Underlying relational dimensions of flow transitions along ring roads and their impacts on the typo-morphology of open spaces: two cases from Nordic countries

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ABSTRACT

This study explores the roles and functions of urban voids and their relationship with the built forms alongside ring roads. This investigation sheds light on the typo-morphology of open spaces in regard to the flow transitions (in substance, intensity, and/or direction) of ring roads, addressing several relational aspects between the built and non-built environments in two case studies: Greater Helsinki, Finland and Oslo, Norway. By using a descriptive mapping method, this study classifies open spaces and then qualitatively describes the levels and degrees of spatial and social interaction and exchange. In both case studies, new patterns of open spaces gradually evolved, in which their primary roles were not only to contain the physical exchange neutrally, but also to provide a symbolic spatial meaning and experience in accordance with the flow. This study describes six dimensions of flow transitions and their impacts on open spaces alongside ring roads and the levels of spatial and social interaction there. Finally, it calls for the adoption of new approaches to improve the existing networks of open spaces as binding elements alongside ring roads, where their emptiness and fragmentation could be used to overcome spatial inertia, discontinuity, and disintegration.

1. Introduction

Cities and regions function on the connective networks of infrastructure that facilitate a constant flow of people, goods, and information. Flows no longer designate a state of movement only, but rather become an end and a cultural criterion for architecture and urban design, where the lack of flow acts as an indicator of marginality that should be avoided. The recent intensification of economic exchanges along with cultural, technological, and social interactions on a global scale has created a new spatial form dominated by the logic of flows. Envisioning the notion of eventual continuity and consistency, the logic of flows implies a restructuring of the physical space in which more focus is placed on connecting and generating the lines or trajectories of centrifugal urban flow (Arcaute et al., 2015; Ballantyne & Smith, 2012; Batty, 2011; Chettiparamb, 2005; Delalex, 2006; Hillier, 2012; Law & Urry, 2004; Moens-Gigengack, 2005; Murdoch, 1998; Urry, 2004).
This vision has become increasingly engaged and recognised in polycentric urban structures in the progressive pursuit of space and as a by-product of network urbanism (Batty, 2011; Castells, 2000; Dupuy, 1991; Handy & Niemeier, 1997; Oswald et al., 2003; Sieverts & Lough, 2003).

On the one hand, as a mediator and facilitator of flow, infrastructure constitutes the primary support of interchangeability, exchange, and the physical, social, and visual interactions that influence and shape a vast range of open and public spaces and designs (Bélanger, 2006; Delalex, 2006; Fotheringham, 2001; Hall, 2009; Hall & Pain, 2006; Miller, 2004). The complementarity among the infrastructure, open spaces, flow types, and their interaction patterns has been used as a primary design principle for organising spatial structures (Angélil & Klingmann, 1999; Appleyard, 2016; Condeço-Melhorado et al., 2014; Miller, 2004; Rodrigue, 2013). On the other hand, the proposed open system of centrifugal flow that constitutes an expansive figure in urban development creates critical transitional zones along certain elements and boundaries such as ring roads. This shift in planning development and discourse (from hierarchical dependent development to networked independent development) entails a significant change in the role and functionality of boundaries in general and ring roads in particular from being the boundary of the urban flow to becoming a route of mixed-use flows. Additionally, these transitions of the characteristics of ring roads, including reducing traffic speed, increasing spatial density, planning mixed-use activity, and allowing frontage access directly from the highway, introduce new types and patterns of spatial interactions. Spatial interaction is a basic concept that involves how dynamics and locations are organised to interact with each other, where any change can be treated as a flow (Batty, 2011, p. 195). Michael Batty, for example, defines spatial interaction as the movement of activities between different locations, which ranges from traffic distributions and migration patterns to changes caused by economic growth, ageing, regeneration, etc. (Batty, 2009, p. 1043).

This process, however, clashes with the existing fragmentations, discontinuities, and heterogeneities of the built and non-built environments alongside these routes. Understanding the association between highways and the sprawling fragmented environments alongside them confirms the implicit presence of the non-built spaces that are significant in their landscape. Ring roads have been initially planned as the boundaries of centripetal spatial structures distributing the interurban flow of high-speed traffic around urban territories. They contain specific types of flows at a rate higher than in urban centres, mainly traffic and logistic flows, and are usually conceived solely from the traffic engineering convention perspective. Nonetheless, ring roads and their relative and relational positions in-between urban centres play major roles supporting flow transitions and regional restructuring at different scales. Changes that are occurring between urban centres, including areas alongside ring roads, are developing more flow trajectories, changing their initial form and intensity and altering not only the built but also the non-built spaces.

This study, therefore, argues that although they are devoid of continuous urban identity and lack interactive character, the emerging mixed-use non-hierarchical urban flows have altered not only the typo-morphology of built environments but also the types and patterns of spatial and social interactions embodied in open spaces alongside them. Open spaces are among the spaces that outline and embody spatial interaction and social
exchange, and the proposed locational factor – alongside ring roads – provides critical yet understudied areas for analysing the effects of flow transitions on urban voids. Therefore, the objective of this study was to answer one question: how do the flow transitions (in substance, intensity, and/or direction) along ring roads affect the typo-morphology of the open spaces and levels of interaction there? This work is concerned with the urban conditions of the void spaces alongside ring roads and their qualities and functions in the contemporary urban scale and structure. By considering different influential factors of urban dynamics, this study provides a qualitative examination (descriptive mapping) of the open spaces alongside ring roads in two selected regions from Nordic countries: Greater Helsinki, Finland and Oslo, Norway. This discussion aims to re-evaluate the roles and functions of the selected ring roads in the current spatial structure and their effects on the typo-morphology of the open spaces alongside them. This study adds to the overall knowledge about marginal open spaces and their spatial transitions, social exchanges, and interstitiality, as well as the dynamic evolution required in urban development.

Extensive research has been performed with respect to the relationships among flows, architecture, and urban forms (e.g., Ballantyne & Smith, 2012; Batty, 2009, 2011; Castells, 2000; Christaller, 1966; Harvey, 1990; Hilberseimer, 1949; Mossop, 2006; Shane, 2006), the impacts of flows on public spaces (e.g., Appleyard, 2016; Bulu, 2012; Castells, 1989, 2000; Mossop, 2006; Weinstock, 2013), the relationships between flows and the global economy (e.g., Castells, 1993; Harvey, 1990; Lyster, 2006; Sassen, 2001), and the ecological dimensions of flows (e.g., Dorsch & Flachsland, 2017; Roggema, 2019; Ullman, 1973). Moreover, the relationship between infrastructure and fragmented open spaces (e.g., Berger, 2006; Brighenti, 2013; Corner, 2006; Matos, 2009; Moens-Gigengack, 2005; Silva, 2019), as well as the roles and values of infrastructure in urban development, have also been studied (e.g., Batty, 2009; Castells, 1989, 2000; Harvey, 1990; Hesse, 2010; Mangelsdorf, 2013). Several studies have recognised the influence of streets on social life (e.g., Daraganova et al., 2012; Kyriakidis & Bakogiannis, 2018; Latané et al., 1995) and the positive effects of slow traffic and short distances on physical activities and interactions (e.g., Appleyard, 2016; Handy & Clifton, 2001; King et al., 2003; Latané et al., 1995). However, less attention has been paid to case study–based research on the effects of spatial transitions on the formation and transformation of interstitial open spaces alongside ring roads.

The following section discusses the relationships among the road infrastructure, proximity factor, and resulting flow patterns. Then, the interstitial dimension and characteristics of peripheral open spaces are highlighted before explaining the methodology and describing the data used in this study. Subsequently, the case studies are thoroughly analysed. Finally, the results and conclusions are presented.

2. Hierarchical patterns of flows and the proximity factor

Sixty years ago, spatial interaction theory was developed to show how flows (usually of physical traffic) could be synthesised into volumes of activity defining locations (Batty, 2011, p. 195). Spatial interaction patterns are representations of the activity dynamism in which the flow becomes an almost tangible expression of the centrality of an urban structure (Delalex, 2006). Infrastructures support the dynamics distribution and govern
the general production and directions of these flows (Batty, 2009; Castells, 1989, 2000; Fotheringham, 2001; Harvey, 1990; Hesse, 2010; Mangelsdorf, 2013; Miller, 2004). This distribution determines different contextual relations, or lack thereof, that define certain spatial characters of the land. However, infrastructure is dominant and hierarchical. This hierarchical logic is still based on the notions of proximal and physical contiguity (Delalex, 2006; Fahmi, 2012; Rodrigue et al., 2013). The hierarchical logic of a road network, for example, facilitates different types of flows in a hierarchical tree-like pattern, which also creates hierarchical patterns of spatial interaction. Dynamics as well as motion are essential to any theory of flows and spatial interaction in cities (Batty, 2011, p. 195). Understanding these notions begins with understanding the changes occurring between locations that in themselves define new flows, and hence movement (ibid.). The prime objective of the notion of spatial interaction is to improve efficient connections and relations between land uses (built and non-built uses) based on features of complementarity, intervening opportunity, and transferability of the movement of people, freight, services, energy, and/or information (Batty, 2009; Wang et al., 2017).

The First Law of Geography establishes the foundational principle of this hierarchical pattern of spatial interaction, interchangeability, dependence, and autocorrelation. According to Tobler’s law, everything is related to everything else, but near things are more closely related than distant ones. Accordingly, supported by road infrastructure, the intensities, types, and directions of flows are determined by an inverse relationship between distance and interaction patterns (Miller, 2004; Waters, 2017). Moreover, several researchers agree that distance plays an important role in social networks and social interaction; spatial proximity influences the occurrence of social contacts (e.g., Daraganova et al., 2012; Illenberger et al., 2013; Latané et al., 1995; Mok et al., 2007). In this respect, distant locations have initially limited spatial and social interaction and their relations are dominated by heterogenous flows (Gutiérrez & García-Palomares, 2007; Montis et al., 2007; Roth et al., 2011; Waters, 2017).

Hierarchical road networks have created networks of barriers that result in isolated open areas (Laforzetta et al., 2013). Ring roads, for example, are designed as traversed-through routes where the open spaces are functionally and geometrically organised on a neutral and horizontal background with limited interactions (Miller, 2004; Waters, 2017). The levels of spatial interaction and social exchange are limited by specific land use, building regulations, and accessibility restrictions. Consequently, open spaces alongside these routes are not considered to be essential in urban life (Castells, 2000; Lyster, 2006; Mossop, 2006). Instead, they are considered as residual or leftover spaces that are produced by a hierarchical, closed, less comprehensive, and asymmetrical planning vision along with a lack of spatial sensitivity in the infrastructure design (Berger, 2006; Silva, 2019). The physical effects of flow fluctuations and the high-speed traffic on ring roads can result in conflicts regarding the spatial instability, unpredictability, separations, and discontinuity between the existing structures alongside them and future regional development. These features have forced urban designers and architects to adjust their objectives accordingly.
3. Interstitial open spaces: the protagonists of the emerging urban landscape

The urban voids (or the non-built areas) of physically distant and disconnected places are defined either as residual spaces whose evidence of emptiness is due to an absence of appropriation, as marginal spaces whose emptiness is due to the persistence of conflict caused by urban expansion, or simply as areas that have not been occupied yet (Matos, 2009, p. 62). In the literature, different spatial concepts and terms can describe these marginal open spaces, such as the inter-fragmentary space and drosscape (Berger, 2006), the interstitial space (Matos, 2009; Silva, 2019), splintering urbanism (Graham & Marvin, 2001), and the in-between space (Sieverts & Lough, 2003). These terms and concepts generally refer to the spatial conditions of the undeveloped built or non-built spaces between or within urbanised areas that are mainly driven by transport infrastructure. They presuppose boundaries or surroundings, which define their interstitial character (Silva, 2019, p. 63). Additionally, the marginality of these open spaces is related to their weak spatial and functional relation with their surroundings and associated with disjunctions and rupture (Bhabha, 1994; Brighenti, 2013; Deleuze, 1986). These spaces are exemplified by the backyards of commercial buildings, parking areas for heavy vehicles, types of farmland, hills, deserted industrial plots, or residual landscapes that are created by heavy infrastructure (Silva, 2019; Wolman et al., 2005).

Despite these features, urban voids have been spaces of experimentation and recreation in urban development processes, where their resilience transforms them into spaces of difference and permanence (Matos, 2009, p. 62). Moreover, interstitial open spaces distributed on the edges of urban areas are characterised by a hybrid urban-rural condition (Gallent & Shaw, 2007; Sieverts & Lough, 2003; Silva, 2016), which can be considered as an asset. These additional characteristics have supported the shift of the contemporary conceptualisation of peripheral open spaces from constituting an all-inclusive ‘background’ to a contained ‘figure’ (Sieverts & Lough, 2003, p. 4). The contemporary expansive centrifugal form of cities and regions, the growing dominant logic of networked instead of non-hierarchical flows, mixed-use activities, economic shifts, and advancements in communication technology and mobility have opened the closed spatial structure and further decreased the effects of distance (Ahuja et al., 1993; Godts & Janssens, 2012; Hesse, 2010; Illenberger et al., 2011; Knox & Marston, 2015; Mangelsdorf, 2013; Pun-Cheng, 2017; Weinstock, 2013). This situation has advanced peripheral development in general and induces dynamic redistribution between the scales, speeds, forms, and spaces by articulating, expanding, and/or replacing existing spatial relations between the elements of the urban system including the production of open spaces (Arcaute et al., 2015; Batty, 2009, 2011; Ballantyne & Smith, 2012; Castells, 2000; Chettiparamb, 2005; Hillier, 2012; Larkham & Conzen, 2014; Law & Urry, 2004; Moens-Gigengack, 2005; Murdoch, 1998; Moens-Gigengack, 2005; Oswald et al., 2003; Roggema, 2019; Sieverts & Lough, 2003; Urry, 2004).

Moreover, these modern developments lead to the expansion of the attractive urban character, where the morphological, functional, visual, temporal, social, and perceptual dimensions collectively are essential parts of the new spatial experience (Heath et al., 2010; Ye et al., 2016; Ye & van Nes, 2014). The built and non-built interact, entangle, and
interweave to enable fields of continuity (Koolhaas, 1994). Boundaries between architecture, infrastructure, and landscape dissolve to facilitate open spaces of flows and fluid morphologies (Koolhaas, 1994, p. 11; Angélil & Klingmann, 1999, p. 24; Matos, 2009, p. 68). This dissolution of boundaries results in an undetermined spatial and functional state that firmly rejects the hierarchical order and imposition of spatial limits (Angélil & Klingmann, 1999; Koolhaas, 1994). However, this emerging topography of open spaces is warped into contradictory patterns of flows that are defined by complex topological relations (or the lack of any relation) to ring roads. This, accordingly, has raised new questions about the interstitial open spaces, mainly because of their fragmentation, ambiguity, and the lack of a recognisable typology or definition. This fragmentation, which is associated with the spatial dispersion of expanding cities, has contributed to the discontinuity and disintegration of the scattered urban fabric. The new relationship among distance, flow type, and the corresponding typo-morphology of open spaces has altered the urban landscape and topography as well as the forms and levels of spatial and social interactions. Therefore, the need to re-evaluate the value of these spaces occurs concomitantly with the rapid urbanisation and new directions of flows, where their emptiness and fragmentation could be used to overcome spatial inertia, discontinuity, and disintegration. Contributions from political ecology, urban agriculture, ecosystem services, natural capital, green-infrastructure studies, and regional policy emerge as necessary complements to understand the multifaceted nature of the non-built geography of distant locations (Silva, 2016, p. 32).

4. Methodological framework and data

The flow transitions along ring roads, which include changes in the intensity, type, and/or direction of the flows, have customised not only infrastructure but also the open spaces alongside ring roads. Generally, public and open spaces are containers for interaction, interchangeability, and exchange that merge with infrastructure, commerce, and information systems. In addition, they can further extend new patterns of spatial, social, cultural, economic, and political relationships (Corner, 2006; Lyster, 2006). Therefore, this study focuses on the physical extent of the urban flow in the non-built areas next to ring roads. It maps certain types and characteristics of open spaces and identifies the spatial changes that are caused by the flow transitions alongside the ring roads. This analysis first classifies open spaces describes their formal qualities, explores their associations with the existing spatial structures, and qualitatively describes the levels and degrees of the spatial and social interactions in the selected study areas.

This study maps and classifies two types of open spaces:

- Operational and service open spaces: mainly parking areas that are ≥100 m².
- Leisure and recreational open spaces: mainly plazas, parks, gardens, outdoor sport facilities, and interior courtyards that include defined sitting areas or playgrounds.

This study considers operational and service open spaces as areas of limited interaction and exchange. In contrast, leisure and recreational open spaces are considered to be active zones with a high potential for spatial and social interaction and exchange. This
study argues that, whereas operational and service open spaces are physical handicaps that can provide limited heterogenous spatial and social interaction patterns, leisure and recreational open spaces can play a major role in boosting the overall neighbourhood quality, social exchange, and cultural events that constitute a central aspect of urban life. However, this study disregards incidental or residual spaces\textsuperscript{2} from the analysis because of their passive role in terms of social exchange and spatial interactions. This study also disregards the street network from open space mapping because of its indefinite boundary and dual functionality. Second, this study qualitatively discusses the impacts of flow transitions on the spatial interaction and social exchange. This description is achieved by using the form, size, design quality, and surrounding land use, as well as any significant physical aspect that exists in these determined open spaces that may have a significant effect on the existing users.

For this study, ArcGIS software (ArcMap) and its satellite base map were used to draw and produce the maps. For the case of Oslo, Google Maps (2018), its labelled places, and 3D satellite images were utilised to manually construct the typo-morphology dataset of the open spaces and the classification for the study areas. In the case of Greater Helsinki, some of the data were obtained from the Finnish national geo-portal service, Paikkatietoikkuna. In particular, the topographic database for 2018 was employed for this investigation. However, the classifications that were provided are not specific in terms of what this analysis requires, and other types of open spaces were not covered. Therefore, the rest of the data were created manually by using the same method that was employed for Oslo. The satellite map in the ArcGIS software program is from 2013. Therefore, Google Maps (2020) was utilised to verify the existing open spaces in each case study.

4.1. Case studies and analysis

The following sections present the analysis of two case studies from Nordic regions: Greater Helsinki, Finland and Oslo, Norway. Although these metropolitan areas have similar aspects in terms of population, jobs, and growth rate, each case study provides a discussion with a different spatial model; Greater Helsinki has a polycentric model, whereas Oslo has a compact model. This provides insights into the changing role and function of the ring road itself in different operating urban models. Moreover, the common denominator for these areas is a contemporary regional shift towards centrifugal expansive development and flow. In each case, the analysis focuses on two types of areas: those alongside the inner ring road and those alongside the outer ring road. The precise boundaries of the study areas were measured as 500 m from each side of the ring (500 m buffer). Subsequently, the study describes certain relational dimensions of the flow transitions and their impacts on the spatial interactions and social exchange related to the mapped open spaces. See Figure 1.

4.1.1. Case study: greater Helsinki, Finland

Characterised by urban sprawl, Greater Helsinki has evolved from a monocentric to a decentralised to a polycentric structure, and the flow transitions can easily be observed (Amr, 2020a; City Planning Department of Helsinki, 2009). The capital region of Greater Helsinki (study area) covers 770.26 km\textsuperscript{2}, the population (as of July 2020) is 1,193,539, and the population density is 411.1/km\textsuperscript{2} (City of Helsinki, 2020). Recently, the Helsinki
region has commenced a new urban development vision to facilitate its polycentric structure based on the spatial concept of space of flow by Castells (2000) (Amr, 2020a; Granqvist et al., 2019; Vasanen, 2012). This conceptualisation is supported by the radial-ring-road urban traffic structure, which acts as the focus to support the flow transitions and the proposed nodal development (Amr, 2020a, 2020b; City Planning Department of Helsinki, 2009). Whereas the urban flow is induced by the radial growth corridors, the inner ring roads, Ring I (spans 23.3 km) and Ring III (spans 47.8 km), continue to accommodate massive flows of traffic. This functional separation between the radial corridors and ring roads is one of the main aspects that maximise the barrier effect and minimise the interaction and exchange between these ring roads and the spatial structures alongside them. Moreover, the initial centripetal flow has not only created movement heterogeneities but has also shaped heterogeneous patterns of spatial interaction and social exchange next to the ring roads. See Amr (2020b) for more detailed typo-morphological analysis of the built environment. It is worth noting that the scrutinised ring roads were initially constructed as urban limits but without regard to municipal borders.

Recently, the new smart growth agenda and its flow transitions along the ring roads in Greater Helsinki (Helsinki-Uusimaa Regional Council, 2014, 2015) have mainly supported mixed-use development; however, there are limited effects on the existing open spaces. Despite the changing patterns of the building forms, especially alongside Ring I, the forms and sizes of the open spaces that are associated with residential use have almost remained the same. Although housing development is directly connected with transportation nodes, parking areas are the dominant open spaces alongside Rings I and III. The flow transition in this case has not affected the hierarchical role of both rings yet. Although the functional role of Ring I has gradually shifted to become conjoint, the existing road topologies ramifying from it have retained the structural characteristics of tributaries of loops and cul-de-sacs (Amr, 2020c). Moreover, the functional role of the third ring road remains hierarchical and the structural characteristics of the existing road topologies that ramify from it have also remained tributaries of loops and cul-de-sacs (ibid.). This characteristic clearly indicates the car dependency and domination of high-speed traffic flow in comparison to mixed-use urban flow. Figure 2 shows the relative and relational features of the ring road, existing structures, and open spaces alongside Ring...

![Figure 1](image-url)
Table 1 summarises the types, forms, and qualities of the open spaces alongside Ring I and presents the levels of spatial and social interaction accordingly. The differences between the areas that are reserved for parking and those that are designed for leisure and recreational activities for residential use are significant alongside Ring III, which is due to the logistic concentration, especially in Vantaa Aviapolis (Amr, 2020a). Moreover, the positioning of the parking areas closer to Ring III has affected the visual perception of the users, quality of the surrounding neighbourhood, quality of the surroundings, and the overall experience of the users.

Figure 2. Relative and relational features between the ring road, existing structure, and open spaces alongside Ring I of Greater Helsinki. Created by the researcher, June 2020.
### Table 1. The types, forms, and qualities of open spaces alongside Ring I, Greater Helsinki.

**Greater Helsinki: The Inner Ring Road (Ring I)**

| TYPE | SURROUNDING USE | POSITION | DIAGRAM | DESIGN QUALITIES |
|------|-----------------|----------|---------|------------------|
| Operational and service open spaces (passive) | Parking areas (Surface Lots) $\geq 100 \text{ m}^2$ | Residential | Scattered in between a residential complex | - Typical suburban image of medium density paved parking surfaces with high visibility and domination  
- Defined areas and boundaries  
- Limited but direct accessibility between the buildings and the street  
- Limited interior landscape | - Limited interaction and interchangeability through this type  
- Limited to certain users |
| Others: Mainly businesses, corporations, and commercial uses | Within a business or commercial complex | - Adjacent to a business or commercial complex  
- Juxtapose and absolute | - Typical suburban image of the paved surfaces with high visibility and domination  
- Unlimited and direct accessibility between the buildings and the street  
- Defined areas and boundaries  
- Delineated interior landscape such as the curbs and trees. | - Limited spatial interaction but better interchangeability and exchange through this type  
- Limited to certain users during certain times |

(Continued)
Table 1. (Continued).

| TYPE                                             | SURROUNDING USE                          | POSITION                        | DIAGRAM | DESIGN QUALITIES                                                                 | DEGREE OF SPATIAL AND SOCIAL INTERACTIONS                      |
|--------------------------------------------------|------------------------------------------|---------------------------------|---------|----------------------------------------------------------------------------------|------------------------------------------------------------------|
| Leisure and recreational open spaces (active)    | Private playground and setting area      | Residential                     | Centralized area within a residential complex | - Significant opposition between the architectural volumes and these open spaces  
- Standard design and repetitive forms  
- Both defined and undefined pockets of areas and boundaries  
- Pedestrian and cycling accessibility only  
- Equipped with sitting areas and/or a playground | Limited users with high potential of spatial interactions and interchangeability. However, the area is significantly smaller for this density and it is smaller in comparison to the parking areas |
| Parks or gardens                                 | Not specific but are mostly near the residential area | At the marginal edge of relatively large built up concentrations | ![Diagram of Centralized Area] | • Natural areas, organic lines, with defined routes and a playground | High potential of interaction and interchangeability, but this type is not significant |

(Continued)
| TYPE | SURROUNDING USE | POSITION | DIAGRAM | DESIGN QUALITIES | DEGREE OF SPATIAL AND SOCIAL INTERACTIONS |
|------|-----------------|----------|---------|------------------|------------------------------------------|
| Outdoor sport facilities (football pitches, golf courses, tennis court, or gymnastic area) | Mostly near residential concentrations | Adjacent to residential concentrations | ![Diagram](image) | - Variation in the size and standardization of the design<br>- Usually associated with parking areas | High potential of interaction and interchangeability |
| Other | Educational facilities: schools and kindergartens | | | | |
other open spaces, spatial interaction, and social exchange. The expanses of pavement and parked cars can create a visually harsh environment that adversely affects the spatial image. In addition, surface parking expansion in residential areas can weaken the sustainability of these areas, increase the carbon flow, and decrease the vitality of future mixed-use development. Figure 3 illustrates the relative and relational features of the ring road, existing structures, and open spaces alongside Ring III. Table 2 summarises the
Table 2. The types, forms, and qualities of open spaces alongside Ring III, Greater Helsinki.

**GREATER HELSINKI: THE OUTER RING ROAD (RING III)**

| TYPE | SURROUNDING USE | POSITION | DIAGRAM | CHARACTERISTICS | DEGREE OF SPATIAL AND SOCIAL INTERACTIONS |
|------|-----------------|----------|---------|-----------------|------------------------------------------|
| Operational and service open spaces (passive) | Parking (Surface Lots) | Residential | Adjacent to a residential complex | - Typical suburban image of low-density paved parking surfaces with high visibility and domination - Defined areas and boundaries - Limited but direct accessibility between the buildings and the street - Limited interior landscape | - Limited interaction and interchangeability through this type - Limited to certain users |
| Others: Mainly logistic use and corporations | Surrounding the whole premises | Residential | - Typical suburban image of paved surfaces with high visibility and domination - Unlimited and direct accessibility between the premises and the street - Open areas with defined boundaries - Lack of interior landscape | - Limited spatial interaction but better interchangeability and exchange through this type - Limited to certain users during certain times |
| | | | | | |

(Continued)
| TYPE | SURROUNDING USE | POSITION | DIAGRAM | DESIGN QUALITIES | DEGREE OF SPATIAL AND SOCIAL INTERACTIONS |
|------|----------------|----------|---------|------------------|-------------------------------------------|
| Leisure and recreational open spaces (active) | Private playground and setting area | Residential | Centralized area within a residential complex | - Areal variation between the architectural volumes and these open spaces - Slendered design and repetitive forms - Both defined and undefined pockets of areas and boundaries - Only pedestrian and cycling accessibility - Equipped with sitting areas and/or a playground | Limited users with a high potential of spatial interactions and interchangeability – Moreover, the area is relatively small for this density and distance and it is smaller in comparison to the parking areas |
| Parks or gardens | Not specific but are mostly near residential areas | At the marginal edge of relatively larger built up concentrations | Natural areas, organic lines, with defined routs and a playground | High potential of interaction and interchangeability, but that distance and the surrounding interchangeability, but maximize the car dependency |
| Outdoor sport facilities (e.g., football pitches, golf courses, tennis courts, or gymnastic areas) | Mostly near residential concentrations | Adjacent to residential concentrations | - Variation in the size and standardization in the design - Usually associated with parking areas | High potential of interaction and interchangeability |
| Other | Educational facilities: schools and kindergartens | | | | |
types, forms, and qualities of the open spaces alongside Ring III and presents the levels of spatial and social interaction accordingly.

Although the spread of parking areas has negatively affected social exchange and spatial interactions, these spaces are being reconceptualised as potential zones for future urban development. The shift towards urbanity and minimising traffic flow is replacing the existing surface lots to enhance interaction and exchange. For example, in 2019, the city of Helsinki organised an open international competition with the objective of creating a vibrant urban centre along the eastern part of Ring I, which is called

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**Figure 4.** Relative and relational features between the second ring road of Oslo, existing structure, and open spaces. Created by the researcher, June 2020.
Helsinki East Urban Centre or *Itä-Helsingin keskusta*. The huge parking areas on the site were targeted to be replaced with urban character functions for drawing a possible path to create new continuities between urban fragments. It could be argued that these parking areas have emerged as ‘Meanwhile temporary spaces’ until ‘Actual Development’ is obtained providing a certain degree of activity.

### 4.1.2. Case study: Oslo, Norway

Oslo has pursued a compact growth strategy for 30 years (Bergsli & Harvold, 2017; Næss et al., 2010; Tønnesen et al., 2014). According to the latest statistics, Oslo (the capital city and municipality) covers an area of 480.75 km², and as of February 2020, the population of the capital city was 693,491 (Oslo Municipality, 2020). Like Greater Helsinki, the initial visions of the city were planned by using a general radial-ring-road system. This initial centripetal flow has created movement heterogeneities as well as limited and heterogeneous patterns of spatial and social interaction along the ring roads. The city has adopted a mixed land-use strategy in which facilities are located within walking distance of each other, which is known as a 10 min city or a compact city (The Ministry of Local Government and Modernisation, 2019). Moreover, a nodal development strategy next to the third ring road has developed as a step toward a polycentric structure. See Amr (2020b) for more detailed typo-morphological analysis of the built environment.

Along the second ring road, which stretches 21 km, this shift towards urban flow has noticeably modified leisure and recreational open spaces in terms of size, form, and design qualities, which has directly increased the levels of spatial interaction and social exchange. Due to the constant demand for centrally located dwellings and businesses along with the containment policies of its compact model, the second ring road was transformed into a boulevard. This transition has impacted the road infrastructure such that the functional role of the second ring road has shifted to become *mosaic*, and the structural characteristics of the existing road topologies that result from it have been replaced by grid street patterns (Amr, 2020c). Moreover, housing development is directly linked to public transportation, and the open spaces that are reserved for car parking are significantly smaller than those for Greater Helsinki, especially those that are associated with residential use. However, parking on streets is allowed and is the most common way of parking, as found in this case study. Consequently, the street network has the highest level of spatial interaction and social exchange, followed by the existing leisure and recreational open spaces.

Urban flow in this case has not only diminished the barrier effect of the second ring road but has also affected the relationship between the ring road and architectural design; new architectural elements, a novel elevation design, and a different orientation of the main entrance have emerged in a direct relation with the ring road. Moreover, urban flow and densification as well as mixed land use have created more engaging environments next to the second ring road, where extended functions and sitting areas (e.g., cafes along the roadside) are noticeably growing. Investments in urban street life and streetscapes were also found in this case due to these urban transitions. As a result, higher levels of spatial interaction and urban interchangeability were found along this section of the second ring road. Figure 4 displays the relative and relational features among the second ring road of Oslo, existing structures, and open spaces. Table 3 summarises
| TYPE | SURROUNDING USE | POSITION | DIAGRAM | DESIGN QUALITIES | DEGREE OF SPATIAL AND SOCIAL INTERACTIONS |
|------|----------------|----------|---------|-----------------|------------------------------------------|
| Operational and service open spaces (passive) | Parking areas (Surface Lots) $\geq 100$ m$^2$ | Residential Adjacent to a residential complex | ![Diagram](image1.png) | - Typical inner-city surface lots with minor visibility and domination  
- Linear organisation that is mainly associated with cul-de-sacs  
- Direct accessibility from the street  
- Defined areas and limited interior landscape | - Limited interaction and interchangeability through this type  
- Limited to certain users |
|   |   | Residential and mixed use Within the complex's courtyard | ![Diagram](image2.png) | - Typical inner-city surface lots with minor visibility and domination  
- Centralized organisation  
- Indirect accessibility  
- Defined areas and limited interior landscape |   |
| Others: Businesses, corporations, commercial, and services | Surrounding the whole premises |   | ![Diagram](image3.png) | - Direct accessibility from the street  
- Defined areas and boundaries  
- Delineated interior landscape such as curbs and trees | - Limited spatial interaction but better interchangeability and exchange through this type  
- Limited to certain users during certain times |
|   |   | Adjacent to a business, commercial, or service complex | ![Diagram](image4.png) |   |   |

**NOTE:** Parking on the streets is allowed and it is the most common way of parking that can be found in the study areas. As a result, the street network has the highest level of interaction and interchangeability. However, this study does not include this because of its indefinite boundary and dual functionality.

(Continued)
**Table 3. (Continued).**

**OSLO: THE SECOND RING ROAD**

| TYPE                                           | SURROUNDING USE             | POSITION       | DIAGRAM | DESIGN QUALITIES                                                                 | DEGREE OF SPATIAL AND SOCIAL INTERACTIONS                                      |
|------------------------------------------------|-----------------------------|----------------|---------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| Leisure and recreational open spaces (active)  | Private playground and setting area | Residential     | Courtyard | - Modern landscaping and interior design in most cases  
- Defined areas and boundaries  
- Limited accessibility  
- Equipped with sitting areas and/or a playground | Limited users with high potential of spatial interactions and interchangeability |
| Parks or gardens                               | Not specific but mostly near residential or mixed use | Within the existing structure | ![Diagram](image) | Organic and regular design lines, with defined routes, different activities, and a playground | High potential of interaction and interchangeability |
| Outdoor sport facilities (football pitches, golf courses, tennis courts, or gymnastic areas) | Not specific but mostly near residential or mixed use | Within the existing structure | ![Diagram](image) | Variation in size and standardization in design | High potential of interaction and interchangeability |

NOTE: The street network in this case, including the second ring road, has the high potential for interaction and interchangeability because they promote pedestrian and cycling movements. Moreover, the street furniture along some sections includes sitting areas that promote interaction and interchangeability.
the types, forms, and qualities of the open spaces that are alongside the second ring road and presents the levels of spatial and social interaction accordingly.

The third ring road, which spans 36.2 km, has a different geography than the second ring road, which affects the patterns of urban interchangeability and spatial interaction. The third ring road officially functions as a highway, and the dominance of the traffic flow and differences in the levels and topography along some sections do not allow direct accessibility. This situation has increased the barrier effect of the third ring road in

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**Figure 5.** Relative and relational features between the third ring road of Oslo, existing structure, and open spaces. Created by the researcher, June 2020.
Table 4. The types, forms, and qualities of open spaces alongside the third ring road, Oslo.

| TYPE                                           | SURROUNDING USE          | POSITION                        | DIAGRAM                                      | DESIGN QUALITIES                                                                 | DEGREE OF SPATIAL AND SOCIAL INTERACTIONS                                                                         |
|------------------------------------------------|--------------------------|---------------------------------|----------------------------------------------|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Operational and service open spaces (passive) | Residential              | Adjacent to a residential complex or building |                               | - Variations in forms with minor visibility and domination                         | - Limited interaction and interchangeability through this type                                                   |
|                                                 |                          |                                 | - Direct accessibility from the street       | - Defined areas and limited interior landscape                                    | - Limited to certain users                                                                                       |
|                                                 | Parking areas (Surface Lots) ≥100 m² | Adjacent to a residential complex or building | - Direct accessibility from the street       | - Defined areas and limited interior landscape                                    | - Limited to certain users during certain times                                                                   |
| Others: Mainly businesses and corporations     |                          |                                 | - Direct accessibility from the street       | - Defined areas and boundaries                                                     | - Limited spatial interaction but better interchangeability and exchange through this type                      |
|                                                 |                          | Surrounding the entire premises | - Defined areas and boundaries               | - Limited interior landscape                                                       | - Limited to certain users during certain times                                                                   |
|                                                 |                          |                                 |                                              |                                                                                  |                                                                                                                  |

**NOTE:** Most of the residential buildings in this case are the single house type, typical house type in suburban structure with single or individual parking space, which makes the most parking areas less than 100 m² (insignificant to this analysis).
### Table 4. (Continued).

**OSLO: THE THIRD RING ROAD**

| TYPE | SURROUNDING USE | POSITION | DIAGRAM | DESIGN QUALITIES | DEGREE OF SPATIAL AND SOCIAL INTERACTIONS |
|------|-----------------|----------|---------|------------------|------------------------------------------|
| Leisure and recreational open spaces (active) | Private playground and setting area | Residential | Centralized area within a residential complex | - Relative opposition between the architectural volumes and these open spaces - Standard design and repetitive forms - Limited accessibility - Equipped with sitting areas and/or playground |
| Limited users with a high potential for spatial interactions and interchangeability | Not specific but mostly near residential or mixed use | Within the existing structure | Organic and regular design lines, with defined routes, different activities, and a playground | High potential of interaction and interchangeability |
| Parks or gardens | | | | |
| Outdoor sport facilities (football pitches, golf courses, tennis courts, or gymnastic areas) | Not specific but mostly near residential areas or within educational use | Within the existing structure | Variation in the size and standardization in the design | High potential of interaction and interchangeability |
comparison to the second ring road and has minimised the spatial interactions and social exchange. The spread of the low-density single housing style has also limited the typo-morphology of social exchange and interaction. In addition, the proposed mixed-use urban nodes next to the third ring road are associated with more areas that are reserved for parking than open spaces for leisure and recreational activities. However, despite this transition, the functional role of the third ring road remains hierarchical and the existing road topologies that ramify from it have also retained the structural characteristics of tributaries of loops and cul-de-sacs (Amr, 2020c). It is worth noting that the scrutinised ring roads were initially constructed as urban limits with regard to municipal borders. However, owing to growth and containment policies, they are currently operating within the urban structure of Oslo. Figure 5 presents the relative and relational features among the third ring road of Oslo, existing structures, and open spaces. Table 4 summarises the types, forms, and qualities of the open spaces alongside the third ring road and presents the levels of spatial and social interaction accordingly.

5. Discussion

The analysis of the case studies summarised the common attitudes and features of open spaces next to the ring roads of two case studies (Greater Helsinki and Oslo) as containers for spatial interactions and social exchange. This investigation explored the types and forms of open spaces and the processes, conditions, and effects these roads have produced. The basic analysis was interpreted morphologically by the associations with the surrounding flows and building land use. This study revealed that the technical role of ring roads and their high-speed traffic flow influences the initial layer of the typo-morphology of open spaces in the selected case studies. Movement heterogeneities, the barrier effect of ring roads, low-density single housing, and diffused and discrete public and open spaces (e.g., gas stations, lounges, and car parks) that can be clearly seen alongside Ring I and III of Greater Helsinki and the third ring road of Oslo have also shaped the heterogeneous forms of the spatial and social interactions. This situation has created complex topographies and uneven development that varies in thickness, form, and intensity in the study areas. The constant high-speed traffic flux in the study areas, except the second ring road of Oslo, shows higher degrees of spatial instability and unpredictability.

Densification and the promotion of smart and sustainable development in both the case studies have generated new types of flows and motions. The results show that, on the one hand, these flow transitions have disrupted the initial hierarchy of the scales in the study areas and replaced the typologies and patterns of movement (see Amr, 2020c). They have altered the urban and architectural design, and mixed-use activities and non-hierarchical urban flows have emerged as the primary actors in regional restructuring processes. This situation has also shifted the planning perspective of ring roads from the traffic engineering convention to the urban design perspective with the objective of reducing the polarisation of its binaries. This characteristic is demonstrated in the second ring road of Oslo and in some sections of Ring I in Greater Helsinki. On the other hand, flow transitions influenced the qualities and typo-morphologies of the open spaces in the case studies. Their realisation has developed from absolute, heterogeneous, and individual
Table 5. Key findings (differences and shared characteristics) across the two case studies.

| Location     | Urban form          | Flow type                  | Effect of distance          | Relation of urban grid with the ring road | Dominant open space type                      | Spatial interaction and social exchange |
|--------------|---------------------|----------------------------|-----------------------------|------------------------------------------|-----------------------------------------------|-----------------------------------------|
| Greater Helsinki | Mixed typo-       | Ring I (23.3 km)          | Polycentric                 | -Mixed-use -High-speed -Hierarchical     | Flow transition has decreased the effect of distance morphology of open spaces | No direct relation except along certain sections Medium potential for spatial interactions and social exchange |
| Ring III (47.8 km) | -Mixed-use but mainly logistic -High-speed | Hierarchical               | No significant change was found | No direct relation with the ring road | Mainly parking and service open space (passive-suburban) | Limited potential for spatial interactions and social exchange |
| Oslo         | Compact             | Second ring road (21 km)  | -Mixed-use -Low-speed -Non-hierarchical | Flow transition has replaced the initial effect of distance | Direct relation with the ring road | Leisure and recreational open spaces (active-urban) High potential for spatial interactions and social exchange |
|              |                     | Third ring road (36.2 km) | -Mixed-use -High-speed -Hierarchical | Flow transition has decreased the effect of distance | No direct relation except along certain sections | Mixed typo-morphology of open spaces Medium potential for spatial interactions and social exchange |

conceptualisation to more homogenous, integrative, relational, and multiple patterns in which more attention is given to their function, value, and meaning.

In both cases, the emergence of flexible spaces, spread of urban character, and development of hybrid relations among the spaces, buildings, and infrastructure have associated the flow transitions with urbanity. In addition, the changes in the transport culture, patterns and types of movement, and levels of interfaces and accessibility are also associated with the flow transitions in the selected study areas. From a general perspective, these factors diminish the initial effects of distance, define new relational connections, and reintroduce new patterns of the spatial interactions and social exchange in the study areas. However, these changes have not impacted the selected study areas equally. In the case of Greater Helsinki, the effects of the urban flow transition alongside the selected ring roads are mainly limited to the development of urban nodes next to some sections of Rings I and III, whereas the high-speed traffic flow continues to dominate both rings. This characteristic has directly affected the types and forms of open spaces and the spatial and social interactions next to the ring roads, where parking areas are the most popular form of open spaces. In contrast, the mixed-use development and the expansion of the grid street pattern in the case of Oslo, especially alongside the second ring road and selected sections of the third ring road have reduced the domination of high-speed homogenous traffic flow. This
situation has impacted the current patterns of spatial interactions and the urban interchangeability, where the ratio of the open areas that are reserved for parking has significantly decreased and those of the open spaces for leisure and recreation have significantly increased. Table 5 summarises differences and shared characteristics across the two case studies.

As mentioned earlier, Greater Helsinki and Oslo generally operate under different urban models. This, consequently, affected the pace and the scale of the transition of the built as well as the non-built spaces. The analysis shows that, although the outer ring roads in both case studies share similar outcomes, the inner ring roads do not. This can be directly linked to the differences between the operated models in each city. Due to the containment policies of the compact model, areas alongside the second ring road of Oslo were completely transformed in response to the flow transition where the ring road itself has become a route of the flow instead of a boundary. However, the time factor must be acknowledged in this case. Oslo has been adopting the compact model for a while now in comparison with the relatively recent shift in planning policies (the polycentric model) in Greater Helsinki. Moreover, the results of this analysis demonstrate a gradual change in response to the flow transition, which could be comparable to the case of Oslo once we consider the timeframe difference between the two cases.

This study revealed that new typologies of public and open spaces are gradually evolving in both case studies, where their primary role is not only to contain the physical exchange neutrally but also to provide a symbolic spatial meaning and experience in accordance with the flow. Additionally, the analysis elucidated several shared features and dimensions of the flow transitions in the study areas that affect the patterns and types of spatial interactions and social exchange, as follows:

1. Structural dimension: The barrier effect of the ring roads, fragmentation of the leisure and recreational open spaces, and dispersion of parking areas, except for the second ring road of Oslo, have limited spatial interaction and urban changeability. They have hindered the flow transitions, causing flow interruption and separation at different levels.

2. Aestheticisation and visual dimension: Increases in the aesthetic character of the urban open spaces and the reflexive attitude regarding the road image that are associated with the flow transitions have gradually transformed the surrounding landscapes, particularly in the inner ring roads of the two cities studied. However, struggles caused by the existing spatial forms and their aesthetic appearances call for greater consideration in terms of the urban landscape, integrative design approaches, and harmony between the built and non-built environments that are next to ring roads alongside the outer rings of both cases.

3. Accessibility dimension: This dimension is entangled with the flow transitions along ring roads and the levels of spatial interaction and social exchange. The recurring interest is to reduce or replace high-speed traffic flows with other sustainable mobility options to facilitate circulation and transitions among the road network, existing buildings and open spaces, and future development. This dimension, as a result of flow transition, has impacted the typo-morphology of open spaces particularly alongside the inner ring roads of both case studies.
(4) Emergence dimension: The flow transition towards urbanity has been associated with the emergence of different hybrid spaces, relations, and programs for buildings and infrastructure in both Greater Helsinki and Oslo. These changes enhance spatial and social interaction and provide closer relations with the surroundings. Mixed-use urban flow has also influenced the emergence and spatial adjustment by modifying the open spaces that are responding to the growing spatial densities. For example, investment in street life and mixed-use activities and the emergence of cultural flow and urban landscapes were discovered particularly alongside the inner ring roads of both cases. The emerging patterns of mixed-use development alongside ring roads (see Amr, 2020b) are not limited to mixed usage in the buildings themselves but are also evident in the interactions with the non-built surroundings (streets, parks, etc.).

(5) Availability dimension: The displacement of or encroachment upon the open space is a potential impact of the flow transitions next to ring roads in both case studies. Urban and population growth would place further demands on the existing open spaces, which could be replaced with densified built-up functions, creating a shortage of leisure and recreational open spaces.

(6) Ecological dimension: Both case studies were characterised by urban sustainable development agendas in which ecological dimensions were addressed. Reducing the high-speed heterogenous traffic flow and developing more sustainable mobility options, as well as investing in urban landscapes and green areas, are associated with the flow transitions next to these ring roads. These actions should directly affect the quality of open spaces, which improves the spatial and social interaction.

6. Conclusion

With continuously expanding urban environments, the areas next to ring roads no longer passively support heterogenous flows. Ring roads and the areas alongside them are entangled with the general logic of flows that form a spatial field of binaries that constantly generate new patterns of spatial interaction and social exchange that are present in open spaces. The conventional abstract use of ring roads and traditional operational area development methods along them are raising spatial, social, cultural, ecological, and economic concerns. The positions, forms, and sizes of the leisure and recreational open spaces and their relations to the overall spatial structure do not correspond to the existing densities or the intended vision of the spatial and social interaction. High-quality open spaces and the availability of recreational facilities are central to contemporary neighbourhood quality and urban development. The complementary integrative relationship between the built and non-built environments is a foundational principle for this urban spatial experience. Therefore, cities and regions require strategies for intervention, inclusion, and containment for areas alongside ring roads, using open spaces as tools to unify urban forms and functions. This intervention should acknowledge the current direction of urban flows and provide new understanding of the existing landscape for better spatial interaction. Open spaces alongside ring roads offer adequate resources to create viable spaces. Unlike the rigidity of the built fabric, the adaptability and resilience of the transformation and articulation of non-built spaces
allows them to be employed in regional restructuring to overcome the fragmentation and heterogeneity of the existing spatial interaction patterns. Therefore, this paper recommends the recognition of open spaces alongside ring roads as binding elements instead of mere background. Further, it calls for a comprehensive plan that invests in the existing network of leisure and recreational open spaces to develop responsive patterns of spatial interaction and urban interchangeability.

Notes

1. Here, relative relational position of distant locations is described in reference to the city core.
2. Incidental or residual spaces include empty lots, transit borders, natural features and semi-wild areas, protected natural areas, agricultural fields, landfills, swamps, orchards, restricted public land with open space potential such as cemeteries, and landscaping around buildings.

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