

#39

THE MORPHOLOGY OF PORTO ALEGRE'S INDUSTRIAL DISTRICT:

Between economics locational theories and space syntax methodologies

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ABSTRACT

Economics has come a long way into describing the associations between space and industrial production. Since then, there has been considerable research on regional industrial distribution but not quite as much on how industrial sites organize themselves spatially inside urban spaces. This blunders on the hindrance of relating important economics spatial variables, as metrical distance, transport time and site costs, to morphological properties of self-organized and fragmented urban areas. As such, an economical based understanding of cities industrial distribution and agglomeration spatial patterns is still scarce.

Space syntax methodologies offer interesting alternatives to classical economic models, since its methods enable a complex system approach to main economics and regional studies spatial and morphological variables. Its angular analysis allow the evaluation of topological distances, better suited to city network analyses than traditional locational theories approaches, and centrality measures depicted with this method can distinguish and pinpoint the industrial activity attractors only referred by theoretical economics, which permits a better interpretation of the economic spatial logic inside urban spaces. Therefore, this paper explores these relations between economics locational theories and urban spaces morphological properties, taking as its empirical case the 4th District-Development Corridor industrial area at Porto Alegre/RS, Brazil, which comprehends one of Porto Alegre Metropolitan Region's (PAMR) main industrial sites.

To demonstrate such relations, the distribution of industrial structures in Porto Alegre's 4th District-Development Corridor Area was mapped and compared to its spatial network, modelled applying angular analysis. Integration and choice measures, correlated to the Kernel Distribution of industrial agglomerates provided robust evidence to corroborate the hypothesis that industrial land use follows the spatial logic suggested by regional economics locational theories in urban contexts. Global integration and choice measures correlation evidences that industrial activities tend to concentrate near the highest global accessibility areas, and, especially, have a strong dependence relation with most relevant "through-movement" routes in the system. However, the sites are scattered alongside these areas, placed in segments with lower global but high local integration and choice values, which denote a localised "clustering effect" provided by higher value global segments.

The results discussion displayed here suggest that space syntax methodologies can provide relevant theoretical and practical contributions to economics locational theories, since they can depict attributes and effects regarding spatial logic of economic activities distribution in urban contexts, phenomena yet to be described and explored by economic locational theories.

KEYWORDS

Urban Morphology, Space Syntax, Locational Theories, Industrial Sites

1. INTRODUCTION

Theoretical Economics has come a long way into describing how places' spatial properties relate to locational patterns in economic activities and, particularly, how industrial production sites distribute and organise themselves territorially at regional scale. Although there is considerable research done in the matter, the utmost of economic models, derived from classical geography economics, refer to a variable defined as crucial for the determination of special-economic relations: the metrical distance. This happens, mainly, because the transportation time – a metrical distance dependent variable – configures itself as fundamental in production costs and prices composition, thus, having influence in industrial competitiveness in local, regional and global markets.

Metrical distance first appeared in regional studies as a key variable for industrial locational patterns in Weber's *Theory of Locations of Industries* (1929) who elicited that the sole regional factors that had influence on location and distribution of industrial sites were labour and transportation costs. These costs were conditioned to a distance, from the industrial sites, towards a series of discrete points in space representing both inputs – workforce and raw materials – and production distribution areas. According to Weber (1929), industrial sites would locate themselves inside regions that minimize locational costs, orientated by minimal metrical distances amid those referential marks and the placement of industrial plants. This approach suited well the economic abstraction of physical features at regional scale, hence, it was followed by other prominent economists as Lösch (1938) and Isard (1956), who also discoursed about industrial location dynamics. Despite Weber's (1929) work classical nature, even contemporaneous New Economic Geography models, describing industrial agglomeration and regional growth, such as Fujita and Mori's (1996), and, Fujita and Thisse's (2002) maintain metrical distance as a comparative measure in analysis of how economic activities differentiate places at regional level and inform agglomeration processes.

Although metrical distance is one of the binding variables in economics regional analyses, it faces serious hindrances when applied to smaller interconnected heterogeneous systems, such as urban grids at local scale. These limitations became evident on Alonso (1964), and Muth (1969) neoclassical urban models, which applied metrical distance in order to explain location, land use, and site costs dynamics inside cities. Even though these models allow remarkable economic conclusions, providing evidences that industries tend to concentrate themselves near central business districts, they are overmuch limited in spatial forms description and do not contemplate multiscale or multidimensional analyses at urban scale, roughly explaining the attractors involved in industrial spatial distribution. This shortcoming relates to the economics locational theories need of setting discrete referential points in metrical distances and spatial fluxes measurements. Due to modification of productive systems and integration of industrial chains, resulting from the shift towards flexible production models, the increase in number of displacements between origins and destinations makes the efficient establishment of such points through traditional methodologies a demanding task. Added to this, the very fragmented, discontinuous and self-organized configurational structure of urban spaces (PORTUGALLI, 2006) makes it challenging to use an essentially non-network based economic theory to study the interactions between industry and urban.

Attempts to analyse urban and metropolitan areas as complex systems and use different concepts of distance, such as topological, in economic analyses are rare, given the predominance

of classical geography economics models. Still, alternatives to orthodox economic analyses are found in Allen's (1997) self-organising urban growth attractor's models, in Boudeville (1972), who applied network topological models to describe industrial polarization processes at regional scale based on Perroux (1955) work, and in Crocco, Ruiz and Cavalcante (2008), which study the relationship between urban-regional space and financial services, through the construction of spatial networks. In addition to those, other cross-disciplinary studies have been developed, such as Chiaradia et.al. (2008), which correlates use value and relative accessibility – integration; Roccasalva & Pluviano (2012) analysis, which correlates *bewteenness* centrality to industrial clustering effects; and Yang (2015), which studies the influence of urban networks morphological properties with location and land use through economic big data and space syntax methods and tools. Nevertheless, the need for spatial-statistical analysis non-based integrally on locational economics metrical distance, and an economic driven approach for urban spatial variables through space syntax is still incipient.

Hence, the objective is to display analyses results combining economic locational theories concepts and space syntax methodologies in order to assert if integration and choice measures can depict the logics of industrial agglomeration processes, as stated in regional and urban economic theories. This paper also focuses on describing relations between movement potentials and flow probabilities through urban networks, and industrial activities organization patterns, evaluating "clustering effects" dynamics provided by those both in global and in local scale. The analysis area where industrial land use relations with morphological features are empirically tested is the 4th District-Development Corridor (PDDUA, 2010) area at Porto Alegre/RS, Brazil, which comprehends one of Porto Alegre Metropolitan Region's (PAMR) main industrial sites, and is undergoing an extensive economic restructuring from the beginning of the 21st century, however conserving some of its old industrial sites.

Findings addressed by space syntax methodologies can lead to innovations on economics locational analysis since they depict the urban network morphological attributes and inform the spatial logic of economic activities diffusion and "clustering effects" in urban contexts, phenomena not yet fully explored and described by urban planning and economics locational theories.

2. DATASETS AND METHODS

To appraise relations between economics locational theories and space syntax methodologies it was apposed two main sets of data on a GIS (QGIS, 2016) database: Porto Alegre's industrial sites locations and its road network decomposed in an angular segment map.

Industrial sites locations encompasses all industrial dedicated structures located within the Porto Alegre's 4th District-Development Corridor perimeter. Composed by old industrial neighbourhoods in process of productive restructuring (4th District) and by the modern industrial metropolitan pole, enacted by 2010's master plan inside the Development Corridor (PDDUA, 2010), this analysis area corresponds to one of PAMR most industrialized regions. This area also incorporates main interstate highways (BR-101, BR-290 and BR-448) and important local A-Roads that cross Porto Alegre northern periphery, being representative to regional transport networks and road structuration. Regarding the locational data gathering for the industrial sites, its accuracy was achieved by comparison between empirical collected data, Porto Alegre's Land Use and Zoning Map (2010) and satellite data (Google Maps, 2016), mapped altogether in a single polygon shape database. These polygons also contain information about the constructed area of each structure, which is used as a weighting variable in employed geo-statistical analyses.

Porto Alegre's road network was based on Rigatti & Zampieri (2011) axial map, which was updated by Gambim (2014) in order to incorporate recent urban sprawl patterns, and further converted in segments for proper angular analyses. The once axial map was also partially reconstructed in 4th District-Development Corridor areas using road-centre line representation based on Turner (2007), in order to refine the angular analysis modelling (HILLIER, 2007). This partial adaptation towards road-centre line was made because method's finer portrayal of choice measurements

in angular analysis (TURNER, 2001; 2007), which captures represent differences in movement potentials and flow probabilities at a block level better than simple axial lines. In addition, this method can minimize any edge effects in global integration analysis (TURNER, 2001; 2007), which is important as most of the analysis area is close to the system's border.

Integration and choice measures were analysed globally (radius n) and locally (radius R7 step) in order to describe urban grid topological distances and morphological patterns within the 4th District-Development Corridor Area. Using integration and choice analyses at R7 step, instead of traditional R3 step (HILLIER, 2007), justifies because the mean depth differences among Porto Alegre north (orthogonal grid) and south (discontinued grid) areas are remarkable and only R7 step is capable of revealing the unevenness of sprawl and growth between these two city sectors (BRAGA, 2014). As well, R7 step consists in the last topological radius capable of depicting local centres, without confining the highest segments to areas with predominant orthogonal grid patterns, before the results approximate to global radius (Rn), thus, providing, for these analyses a better spatial logic description. Both global and local analyses have its representations restricted to determined percentiles – which depict the highest value segments for each analysis – intending to establish a parameter for the statistical correlation made through geo-statistical analysis. The calculation of these percentiles, nevertheless, is not arbitrary, and follows a logic proposed in Pareto Distribution Principle or Pareto's Law (PARETO, 1971), where, in order to be a significant correlation, at least 20% of causes – represented by segment values in angular analysis – needs to be responsible for at least 80% of the effects – determined by industrial structures locations. Such correlation basis established by Pareto (1971), however, is reducible to higher percentiles, in pursuance of establish more robust and precise correlations between cause and effect. The empirical analyses developed use, in addition to Pareto's percentiles above 80th (20%), to assess base correlations, percentiles above the 95th (5%), in order to halve the 10% correlation spectrum previously used by Roccasalva & Pluviano (2012) and verify in a more detailed way correspondences between industrial organization and urban morphology. Tables below demonstrate the first above percentile values in each angular analysis.

Total Number of Segments	Segment Value in 20% Integration – Rn	Segment Value in 20% Integration - R7	Segment Value in 20% Choice – Rn	Segment Value in 20% Choice – R7
66627	5.613,47	68,97	2.179.892	830,00

Table 1 - Total number of segments in angular analysis and value of first segment above 80th percentile – top 20% (Pareto Distribution) for integration and choice

Total Number of Segments	Segment Value in 5% Integration – Rn	Segment Value in 5% Integration - R7	Segment Value in 5% Choice – Rn	Segment Value in 5% Choice – R7
66627	6.214,79	89,35	31.794.504,00	1.551,00

Table 2 - Total number of segments in angular analysis and value of first segment above 95th percentile – top 5% for integration and choice

Analysis Area

- 4th District-Development Corridor Area
- Non-Industrialized Development Corridor Area

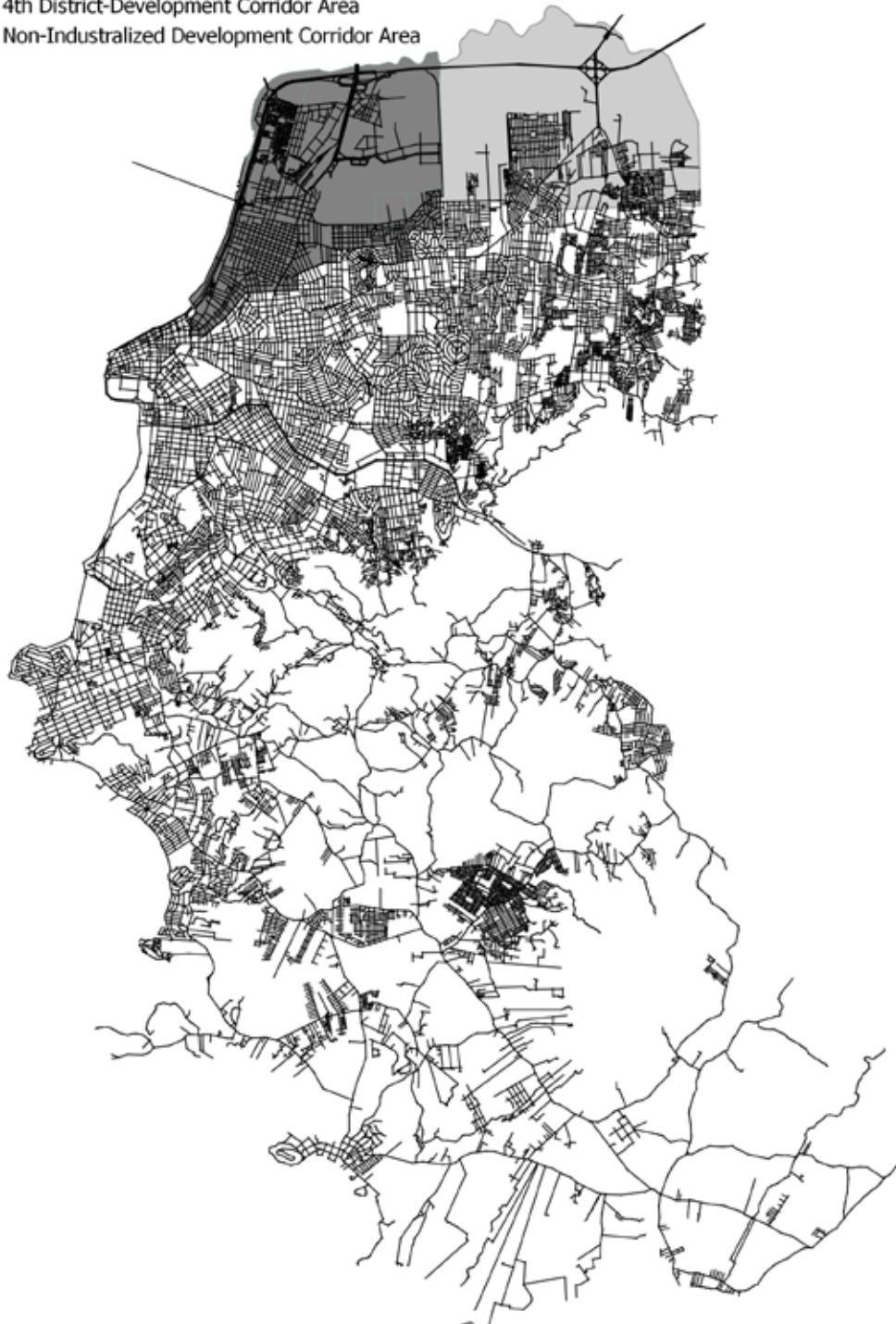


Figure 1 - Porto Alegre's Angular Segment Map and 4th District-Development Corridor Analysis Area

Space Syntax Angular Analyses, as depicted, were combined and overlaid with a geo-statistical spatial diffusion analysis based on the Kernel Distribution Method (WAND & JONES 1995; BAILEY & GATRELL, 1995), in order to establish correlations among the morphological features found in urban spaces – represented by integration and choice measures, and the industrial sites organization patterns. Such combination between analyses allow to perceive where urban “attractors” or “gathering axis” are located and to observe where the industrial “clustering effects” happen, permitting an approximation to dynamics proposed by economics locational theories.

The Kernel Distribution Method, or Kernel Density Estimation, consists in a non-parametric approach to estimate spatial density functions of a variable within determined areas. Thus, it permits to visualise variables patterns and tendencies on spatial distribution, agglomeration and diffusion potential, resorting to a finite data sample (MURPHY, 2012). It is possible, implementing this method in a GIS database, to spatialize gathered industrial sites data through a heatmap, which reveals, not only areas with higher structures density – denoting industrial agglomeration patterns – but also, assess the probability of diffusion and coverage of these structures, depicted from a metrical distance based radius – or *buffer*. As such, this method can be employed as a means to evaluate the industrial clustering dependence – on terms of nearness – of the circulation network it is embed, establishing its “attractors” through the correlation with movement potentials (integration) and flow probabilities (choice), denoting consequential “clustering effects” of each configuration at different scales.

The Kernel Estimation used in these empirical analyses is modelled through an Epanechnikov (1969) function, which possesses a minimum variance, leading to improved results on spatial diffusion and density measures. The metrical radii are set at 500m (R500) – the average intra-industrial short displacement routes distance – from the industrial sites polygon centroids weighted by industrial structure constructed area. Although using centroids is not ideal, because it underestimates the diffusion radius and influence span, as it does not irradiate the radius from the polygon form but from its centre, it was the best possible approach allowing spatial analyses, since QGIS (2016) software do not accomplish polygonal based Kernel Estimation.

3. RESULTS

Analyses results indicate the existence of robust geo-statistical correlations between industrial activity organization and distribution, and the urban network morphological properties visualised through integration and choice measures, both at local and global scales.

Those results demonstrate that the industrial sites are rather associated with closeness centralities, with its locational tendencies related to high global and local integration routes, denoting a somewhat significant reliance on the movement potentials provided by spaces with higher relative accessibility. This reinforces spatial vicinity logic in the formation of industrial agglomerations inside urban spaces, as stated by economics locational theories, since it explains intra-industrial and regional movements’ dynamics, and its relations with supportive activities such as retail and services. As well, those findings are related to industrial activities diffusion patterns, as integration is suggested to have a place in the initial development of the industrial spaces.

On the other hand, results regarding choice measures denote that industrial sites locations are remarkably dependent of betweenness centralities, with locational tendencies presenting correlations with high flow probabilities at global and local scales, each one denoting a specific configurational logic. Global results emphasises city’s *supergrid* relevance concerning industrial sites organization, as these road segments function as “gathering axis” conducting the industrial polarization processes within city, being responsible for main industrial “clustering effects”, as proposed by economics locational theories. Results at a local scale, however, unveil industrial sites tendencies to form “enclaves” places with high local flow probabilities that tend to be segregated from main urban traffic. Such places favour short displacements within industrial sites, providing a reduction on travel time and increasing production chains movement efficiency. As a result, this, alongside the spatial vicinity logic, leads to diminishing costs on production, higher productivity, and local “clustering effects”

Angular Segmented Circulation Network and Kernel Estimation Analysis	Total - Industrial Sites	Industrial Sites - Within 500m Radius	Industrial Sites - Outside 500m Radius	Correlation - Angular Analysis
Integration Rn (Top 20% Segments)	1851	1551	300	83,8%
Integration Rn (Top 5% Segments)	1851	1026	825	55,4%
Integration R7 (Top 20% Segments)	1851	1840	11	99,4%
Integration R7 (Top 5% Segments)	1851	1521	330	82,2%

Table 3 - Total number of industrial sites; Number of industrial sites within and outside Kernel Estimation 500m radius of at least one route segment above specified percentile (20% and 5%); And Correlation between Integration Angular Analyses and Industrial Sites Location.

Global integration analysis (Fig.2) establish that 83,8% (Table 3) of industrial sites total are located within 500m from at least one top 20% route segment, revealing the existence of a Paretian (1971) cause-effect correlation between high relative accessibility and tendencies of industrial distribution and organization at a global level. However, when a more restrictive percentile is applied to global integration analysis (Fig.3), it is revealed that only 55,4% (Table 3) of the industrial sites are located within 500m of at least one top 5% route segment, a rather small correlation if compared with the Paretian results, being 28,4 p.p. lower. Furthermore, it can be observed that those recurrences in top 5% happen in areas adjacent to highest global accessibility fringes, far from the most integrated segments within the restriction and from the relative accessibility core. Such analysis demonstrate that high global integration may have a lesser importance as an industrial “clustering effect” factor than once anticipated. Nonetheless, the larger industrial agglomerations (indicated by darker spots in Kernel Estimative) that are found in between integrated segments, corresponding to the aged industrial area, suggest that “to-movement” areas may function as industrial “attractors” in the early stages of its development. This corroborates neoclassic urban economics proposition about industrial location and land use (ALONSO, 1964; MUTH, 1969), as the spatial logic found on network analysis through geo-statistical methods is similar to that theoretically implied in those models.

Local integration analyses indicates that industries have a more complex relation with closeness centralities than global analyses can effectively evaluate. Paretian analysis (Fig 4.) reveal that 99,4% (Table 3) of total industrial sites are located within 500m from at least one top 20% route segment, indicating a robust cause-effect relation between tendencies of industrial sites distribution and the most integrated segments at a local scale, well above Paretian Distribution (1971) established bias. With this correlation, it is possible to explain the movement dynamics and spatial logic vicinity within industrial areas, as presupposed by economic theories. Higher local accessibility conditions implicate in efficient transport routes inside industrial areas, diminishing transport costs and improving firm’s productivity (PORTER, 1998), which leads to a more clustered and interdependent organization in these areas. Is noteworthy, however, that local areas with greater local integration values are infrequently occupied by industrial sites, as observed through Kernel Estimative darker spots absence near R7 step integration cores. Those local integration cores – found on orthogonal grid areas – are generally committed to retail and services activities (ALONSO, 1964; YANG, 2015), that demand more public displacements and visibility, thus, a higher relative accessibility. Such locational predispositions of industrial sites can be better observed through application of a restrictive percentile on local integration analysis (Fig.5), which reveals that 83,2% (Table 3) of total industrial sites are located within 500m of at least one top 5% route segment. Although presenting a high correlation, reinforcing the Paretian findings, the a significant difference of 16,6 p.p, demonstrates that industrial placements are high within mid-range local integration areas, which, in general, also have a lesser land value (CHIARARDIA, et.al 2008), being more attractive to area intensive industrial

activities. The spatial logic found in local integration analyses concurs with Isard's (1956) patterns of industrial locations regarding transportation, with Alonso (1964) and Muth (1969) economics statements on urban industrial distribution, and with Yang (2015) functional locational patterns.

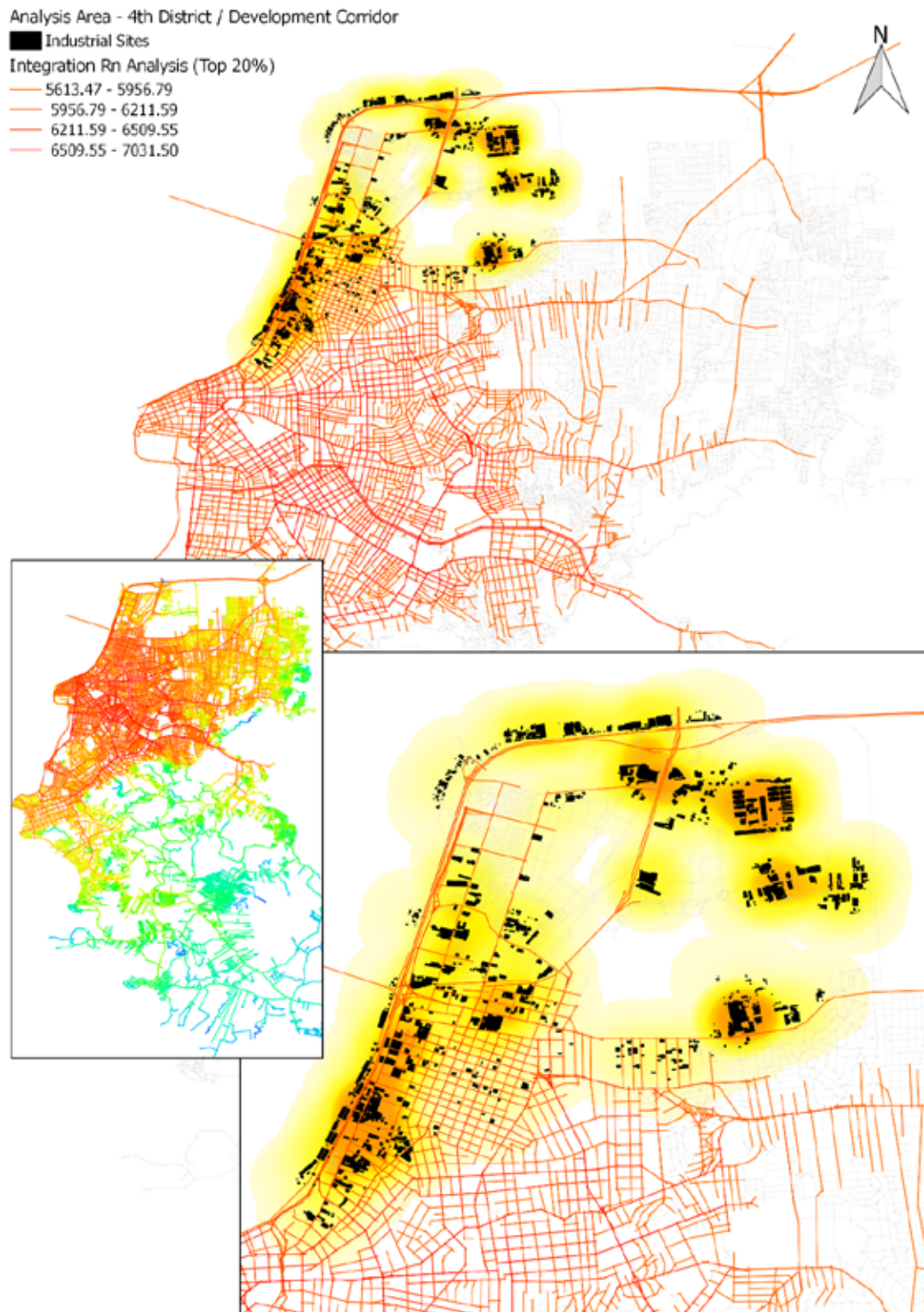


Figure 2 - Integration Rn angular analysis (top 20% segments) and Porto Alegre's industrial sites kernel distribution (500 m radius)

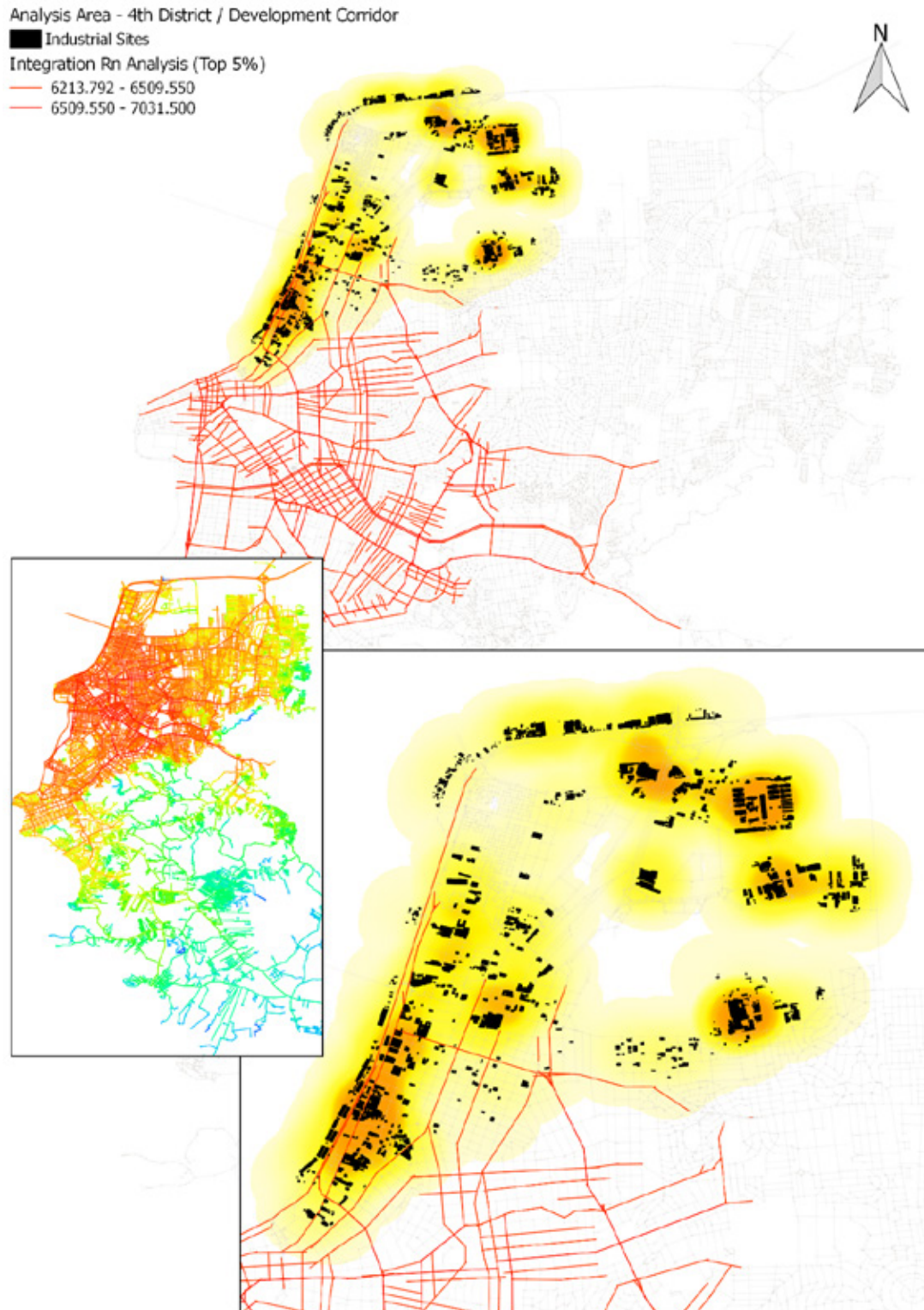


Figure 3 - Integration Rn angular analysis (top 5% segments) and Porto Alegre's industrial sites kernel distribution (500 m radius)

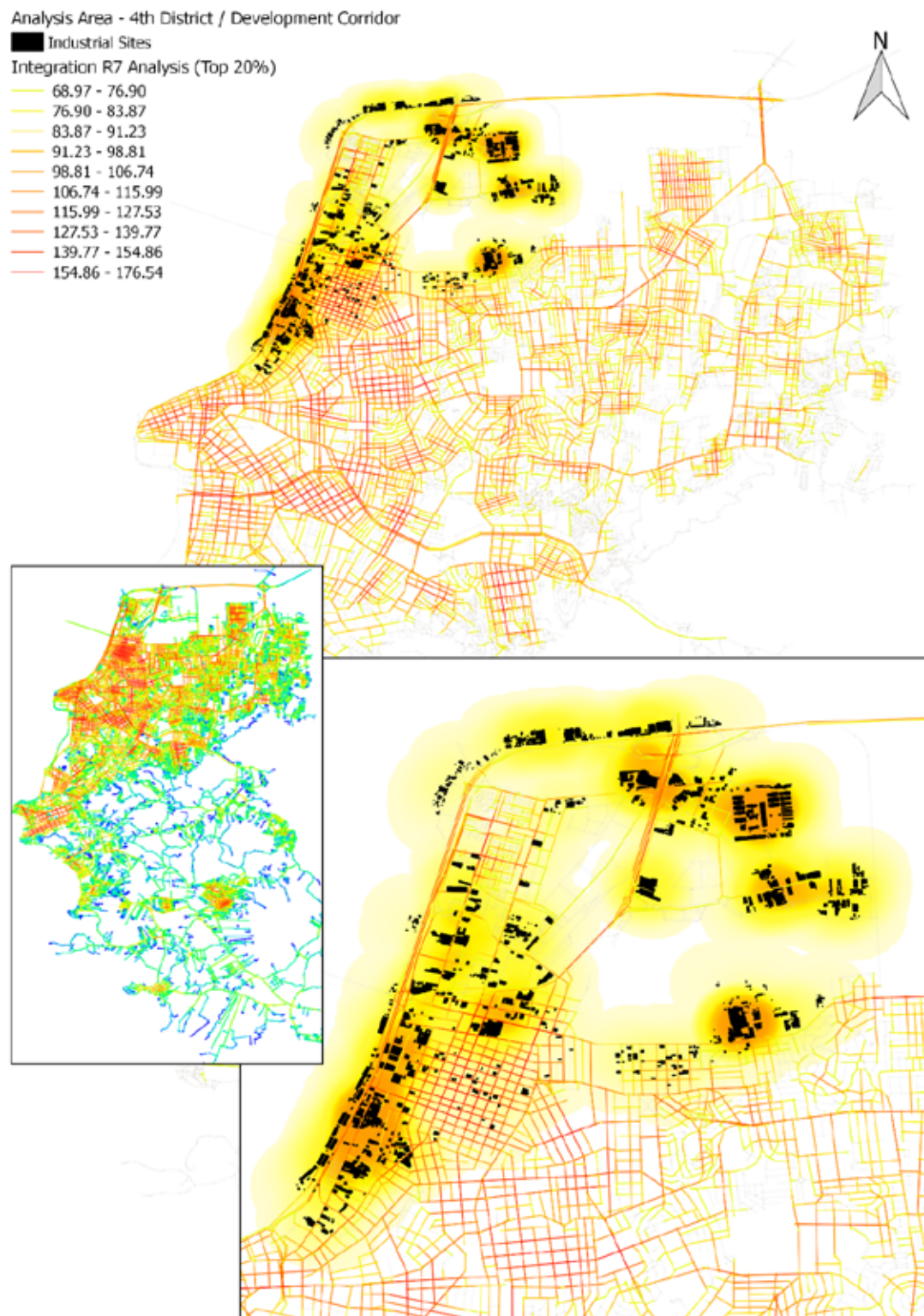


Figure 4 - Integration R7 angular analysis (top 20% segments) and Porto Alegre's industrial sites kernel distribution (500 m radius)

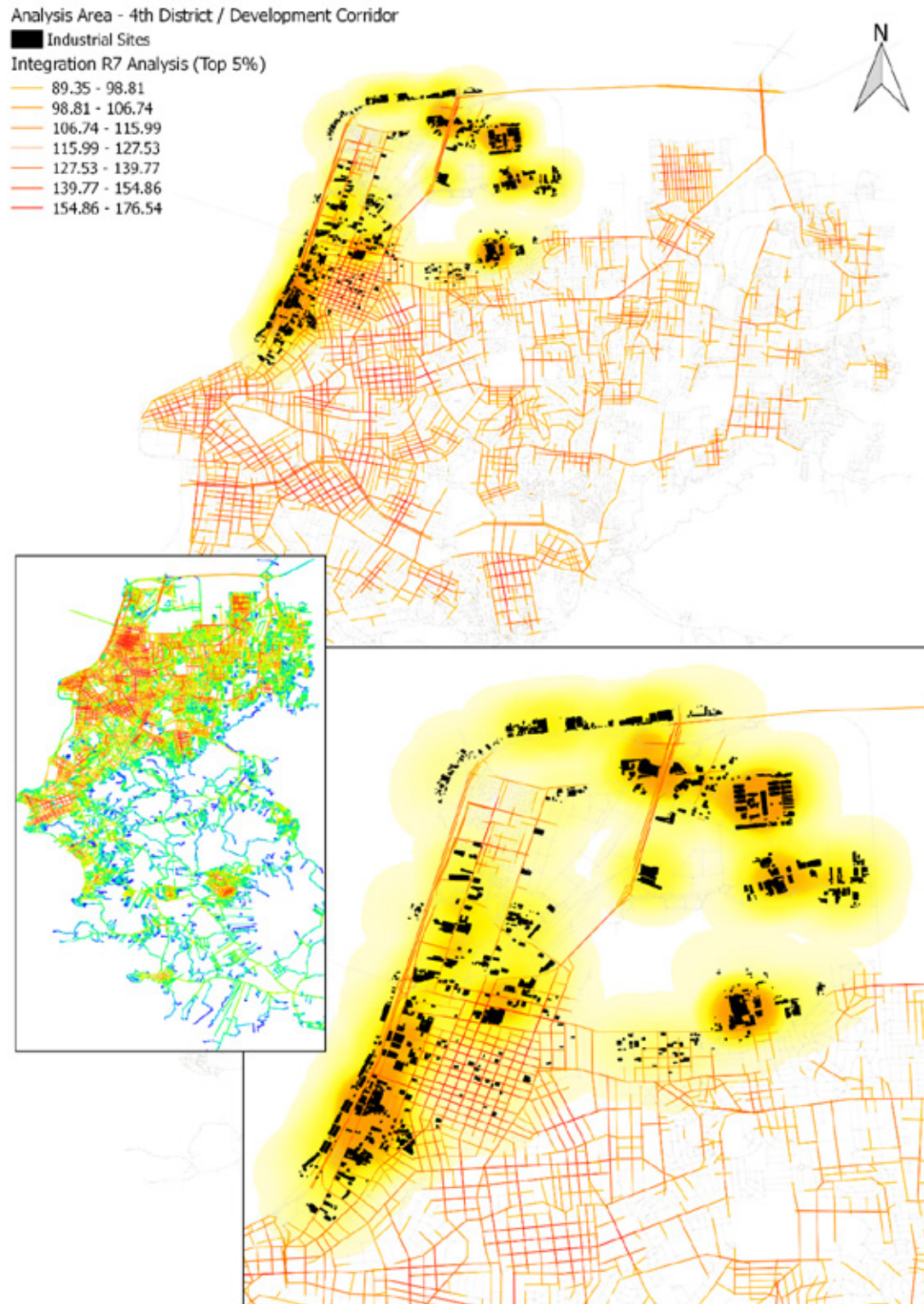


Figure 5 - Integration R7 angular analysis (top 5% segments) and Porto Alegre's industrial sites kernel distribution (500 m radius)

Angular Segmented Circulation Network and Kernel Estimation Analysis	Total - Industrial Sites	Industrial Sites - Within 500m Radius	Industrial Sites - Outside 500m Radius	Correlation - Angular Analysis
Choice Rn (Top 20% Segments)	1851	1806	45	97,6%
Choice Rn (Top 5% Segments)	1851	1481	370	80,0%
Choice R7 (Top 20% Segments)	1851	1832	19	99,0%
Choice R7 (Top 5% Segments)	1851	1530	321	82,7%

Table 4 - Total number of industrial sites; Number of industrial sites within and outside Kernel Estimation 500m radius of at least one route segment above specified percentile (20% and 5%); And Correlation between Choice Angular Analyses and Industrial Sites Location.

Global Choice analysis (Fig.6) establish that 97,6% (Table 4) of the industrial sites total are located within 500m of at least one top 20% global “through-movement” route, which constitutes a significant Paretian Correlation (1971). Geo-statistical Kernel Estimative analysis unveil that industrial sites locational tendencies are strictly related to the A-Roads and B-Roads (TURNER, 2009) responsible for the urban structuration of 4th District-Development Corridor area, being enclosed by those routes. It is noteworthy, however, that those road segments are mostly composed by the lowest spectrum of choice angular analysis on Paretian correlation (1971), as urban network highest choice segments consists in the A-Roads responsible for connecting city’s north and south areas (Fig.6). Even though this correlation is substantial and capable of explaining industrial sites spatial logic of distribution, regarding its dependence towards segments with high flow probabilities that concentrate industrial transportation routes at an urban scale, it is through a higher percentile restriction analysis that regional dynamics between economic and configurational became discernible. When restricted to a higher percentile, global choice geo-statistical analysis (Fig.7) indicates that 80% (Table 4) of all industrial sites are located within 500m of top 5% global choice segments. These segments accurately represent city’s *supergrid*, composed by Interstate Highways and main A-Roads within 4th District-Development Corridor area, which function as “gathering axis”, being responsible for the transportation outside industrial area towards Porto Alegre’s Metropolitan Region. These high flow probability roads, as observed through Kernel Estimation analysis, conduce the industrial polarization processes within city, indicating that industrial agglomerations and clusters tend to emerge in its vicinities, in a logic similar as proposed in Allen (1995) urban evolution model, being responsible for main industrial “clustering effects”, as proposed by economics locational theories.

Local choice analysis (Fig.8) also exhibit a high Paretian correlation (1971), as 99,0% (Table 4) of the industrial sites total are located within 500m of at least one top 20% local “through-movement” route. This analysis unveil industrial sites tendencies to form “spatial enclaves”, places with high local flow probabilities that tend to be segregated from main urban traffic. This “enclaves” phenomenon is also supported in a more restricted percentile local choice analysis, which also reveals the connections between industrial sites (Fig.9). This analysis demonstrate that 82,7% (Table 4) of the industrial sites total are located within 500m of at least one top 5% local choice route. Such “spatial enclaves” favour short displacements within industrial sites, providing a reduction on travel time and increasing production chains movement efficiency. As a result, this, alongside the spatial vicinity logic, promoted by high local integration – which even overlays local choice routes – leads to diminishing costs on production, higher productivity, leading to the occurrence of “clustering effects” within urban networks. These findings corroborate Roccasalva & Pluviano (2012) assertions about betweenness centrality as the main morphological attractor in the emergence and conveyance of industrial agglomerations development inside urban spaces, also concurring with theoretical economics proposition about industrial spatial organization dynamics.

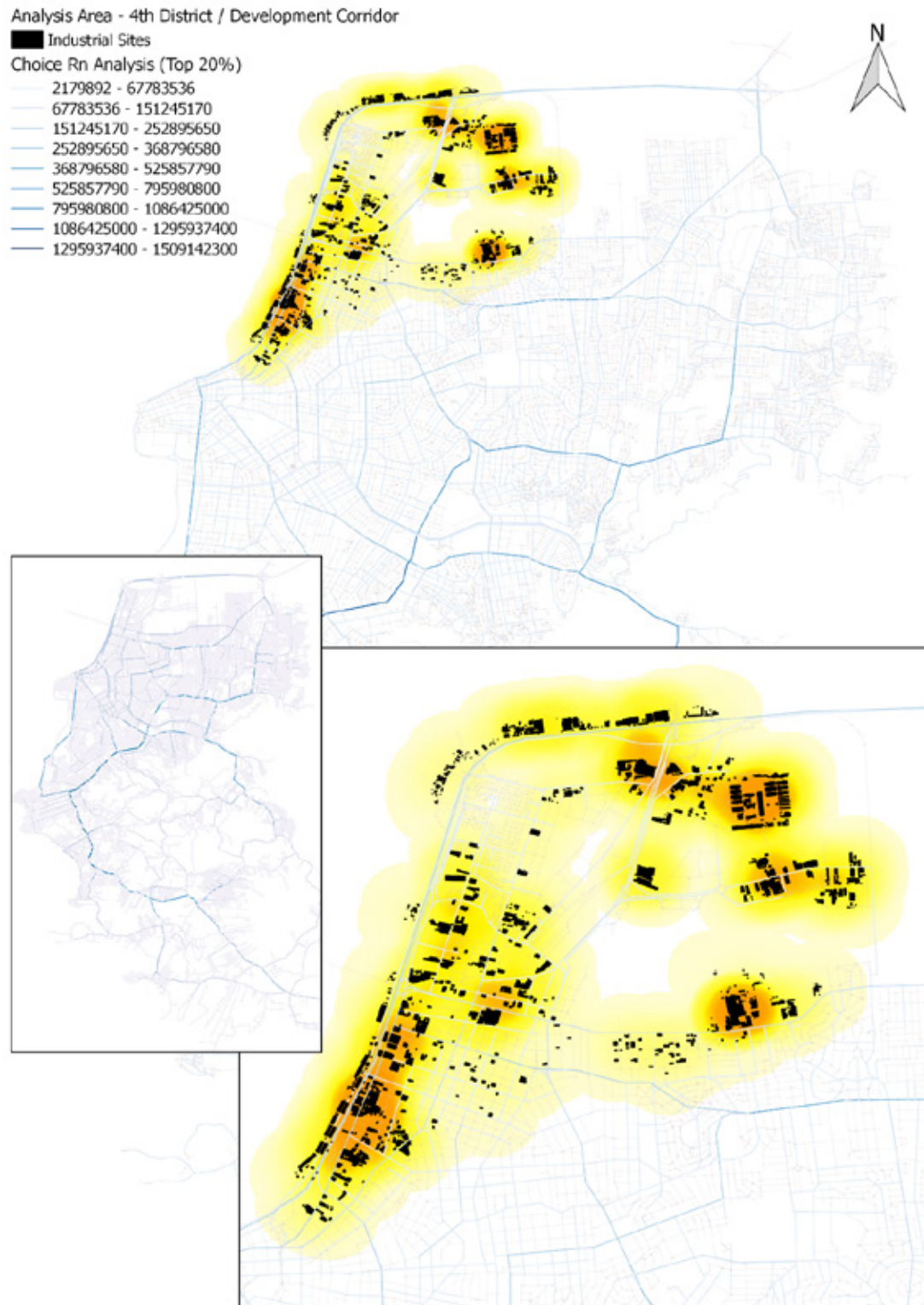


Figure 6 - Choice Rn angular analysis (top 20% segments) and Porto Alegre's industrial sites kernel distribution (500 m radius)

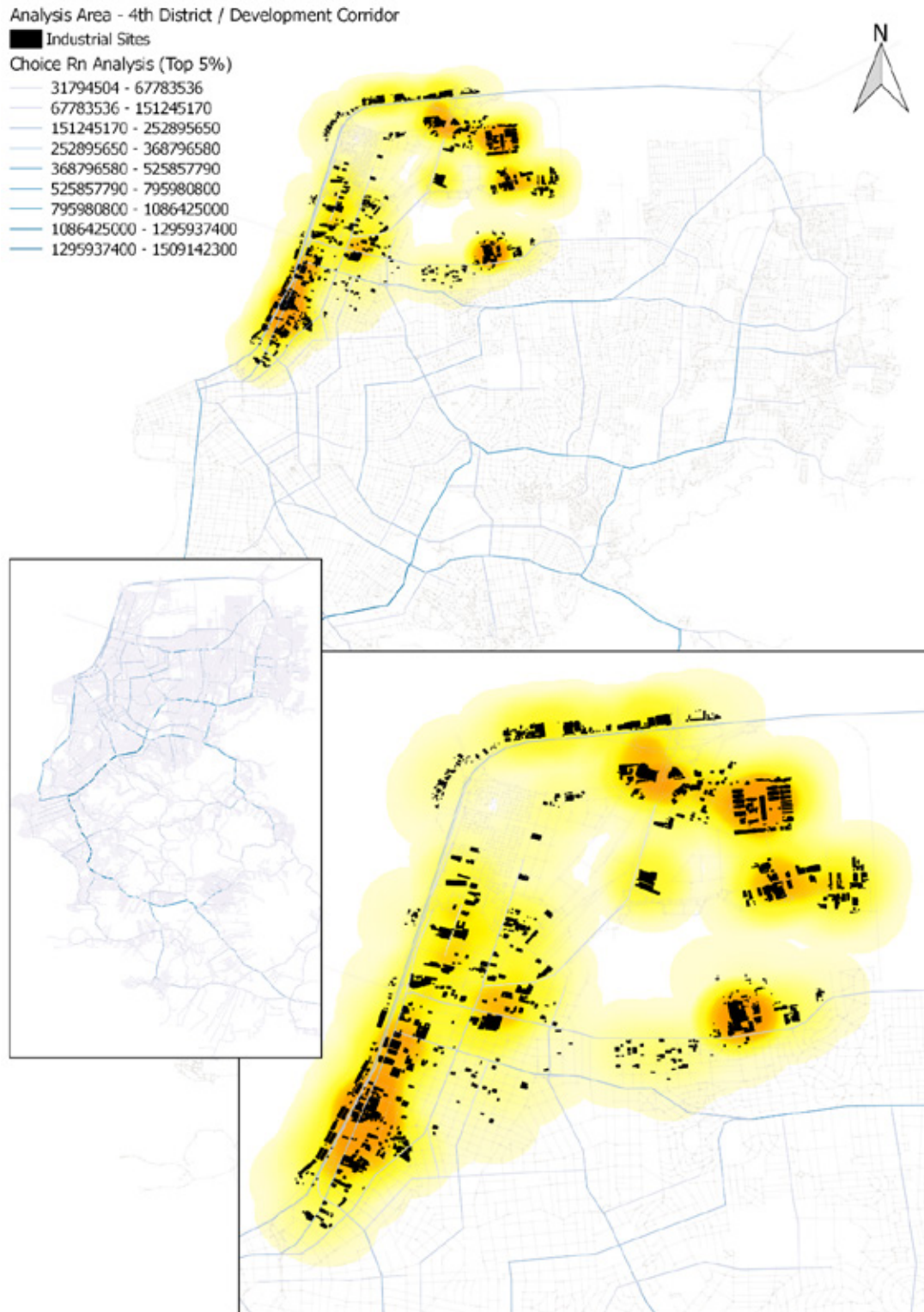


Figure 7 - Choice Rn angular analysis (top 5% segments) and Porto Alegre's industrial sites kernel distribution (500 m radius)



Figure 8 - Choice R7 angular analysis (top 20% segments) and Porto Alegre's industrial sites kernel distribution (500 m radius)



Figure 9 - Choice R7 angular analysis (top 5% segments) and Porto Alegre's industrial sites kernel distribution (500 m radius)

4. CONCLUSIONS

Results assessed using geo-statistical analysis along space syntax methods demonstrated significant correlations between urban morphological features and the industrial sites organization, which concur with the industrial activities spatial logic presupposed in economics locational theories and models. Integration and choice measurements are capable to point toward tendencies in industrial sites diffusion and organization, indicating spatial patterns of movement dependence that are followed by industrial development. These measures also explain the relations among morphological features and the “clustering effect” tendencies, demonstrating that main roads – with high closeness and *betweenness* centralities – can function as “gathering axis” conducting the development and the industrial distribution patterns.

The case study determined that Porto Alegre’s industries locational patterns and diffusion, relate intrinsically to the morphological properties of the urban grid at different scales. Industrial sites tend to locate themselves in the fringes of global closeness centralities, denoting that high global integration and “to-movement” have a minor “clustering effect” factor than once anticipated. These industrial sites, however, are found close to high integration areas at local scale, although away from the integration cores, in regions that favour small displacements in between firms, allowing the creation of efficient transportation routes. Regarding *betweenness* centralities, industries tend to unveil dependence towards high global “through-movement” routes, corroborating results found by Rocassalva & Pluviano (2012). These areas correspond to the *supergrid* structure, and conduce regional flows. In addition, it is observed an industrial sites dependence towards local “through-movement” routes, which form “spatial enclaves” segregated from main urban traffic, also favouring short displacements in between firms.

This research, although preliminary, also validates the use of multiscale and multidimensional analysis of spatial dynamics, via combined geo-statistical and space syntax methodology, in economic driven studies, as the correlations needed to attain significance were achieved. In this paper it was asserted that topological distances measured by angular analysis presents itself as feasible “conversions” of traditional metrical distance used by economics locational theories, making conceivable a refined representation of spatial networks morphology for economics analyses. Therefore, it proves itself more reliable – and less complex, as it requires less reference points – than metric distances to depict routes, movement potentials and flow probabilities, that can function as alternatives to represent movement dynamics in economic models. Therefore, incorporating socio-economic data into space syntax modelling presents itself as an interesting development that can lead to innovations in both fields of knowledge, contributing to develop new analysis methods, visualise theoretical presuppositions, and statistically verify relations between cities dynamics and economic phenomena. As such, it also provides evidence that in urban planning strategies must consider, in the creation and development of urban industrial districts, must consider the multiscale analysis of urban and regional spatial network topology, in order to maximise infrastructure investments and provide the basis for true economic development of urban and metropolitan areas.

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