Pattern Recognition and Transformational Growth Adjustments alongside ring roads: Descriptive Mapping from Four Case Studies

Abstract

This paper aims to examine the existing patterns of ring roads in four diverse cities—Greater Amman in Jordan, Kuwait City in Kuwait, Oslo in Norway, and Greater Helsinki in Finland—to explore how these patterns respond to growth and elucidate the contemporary urban practices of these cities. Spatial mapping was used to measure density, mixed land use, and accessibility and identify growth characteristics parallel to the tracing processes of spatial insertion, replacement, and use change. The results illustrate that in master plans, the areas alongside ring roads were delineated either too vaguely or too prescriptively. The existing patterns of road and land use, particularly high residential concentrations, challenge the functionality of ring roads and negatively affects urban spatial qualities and services that should accompany the high-density study areas. Cumulatively, they have formed spatial non-homogeneities that challenge accessibility and dependency factors. In addition, the growth indicators represent urbanisation processes, generative schemes, and counter-formulation actions, where the replacement of the physical structure and functional character of ring roads as road restructuring is a prerequisite for generating less vulnerable urban structures. Therefore, the cases presented here raise important questions about the challenges and potential of ring roads and the areas alongside them in urban structures, in the context of the sustainable growth agenda.

Keywords: Ring road, spatial pattern, residential concentration, urban growth

1. Introduction

As the scale of cities and their urban boundaries are continuously expanding, planning their perimeters has equally been ongoing and experimentally explored (Ward, 2004; Batty, 2008; Chen & Jiang, 2018; Chapin, 2012). The growth machine concept centres the planning domain as a fundamental part of the development of any given locality worldwide (Hillier, 1996; Molotch, 1976). This concept provides the key operative motivation for the continuous production and reproduction of cities, forcing localities to compete to acquire the preconditions of growth such as transportation, dynamic distribution, and administrative principles (Batty, et al., 1999; Jonas & Wilson, 1999; Molotch, 1976; Wezemael, 2012). The growth machine concept transforms the spatial geography by either expanding the territorial boundaries through insertion or by counter-formulating existing boundaries through replacement and change in use to facilitate continuous growth. Changes in demand preferences for land, buildings, and access will continue to be a significant driver affecting both land-use efficiency and growing urban form and patterns (e.g., Batty & Kim, 1992; Brade, et al., 2009; Longley & Mesev, 2001). Nonetheless, this process does not leave space untouched, and this is predominantly the problem with these types of changes. Utopian assumptions such as dynamics yielding desired growth patterns, homogeneous land-use distribution, and maximising spatial potential and capacities (e.g., Anas et al., 1998; Knaap & Lewis, 2011) have also intensified the inequalities of dynamics and flow (Fotheringham, 1984; Sassen, 1996).

In addition, the economic and political agendas play instrumental roles and are dominant reference points shaping linear growth processes of the spatial structure (e.g., Eckardt, 2005; Portugali & Alfasi , 2008; Forester, 1989). The actions and means of these agendas that control urban development schemes are embedded in land-use policies and road construction, and therefore, define areas of influence, distinguish locational properties, conceptualise relative and relational characteristics, and predict certain urban qualities and behaviour such as urbanity, accessibility, mobility, and connectivity. Consequently, recognising spatial patterns is complex, as it depends on the spatial scale of observation, especially when the operating planning discourse has changing definitions and locations of the desired growth patterns (e.g., Kasanko, et al., 2006; Zambon, et al., 2017). Overlapping spatial models and economic and political agendas has generated the desired and struggling patterns of urban expansion that are being built alongside fixed infrastructure.

Street networks are among the primary explanatory factors that initiate spatial conditions for growth (Graham & Marvin, 2001; Dupuy, 2000). From a policy perspective, the street-based urban structure is a linear, and statutory process and only general elements and relationships are specified by strategies and plans. In practice, these street types do not float loosely in typological space, but rather, tend to be systematically recognised and ordered in definite sets. They are mostly engendered from highways or traffic engineering conventions and urban design and planning traditions (e.g., Marshall, 2005; Kono & Joshi, 2019; Ignaccolo, et al., 2016). The linear hierarchical listing of street classification is not just a description of possible types, but it is also a prescription for ongoing management and future design (e.g., Marshall, 2005; Suzuki, et al., 2013). Their spatial correlation and impact together serve as the main catalyst in urban form and development. Relative and relational locational qualities develop according to each street type, and by extension, to the areas alongside them. Several growth indicators are also linked both directly and indirectly to road types and their spatial settings, including movement and mobility, land value, accessibility, and densities (Handy, 1992; Handy & Niemeier, 1997; Barrett, 1996).

The modernist paradigm advocates a strict separation between roads for traffic and roads, providing access to buildings (Ward, 2004; Buchanan, 1958; Tripp, 1950). It identifies the road network as a separate system in which each road has a function and is designed accordingly (Marshall, 2005; Oc & Tiesdell, 1997; Trench, 1997; Southworth & Owens, 1993; Bacon, 1975). Therefore, the desired pattern of growth is defined by the interdependent behaviour of each street type and function, in which the fastest and highest-capacity roads will be segregated from pedestrians and non-motor traffic to support the necessary urban qualities (Punter, 1996; Marshall, 2005; Ministry of Transport, 1964). The modernist paradigm associates highways with disurbanism, severance, and physical intrusion, which often leads to a sense of sprawl and formlessness (Carmona & Punter, 1997; Hollins et al., 1997; Oc & Tiesdell, 1997; Hillier, 1996).

This paradigm was later replaced by the rhetoric of sustainability, smart growth, and neo-traditional urbanism (e.g., Gulhan & Ceylan, 2016; Danielsen, et al., 1999; Katz, 1994; Newman & Kenworthy, 1999; Williams, et al., 2000). Prioritising sustainability in growth has created new spatial patterns and conditions for accommodating compact, dense, and mixed-use development (Jabareen, 2006; Jenks & Burgess, 2001; Symes, 1997; Jenks et al., 1996). The theoretical conceptualisations of growth as an ideology and urban planning as a theory are challenged by the parties involved and the existing operating structure. By countering the top-down linear planning process, the sustainable agenda demands a collective understanding of the spatial reality and proposes alternatives that support mobility, movement, and dynamic distribution. For example, several policy frameworks acknowledge the use of sustainable approaches in transportation infrastructure and highway project development by incorporating diverse concepts such as environmental protection and carbon footprint reduction, regional air quality improvement, social equity and lifestyle, and environmental management system use (e.g., Berkowicz, 2000; Brønnum-Hansen, et al., 2018; Jensen, et al., 2017; US Department of Transportation, 2012; American Association of State Highway and Transportation Officials, 2001). Moreover, frameworks positing the urban environment as the desired growth factor that encompasses health and carbon footprint reduction, have called for restructuring the spatial form logic, its new scale, and components, and the existing infrastructure, street network, and mobility. In this way, cities are no longer seen as just morphological entities with clear and detectable borders, but rather as polynuclear functional urban regions (Hall, 2009; Parr, 2004; Vasanen, 2012; Parr, 2005; Moens-Gigengack, 2005).

Nonetheless, the issue of spatial rescaling is challenged by several aspects such as the initial road designation, its functions, and the existing structures alongside the road. The functionality of previously celebrated elements such as highways, following the shift in forces and discourse, may have little bearing. Moreover, owing to growth, the continuous changes in their relative and relational positions are also posing questions regarding their functionality in the contemporary structure. Due to these continuous growth ideologies, ring roads are among the elements that have an unsettled role and functionality in the contemporary spatial structure and an unsettled relationship with the centre. In addition to channelling traffic, ring roads are prominent infrastructural elements and service-catering components that initiate sequential spatial growth around the core of a city, enable movement and transitions within the urban system, and provide a quick means of spatial expansion. Building ring roads also has socio-political dimensions and an economic influence on the demand for and access to land, such as in the case of China. In Beijing, the ring road system plays a crucial role in spatial organisation, land-use distribution, automobile transportation, and town and peripheral accessibility (Yang et al., 2013 Webster et al., 2010 Zhao et al., 2009). Subsequently, it has supported the centralised political agenda and economic vision of the region. However, this has increased rural and green-field land consumption and car dependency, which is directly associated with an increase in the carbon footprint, fuel consumption, and air pollution (Webster et al., 2010).

Generally, despite the extensive studies on the correlation between street networks and spatial growth (Tripp, 1943; Jacobs, 1961; Mumford, 1963; Bruegmann, 2006; Squires, 2002), land-use effects on building roads (Buchanan, 1958; Handy et al., 1998; Burgess, 1996), and movement and urban sustainability (Hebbert, 2003; Papageorgiou, 2004; Newman & Kenworthy, 1999; Calthorpe, 1993), little attention has been paid to the spatial conditions alongside the ring roads. While the locational factors of ring roads in regional structures raise important questions about their viability and functionality, their spatial densities affect urban quality, territorial cohesion, and flow. Several studies have explored traffic patterns and flow in ring roads (e.g., He & Guan, 2007; Guan & Hu, 2005; Kerner, 2002; Zhao et al., 2009). Nonetheless, the issue of the accumulative spatial structure alongside ring roads under the current operating planning framework remains unexplored. Additionally, within spatial organisation plans or highway layout standards, very little specifies the spatial patterns alongside ring roads.

This study builds its arguments on the unavoidable inclusion of areas alongside ring roads in the growing urbanising structure and discusses their potential capacity for development. By doing so, this study aims to develop further understanding of the spatial formation and transformation procedures of areas alongside ring roads under *continuous growth* as a dominant ideology. By casting this issue in a novel framework, it contributes to the literature on spatial patterns alongside ring roads with reference to growth stimuli, dynamics, urban models, scale, and role of the ring road in the spatial structure.

2. Reappraisal of the spatial conditions alongside ring roads: Methods and areas of research

This study examines the components, spatial formation, and transformation processes to first extrapolate the existing patterns alongside ring roads. Second, this paper explores how these areas are perceived in growth ideologies and correspond to contemporary practice. The study examines different modes of urban governance, models, and planning attitudes that produced the existing patterns and identifies the transformation and adjustments processes, if they exist, in each case study. By tracing the processes of insertion, replacement, and change in use, this study interprets the existing patterns and their opportunities for development contextually, with reference to the operating urban model of each site. The descriptive strategy is carried out using official master plans, interviews with academics and professionals from each study area,[1] and GIS data. Two types of GIS data were mainly used; the first involved building footprints of the existing spatial structure in the study areas, while the second focused on land use. The data were not completely accessible for the researcher in most cases, and therefore, a specific method was used to build these datasets.[2]

[1] The researcher conducted 11 interviews with professionals and academics: three in Oslo, three in Greater Helsinki, two in Greater Amman, and five in Kuwait. The interviews were conducted between October 2018 and January 2019 and were recorded and fully transcribed. The direct quotes are not linked to the names of the interviewees to ensure anonymity. Instead, the researcher refers to the quoted information using initials, for example, 'Interviewee GA-1' refers to interviewee 1 from Greater Amman and so on.

[2] For the building-footprints dataset, for Kuwait, the researcher used ArcGIS software (ArcMap specifically) and its satellite base map to draw the study areas, and no GIS data were obtained. For Oslo and Amman, the researcher obtained some of the building footprints for the study areas. For Oslo, some of the data were obtained from the Geonorge website, particularly for N50 Map Data. The data obtained from this map covered around 10% of the required data in the study area. The rest of the data were constructed using the same method used for Kuwait. For Amman, some of the data were obtained from the Greater Amman Municipality. The percentage of the data obtained in this case was around 25% of the data required. The rest of the data were created using the same method used for Kuwait and Oslo. The satellite map in ArcGIS software is from 2013. Therefore, the researcher used Google Maps (2018) to obtain the latest spatial building footprints in the study areas and added the missing parts accordingly. For Helsinki, the building footprints were obtained using the Finnish national geo-portal service Paikkatietoikkuna. For the land-use dataset, for Kuwait, the researcher could not obtain spatial data on land-use in the study areas. Therefore, the researcher used Google Maps (2018), its labelled places, and the 3D satellite images and views to construct the land-use dataset for the study areas. For Oslo, some of the necessary data were found in the Geonorge website, particularly for the N50 Map Data. This map contains public buildings and facilities and covers only around 10% of the data required. The rest of the data were constructed using the method used for Kuwait. For Amman, some of the data were obtained from the Greater Amman Municipality as a point data set. The percentage of the data obtained in the case of Amman was around 25% of the data required. The rest of the data were created using the same method used for Kuwait and Oslo. For Helsinki, the researcher obtained the land-use dataset from the National Land Survey of Finland, specifically from the topographic database for 2018. However, the classifications of land-use were not as specific as required. Consequently, the researcher adopted the previous method using Google Maps (2018), its labelled places, and the 3D satellite images and views to construct the detailed land-use dataset.

This study focuses on eight areas in four different urban environments, and it examines four urban regions from two main contexts: Greater Amman and Kuwait from the Middle East, and Oslo and Greater Helsinki from the Nordic countries. Each case study provides a discussion with different spatial models and policy frameworks. Therefore, the main aim of this study is not only to compare the spatial situation alongside ring roads between Middle Eastern urban regions and Nordic urban regions but also to identify and assess the existing structures in each of the selected areas. This approach can identify patterns across different contexts and trace the spatial and planning transformations in each case separately. While all of the case studies share a general concentric radial-ring road system around their cores, this comparative aims to explore the use of ring roads across spatially, culturally and geographically different contexts. The selected study areas cover diverse urban settings as seen in the urban discourse, scale, population densities, economies, and the general levels of infrastructure development. Nonetheless, this research aims to determine the challenges and opportunities alongside ring roads that could improve urban governance and land-use development.

In each case, the study focuses on two areas of inquiry: areas alongside the inner ring road and areas alongside the outer ring road. The precise boundaries of the study areas are determined in this case by measuring 500 metres from each side of the ring (500 m buffer). The length of the chosen ring roads is almost the same, which makes the buffered surface areas similar. However, the operational policy that controls and manages the overall structure is different. Each case study includes a discussion on the distinct specific model, and addresses the ring roads and the areas alongside them: Greater Amman has a metropolitan-decentralised structure, Kuwait has a centralised-low-density structure, Greater Helsinki has a metropolitan-polycentric structure, and Oslo has a compact structure. This allowed an investigation into the variables of the different physical settings, and thus, broadened the discussion.

The place-based classification of the existing structure was conducted using typo-morphological mapping. The typological study described and characterised the study areas based on the dominant type of occupation (i.e., residential, industrial, etc.) and urban qualities (i.e., urban, rural, etc.). The land-use percentages in this part are calculated based on the ground floor area ratio only because of the limited data. The morphological part uses the built-up footprint, density, and size in each study area and classifies the spatial configuration and arrangement into three main categories: dispersed, uniform, and clustered. Finally, the research identifies street structure patterns that ramify from the ring road by highlighting the existing types of streets (i.e., primary distributor, district distributor, local distributor, and access distributor; Marshall, 2005, pp. 73-102). The street structure pattern was mainly described on selected sections of the study areas as tributaries, which implies deep branching with systematic uses of cul-de-sacs or layered loop roads; and griddy, typically found in regular layouts of new settlements laid out in a grid (Marshall, 2005, p. 144). Mapping the layouts of streets coming off the ring road helps demonstrate the key properties of preferred growth indicators, such as density, mixed land use, accessibility, dependency, and connectivity factors.

2.1 Area 1: Unstructured landscape outside urban flow: Greater Amman, Jordan

The latest master plans for Greater Amman, Jordan have proposed decentralising growth in three urban nodes, or satellite towns, around the inner city of Amman and alongside the inner ring road to facilitate the metropolitan vision of the city and its new urban scale (see Greater Amman Comprehensive Development Plan GACDP 1986 and Amman Master Plan: Metropolitan Growth 2025). This strategy aims to manage spatial expansion and minimise dependency on the city centre. The growth strategies in these master plans were enabled by radial growth corridors, and the entire land-use system and dynamic distribution were planned accordingly. However, although each urban node was accompanied by a radial growth corridor, the distribution of growth dynamics and generators was mainly structured on the opposite sides of these nodes to the north western, western, and southern parts of the city. The share of growth dynamics and development strategies distributed and targeted at these nodes alongside their radial corridors are insignificant in comparison to those in other parts of the city (Amr, 2018).

The first ring road in Amman (Al Hezam Ring) was planned as the city limit and sought to contain the urban structure while protecting the rural and suburban areas. The construction of the 18.2 km Al Hezam Ring in the late 1970s aimed to facilitate the smooth passage of heavy vehicles away from the congested street system of Amman. Areas alongside the Al Hezam Ring were not targeted to accommodate growth and were not opened for development despite the three planned urban nodes. Instead, they were mainly reserved for large-scale projects, quarries, and general industries. The location of the Amman Civil Airport, Marka Airport was also coordinated with the overall urban vision alongside this ring road. Without any structural and detailed plans guiding the expansion process, a general zoning assignment of land-use was sufficient for these areas. However, the gradual occupation of land began to challenge the overall structure. The Al Hezam Ring served its purpose until the areas alongside it became utilised, as the cheap land value and loose zoning system attracted spatial expansion (Interviewee GA-1). This process produced a denser structure alongside the ring road and impeded its functionality; it has also placed an extra financial burden on the city administration to provide these localities with the infrastructural network that was not anticipated but is now deemed necessary.

Later, it became necessary to construct another ring road to serve the metropolitan vision and channel heavy regional traffic away from the congested Al Hezam Ring. In the latest master plan of the city, The Amman Plan: Metropolitan Growth 2025, a second ring road was planned to align with the new metropolitan border, and areas alongside the new ring road were planned using the same strategy used for areas alongside the Al Hezam Ring. Similarly, because it is an outer road, the plans for the second ring road were also prepared by the Ministry of Public Works and Housing. However, the construction process of the second ring road was not within the government’s budget (Interviewee GA-1). To obtain the funds necessary from the World Bank, the second ring road had to be transformed into a growth corridor instead of a highway, and areas alongside it had to be opened for development and growth. In the proposed plans, this road and the areas alongside it were intended to be constructed in the form of an urban spine of the metropolitan area (GAM, 2010, pp. 52-53). The new road, the Amman Corridor, was constructed eight kilometres to the east of the Al Hezam Ring and was completed in late 2016. It is worth mentioning that the purpose of exploring the spatial situation alongside this road is to highlight the change in the planning strategies and discuss if they can be implemented and activated successfully. The study highlights the existing structure alongside the Amman Corridor that was formed mainly before the shift in urban policies took place.

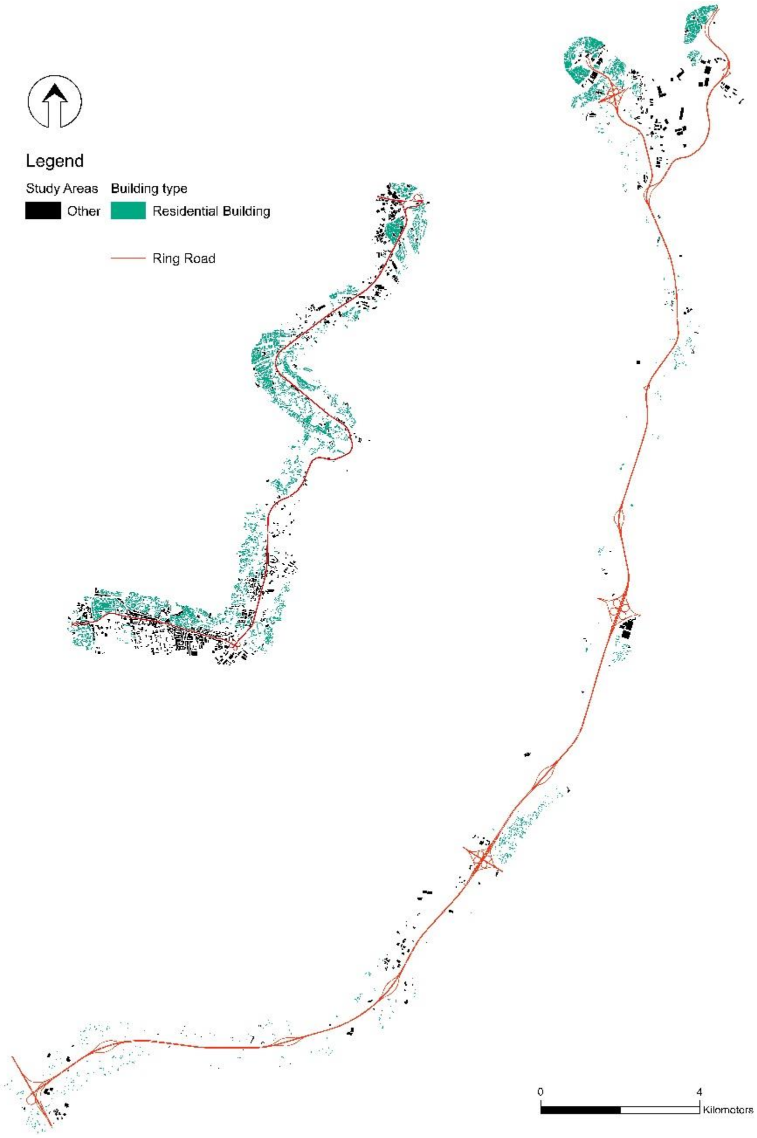

Figure 1: The residential distribution (in green) alongside the ring roads in Amman, March 2019

From the standpoint of typology, the place-based mapping demonstrated that 52% of the existing structure alongside the Al Hezam Ring is residential, comprising either single-family houses of one to two floors or medium-size apartment buildings with a maximum of four floors. Figure 1 illustrates the residential distribution, which is shown in red, in reference to other existing structures in the study area, which are shown in black, alongside both rings. Alongside Al Hezam Ring, the two sides of the road are completely separated with few pedestrian paths, which are in very poor condition. The study area lacks sufficient urban amenities that should accompany areas of this residential density, such as educational, medical, and recreational amenities. This creates a higher dependency on the inner city, thus questioning the functionality of the planned urban nodes in this area (Amr, 2017; Amr & Saad, 2015). According to the municipal regulations, the minimum setback between the buildings overlooking the ring roads and the ring road itself is 10 m from each side.

Nonetheless, most of the commercial and industrial structures are attached to the road and open out directly onto it, ignoring the setback, functionality, and flow of the Al Hezam Ring. The spatial mapping illustrates that 42% of the existing structures dispersed alongside the ring road are commercial and industrial establishments, and areas alongside the second ring road are barely occupied. However, the existing structure lacks basic utilities and services—such as schools, medical and entertainment functions—in a way that increases dependency factors and facilitates commuting.

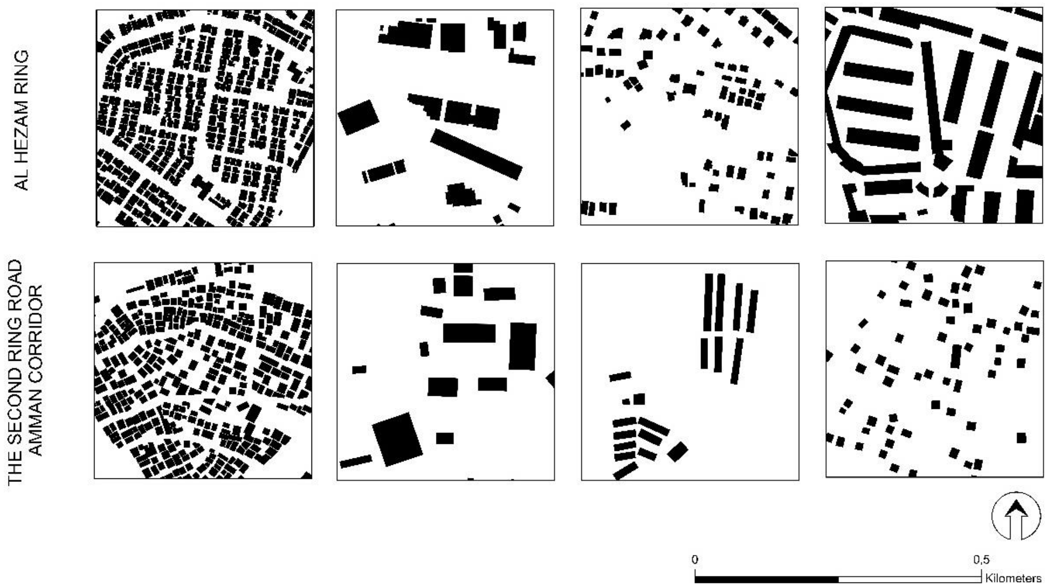

Figure 2: Spatial patterns alongside the ring roads in Amman, March 2019.

At the morphological level, various types of figurative arrangements have been found alongside both rings, forming non-homogeneous and non-uniform structures. The spatial mapping of the study area alongside the Al Hezam Ring demonstrates different patterns ranging from irregular and dispersed concentrations, which occur alongside the middle part, to regular and clustered ones, mainly alongside the northern areas and parts of the southern areas. Despite the low density, similar figurative patterns are found alongside what would have been the second ring road (Figure 2). The dispersion and isolation alongside this road are higher because of its distant location.

The spatial structure alongside the Al Hezam Ring is challenging not only because of its location and land-use distribution but also because of the street network linking the ring road with the street system and the rest of the structure. Although areas alongside the ring roads are under the authority of the Greater Amman Municipality (GAM), the road is managed by the Ministry of Public Works and Housing, and construction and maintenance processes are the responsibility of the latter. The absence of a collaborative planning vision for the street network between the GAM and Ministry of Public Works and Housing has affected the accessibility factors in this case negatively (Interviewee GA-2). A glance at the streets that emerge from both ring roads reveals diversity in the labels associated with different types of street patterns. Figure 3 illustrates the different structural patterns in the streets attached directly to the ring road. The spatial mapping indicates that there are a variety of structural street patterns; from organic and discontinuous, to geometric and orthogonal and rectilinear patterns. The street mapping shows a tributary pattern of loops and cul-de-sacs in some sections and semi-gridded pattern in some others. In most sections, there are no services or parallel roads for cars, and the transition ramifies directly from the ring road itself. This structure has negatively affected urban indicators such as accessibility and walkability and has produced commuting patterns dependent on private vehicles.

Figure 3: Structural patterns of streets that ramify from the ring roads in Amman, March 2019

The latest two master plans for Amman (1986 and 2006) include a growth strategy for the opposite sides of the first ring road, leaving a very loose zoning system without detailed structural plans to control areas alongside. This produced the current spatial disparities, and the result is a dense, underdeveloped, and complex structure that lacks efficient services and amenities. The juxtaposition of industrial and residential areas has formed struggling, non-homogeneous structures. However, the new development direction proposed alongside the second ring road is also critical because the applicability and functionality of the urban spine concept are directly linked to a functioning street network and homogeneous dynamic distribution. In this case, the constructed corridor is disconnected and far from the city structure and its street system. Even if the city managed to apply the growth strategy for Amman Corridor successfully, the Al Hezam Ring and the areas alongside it would be trapped in the middle. This paper argues that the spatial and functional situation of the road and extended areas alongside it will worsen once the growth strategies alongside the Amman Corridor begin to develop. The Al Hezam Ring will remain the only ring road in the middle of a dense and spatial structure from all sides. Including areas alongside the Al Hezam Ring within the overall city structure seems inevitable. However, there is no current or planned redevelopment growth strategy to address and serve the existing setting and the growing densities alongside the ring road. Only minor infrastructural projects such as intersections and pedestrian bridges have been implemented at certain intersections, mainly in the southern part of the Al Hezam Ring, to improve the functionality of the road and minimise congestion.

2.2 Area 2: Repeated dissipative structure, Kuwait Region, Kuwait

The spatial structure of Kuwait is arranged according to a concentric ring-radial road grid system. This grid aimed to establish districts for sequential development, and the current structure has seven ring roads and four radial roads. This study spatially mapped the fourth 19 km ring road, which is the last ring road to have been constructed from the first master plan in 1951–1952, and the fifth 36.8 km ring road, which was proposed in the following master plan in the late 1970s. Although the spacing between these two ring roads is 2 km, these roads are eight-to-ten-lane highways (four or five lanes on each side of the road) and have a speed limit of 100 km/h. The city was planned with an auto-dominated structure, and the street network and land-use distribution were planned to serve and embrace this concept. In this case, the deliberate use of ring roads is a strategy for handling traffic and movement (Interviewee K-1). The car-oriented structure has extended the high dependency on car use in parallel with the absence of an efficient public transport system. Additionally, the land-use system has not changed significantly since the early plans for the city in the 1950s (Abdo, 1988).

Although they form a concentric grid system, each type of road has distinct physical and functional characteristics. The radial roads are more central for zoning and land-use distribution, and some have become boulevards, while the ring roads serve mainly as a separation mechanism for successive expansion (Interviewee K-2). Generally, the two main entities controlling development in Kuwait are the Kuwait Oil Company and the Public Authority for Housing Welfare (PAHW). Focused on housing, the Kuwait municipality designates the use of areas for development (Abdo, 1988; Gardiner & Cook, 1983). A significant amount of land has been dedicated to housing because Kuwaitis prefer single occupancy and low-density developments and rarely live in apartments (Alghais & Pullar, 2017). Although the municipality of Kuwait is the only regulatory agent controlling the physical space, maintaining the hard and soft surfaces of the spatial structure is a shared responsibility between the municipality of Kuwait and several ministries.

At the typological level, the land-use distribution alongside the fourth and fifth rings is an extension of the overall land-use distribution system at the city level. Both study areas are dominated by residential use. While 40% of the existing structures alongside the fourth ring road are residential, 62% of the structures alongside the fifth ring road are residential. However, the possibilities for pedestrians to cross these roads is very limited. Figure 4 illustrates the residential distribution in green and other existing structures in the study area in black. The spatial mapping shows concentrations of mixed-use areas with relatively high density to the east of both ring roads. From the eastern side, the fourth ring road ends in neighbourhoods called Hawalli and Salmiya, and the fifth ring road ends in Salmiya. These areas are considered the densest and the most mixed-use areas in the entire country. The residential areas in this part are mainly occupied by expatriates. This pattern was developed by the municipality in its early plans. As a result, vast areas are reserved for parking lots, and despite these densities, this part of the study area lacks educational amenities for its inhabitants, which means higher dependency indicators. Areas alongside the middle parts of both rings are low-density residential neighbourhoods that are exclusively for Kuwaiti citizens. Each neighbourhood is centred on an official governmental facility called a co-op society, which is a central service area. The central location of the co-op society in each neighbourhood has helped to overcome the segregated spatial structure by providing central essential amenities and services. On the western side, there are concentrations of commercial use, light industries, and major utilities.

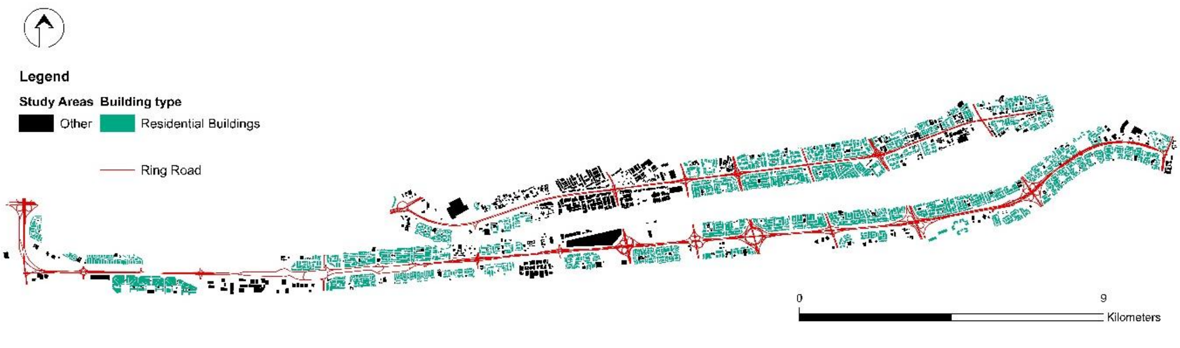

Figure 4: The residential distribution (in green) alongside the ring roads in Kuwait, March 2019.

The typo-morphological mapping of the study areas shows minor reactions and adjustments of transformational processes to mitigate the impact of the highway-driven structure. These adjustments include adding road capacity and changing plot sizes. According to municipal regulations, setbacks alongside ring roads are public property and are reserved for future road expansion. Setbacks alongside ring roads have recently decreased and have been replaced by car lanes, and so people and buildings have become closer to the highway, and the plots have become smaller, with higher densities. Sometimes, these setbacks are rented by private parties and used for commercial purposes (Interviewee K-3). The decentralisation processes involved in public land-use entail another shift in growth policies, as the municipality implemented a mixed land-use strategy to break up the mono-functionality of the districts. The city has begun a vital re-localisation system by reserving some of the property in front of ring roads, mainly alongside the fourth and fifth rings, for public institutions and governmental units. For example, on the northern side of the fifth ring road, in the Surra area, the front of the ring road is dominated by ministries and headquarters of public institutions.

At the morphological level, spatial mapping shows a clear geometric and regular pattern. The built-up structure on the eastern side of each study area has a mixed form, varying from traditional medium-sized buildings with a minimum of four floors, to modern high-rise buildings. The areas in the middle part alongside the fourth and fifth ring roads are mainly traditional single-family houses with one to three floors. Although at the neighbourhood scale, the spatial patterns seem to be uniform and there is no dispersed structure, the overall pattern at the city level can be described as dissipative (Figure 5).

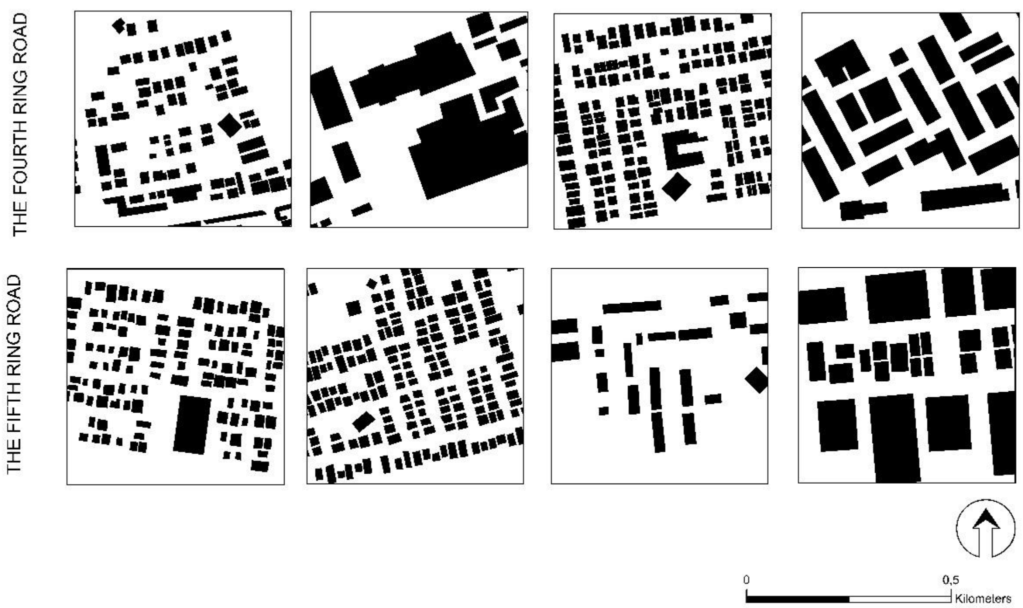

Figure 5: Spatial patterns alongside the ring roads in Kuwait, March 2019.

This regular and geometric urban layout is built on an orthogonal and rectilinear tributary pattern of loops, which is a discouraging pattern for movement and growth (Marshall, 2005, p. 31). Figure 6 illustrates that the study areas have one street structure that ramified from the ring road, the primary distributor. It is clear that there are no direct entrances or openings between the ring road and the areas alongside them and also that entry to any neighbourhood can occur either through a parallel road or through the district distributor. The spatial mapping in this study area shows an auto-dependent commuting pattern with long trips.

Figure 6: Structural patterns of streets that ramify from ring roads in Kuwait, March 2019.

Even with an auto-dependent, highway-driven, low-density, relatively small, and centralised structure, ring road use as part of growth strategies has affected certain growth indicators negatively and has challenged some of the key principles of urban design. The sprawling structure is a result of the use of ring roads and their physical and functional characteristics, whose utilisation parallels that of land and housing distribution. Having several ring roads within the city structure in conjunction with the absence of a regional planning vision has created certain spatial and functional qualities. Ring road use has created a relationship among public buildings, commercial use, population flow, and road structure that has directly affected several urban and growth indicators, such as increasing land values and critical accessibility, walkability, and movement factors. For example, the property values alongside highways are typically low and decline as one gets closer to the highway, whereas they increase the further one moves away from the highway. Controversially, in Kuwait, property values alongside the highways are the highest (Interviewees K-1 and K-4). The unbalanced land-use distribution and the concentrations of mixed-use areas on the eastern side of the city, in parallel with the structure of the road system, have complicated the relatively small city structure.

2.3 Area 3: Counter-formulation, Oslo, Norway

Oslo has pursued a compact growth strategy for 30 years (Bergsli & Harvold, 2017; Næss et al., 2010; Tønnesen et al., 2014). The initial visions of the city were planned using a general ring-radial road system to free the central area from congestion. When the second ring road, stretching 21 km was constructed, it corresponded to the city limit and the municipal border. However, with the constant demand for centrally located dwellings and businesses, it was transformed into a normal street. The third ring road, which spans 36.2 km, officially functions as a highway. The distance between the second and the third rings is approximately 2 km. The areas alongside ring roads in Oslo are open for development. However, private ownership—housing, in particular—is problematic because old structures must be demolished to facilitate more densified and compact growth development strategies.

Under a centralised system, the city carries out intensification and development processes connected to the public transportation system, mainly the rail system. As a result, the development of areas including those alongside the second ring road was unavoidable during these processes. This was facilitated by transformational planning attitudes and densification processes to expand similar spatial patterns that fit the structure of the inner city. Two major infrastructural development projects have resulted from densification strategies. The first is the transformation of the second ring road into a boulevard. The physical character and the functionality of the second ring road were transformed completely into a normal street in some parts and an avenue in other parts, with a speed limit of 40–50 km/h. The municipality succeeded in reducing the road capacity from four to two lanes and created parking spaces on the side, parallel to the bus lanes serving areas alongside the ring road. During the summer, the municipality prohibits the use of cars in some areas alongside this road.

The second major infrastructural development is a metro ring alongside the third ring road, which was completed in 2007 (Johansen, 2004, p. 47). This ring completes and closes the public transit loop that reaches the peripheral parts of the city. As the public transport system has mainly followed the radial roads, the metro ring has emerged as a significant improvement that corresponds to the growth vision and densification processes. The coordination between land-use and the transport strategy plans in Oslo has made the metro ring an important contributor to sprawl reduction in the urban region. It offers a sustainable mobility option for more accessible, connected, and reachable spatial structures. The city has also embarked on a nodal development strategy by using the intersections of the radial roads with the third ring road. In this way, the city continues to enhance the spatial flow and connectivity with neighbouring municipalities and surrounding smaller cities and minimises mono-centricity. The strong subway connections parallel the strong radial public transport, and the city aims to channel growth through these nodal points.

At the typological level, the spatial mapping of the study areas found that 58% of the areas alongside the second ring road in Oslo have been engaged in residential use, mostly in the form of high-density mixed-use apartment buildings with small patches of single-family houses. This structure has been gradually replaced by denser apartment buildings with various shops on the ground floor. Commercial and business uses, which account for 35% of these structures, are usually mixed with residential units. The spatial mapping of the land-use shows no significant percentages of services and utilities alongside the second ring road, which indicates high dependency. However, the problems linked to this dependency have been solved using an efficient public transit system.

Similarly, approximately half of the existing structures in the study area alongside the third ring road are residential, mainly comprising low-density single-family houses on the west and apartment buildings on the east. Spatial mapping shows the concentrations of businesses and industries, especially in the northern and eastern parts of the study area, where nodal development is proposed. The spatial mapping also reveals various land-use and services within the study area, such as hospitals, museums, and sports facilities. The spatial mapping shows notable replacements of industrial and warehouse areas with densified residential and mixed-use areas that support the compact vision and the nodal development strategy. Land-use policies have changed to facilitate business-oriented growth in addition to residential use, and Figure 7 illustrates the residential distribution in the study areas in red. The other existing structures in the study area are shown in black.

At the morphological level, the spatial structure alongside the second ring road has integrated smoothly with the rest of the city, especially after diminishing and shifting the physical and functional characteristics of the ring road. The city has overcome the existing spatial rupture that formed over the years between the two sides alongside the second ring road by replacing the suburban structure with an urbanised environment that includes regularly concentrated and multi-story buildings. Currently, the area is almost fully occupied and urbanised.

On the other hand, the situation alongside the third ring road is different, and there is a huge difference in morphology between both sides of the road. Although the study area is dominated by residential use structures similar to those alongside the second ring road, the figurative qualities differ. The existing structure is dispersed and has an organic suburban character, mainly alongside the western and eastern parts, while in the middle, several infrastructural projects are ongoing. By tunnelling parts of the third ring road—by more than ten kilometres—and developing new areas above ground, the metro ring and the nodal development strategy are responsible for significant topographic changes. However, the current physical and functional roles of the third ring road in Oslo are confusing in the context of these transformations.

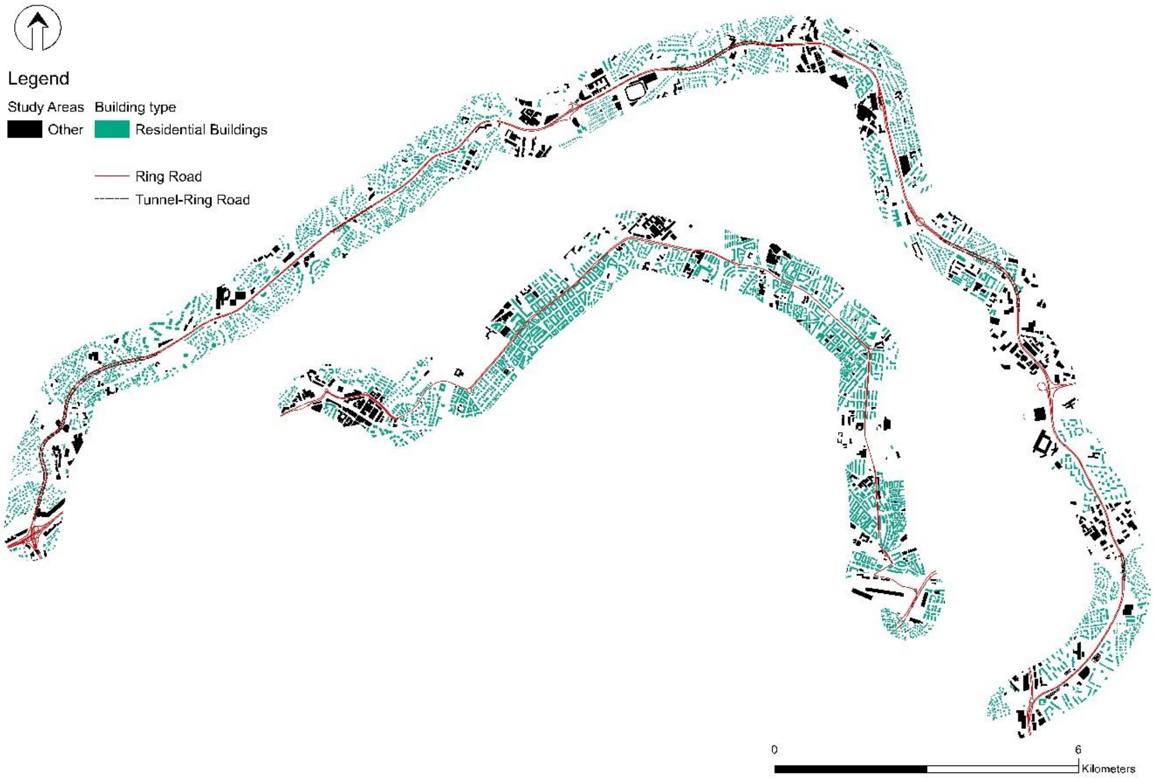

Figure 7: The residential distribution (in green) alongside ring roads in Oslo, March 2019

Figure 8 illustrates similar patterns alongside both rings. However, as mentioned previously, the morphological situation alongside these rings is reversed: there are urbanised, regular, and high-density structures with small concentrations of suburban areas alongside the second ring road. Parallel, organic, suburban, and low-density structures permeated by urbanised zones are found alongside the third ring road.

The spatial mapping of the study areas in Oslo shows the main structural pattern of the streets that ramify from what was once the second ring road. The primary distributor, the second ring road, has changed into a district distributor, and an orthogonal and rectilinear grid street system ramifies from it along some sections of the second ring road. The current urban design guidance typically depicts a grid-like pattern as the preferred pattern for growth (Marshall, 2005, p. 31). The study found a clear, commuting pattern that includes the public transit system. On the other hand, the study area alongside the third ring road shows that a tributary pattern of loops and cul-de-sacs ramifies from the primary distributor and follows the physical suburban structure. However, in the areas in which nodal development is being implemented, a geometric grid pattern, similar to the structural patterns of streets alongside the second ring road has been developed to facilitate the growth strategy (Figure 9). In general, the metro ring facilitates a clear public commuting pattern.

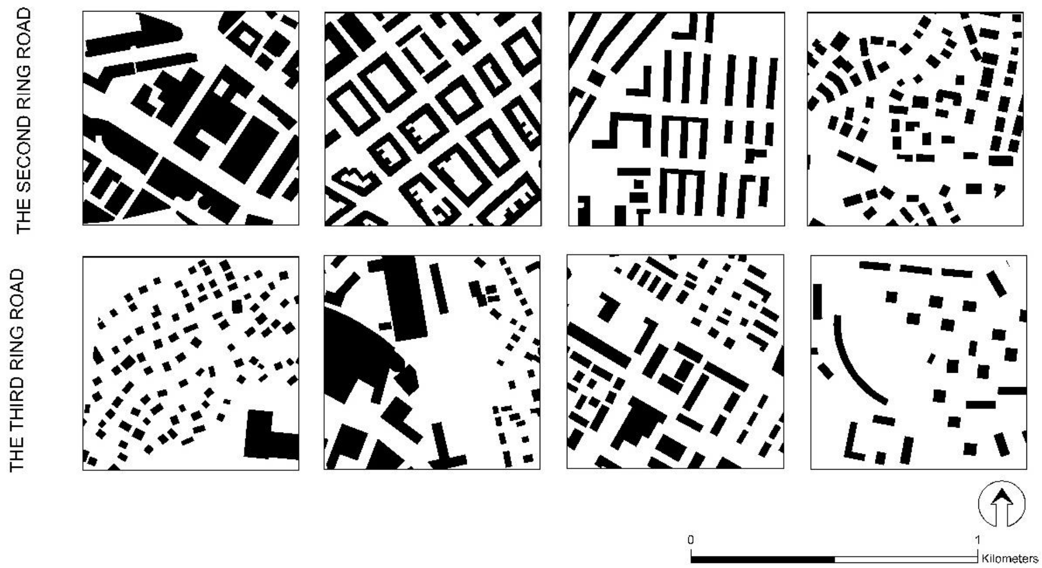

Figure 8: Spatial patterns alongside ring roads in Oslo, March 2019

This paper argues that the nodal development growth strategies, in parallel with the Oslo Metro Ring Line, will transform the topography alongside the third ring road in the long term. However, the municipality must find a mechanism to manage and overcome the existing spatial structure in their urbanisation processes. It must also have a clearer land-use strategy, particularly for areas around the proposed nodes, as private land ownership and high residential concentration are becoming obstacles to urban gentrification (Interviewee O-1, 2, and 3).

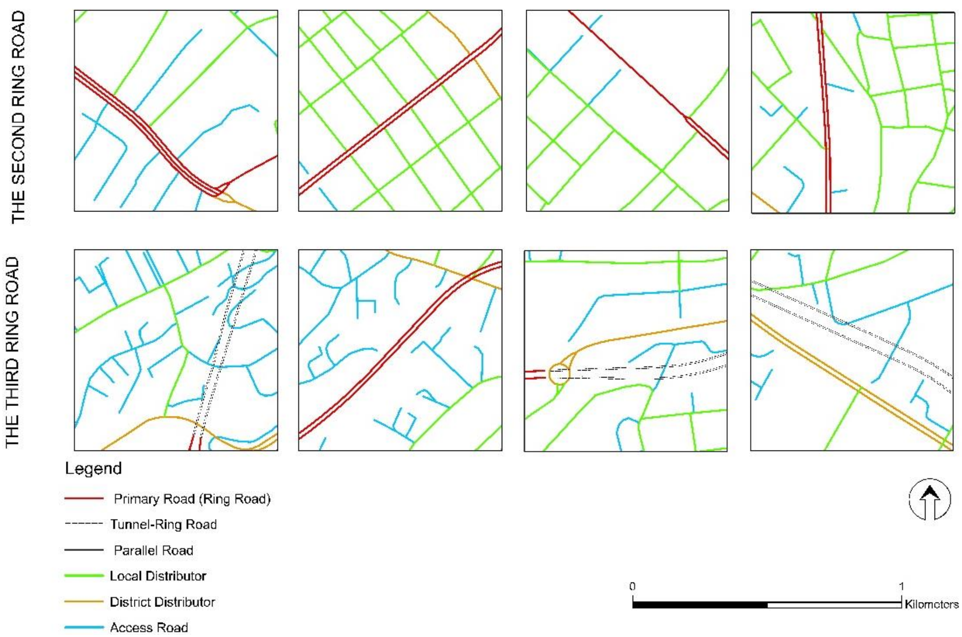

Figure 9 :Structural patterns of streets that ramify from ring roads in Oslo, March 2019.

2.4 Area 4: Cracks between the polycentric, Greater Helsinki, Finland

The Greater Helsinki is a metropolitan area that contains four municipalities: Helsinki, Espoo, Vantaa, and Kirkkonummi. The metropolitan vision is structured on a ring-radial road system, and its general growth strategies have mainly followed the radial corridors and public transportation nodes. The current road structure consists of seven concentric radial roads and two main ring roads: Ring I and Ring III. The shortest distance between these rings is 4 km, and the longest is approximately 17 km.

Similar to the other cases, the aim of constructing ring roads in Greater Helsinki was to channel heavy traffic outside the inner city. However, the difference, in this case, is that the ring roads facilitate, in both direct and indirect ways, a poly-nuclear urban structure as well. The first ring road in Greater Helsinki, the 23.3 km Ring I, passes through Espoo on the western side, and continues to cross the spatial structure of Helsinki. The third ring road, Ring III, which spans 47.8 km, passes through the administrative borders of Espoo, Vantaa, Helsinki, and Kirkkonummi. These two ring roads are highways that are owned and managed by the state, and their development plans follow the standards of the regional state authority. In terms of regulation, there is no direct accessibility from these roads to their surroundings, which results in longer paths leading to separated nodes and a dispersed street network.

Although both rings cut through the spatial structure without any regard for municipal borders, the initial plans at the city and regional levels have no detailed growth strategies targeting the areas alongside these rings. The areas alongside Rings I and III have generally been assigned to varied land use, and a significant area of land was reserved for logistics, consumer businesses, and medium and light industries. Even in this context, ring roads act as physical impediments to the urban flow, which can be critical considering their position in relation to municipal borders and the overall metropolitan structure.

However, generated by growth ideologies, this polycentric structure and its expanded localities have transformed occupational patterns and their arrangements in some sections alongside ring roads in Greater Helsinki. The contemporary practice of continuous growth as a dominant ideology has generated several urban visions and redevelopment strategies targeting select existing concentrations alongside both rings: the Espoo Innovation Garden alongside the western part of Ring I and Aviapolis alongside the northern part of Ring III (Amr, 2019). Large infrastructural investments alongside critical areas have been constructed, including tunnelling parts of the ring roads and building new mixed-use districts above ground, as well as improving public transit and access to those parts.

The spatial mapping of the existing structure alongside Ring I indicates that residential use dominates the urban scene: 59% of the existing structures are residential. However, the general characteristics of the residential areas are wide-ranging, as they include everything from suburban, low-density, and single-family houses mostly in the northern part, to modern apartment buildings with relatively higher densities in the eastern parts. Alongside residential use, one-third of the land is used by scattered business firms and industrial sites. The spatial mapping shows no significant medical or educational use in the study area alongside Ring I, which indicates higher spatial dependency factors.

The structure alongside Ring III has different spatial qualities. Commercial, business, and industrial buildings together constitute 60% of structures alongside this road, while 36% are residential, with a relatively low level of urban amenities. The general peripheral position, with reference to the overall municipal and polycentric structure, and the existence of Vantaa Airport to the north of Ring III, in particular, have influenced large-scale logistics and industrial use in the study area. This industrial distribution alongside Ring III was in line with the municipal strategies, particularly in Vantaa, to buffer the ring road through industrial and logistic use, while planning residential use for areas farther away from the ring road (Interviewee GH-1). However, the residential concentrations in this part of the study can be described as isolated suburban, low-density, and single-family patches, each having high dependency factors. Figure 10 illustrates the residential distribution, which is shown in green, in reference to other existing structures, which are shown in black, in the study areas in Greater Helsinki.

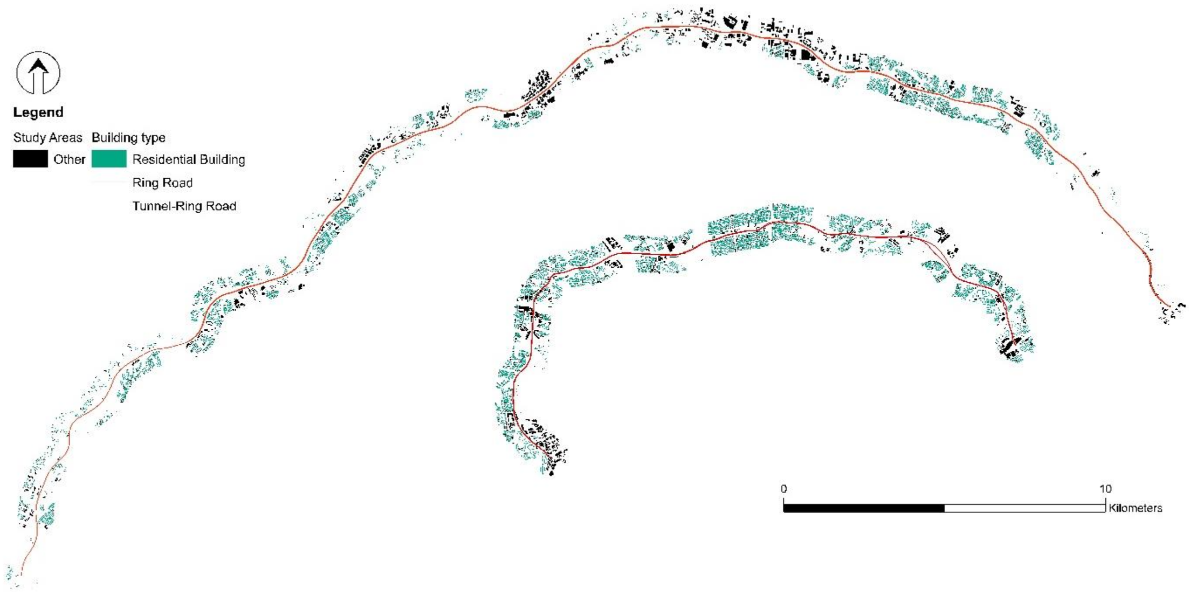

Figure 10: The residential distribution (in green) alongside the ring roads in Greater Helsinki, March 2019

The morphological mapping demonstrates two distinct figurative patterns between the areas alongside Rings I and III. Gradual attempts at urbanisation can be seen alongside the western and eastern parts of

Ring I, namely high-density and regular structures, while dispersed organic low-density and non-uniform suburban concentrations can be found alongside the rest of the first ring road. Most of this structure is located within the municipality of Helsinki. The areas alongside Ring III have organic, dispersed, and non-homogeneous structures alongside the road without exception. Figure 11 shows the types of spatial patterns alongside the study areas in Greater Helsinki and illustrates similar figurative arrangements between Rings I and III.

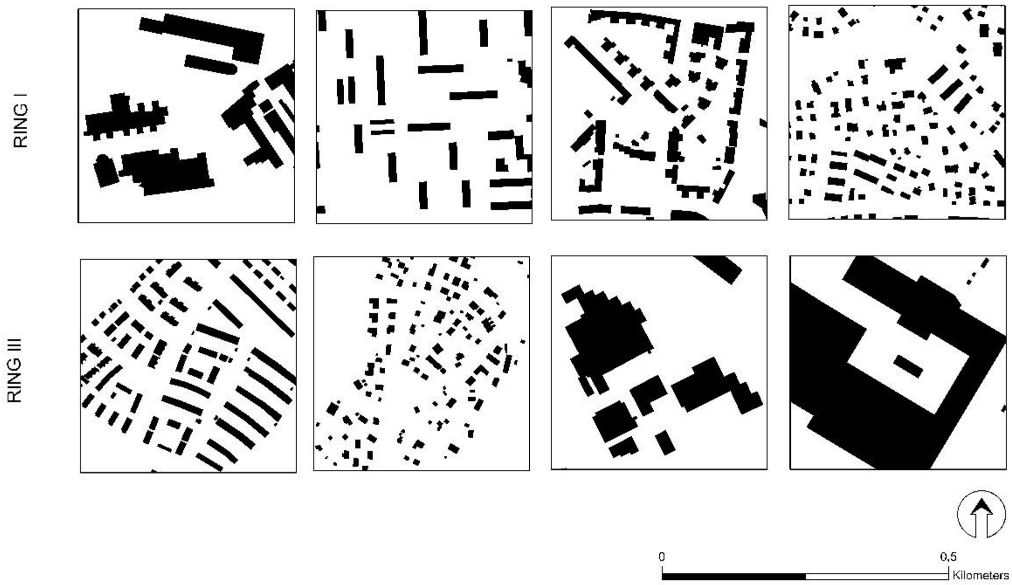

Figure 11: Spatial patterns alongside ring roads in Greater Helsinki, March 2019

A glance at the structural pattern of the streets ramifying from the ring roads in Greater Helsinki reveals a major pattern: a tributary organic pattern of loops and cul-de-sacs that usually exist alongside the low-density suburban and rural areas. The spatial mapping alongside both ring roads shows no direct accessibility, and entry to any attached district is facilitated by either a parallel road or a district distributor road. However, alongside the sections in which tunnelling projects have been constructed, the morphology of the ring road itself has dissolved, and entirely different street and accessibility patterns have developed (Figure 12). Approximately two kilometres of Ring I and three kilometres of Ring III are underground. The commuting patterns and accessibility factors are mainly based on private cars with longer trips, and the street surface area is larger in comparison with other areas alongside other arteries.

Figure 12: Structural patterns of streets that ramify from the ring roads in Greater Helsinki, March 2019

In summary, this study argues that the peripheral patterns are because of the position of the ring road with reference to the municipal border and the overall structure. The absence of a clear growth framework controlling the residential distribution alongside the ring roads has formed a non-homogeneous structure, particularly alongside Ring III. Ideally, areas alongside ring roads in a polycentric structure can be seen either as central locations between at least two urban centres with higher growth indicators and spatial potential or as the peripheral edges that form cracks and disconnections that threaten the polycentric flow in the long term. However, the current peripheral structure alongside Rings I and III in Greater Helsinki will challenge the existing and future growth processes.

3. Discussion

The deficiency in recognising and accommodating suitable movement and creating desired local and regional patterns that correspond to the spatial density alongside ring roads increases the spatial struggles at the local and regional levels. By drawing on a descriptive analysis, this study has explored a diverse range of urban design and planning aspirations alongside eight ring roads in four different contexts and has approached the contemporary practice of urban development alongside ring roads from several perspectives. While the focus is on identifying physical patterns in the case studies selected, namely road and land-use patterns, we touch on several related issues.

3.1 Policymaking and the regional vision

Fragmented planning processes operating at different spatial scales and limited considerations of spatial interdependency lead to unintended sub-optimal spatial patterns. The results have demonstrated some of the current inconsistencies in the specifications of policy implications and the spatial patterns produced. This study found that areas alongside ring roads are expressed either too vaguely, as in the cases of Greater Amman, Greater Helsinki, and the initial plans of Oslo, or are over-prescriptive for the purposes of prescription, as in the case of Kuwait. In most cases, the scrutinised ring roads were initially constructed with regard to municipal borders, as in the cases of Amman and Oslo, or were used as part of a city growth strategy, as in the case of Kuwait. However, in the case of Greater Helsinki, the study could not identify an overall strategy to determine where to construct a ring road and what its relationship should be with the overall metropolitan area. Ring roads, in the case of Greater Helsinki, pass through the spatial structures without any concern for municipal borders.

The results also show that the initial plans have assigned ring roads without actually being able to predict the patterns that would result alongside them. This lack of detailed conception and indeterminacy in the cases of Oslo, Greater Helsinki, and Greater Amman has allowed for a certain amount of spatial flexibility. Nonetheless, the results have been complex structures with high dependency factors. On the other hand, the case of Kuwait showed an over-prescriptive and strictly controlled example at a relatively small scale, and yet the formed structure continues to suffer from unpredictable results such as congested highways, disconnected spatial structures, and high dependency factors. The spatial challenges originated from envisaging a narrow and linear frame of reference of growth strategies that extrapolate certain variables and locations without considering the spatial interdependency circumstances of the remaining elements.

3.2 Existing structures and movement

Despite the detailed design strategies at the micro-level, the continuous anticipation of growth and the inadequacy of a deterministic view of the spatial pattern indirectly form a coarse structure. The study found that the physical character of ring roads and the spatial non-homogeneities alongside it preclude general growth and efficient urban design, increase urban vulnerability, and create flow disjunction. The initial land-use assignment alongside ring roads has been inefficiently dispersed. In some locations within each study area, functional zones juxtapose where small houses may border a large corporate centre or a mega-mall. Despite the scale, population densities, socio-cultural differences, urban growth strategies, and economic and political agendas, similar physical and functional characteristics are found across the study areas. The physical and functional characteristics alongside ring roads in the case of Kuwait, a relatively small-scale and low-density area, are similar to the Helsinki metropolitan region.

The study areas are highly occupied, with several residential use buildings, and the densities were calculated based on the ground floor ratio. Nevertheless, the residential concentration is higher if we consider the floor area ratio and their multi-levels. This means that people live closer to the highways, where the physical accordance of urbanity and growth is challenged by the characteristics of ring roads and their existing structure. This raises major strategic concerns and challenges any credible current and future development strategies. The formative influence of ring roads on the urban layout is associated with functional characteristics such as breaking the traditional relationships among buildings, public space, and movement while lacking identity and urbanity.

Except in the case of Oslo and selected parts of Greater Helsinki, the auto-dependent commute pattern of the examined ring roads is the consequence of a lack of an effective public transit system. Thus, the surface road area serving a neighbourhood alongside the ring roads is larger than the surface road area serving neighbourhoods alongside other types of roads. The standard urban models in this study, whether monocentric or polycentric, share a vague vision of land-use patterns and densities that formed in motorised commuting fashion alongside the ring roads. This random pattern alongside the ring roads in the study areas has resulted in the expansion of the surface road area alongside each ring road to improve movement and accessibility, which contradicts sustainable measures and contributes to a high carbon footprint and increased noise and air pollution, fuel consumption, and traffic congestion.

3.3 New relative and relational indices and spatial adjustments

Prioritising growth and its generative urbanisation processes in contemporary practice is changing the sizes of cities and transforming planning attitudes to include localities alongside ring roads. A shift in contemporary development practices to minimise the impact of ring roads and replace the spatial structures and land-use alongside them are clear indicators of the struggling structures alongside the ring roads. The study found similar growth modifications and adjustment attitudes across all of the areas that are attempting to mitigate the surface and physical characteristics of the ring roads and areas alongside them such as tunnels, bridges, pedestrian paths, and bike lanes. For example, in the case of the second ring road in Oslo and selected areas in Greater Helsinki, a joint planning mechanism and negotiations among all parties have been set up to solve the private ownership barrier. Parallel, nodal development strategies and new mobility solutions are being implemented as a counter-formulation to accommodate growth alongside ring roads in Oslo and Helsinki. In the case of Greater Amman, there has been a massive yet early shift in the planning process to replace the second ring road with an urban growth corridor. However, thus far, no primary spatial changes have been found in the case of Kuwait. Figure 13 and Table 1 summarise the major points of the spatial mapping carried out in the study areas.

The spatial mapping identified several mechanisms that helped overcome the complex spatial situation alongside the ring roads and facilitated growth.

Figure 13: A summary of land-use distribution and intensification alongside ring roads in the study areas based on the ground floor area.

4. Conclusions

Areas alongside ring roads, like any component of a spatial structure, cannot be steered according to the principles of a prescription, particularly with informal land-use assignment. By examining the interdependent behaviour of the road network in general and ring roads in particular, as well as the multidisciplinary spectrum of urban planning and development, this study makes it clear that the current spatial situation has resulted in disjunctive patterns. The peripheral structure, the prevalence of private ownership, the regularity system, and the dominance of residential use, as well as the barrier effect provided by the ring roads themselves, are obstacles that need to be overcome before furthering any new growth strategies. The continuous changes, because of growth, in the relative and relational positions of ring roads and, by extension the areas alongside them, calls for more nuanced initial master planning to take account of ring road urban externalities. This issue has to be framed not only from spatial and traffic perspectives but also from socio-ecological standpoints, especially with the growing risks of climate change and other challenges to human health. The study recommends more sustainable interventions, responsive growth strategies, new mobility solutions, and local partnerships and collaborations to control and direct existing patterns alongside ring roads to contribute to the overall structure. Growth ideologies have to develop smart land-use management practices and continuous project reviews instead of a general prescription and assignment process. This will entail overcoming bureaucratic procedures and outdated policies that govern and operate those areas and necessitate support for more corresponsive, resilient, and non-linear planning processes and frameworks. Consideration should be given to policy learning and dialogue with stakeholders, and a continuous iterative review of policies and procedures should be conducted to avoid unintended sub-optimal spatial patterns. Finally, the study suggests context-specific concepts and tools with a reasonable probability of implementation in both the short and long term, such as new context-dependent building regulations in which municipalities and regions are required to adopt special regulatory instruments to control the location, type, density, layout, design, and pace of private development for inclusive application.

	Location	Functional Occupation	Spatial Qualities	Patterns of Arrangement	Accessibility alongside ring roads	Transformations – Growth Strategy	Notes
Amman **Decentralisation**	The first ring road– Al-Hezam Ring	Residential medium density	Mostly Peripheral	Mostly Dispersed	Accessible by car only with no public transit alongside the ring road	No significant change in growth strategies but minor changes at the ring road itself to improve its functionality; pedestrian bridges and intersections. No significant change at the spatial level.	High dependency
	The second ring road – Amman Corridor	Residential Relatively new	Peripheral	Dispersed	Accessible by car only with no public transit alongside the ring road	Major shift in growth strategies using the urban spine concept, the second ring road was transformed into a growth corridor.	High dependency
Kuwait **Centralised - Grid**	The fourth ring road	Residential and Commercial Low density	Partially Urbanised	Regular	Accessible by car only with no efficient public transit alongside the ring road	No significant change in growth strategies but minor changes at the ring road itself to improve its functionality; expand the road capacity.	Partially sufficient
	The fifth ring road	Residential Low density	Partially Urbanised	Regular	Accessible by car only with no efficient public transit alongside the ring road	Minor change in distribution urban dynamics and public institutions.	Partially sufficient
Oslo **Centralised - Compact**	The second ring road	Residential High density	Urbanised	Compact	Accessible by public transit, mostly buses and trams, with limited cars used allowed	Major transformation; densification processes after transforming it to a normal street.	Sufficient
	The third ring road	Residential Medium density	Mostly Peripheral	Mostly Dispersed	Accessible by public transit, metro ring, and cars	Major transformation; nodal development at some intersection between the radial corridors and the third ring road. The construction of the metro ring.	Medium dependency
Greater Helsinki **Polycentric**	The first ring road– Ring I	Residential Medium density	Mostly Peripheral	Mostly Dispersed	Accessible by cars only	Minor change alongside the western part using cluster development strategy.	High dependency
	The third ring road– Ring III	Commercial and Residential Low density	Peripheral	Dispersed	Accessible by cars only	Minor change alongside the northern part using cluster development strategy.	High dependency

Table-1: Important highlights of the case study areas

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