distinct from each other. Sometimes the combination of these forces in one area causes concentration and in another area causes dispersion.

In this paper, 4 main dimensions, 14 subcategories, and 60 driving factors affecting the spatial structure of metropolitan areas were identified, but it was found that there is a distinction between forces and identified factors according to geographical differences (Fig. 2). It was also found that the driving factors of the three dimensions of developmental, incentive, and disincentive and transformative dimensions under the influence of the contextual and intrinsic dimension rooted in the differences of geographical areas, have different effects on spatial structure in metropolitan areas. Sweet et al. (2016) point out that the three driving factors of accessibility, governance, and globalization and their interaction in the major metropolitan areas of Canada, due to the contextual and intrinsic differences in each metropolitan area has led to the formation of three monocentric, polycentric and dispersed patterns. Measuring the relationship between the indicators affecting the spatial structure in some studies also showed that some of the indicators in different geographical areas lead to different spatial structure. For example, GDP growth increases the intensity of monocentrism in the Asian metropolitan areas (Lan, 2019; Li & Liu, 2018), while this factor in European metropolitan areas increases the degree of polycentrism in spatial structure (Meijers & Burger, 2010; Meijers & Sandberg, 2008).

5. Conclusion

As the results show, the spatial structure of metropolitan areas in the world is formed and changed under the influence of 4 major dimensions including developmental, transformative, incentive and disincentive, and contextual and intrinsic dimensions (Fig. 2). The first dimension influencing changes in the spatial structure of metropolitan areas is the “developmental” dimension. This dimension includes factors as well as driving forces, which by creating the necessary development infrastructure change the spatial structure in metropolitan areas. The second dimension is the “transformative” dimension, which includes factors and driving forces, causes change and transformation in metropolitan areas. This dimension, on the one hand, is influenced by the flows of demographic changes and related migrations and developments arising from these changes in culture and social inclination, on the other hand, by driving factors from top-down in the form of governmental measures, and regulations of spatial planning at the national, regional and local levels, lead to a change in the spatial structure of metropolitan areas. The third dimension is the “incentive and disincentive”, which on the one hand encourages increased population density and activity, and on the other hand, as a disincentive dimension, prevents the increase of density in the spatial territory of metropolitan areas. This dimension includes factors such as social welfare and driving forces like rules and regulations. “Contextual and intrinsic” dimension refers to factors that contain fixed or less changeable elements. These factors are naturally and climatically inseparable from metropolitan areas or have been formed and completed throughout the historical process, and it is impossible to change or eliminate these elements. Some of these factors are more changeable than natural and historical factors; these factors are formed and developed in social processes under the influence of cultural changes.

In this study, an attempt was made to classify and explain the general knowledge of factors and driving forces affecting the formation, change, and development of spatial structure in metropolitan areas through a systematic review. However, the impact of many driving factors is still unclear. Although studies have paid more attention to the three developmental, transformative, incentive, and disincentive dimensions than the contextual and intrinsic ones, authors believe that the study and understanding of this dimension, on the changes in spatial structure still need to be studied. Furthermore, in the last decade, some studies have sought to analyze the relationship between spatial structure and economic indicators such as the relationship between polycentrism and greater economic productivity (Meijers & Burger, 2010; Kwon & Seo, 2018), the relationship between mono or polycentric with GDP (Brezzi & Veneri, 2015), the relationship between daily commuting costs and polycentric pattern (Veneri, 2010). These studies are limited in number as well as in the geographical area of Western Europe and East Asia (mostly in the metropolitan areas of China). In fact, in this area, there is a lack of measurement and relationships among the factors affecting the spatial structure of metropolitan areas, especially metropolitan areas located in other less studied or unexplored geographical areas such as West Asia, Africa, Oceania, and Latin America.

Declaration of competing interest

None.

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