ORGANISING COMMITTEE

TERESA HEITOR
MIGUEL SERRA
JOÃO PINELLO SILVA
MARIA BACHAREL
LUÍSA CANNAS DA SILVA
STEERING COMMITTEE
LUIZ AMORIM
Laboratório de Estudos Avançados em Arquitetura, Universidade Federal de Pernambuco, Brazil

RUTH CONROY DALTON
Architecture and Built Environment, Northumbria University, UK

JIN DUAN
Southeast University, China

MARGARITA GREENE
Escuela de Arquitectura Pontificia Universidad Católica de Chile, Chile

TERESA HEITOR
Instituto Superior Técnico, Universidade de Lisboa, Portugal

BILL HILLIER
Space Syntax Laboratory, The Bartlett, UCL, UK

FREDERICO DE HOLANDA
Faculdade de Arquitetura e Urbanismo Universidade de Brasília, Brazil

KAYVAN KARIMI
Space Syntax Laboratory, The Bartlett, UCL, UK

YOUNG OOK KIM
School of Architecture, Sejong University, Korea

DANIEL KOCH
School of Architecture and the Built Environment, KTH, Sweden

AYSE SEMA KUBAT
Faculty of Architecture, Istanbul Technical University, Turkey

LARS MARCUS
Chalmers University of Technology, Department of Architecture, Sweden

AKKELIES VAN NES
Faculty of Architecture, Delft University of Technology, The Netherlands

ALAN PENN
Bartlett Faculty of the Built Environment, UCL, UK

JOHN PEпонIS
School of Architecture, Georgia Institute Of Technology, USA

SOPHIA PSARRA
Space Syntax Laboratory, The Bartlett, UCL, UK

LAURA VAUGHAN
Space Syntax Laboratory, The Bartlett, UCL, UK

JEAN WINEMAN
Taubman College of Architecture and Urban Planning, University of Michigan, USA
TABLE OF CONTENTS

4. SPACE, SOCIETY, AND SUSTAINABILITY
#140
**THE SOCIO-SPATIAL DEVELOPMENT OF JAFFA–TEL AVIV:**
The emergence and fade-away of ethnic divisions and distinctions
Or Aleksandrowicz, Claudia Yamu, Akkelies Van Nes

#141
**MAKING SENSE OF SPACE SYNTAX FOR BROAD SOCIETAL ISSUES**
Carlos Balsas

#142
**NO PROJECT FOUND**
Development of the nineteenth-century unplanned cemetery
Egle Bazaraite, Teresa Heitor, Maria Manuel Oliveira

#143
**GENERIC FLOWS OF SUSTAINABLE URBAN FORM:**
An investigation on integrated interactions between energy and information flows in the context of urban form. The case of Isfahan.
Mostafa Behzadfar , Yones Chanagalvae
e

#144
**‘WE WERE BUILDING A CAMP, THEY WERE BUILDING A CITY’**
Refugee camps as a spatial laboratory for social inclusion.
Marco Buonocore, Valerio Cutini

#145
**SEA AND CITIES:**
Spatial configuration of Brazilian urban beaches
Lucy Donegan

#146
**THE AGENCY OF JERUSALEM LIGHT RAIL:**
A ‘conflict Infrastructure’ beyond its representation
Chun Wing Fok

#147
**THE SUM OF THE PARTS IS GREATER THAN THE WHOLE:**
Multi-scalar socio-spatial definitions of identity in Karachi’s Muhajir majority areas.
Sadaf Sultan Khan, Kayvan Karimi
#148
THE ASSOCIATION OF SPATIAL NETWORK WITH SOCIAL NETWORK IN THE HIGH-RISE SOCIAL HOUSING
Joo Young Kim, Hoon-Tae Park, Young Ook Kim

#149
BIG DATA AND WORKPLACE MICRO-BEHaviours:
A closer inspection of the social behaviour of eating and interacting
Petros Koutsolampros, Kerstin Sailer, Rosie Haslem, Martin Zaltz Austwick, Tasos Varoudis

#150
EMPLOYING VOLUNTEERED GEOGRAPHIC INFORMATION IN SPACE SYNTAX ANALYSIS
Kimon Krenz

#151
THE SPATIAL CONFIGURATION OF MINORITY ETHNIC BUSINESS DIVERSITY IN LONDON’S HIGH STREETS
Vaughan Laura, Sadaf Sultan Khan, Lusine Tarkhanyan, Dhanani Ashley

#152
THE FABRIC OF ENCOUNTER:
Integration and segregation in the spatiotemporal structure of social networks
Vinicius M Netto, João Vitor Meirelles, Maira Pinheiro, Henrique Lorea

#153
LEARNING FROM VILA PLANALTO:
The limits of segregation and urban diversity in a gentrified neighborhood.
Matías Ocaranza, Frederico de Holanda

#154
DIACHRONIC ASSESSMENT OF CULTURAL DIVERSITY IN HISTORIC NEIGHBOURHOODS USING SPACE SYNTAX.
Studies of three neighbourhoods in Istambul
Ilgi Toprak, Alper Unlu, Akkelies Van Nes

#155
AFFILIATION SPATIALLY EXPRESSED.
How social networks structure residential mobilities in London
Anna Tuononen, Stephen Law

#156
URBAN INTEGRATION OF REFUGEE HOMES
Spatial potential for integrative social processes
Lukas Utzig
SPACE, SOCIETY, AND SUSTAINABILITY
THE SOCIO-SPATIAL DEVELOPMENT OF JAFFA–TEL AVIV:
The emergence and fade-away of ethnic divisions and distinctions

ABSTRACT
This paper examines how a cognitive boundary with no physical presence has affected life in the cities of Jaffa and Tel Aviv, not only during its time of existence (1921-1950) but many decades after it was erased from all official documents. In 1921, the national aspirations of Jews in Jaffa, embraced by the local British Mandate government, triggered a segregation process that resulted in an official administrative split of Jaffa’s urban area and the creation of the “Hebrew” city of Tel Aviv on Jaffa’s northern parts. This administrative division had a clear ethnic character, dividing the entire urban fabric into a clearly defined “Jewish” and “Arab” geographical entities and influencing the development of the two municipalities as well as the daily life of their populations. After the 1948 War in Palestine, which led to the flight of almost all of Jaffa’s Arab population and the annexation its area to Tel Aviv, the united city continued to resemble a split city, with the former areas of Jaffa remaining relatively underdeveloped and neglected for decades.

By combining spatial analysis and historical research, this study reveals how the “paper boundary” that was drawn between Jaffa and Tel Aviv in 1921 transformed the life of Arabs and Jews in the two cities in a way that undermined the physical unity of the urban fabric and the spatial potential of its street network. The creation of the municipal border led to the cognitive marginalization of the spatially central Manshiya neighbourhood, and later to its deterioration and eventual destruction. Ironically, the destruction of Manshiya gave a belated physical expression to the historic cognitive separation between the centres of Jaffa and Tel Aviv, working against the wish to unite the two cities into a single urban entity after 1948.

KEYWORDS
Space syntax, ethnic conflicts, spatial potential, cognitive borders, shifting centralities, history of divided cities
1. INTRODUCTION

Space syntax analysis methods have long been applied in studies on divided cities where division lines were physically manifested while preventing or controlling movement between hostile urban territories. Examples from past studies, such as Berlin before and after reunification (Desyllas 2000), Belfast with its peace walls between Catholics and Protestants (More 2010), and Beirut’s division lines of the civil war years (Karimi 2013) show that physical divisions within an urban network affect the social and economic life of cities, as well as their centre-periphery relations. Much less attention, however, has been given to intra-urban “paper boundaries”, which can be defined as non-physical borders whose existence is exclusively dependent on graphical and textual representations that are external to the actual territory. Despite having no tangible physical presence in the city, they do have a hold on the spatial perception of the urban space, and therefore, given the right conditions (like fierce ethnic conflicts), can potentially have a similar effect on city life as physical borders have.

This paper examines how the urban transformation of Jaffa and Tel Aviv, two cities that constitute a single urban entity, has been heavily influenced by the ongoing conflict between Arabs and Jews in British Palestine and especially by the 1921 decision to officially separate Tel Aviv from Jaffa. The division of Jaffa into two separate municipalities sharing a single, interconnected urban network (Figure 1 and Figure 2) created an uncommon situation. Jaffa-Tel Aviv could not be regarded a “divided city” in the common, conventional sense of a city divided by a physical border (e.g. Berlin during the Cold War, Jerusalem between 1948 and 1967). Nevertheless, the urban area shared by the two cities was perceived by their populations as holding a clear geographical definition of separate Arab and Jewish entities, with interconnections between the two unwanted and unwelcome. While Jaffa officially ceased to exist following the 1948 Arab-Israeli War, the flight of its Arab population, and the annexation of its area to Tel Aviv, this cognitive distinction between the former two cities affects the way Tel Aviv’s urban fabric is perceived, planned, and used even today.

Figure 1 - Jaffa and Tel Aviv in 1948, showing the “paper boundary” between the cities and the location of the central Manshiya Quarter
THE SOCIO-SPATIAL DEVELOPMENT OF JAFFA–TEL AVIV: The emergence and fade-away of ethnic divisions and distinctions

Figure 2 - Map showing central urban locations in pre-1948 Jaffa and Tel Aviv
2. SPACE SYNTAX AND HISTORICAL RESEARCH

Space syntax' underlying assumption is that the spatial organization and spatial configuration of an urban street network affect the ways people perceive space or use it (Penn 2003, Hillier and Iida 2005, Karimi 2012), and therefore shape movement patterns within it (Hillier 2012). Such relations have been confirmed in numerous case studies that used space syntax analysis, demonstrating also the predictive capacities of the methodology for planning purposes. Yet this “predictive” capacity could be also exploited for describing (or “postdicting”) certain social aspects of past built environments based on their syntactic spatial properties. For example, in several research projects on excavated towns, results of space syntax analysis conformed to the reconstruction of urban life as reflected by the physical artefacts found during excavations (Craane 2009, Stöger 2011, Van Nes 2011). A similar rationale can be applied to the study of a city’s history, through the coupling of spatial analysis and archival evidence.

In our study, we followed the conceptual path suggested by Griffiths (2012), who called for the integration of space syntax analysis into historical research for supporting explanations of social phenomena organized in time and space. According to Griffiths, this relatively rare approach, which has been applied only in a handful of studies (Zhu 2004, Vaughan and Penn 2006, Griffiths 2008, Craane 2009, Griffiths 2009, Griffiths 2011, Griffiths 2012, Griffiths 2013, Griffiths et al. 2013), “provides a way into conceptualizing and thinking about the role of ‘space’ and its relation to life in the built environment that does not rely uncritically on powerful images imported from well-established historical discourses” (Griffiths 2012, 9) and therefore can “improve historians’ understanding of how changes in the shape of habitable space affected people’s lives and urban culture in particular times and places” (Griffiths 2012, 17).

When dealing with historical research, we should not interpret space syntax analysis results as describing solid and “objective” reality of a city, since the spatial significance of certain locations may depend on other factors than their pure spatial configuration. What we may learn from the juxtaposition of spatial analysis and historical narratives is to what extent the spatial configuration of a city affected the way it was used. In other words, space syntax analysis can be regarded as producing only a description of the “spatial potential” of an urban area; whether this potential was realized or not depends on complementary historical evidence that should be considered. The historical case of Jaffa and Tel Aviv, with its underlying ethnic conflict that controlled the use of urban space, clearly demonstrates this point.

3. CASE STUDY: A CONCISE SPATIAL HISTORY OF JAFFA–TEL AVIV

Jaffa is a historic port city to the shores of the Mediterranean Sea, with a recorded history of about four millennia. In the beginning of the 1870s, it was still a relatively small walled town of about 5,000 inhabitants that served as the main harbour of Palestine, by then under the rule of the Ottoman Empire. A single gate in its walls connected the town’s biggest bazaar and mosque to the main roads leading to the cities of Jerusalem, Nablus, and Gaza. The town was surrounded by a large hinterland of citrus groves.

During the 1870s the town walls were partially dismantled and some new commercial and residential buildings were constructed along the main roads extending from the town’s historic centre. About a decade later, rapid urban expansion to the north of the old town, an area of sand dunes, created Jaffa’s new commercial and residential centre. This development was carried out in a sporadic nature, driven by private initiatives of varied types. It was expedited by increasing Jewish immigration to Palestine, which created an exceptional demand for housing in Jaffa. Although Jaffa’s expansion was not restricted to the north of the old town, the emerging northern quarter was far more urbanized in nature than the main development on Jaffa’s southern part. This difference in character between the northern and the southern extensions of Jaffa was enhanced following the opening of Jaffa’s first train station in the northern part of the city in 1892 (Kark 1990). Jaffa’s main northern quarter was ethnically mixed (i.e., populated by Arabs, mainly Muslims, and Jews) (Great Britain Colonial Office, 1921: 18), and was commonly known by the name “Manshiya”, though its Jewish residents referred to it by a Hebrew name, “Neve Shalom” (Aleksandrowicz 2013).
3.1 THE FOUNDING OF TEL AVIV

The first organized settlement in the northern part of Jaffa (Neve Tzedeq neighbourhood, 1887), was built by a private Jewish association for housing. Similar schemes that followed during the 1890s and 1900s resulted in the establishment of a few other small neighbourhoods, including the Jewish neighbourhood of Tel Aviv, founded in 1909. Unlike its predecessors, Tel Aviv’s foundation was strongly related to what can be described as the “Hebrew cultural project” and its realization in Palestine, especially in the creation of new, “Hebrew” forms of settlement in which the physical environment would support the metaphysical transformation of the Jewish people into an autonomous modern nation (Even-Zohar 1990, Chowers 2002). Thus, Tel Aviv was conceived and developed as a “Hebrew city”, the first of its kind worldwide (Druyanov 1936, Weiss 1957, Katz 1984), and this concept affected the daily life in the neighbourhood and some of its spatial and architectural characteristics (Helman 2002, Harpaz 2013)

Under the rule of the Ottomans, who were openly hostile to the Zionist movement, Tel Aviv’s ambitions to become fully independent from Jaffa could not be realized. New opportunities followed the British occupation of Palestine in late 1917. In July 1920, a High Commissioner for Palestine, the Jewish Herbert Samuel, was appointed as the head of the country’s local civil government. Less than three weeks after Samuel took office, the leaders of Tel Aviv approached him in person, petitioning for a partial independence from Jaffa municipality. The British administration favoured the idea, Jaffa municipality did not oppose it, and an official ordinance that granted Tel Aviv the legal status of a “township” came into effect on 1 June 1921 (Shavit and Biger 2001, 159-63). The newly drawn border between Jaffa and Tel Aviv was shaped according to the “Hebrew city” concept: Tel Aviv’s territory included parts of the older Jewish neighbourhoods of northern Jaffa, while leaving out ethnically-mixed areas like that of Manshiya/Neve Shalom.

The new municipal border, dividing an existing urban fabric, had no roots in the self-organization of the urban activities, nor had it any conspicuous physical elements to be attached to or existing cognitive divisions to follow. Moreover, as with many urban boundaries, the new border lacked physical manifestations, making it impossible to discern where Jaffa ends and where Tel Aviv begins. Nevertheless, as a cultural tool for shaping a common cognitive division of urban space, the new boundary proved to be more than effective.

3.2 THE SOCIAL DIVISION OF URBAN SPACE

The immediate effect of the new status of Tel Aviv on Jaffa’s urban development was the division of planning powers between the Jaffa municipality and the new township of Tel Aviv. In 1925 Patrick Geddes was invited to produce the first masterplan for the Tel Aviv, which was by then nothing more than a random agglomerate of small neighbourhoods (Geddes 1925). This act reinforced the cultural distinction between Jaffa and Tel Aviv, at least in the eyes of the Jewish population. Tel Aviv was constantly trying to differentiate itself from Jaffa as much as possible, both by emphasizing its Hebrew character (which contrasted the “Arab” nature of Jaffa) and by claiming a modern character for its built form, allegedly contrasting the “traditional” and “oriental” character of its mother-city. Geddes’ plan assisted in creating a distinct spatial order which should have shifted Tel Aviv’s centre of gravity up north, as far as possible away from Jaffa’s Old Town and even from the older parts of northern Jaffa, i.e. from the former commercial hub of Manshiya/Neve Shalom.

During the 1920s ethnic tensions between Arabs and Jews in Palestine escalated, culminating in a wave of murderous attacks on Jews in August 1929, mainly in the old Jewish communities of Jerusalem, Hebron, and Safed. As a result, the division of urban space according to ethnic definitions became more acceptable both in Jaffa and in Tel Aviv. The parts of northern Jaffa that were now under the powers of Tel Aviv were regarded a “Jewish” territory, while the territories on the Jaffa side of the border were perceived as purely “Arab”. The “paper boundary” between Jaffa and Tel Aviv created a new reality, in which the northern commercial centre of Jaffa until 1921 (Manshiya/Neve Shalom) was transformed into a “final frontier”. Its growing marginality (despite its central location) now led the public in Jaffa and Tel Aviv alike to perceive it as nothing
more than a slum trapped between the two cities (Hatuka and Kallus 2006, Aleksandrowicz 2017). During the 1940s Jaffa Municipality even promoted two masterplans for the total “reconstruction” (which effectively meant demolition and rebuilding) of the neighbourhood, reflecting its eroded reputation (Aleksandrowicz 2017).

3.3 THE 1948 WAR AND ITS SPATIAL CONSEQUENCES

The 1948 Arab-Israeli War in Palestine resulted in the flight of almost all the Arab population of Jaffa. The city was merged into Tel Aviv’s municipal area, effectively creating a new, united municipality named “Tel Aviv-Yafo” in April 1950 (“Yafo” is the biblical Hebrew name of Jaffa). From the 70,000 Arab residents living in Jaffa before the war, about 3,000 remained in the united city, becoming a negligible minority in a city of more than 250,000 inhabitants (Figure 3). Even before the new municipality was formed, Israel Rokach, the powerful mayor of Tel Aviv, initiated extensive demolition operations in Manshiya and Old Jaffa, as a first step of a massive “urban reconstruction” plan for southern Tel Aviv (Aleksandrowicz 2017). The original plan was not fully realized, and Manshiya and the Old Town of Jaffa remained half-demolished and half-occupied until the late 1960s.

During the 1950s Tel Aviv witnessed a rapid demographic and urban growth, culminating in a city population of 386,000 in 1961. The city’s municipal boundaries were expanded to include 424.2 hectares in 1951 (Shavit et al. 2007, 26), and it became a de-facto urban centre for three smaller towns to its east (Ramat Gan, Givaatayim, and Bnei Brak). The demographic effect of the 1948 War made the ethnic tensions between Jaffa and Tel Aviv a matter of the past. The small Arab population that remained in Jaffa was relocated to its southern areas (Ajami neighbourhood), while new Jewish immigrants were entering the now confiscated Arab properties in the other parts of the city. Yet the spatial distinction between the northern and southern parts of the “united” city did not disappear and retained a new character: instead of the ethno-national distinction between Arabs and Jews, the distinction was now based on the socioeconomic differences between the well-established population of Tel Aviv’s northern neighbourhoods and the weakened populations of its southern neighbourhoods, including Jaffa (Marom 2014). These areas were regarded as slums and were subject to massive “reconstruction” schemes.

The central location of Manshiya and its negative reputation made it an almost ideal candidate for large-scale urban reconstruction project. In 1959, Tel Aviv’s mayor Mordechai Namir began promoting the creation of a new central business district (CBD) in Manshiya. An international competition was announced in 1962, and a preliminary masterplan was conceived in 1965. Demolition of Manshiya’s buildings resumed during the late 1960s and continued until the early 1980s, erasing almost all its pre-1948 urban fabric and extending over about 40 hectares. Nevertheless, because of lack of proper funding for large-scale construction project, most of Manshiya’s territory remained unbuilt except a relatively small complex of office buildings; the previously dense urban fabric was transformed into an accidental mixture of main roads, parking lots, and public gardens.

While Manshiya’s reconstruction was never realized, other parts of Jaffa went into a process of limited gentrification, which began with the mid-1960s project of the “artists quarter” in the remains of Jaffa’s Old Town and continued with a gradual process of reconstruction in parts of the southern Ajami quarter since the 1980s. At the same time, Jaffa retained its old position of “otherness” in respect to Tel Aviv and is still perceived today as a “mixed” and “oriental” city, in spite of being officially an integral part of Tel Aviv (Monterescu 2009). This can be attributed to the concentration of its Arab community (of less than 20,000 in a city of 430,000 inhabitants) in several small neighbourhoods in Jaffa’s southern part. This spatial distinction between north and south persists, percolating to the towns south of Jaffa (Bat Yam and Holon). It is mostly evident in the socioeconomic differences, that still have a clear spatial component: poorer populations of Tel Aviv’s metro area tend to live in the former areas of Jaffa and the towns to its south (Figure 4).
THE SOCIO-SPATIAL DEVELOPMENT OF JAFFA–TEL AVIV:
The emergence and fade-away of ethnic divisions and distinctions

Proceedings of the 11th Space Syntax Symposium
4. DATASETS AND METHODS

The effects of the historic "paper boundary" between Jaffa and Tel Aviv on the development of their urban area is analysed here with respect to the gradual urban development and growth of the cities. This diachronic type of analysis is expected to trace transforming and evolving urban centres, depending on the cities' growth pattern (Can et al. 2015). We compared five historical stages in the development of Jaffa and Tel Aviv: Jaffa of the late 1870s, at the beginning of its expansion outside of the city walls; Jaffa at the beginning of the British Mandate, shortly before the delineation of the border with Tel Aviv; Jaffa and Tel Aviv of the late 1940s, just before the 1948 Arab-Israeli War; the united Tel Aviv-Yafo in 1965, including the towns to its east; and present day Tel Aviv-Yafo's metro area. For each stage, we used the most reliable cartographic documents available: the 1879 map of Jaffa and its environs by Theodor Sandel (scales 1:9100 and 1:31800); a 1918 map of Jaffa by the British Survey of Egypt (scale 1:6000); a 1944 Survey of Palestine maps of Jaffa and Tel Aviv (scale 1:10000); a 1965 Survey of Israel map of Tel Aviv-Yafo, Ramat Gan, Givatayim, and Bnei Brak (scale 1:10000); and a present day OpenStreetMap of Tel Aviv-Yafo metro area.

The space syntax analysis types applied in this study for all five stages in the cities' development are two: high metric radius normalised angular integration (NAIN) and low metric radius normalised angular choice (NACH). These two types of analysis highlight intricate differences at the neighbourhood and city level. Both manually drawn axial maps and road centre lines were used based on the availability of data. According to Turner (2007), there is only a small difference between using an axial map and a road-centre line map for Choice analysis when weighted according to segment length, and the same maps can also be used for calculating Integration values. The analysis was conducted with Depthmap X (Varoudis 2014). An additional axial map was created based on the 1944 maps, in which axial lines cut by the municipal border were divided into two separate lines, in a way that simulates the existence of a physical barrier between the cities, mimicking the assumed cognitive effect of the "paper boundary". A comparison of the NAIN and NACH values of the "split" model with those of the "normal" 1944 model was expected to quantify the loss of Manshiya's spatial potential due to the ethnic conflict between Arab and Jews.

Space syntax methodology works with two key concepts of centrality – Integration and Choice (also referred to as potential to-movement and potential through-movement). The NAIN analysis represents the to-movement potentials on various scales, in locations where urban centres tend to cluster around. Choice values may indicate the likelihood of certain urban areas to attract pedestrian or vehicular movement, assuming humans prefers to take the shortest and least convoluted route to a certain point. The NAIN and NACH measures correspond to the two basic elements of any trip: selecting a destination from an origin (NAIN), and choosing a route between origin and destination (NACH). Since the ethnic conflict negatively affected movement patterns between Jaffa and Tel Aviv, it is interesting to compare these two types of spatial analysis with our historical knowledge of the actual way in which urban life in the two cities unfolded.

5. RESULTS

The NAIN analyses of Jaffa and Tel Aviv (Figures 5-7, Table 1) correctly highlight the urban centres and main shopping streets of Jaffa and Tel Aviv during all stages of their development. They also reveal how the central core of the entire urban system gradually shifted from Jaffa's historic core to north-east due to an asymmetrical urban growth. Already in 1918, Jaffa's Old Town (the part that was until the early 1870s confined to the city walls) was losing its central position to the new commercial hub emerging around the Clock Square, along the road to Gaza (today's Yefet Street), and from there extending north into Manshiya and south along King George Boulevard (today's Yerushalayim Boulevard). The shifting of the system's centre of gravity to north-east continued as the whole urban system expanded during the 1930s and 1940s. In 1944, Tel Aviv's central locations (Magen David Square, the CBD's core) already showed higher integration values than Jaffa's central Clock Square, reflecting the fast expansion of Tel Aviv.
After 1948, when Tel Aviv grew to be the core of a metropolitan area, highest Integration values are found away from the old centres in Jaffa and Tel Aviv alike, along the eastern extension of the historic Nablus Road (today's Menahem Begin Road), including its north-eastern (Jabotinsky Road) and northern (Namir Road) branches. At the same time, Tel Aviv's historic central locations continued to show higher Integration values than Jaffa's central locations. The disintegrating effect of Manshiya's complete demolition made Integration values of Yefet Street and Manshiya's Al-Abbas Street (today's HaMered Street) substantially lower than in Tel Aviv's historical main streets.

The NACH analyses (Figures 8-10, Table 2) show a clear difference in the internal cohesion of Jaffa's urban fabric, when compared to that of Tel Aviv, since the 1940s and on. Jaffa's main streets showed substantially higher Choice values than the main streets of Tel Aviv, reflecting a concentration of Jaffa's commercial activities in a relatively small area. The expansion of Tel Aviv to the north during the 1930s and 1940s did not create a new urban centre for the city, and its historic downtown area preserved its status, showing the highest Choice values in the whole city (though not in the whole urban system).

Both the NAIN and NACH analyses underline the importance of Manshiya as a central hub of urban activity since the early 20th century until its demolition during the late 1960s and 1970s. Manshiya's main shopping street, Al-Abbas Street, showed substantially higher NACH values than all other main streets in Jaffa and Tel Aviv until the 1970s, while its NAIN values were also among the highest in both cities. With its northern extensions to the north (Al-Alim and HaKarmel Streets) and to the south (Yerushalayim Boulevard), it became a crucial linking artery that connected the urban centres of Jaffa (around the Clock Square) and Tel Aviv (around Magen David Square), as a backbone of the entire urban system until 1948. Ironically, the spatial potential of Manshiya as the strongest connector between Jaffa's historic core and central Tel Aviv was never fully realized because of the ethnic conflict between Arabs and Jews and the cognitive division of space according to the 1921 paper boundary. Since the late 1920s, Jaffa and Tel Aviv led separate urban life, with Manshiya quickly losing its urban significance.

The discrepancy between Manshiya’s spatial potential and its actual urban status is well described by the simulated “split” model of the 1944 map. Compared to the unmanipulated 1944 map, the NAIN analysis of the “split” model shows Manshiya's northern “slum” area as a poorly integrated neighbourhood, with Integration values of AlAlim and Al-Abbas Streets substantially lower than in the original 1944 map. Integration values of Tel Aviv's Magen David Square and its historic core were also substantially lower in the “split” model, implicating that the ethnic division between the cities negatively affected also the spatial Integration of Tel Aviv. NACH analyses of the same maps show almost no differences in Choice values between the main location and streets in both cities except in HaKarmel Street, whose Choice value is substantially lower in the “split” model in a way that underlines Manshiya’s role as a vital enabler of through movement between the cities.

After 1948, Manshiya still provided an important spatial link between Jaffa and Tel Aviv, as both the NAIN and NACH analyses clearly show: Integration and Choice values of Al-Abbas and HaKarmel Streets were the highest among the main streets in both cities in the 1965 map. Yet because of the 1948 massive demolitions in the northern parts of Manshiya, and the deliberate neglect of its remaining buildings, this connective quality never led to the development of vibrant urban life concentrating around Manshiya's main street, contrary to what could have been expected from the spatial analyses.

The complete destruction of Manshiya until the early 1980s substantially weakened the spatial continuum from Jaffa’s Old Town to Tel Aviv’s downtown areas, thus creating a de-facto division between the two city centres. In current day Tel Aviv, the centrality of Magen David Square, as well as the central business district around the intersection of Rothschild Boulevard with Herzl Street and Allenby Street, are also well represented in their Integration and Choice values. The vicinity of Tel Aviv’s historic core (its central business district) to Jaffa-Tel Aviv Road makes the latter a highly-integrated location in the entire urban system. Yet spatial analyses of the 2014 map also show that the two historic centres of Jaffa and Tel Aviv are now only loosely
connected; a comparison to the 1965 map is striking, since it reveals the now-gone spatial importance of Manshiya in stitching the centres of Jaffa and Tel Aviv into a powerful network of interconnections.

Figure 5 - Normalised angular integration (NAIN) analyses of Jaffa and Tel Aviv over time from 1879, 1918, 1944, and 1965, radius n. The 1944 map shows the municipal border between the cities.
Figure 6 - Normalised angular integration (NAIN) analysis of Tel Aviv-Yafo metro area in 2014, radius n
Figure 7 - Normalised angular integration (NAIN), \( r_{mn} \), of the simulated "split" street network (left) that follows the border between Jaffa and Tel Aviv (1944 map). The unmanipulated 1944 map appears on the right.

THE SOCIO-SPATIAL DEVELOPMENT OF JAFFA–TEL AVIV:
The emergence and fade-away of ethnic divisions and distinctions
### The Socio-Spatial Development of Jaffa–Tel Aviv: The Emergence and Fade-Away of Ethnic Divisions and Distinctions

<table>
<thead>
<tr>
<th>Year</th>
<th>1879</th>
<th>1918</th>
<th>1944</th>
<th>1944 Split</th>
<th>1965</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Min.</td>
<td>1.69</td>
<td>2.26</td>
<td>2.77</td>
<td>2.50</td>
<td>3.00</td>
<td>3.19</td>
</tr>
<tr>
<td>System Avg.</td>
<td>1.93</td>
<td>2.58</td>
<td>3.05</td>
<td>2.82</td>
<td>3.38</td>
<td>3.49</td>
</tr>
<tr>
<td>System Max.</td>
<td>2.11</td>
<td>2.77</td>
<td>3.22</td>
<td>3.03</td>
<td>3.59</td>
<td>3.69</td>
</tr>
<tr>
<td>A Jaffa Old City</td>
<td>1.92</td>
<td>2.47</td>
<td>2.95</td>
<td>2.75</td>
<td>3.40</td>
<td>3.45</td>
</tr>
<tr>
<td>B Clock Square</td>
<td>2.09</td>
<td>2.76</td>
<td>3.09</td>
<td>2.92</td>
<td>3.46</td>
<td>3.56</td>
</tr>
<tr>
<td>C Magen David Square</td>
<td>-</td>
<td>-</td>
<td>3.18</td>
<td>2.99</td>
<td>3.53</td>
<td>3.61</td>
</tr>
<tr>
<td>D CBD’s core</td>
<td>-</td>
<td>2.62</td>
<td>3.16</td>
<td>2.91</td>
<td>3.50</td>
<td>3.62</td>
</tr>
<tr>
<td>1 Yefet Street</td>
<td>2.09</td>
<td>2.72</td>
<td>3.06</td>
<td>2.91</td>
<td>3.44</td>
<td>3.53</td>
</tr>
<tr>
<td>2 Yerushalayim Boulevard</td>
<td>-</td>
<td>2.72</td>
<td>3.18</td>
<td>3.00</td>
<td>3.51</td>
<td>3.62</td>
</tr>
<tr>
<td>3 Jaffa-Tel Aviv Road</td>
<td>2.04</td>
<td>2.72</td>
<td>3.21</td>
<td>2.91</td>
<td>3.54</td>
<td>3.65</td>
</tr>
<tr>
<td>4 Herzl Street</td>
<td>-</td>
<td>2.65</td>
<td>3.18</td>
<td>2.91</td>
<td>3.51</td>
<td>3.63</td>
</tr>
<tr>
<td>5 Allenby Street</td>
<td>-</td>
<td>2.56</td>
<td>3.20</td>
<td>3.02</td>
<td>3.53</td>
<td>3.62</td>
</tr>
<tr>
<td>6 Rothschild Boulevard</td>
<td>-</td>
<td>2.59</td>
<td>3.14</td>
<td>2.92</td>
<td>3.50</td>
<td>3.62</td>
</tr>
<tr>
<td>7 HaKarmel Street</td>
<td>-</td>
<td>2.59</td>
<td>3.14</td>
<td>2.91</td>
<td>3.54</td>
<td>3.57</td>
</tr>
<tr>
<td>8 Al-Alim Street</td>
<td>-</td>
<td>2.67</td>
<td>3.13</td>
<td>2.83</td>
<td>3.54</td>
<td>-</td>
</tr>
<tr>
<td>9 Al-Abbas Street</td>
<td>-</td>
<td>2.76</td>
<td>3.19</td>
<td>3.01</td>
<td>3.54</td>
<td>3.54</td>
</tr>
</tbody>
</table>

Table 1 - Value property table of Jaffa and Tel Aviv’s urban central locations over time, NAIN analyses
THE SOCIO-SPATIAL DEVELOPMENT OF JAFFA–TEL AVIV:
The emergence and fade-away of ethnic divisions and distinctions

Figure 8 - Normalised angular choice (NACH) analyses of Jaffa and Tel Aviv from 1879, 1918, 1944, and 1965, with a low metrical radius. The 1944 shows the municipal border between the cities.
THE SOCIO-SPATIAL DEVELOPMENT OF JAFFA–TEL AVIV: The emergence and fade-away of ethnic divisions and distinctions

Figure 9 - Normalised angular choice (NACH) analysis of Tel Aviv-Yafo metro area from 2014, with a low metrical radius
THE SOCIO-SPATIAL DEVELOPMENT OF JAFFA–TEL AVIV: The emergence and fade-away of ethnic divisions and distinctions

Figure 10 - Local normalised angular choice (NACH) of the simulated "split" street network (left) that follows the border between Jaffa and Tel Aviv (1944 map). The unmanipulated 1944 map appears on the right.
THE SOCIO-SPATIAL DEVELOPMENT OF JAFFA–TEL AVIV:  
The emergence and fade-away of ethnic divisions and distinctions

<table>
<thead>
<tr>
<th>Year</th>
<th>1879</th>
<th>1918</th>
<th>1944</th>
<th>1944 Split</th>
<th>1965</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Min.</td>
<td>0.48</td>
<td>0.60</td>
<td>0.70</td>
<td>0.70</td>
<td>0.70</td>
<td>0.70</td>
</tr>
<tr>
<td>System Avg.</td>
<td>1.87</td>
<td>2.37</td>
<td>3.00</td>
<td>2.94</td>
<td>3.35</td>
<td>3.39</td>
</tr>
<tr>
<td>System Max.</td>
<td>2.81</td>
<td>3.56</td>
<td>4.20</td>
<td>4.20</td>
<td>5.00</td>
<td>4.94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Value Property Table of Jaffa and Tel Aviv’s Urban Central Locations Over Time, NACH Analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Jaffa Old City</td>
</tr>
<tr>
<td>B</td>
<td>Clock Square</td>
</tr>
<tr>
<td>C</td>
<td>Magen David Square</td>
</tr>
<tr>
<td>D</td>
<td>CBD’s core</td>
</tr>
<tr>
<td>1</td>
<td>Yefet Street</td>
</tr>
<tr>
<td>2</td>
<td>Yerushalayim Boulevard</td>
</tr>
<tr>
<td>3</td>
<td>Jaffa-Tel Aviv Road</td>
</tr>
<tr>
<td>4</td>
<td>Herzl Street</td>
</tr>
<tr>
<td>5</td>
<td>Allenby Street</td>
</tr>
<tr>
<td>6</td>
<td>Rothschild Boulevard</td>
</tr>
<tr>
<td>7</td>
<td>HaKarmel Street</td>
</tr>
<tr>
<td>8</td>
<td>Al-Alim Street</td>
</tr>
<tr>
<td>9</td>
<td>Al-Abbas Street</td>
</tr>
</tbody>
</table>

Table 2 - Value property table of Jaffa and Tel Aviv’s urban central locations over time, NACH analyses

6. CONCLUSION

Combining spatial analysis and historical research enables to explain how the ethnic and national conflict between Arabs and Jews in British Palestine affected not only the development of the urban fabric of Jaffa and Tel Aviv but also the way this fabric was used by the two communities. The “paper boundary” that was drawn between the two cities in 1921 transformed the life of their Arab and Jew populations in a way that undermined the physical unity and spatial potential of their common urban street network. This discrepancy between spatial potential and actual use of urban space is highly evident in the case of Manshiya: despite its central position within the entire urban system, it became a marginal and neglected area that deteriorated quickly, was widely regarded as a “slum”, and eventually was razed to the ground. Ironically, the complete destruction of Manshiya materialized the earlier non-physical separation between the centres of Jaffa and Tel Aviv in a new, tangible reality, while contradicting the rationale behind the post-1948 unification of Jaffa and Tel Aviv into a single, Jewish-dominated, city.

The application of space syntax in studying the history of cities, as demonstrated here with the case of Jaffa and Tel Aviv, adds a valuable and quantifiable component to the historical understanding of urban processes. Space syntax can expose the “spatial potential” of a city (the predicted intensity of social interconnectedness and movement flows of people) and the location of potential urban centres. Its addition to conventional historical research can thus invigorate the way we understand growth and transformation patterns in cities. At the same time, it also exposes the tensions and interplays between physical and social forces that shape the life of cities, since these forces can control and affect the actual use of space in a way
that may undermine the spatial potential provided by the physical composition of the urban network. The historical case of Jaffa and Tel Aviv may indeed indicate that prolonging ethnic tensions may undermine the prediction of Hillier’s law of natural movement (Hillier 2012) and break the seemingly direct link between street network configuration and movement flows.

Previous studies have shown that social forces or social composition of city populations can overrun spatial forces (Shu 2000, de Holanda and Tenorio 2012). In the case of Jaffa and Tel Aviv, the ethnic and national aspirations and tensions have shaped urban development and spatial use patterns in several ways. First, members of the Jewish community in Jaffa founded a spatially segregated neighbourhood in Jaffa that soon became the core of the city of Tel Aviv. By obtaining a municipal status in 1921 (as well as its clear spatial definition through its "paper boundaries"), Tel Aviv introduced a new type of cognitive distinctions in the urban fabric that were based on the identification of spatial domains as "Arab" or "Jewish". This cognitive division undermined the physical reality of the urban street network, created a new logic of segregated development in Tel Aviv and Jaffa alike, and led to the rapid decline of the centrally-located Manshiya neighbourhood. After the 1948 War, the former "Arab" reputation of Jaffa now undermined its full integration into Tel Aviv. As a result, central parts of Jaffa’s historic core were neglected, demolished, and only sparsely rebuilt, as if Jaffa was still a hostile entity that needed subjugation. These policies led to a physical transformation of the historic core of the two cities, ultimately resulting in spatial separation that could be interpreted as a belated echo of older cognitive distinctions.
REFERENCES


Geddes, P. (1925). Town Planning Report Tel-Aviv, Tel Aviv.


Weiss, A. A. (1957). *The begining of Tel Aviv: the history of the foundation of the city and diary notes* [in Hebrew], Tel Aviv: 'ayanot.

ABSTRACT
Space Syntax algorithms have been applied to a wide variety of territorial situations. Although this technology has potential to help understand, analyse and suggest decision-making processes and public policy solutions for a myriad of urban morphologies, spatial layouts, roadway designs, built environments, and landscape types, its applicability to complex social situations remains understudied. Social interactions within unmediated urban settings are rather difficult to predict and can potentially lead to the perpetuation of social injustices. It is known that such unfair behaviours usually place disproportionate burdens on those whom, quite often, cannot do much to preclude future recurrent practices from repeating themselves under the same or slightly different circumstances. I argue that space syntax thinking and methodologies can also be utilized to reduce, and, perhaps, eradicate many of those social problems especially in cities. The paper analyses the potential use of traditional and innovative social and community oriented planning instruments and concepts, such as social impact assessments (SIA), social audits, social capital indicators and metrics, social sustainability, and social innovation through the lenses of space syntax methodologies.

KEYWORDS
Space Syntax; Societal Complexity; Social Impact Methodologies; social Innovation.

1. INTRODUCTION
Space Syntax algorithms have been applied to a wide variety of territorial situations (Hillier and Hanson, 1984; Vaughan, 2007). Although this technology has potential to help understand, analyse and suggest decision-making processes and public policy solutions for a myriad of urban morphologies, spatial layouts, roadway designs, built environments, and landscape types, its applicability to complex social situations remains understudied. Cities are shaped not only by many political, technical, regulatory and planned decisions but also by unintended, spontaneous, random and intuition-driven sets of actions and reactions.

The physical determinism paradigm has contributed to the pre-conceived notion that design professionals can influence one’s urban environment, therefore influencing, even if only partially, the outcomes of a set of disjointed forces at play. Social interactions within unmediated urban settings are more difficult to predict and can potentially lead to the perpetuation of social injustices in the realms of land-use, transportation, housing, employment, school, race, gender and age discrimination (Harvey, 2009). It is known that such unfair behaviours usually place disproportionate burdens on those whom, quite often, cannot do much to preclude future recurrent practices from repeating themselves under the same or slightly different circumstances. I argue that space syntax thinking and methodologies can be utilized to reduce, and, perhaps, eradicate many of those social problems especially in cities.

The paper analyses the potential use of traditional and innovative social and community oriented planning instruments and concepts, such as social impact assessments (SIA), social
audits, social capital indicators and metrics, social sustainability, and social innovation through the lenses of space syntax methodologies.

This paper is organized into five parts. Part one is the analytical framework centred on social problems, urban and regional planning, and syntax methodologies. Part two provides an overview of several typical social planning instruments and concepts. Part three addresses some of the main issues with the implementation of social instruments at three scales: Local, regional and national. Part four discusses the social realm of urban development from a dynamic processes perspective. Finally, part five presents some concluding remarks.

2. ANALYTICAL FRAMEWORK

This analytical framework comprises a review of three areas: Social problems, urban and regional planning, and syntax methodologies. The intent is to provide the background necessary to understand social planning instruments. The premise is that urban and regional planning has traditionally placed more emphasis on the physical aspects of development, such as land use, transportation, housing, and economic development than on community planning. Societal forces and trends are perceived as being too complex to warrant careful planning along the lines required for planning and designing built structures. Prior attempts at using social planning instruments have had mixed results mostly due to an institutional inability to fully grasp human motivations, desires and resultant, planned and spontaneous, behaviours (Howe, 1988). Social programs usually are developed and implemented to address the needs of disenfranchised groups, and quite often they are pejoratively perceived as belonging to welfare programs (Vaughan, 2007; Fincher et al., 2014). This includes affordable housing, employment services, language and skills development programs for underrepresented groups such as ethnic minorities, public health initiatives and community clinics for low income groups, legal representation, fiscal and financial support programs, and community support for at-risk youth in the form of after school programs, among others.

2.1 SOCIAL PROBLEMS

Urban development occurs according to a myriad of complex forces, laws and regulations. In the built environment however, there is a prevalence of laws on the physicality of development. Those laws allow the relatively well understood computation, modelling and control of most variables and elements. It is known that many of the elements in urban development have a finite nature, which enables their measurability.

On the other hand, social problems such as poverty, spatial segregation, racism, sexism, domestic violence, xenophobia, jingoism, discrimination and social injustices are characterized by their traditionally wicked nature, which means that (1) they do not obey to stopping rules, (2) responses are considered to be only better and worse and not true or false, (3) they are also ill- and variously defined and shaped by strong inter-related variables which interact among themselves often in unknown ways, (4) they suffer from a lack of consensus regarding theirs causes, (5) they have numerous links to other problems, (6) they do not easily allow the opportunity to learn by trial and error, and finally, (7) every wicked problem is essentially unique (Rittel and Webber, 1973).

In the past, physical determinism initiatives were aimed at intervening in the built environment while hoping to achieve results in the social realm such as influencing human behavior. The intensity of this phenomena has evolved over the last few decades. However it accepted that globalization and the information revolution have increased the complexity of social phenomenon (Latour, 2005) due to growing information availability and exchanges.

For instance, in the 1960s-70s the urban renewal program in the U.S. demolished many aging homes when they could still potentially be renovated and upgraded to better living conditions. Although individuals were relocated elsewhere some of the resulting social ills included the place displacement and the breaking down of social networks. These actions were led by the government under notions of scientific rationality and human progress. Quite often, the cleared land was made available for new public private partnerships (PPP).
In the 1980s, the emphasis was on urban redevelopment through a mostly market oriented approach to revitalizing waterfronts and inner city areas. The built form preferred typologies (hotels, museums, aquariums, convention centres) targeted mostly central city locations. The typical outcomes of such redevelopment activities were exclusivity and social discrimination due to an elitization of those spaces (Balsas, 2007).

In the 1990s, many cities and regional metropolitan organizations in the U.S. implemented urban perimeters and urban growth boundaries in order to manage suburban expansion. From a land use perspective, the goal was to encourage development in certain areas and preclude it in others. The main problem with such approach was the strictness of the administrative boundary, which due to political reasons required its periodical adjustment either due to strong market forces or any other public sector goals.

In the late 2000s, the global financial crisis caused severe housing and property markets devaluations. The response adopted was in certain cases based on the resilience paradigm imported from ecological systems. The dilemma was that getting back to the prior modus operandi tended to perpetuate unjust dualities. One finding from such responses was that the need to rebound ought to create more robust realities and stronger social networks (Wasserman and Faust, 1994). Finally, during the early 2010s, the Occupy Wall Street movement in the United States was a social revolt against unfair and undemocratic procedures mostly in cities. The spontaneity of the movement achieved almost epidemic proportions with manifestations in cities as far away as Turkey, Brazil, and Mexico, among others.

2.2 URBAN AND REGIONAL PLANNING

The practice of Urban and Regional Planning has different emphases depending on one’s own regional culture and prevailing or individual ideologies. At the onset, it is important to distinguish the substantive from the procedural nature of planning. The substantive nature pertains to the various professional specializations such as housing, transportation, economic development, etc. The procedural nature refers to the methodological aspects such as plan making, public participation, planning scenarios, policy recommendations, etc. Moreover, planning also varies depending on its scale of intervention.

Planning has been defined as “a process through which society’s goods and services are distributed as equally and efficiently as possible according to the will of the people and with regard to the future” (Mullin, 2000, n.p.). Klosterman (1985, p.5) claims that urban and regional planning can be justified through four basic dimensions: “(1) planning attempts to remedy the negative effects of market actions, (2) planning promotes the common collective interests of the community (provision of public goods), (3) planning provides the data needed for effective public and private decision-making, (4) planning considers the distributional effects of public and private action, and attempts to resolve inequities in the distribution of basic goods and services.”

On the other hand, Angotti (2008, p.8) argues that progressive community planning “seeks to achieve local and global equality, social inclusion, and environmental justice”. Progressive community planning has emerged in opposition to traditional mainstream orthodox plans and their inability to bring about social progress for disenfranchised groups, leaving no other option but to organize and fight for participatory community action, racial equality, socio-economic inclusion, and environmental justice.

Marcuse (2011) has emphasized three currents in planning: a technical current centered on scientific and designer and contractual planning, and two currents centered on social issues, one privileging social reform (i.e. equity planning), and the other emphasizing social justice (i.e. ethical and cultural principles, community-based planning, radical or critical planning, and utopian planning).

The mainstream planning espoused by for instance the American Planning Association in the United States is relatively similar to the many of the spatial syntax applications, which attempt to use rational planning (i.e. ability to influence the urban environment through scientific
principles) to solve complex problems. Moreover, quite often mainstream planning has failed to recognize the tensions between eliminating injustice and preventing gentrification, and its outcomes are invariably marked by spatial injustices. Angotti (2008) suggests de-emphasizing the power of rational planning in the neoliberal city in favour of a stronger emphasis on progressive community planning and its roots in advocacy and social movements (Burdge, 1999; Benford and Snow, 2000).

This type of planning is much more centered on communicative and collaborative planning and on conceptions of the just city. Progressive community planning also recognizes “bundle of processes including conflict, contradiction, and complexity” (Angotti, 2008, p.19). It results in great part from political struggles for social justice (Harvey, 2009) and not from idealistic desires for social harmony. Progressive community planning also requires the need for new visions towards more participatory democracy.

2.3 SYNTAXES (WITH SPECIAL EMPHASIS ON SPATIAL AND SOCIAL SYNTAXES)

Syntaxes are constituted by principles, tenets, rules, laws and best practices. Syntaxes serve to map patterns and to codify rhythms and behaviours, while establishing the grammatical rules for proper procedural practices (Smith, 1977; Hillier and Hanson, 1984; Vaughan, 2007). Their initial utilization emerged out of the study of language and the need to understand the relationship between geometric objects. More broadly speaking, among the various strands of syntaxes one finds physical/spatial, morphological, social, economic, cultural and environmental.

The physical/spatial syntax rules pertain to the characteristics of a location or agglomeration. Topography enables the modelling of development with its natural or man-made features such land use patterns and transportation infrastructure, etc. The morphological syntaxes are greatly influenced by the type and hierarchy of transportation infrastructure as well as the type of built environment, with the latter being directly impacted by legal regulations and norms. Social syntaxes result from societal values, cultural and political traits and behaviours. Over the years in most developed countries, pro-inclusion and pro-diversity viewpoints were converted into anti-discrimination laws (Fincher et al., 2014). For instance, Titles VI and VII of the 1964 Civil Rights Act prohibits discrimination on the basis of sex, race, colour, national origin, and religion in programs and activities receiving federal financial assistance, and employment discrimination, respectively.

Economic rules pertain mostly to the rules of the market and to the functioning of supply and demand for goods and services and to the use of fiscal and financial instruments to accomplish public policy goals. Among some of the most common economic instruments one finds incentives and sanctions. Cultural syntaxes are aimed mostly at promoting cultural diversity and at respecting the authenticity of the built environment through, for instance, the historic preservation of structures and their classification, protection and conservation. Such procedures include among others, cultural asset inventories and the mapping of cultural initiatives and programs.

Finally, environmental syntaxes aim to protect and enhance the quality of the natural environment while reducing nuisances and negative externalities such as pollution and the extinction of endangered species. Critical to environmental syntaxes has been the setting of regulations, programs and standards to help monitor the quality of the natural environment, and to facilitate its administration through incentives and coercive measures. In the United States, the federal government passed the National Environmental Policy Act (NEPA) in 1970, which was then followed by similar measures at the state level (little NEPAs). Also important in terms of environmental syntaxes is the environmental impact assessment mechanism that requires a comprehensive study of all environmental impacts anticipated by new major developments.

These various syntaxes constitute the genesis of contemporary professional specializations. They have resulted from intense theoretical and practical developments, which now enable certain individuals to claim specific bodies of knowledge and to also influence their evolution, tendencies, and future developments (Abbott, 1988; Wallerstein, 1999).
Spatial syntax had its beginnings in architecture, the study of geometric forms, harmonies and proportions in what pertains to a myriad built environment utilizations. Vitruvius Pollio’s and Alberti’s architecture treatises, and their contemporaneous, such as Christopher Alexander (1977), Leon Krier (1998), and Bill Hillier (1996) have looked at issues of urban form, structure, the use of fundamental elements (i.e. roads, land plots, building types, yards, open spaces) and their patterns, and their grammatical (syntax) rules (i.e. width, height, setbacks, usable areas, etc.) (Figure 1.). The practice of urban design has evolved over the centuries to influence not only the siting of fundamental elements, but also to create the most harmonious, efficient, effective, comfortable, safe and secure relationships possible. Since these outcomes were not always well accomplished by dominant syntaxes (e.g. modernism movement in architecture) with the creation of inhospitable urban spaces for instance, more recently there has been emphasis on utilizing syntaxes to improve prior architectonic conditions and to create more human friendly forms (Gehl, 2011) embodied in cathartic architectonic praxis (Morgado, 2016).

Societal evolution has been the prevue of sociology, anthropology and other social science disciplines. However, it has long been recognized that one’s built environment impacts that person’s wellbeing and social development opportunities and relationships (Hillier and Hanson, 1984). Although unravelling those relationships is quite complex due to various economic, historic and family milieus, more and more we are assisting to growing social struggles for empowerment, equal opportunity, equal rights, diversity and inclusion, tolerance and solidarity. A paradox in our societal evolution is the fact that the status quo tends to impact disproportionately those with fewer resources and capabilities to alter the situations, which typically are beyond their own control (Sen, 1999). This requires strong grass-roots involvement and the reaching of a critical mass of developments, usually through social mobilization and the
constitution of social movements (Benford and Snow, 2000), in order for problems to receive political attention and for corrective measures to be codified into law, regulated, implemented, monitored and enforced.

3. SOCIAL CONCEPTUALIZATIONS AND INSTRUMENTS

There are at least five social instruments and methodologies aimed at conceptualizing social problems, inventorying at-risk social situations, characterizing issues, assessing social realities on the ground, and proposing solutions to minimize, and if possible, eradicate socially problematic conditions. These frameworks and instruments are used to remedy situations, which if left to their own devices are very unlikely to get resolved on their own. In addition, there are also other instruments, such as social media (Evans-Cowley, 2010), and social marketing (Lazer and Kelley, 1973; Corner and Randall, 2011), which usually are used without the explicit purpose of advancing certain social causes, but are still recognized as possessing some innate potential to do so.

3.1 SOCIAL IMPACT ASSESSMENTS (SIA)

Social impact assessments (SIA) are processes aimed at identifying, assessing, and administering responses to eradicate unresponsive social practices. SIAs are used to proactively assessing the pathologies of development and consciously eliminating disparities resultant from unfair developments and practices (Barrow, 2000; Becker, 1997). SIAs are similar at least in method to health impact assessments (HIA) (Forsyth, Slotterback, and Krizek, 2010) and to environmental impact assessments (EIA) (Partidário, 2000). For instance, a community forum within an environmental impact assessment involves the projection of social impacts by participants and their identification of the measures necessary to mitigate those impacts (Becker et al. 2003). Some of the most important SIA variables include population characteristics; community and institutional structures; political capabilities; and individual, family, and community resources.

According to the Inter-organizational Committee on Guidelines and Principles for Social Impact Assessment (ICGP), the fundamental SIA principles are: (1) Involve diverse publics, (2) analyse impact equity, (3) focus the assessment, (4) identify methods and assumptions and define significance in advance, (5) provide feedback on social impacts to project planners, (6) use SIA practitioners, (7) establish monitoring and mitigation programs, (8) identify data sources, and (9) plan for gaps in data (ICGP 1995, p.35). ICGP’s framework was recently updated by Arce-Gomez, Donovan and Bedggood (2015) to reflect recent tendencies to dedicate more attention to participatory processes (Becker et al., 2003), ex-post use of SIA mechanisms, and SIA practitioners (Wong and Ho, 2015) (Figure 2.).
3.2 SOCIAL IMPACT ASSESSMENTS (SIA)

Social audits are conducted to analyse the extent of social connections, dependences and interdependences, and autonomies of a given person or entity. Asset mapping on the other hand, is more global and reflects a community planning aimed at inventorying existing social and cultural assets in a community with the main intent of optimizing local resources while minimizing dependence on external ones. Part of this asset mapping technique includes cataloguing assets and making information about those assets known to community members (Wates, 1998).

3.3 SOCIAL CAPITAL

Social capital is an asset that contributes to the development of other forms of community capital (e.g. human, financial, physical, political, cultural and environmental) (Putnam, 2000) (Figure 3.). Although there have been conflicting findings regarding the extent of social capital in communities, there is consensus on three broad conceptualizations of social capital: (1) Linking social capital, (2) bridging social capital, and (3) bonding social capital. Linking social capital takes place within one particular community while bridging social capital pertains to the social relationships between individuals in two or more communities. On the other hand, bonding social capital pertains to the social relations within specific community networks without necessarily transferring capital across different communities (Aldrich, 2012).
3.4 SOCIAL SUSTAINABILITY

Sustainability’s most overlooked dimension has been its social aspects and how social variables not only interact among themselves but also with the economic and the environmental dimensions of development (Polèse and Stren, 2000; Bahadure and Kotharkar, 2012). All three major dimensions of sustainability ought to be analysed according to the various syntax methodologies in order to accomplish most of these broad societal goals: (1) Meeting basic needs, (2) overcoming disadvantage attributable to personal disability, (3) fostering personal responsibility, (4) nurturing the stock of social capital, (5) equitable distribution of opportunities, (6) cultural diversity, tolerance, and empowerment (Colantonio, 2007, p.5).

3.5 SOCIAL INNOVATION

Social innovation comprises novel ways to resolve societal problems. Quite often innovation requires a felt need to do something differently and the intervention of an outside person to either mediate or facilitate the resolution of existing situations (Wates, 1998). Social innovation is also equated with social entrepreneurship, a movement going back to the 1980s, which is dedicated to solving societal problems through “innovative, sustainable and scalable business models” (Santos et al., 2016, p.8) and other non-profit activities. At the core of social entrepreneurship is the notion of impact-oriented economy and the understanding that societal problems can be at least substantially ameliorated, if not completely eradicate. Santos et al., (2016, p.11) recommend placing greater emphasis on how one envisions opportunities through value propositions, through design (i.e. solution architectures, sustainable models, impact frameworks, and value generators), and through specific actions (e.g. pilot designs, resource mobilizations, and inspirational pitches).
4. ISSUES WITH IMPLEMENTATION OF SOCIAL INSTRUMENTS

Social problems are filtered through societal routines, economic dynamics, cultural lenses, and are likely or unlikely to receive media attention almost in a direct proportion to the extent that they benefit a considerable number of individuals. Prior to social media, many social problems would take a long time to be recognized – if they were recognized at all, embraced and resolved. Information and communication technologies (ICT) have created greater awareness of social problems, even if decision makers are unlikely to fully utilize those same technologies to effectively resolve social problems (Rheingold, 2002; Evans-Cowley, 2010).

The effective resolution of social problems requires the implementation of social instruments. And although the first phases of those implementations require mostly data collection, data analysis and the identification of plausible and adequate solutions, the later implementation phases requires knowledge, skills, resources, political will and continued actions such as regular monitoring, evaluation, retooling and refinement, and in certain extreme cases also enforcement (Neigher, 2003).

Politicizing problems usually brings the added visibility needed to increase attention, awareness and the willingness to resolve those complex situations. I argue that different scales create distinct challenges. Professional training has to be combined with the human sensibility that emerges from regular interactions with and among affected people. Such interactions lead to greater ownership of the problems, something which is unlikely to result from the distant and impersonal collection and analysis of statistics and the charting of evolutive trends. It is obvious that those interactions have to be made on the basis of sound data analysis; however in certain cases the legalistic requirements of certain public policy processes have derailed what could have been very fruitful social innovation processes (Balsas, 2017).

4.1 @ THE LOCAL SCALE

The advantage of the local scale is that individuals are closer to reality, there are relatively few participants and there is a limited number of relationships (i.e. family ties), which enable the maintenance of local identities.

4.2 @ THE REGIONAL SCALE

As one moves to the regional scale, problems are marked by regional nuances and the number of participants is also likely to increase, straining resources and turning the participatory processes slightly more complex. At the regional scale there are also various types of relationships (i.e. present, virtual, biophilia, loyalty, etc.). When individuals get involved in social programs and actions aimed at resolving certain issues markedly of a social nature, they may also be interested in maintaining their regional identities. There is likely to be a higher tolerance to innovation from outside than in closer local circles at the lower level of intervention. Finally, there is also a wider utility pool of assets, and hopefully not of liabilities, to draw upon.

4.3 @ THE NATIONAL SCALE

When social issues are common to various regions within a country or major economic trade block, regional differentiation requires tailoring interventions to social realities. Among these, one finds the combination of multilateral interventions in policy making and implementation. Social issues tend to emerge out of bottom-up participatory (and exceptionally, spontaneous) processes, where problems and their root causes tend to be very well known. When those issues reach the national stage they may require the re-conceptualization of solutions, in order to devise adequate shared co-implementation and co-enforcement strategies. To the traditional bottom-up and top-down processes, one can add a sideways process, which to a certain extent results in co-monitorisation and the possibility of implementing adjustments (Ellin, 2013).
5. DYNAMIC PROCESSES AND PROFESSIONAL RELEVANCE

There are at least two ways to look at the development of societal trends. The first places trust in the almost auto-pilot or autopoiesis nature of socio-biological relations (Maturana and Varela, 1980). This view assumes that markets correct themselves with little to no need for public policy intervention. The second recognizes that certain social problems will get worse without the deployment of appropriate measures to understand their root causes, and to limit their scope and incidence especially among disenfranchise societal groups. Both views benefit from systems thinking. Systems thinking theories apply to the relationships among community stakeholders, their networks, skills and capabilities. One of the principles of systems thinking is the acceptance of a dynamic equilibrium and its temporal oscillation due changes in feedback loops (Meadows, 2009). These dynamic processes contemplate (1) design, (2) planning, (3) implementation, and (4) monitoring (governed by accountability, adjustment, the rewarding of novel approaches, the liminality of attrition, and the penalization of non-compliance).

Another aspect that has experienced a resurgence in attention, is the tendency to rely on the notion of “the commons” (Ostrom, 1990) to preserve the stability of natural stocks by imitating or replicating natural systems in what is known as biomimicry. If necessity is the mother of invention, then creativity is likely to be the answer to finding novel solutions to complex problems. An overarching goal of applying systems thinking to social problems aims at stimulating adaptive behaviours in hopes of accomplishing corrections within logics of social responsibility. One of the most recent social innovations at the international level has been the approval of a social responsibility norm, called ISO 26000 (International Organization for Standardization), which is centered on principles of (1) organizational governance, (2) human rights, (3) labor practices, (4) the environment, (5) fair operating practices, (6) consumer issues, and (7) community involvement and development.

The importance of these dynamic processes within syntax frameworks pertains mostly to the professional relevance not only for all those who intervene in urban environments, but, above all, for those who are likely to benefit from those societal innovations. Sanyal (2000) identified four general criteria to evaluate City and Regional Planning’s relevance: (1) Analytical rigor and social relevance, (2) service function, (3) consensus on core professional values, and (4) intellectual capital formation. In an increasingly globalized world, professionals are asked to address ever more complex and multifaceted problems. Although traditional professional relevance of the type responsible for the formation of disciplinary knowledge (Howe, 1988), which resulted from and in silo information systems, still has pertinence, there is need for more multi-disciplinary, multi-tier, holistic and integrated approaches. In the past, Urban and Regional Planning was even blamed for having created dual cities marked by spatial determinism, segregation, social isolation, inhumane habitats, long commutes, etc. A systematic search for more just and equitable cities in the last decade or so has to a certain extent helped to change the profession’s reputation and acceptability (Soja, 2010; Fainstein, 2010).

As we approach the third decade of the twenty first century, we are compelled not to lose track of Pielke’s (2007) four positionalities for how scientists (and professionals broadly defined) can relate themselves to public policy: (1) Pure scientist, (2) science adviser, (3) issue advocate, and (4) honest broker. Although the various levels of intervention are likely to condition each positionality and the role of social science professionals, broader and more encompassing notions of social justice ought to be subjected to regular accountability and introspection.

6. CONCLUSIONS

The purpose of this paper was to analyse the potential use of traditional and innovative social and community oriented planning instruments (Burdge, 1999) through the lenses of space syntax methodologies. These methodologies are widely recognized as adequate to interpret, characterize, analyse and propose solutions to problems in the built environment. I argue that applying such methodologies to social problems requires multi-scalar commitments in terms of visions, agendas, resources, times, and efforts. Big data methodologies are likely to also provide new opportunities to resolving societal problems (Townsend, 2015).
To conclude, it is important to reflect on the value of three important notions: Social capability, social accountability, and social capital. Social capability involves the recognition and awareness of the self and the other. Although the golden rule may seem too rudimentary to some, its longevity has withstood the test of time. Social accountability recognizes the contributions and benefits to the creation, maintenance and or eradication of social problems. In political science and political economy these are commonly presented in the form of rights and responsibilities (see Coleman, 1990).

Social capital involves the notion of the common interpreted in terms of three fundamental aspects: (1.) assets – resources, (2.) syntax – the rules, and (3) the goals aimed at (3.1) nurturing and managing what exists, (3.2) growing and augmenting existing assets when possible, and (3.3) never descending below certain thresholds, as Campbell and Fainstein (2012, p.549) suggest, “a minimum threshold level of resources below which no one is allowed to sink (economics, health, self-respect, access to education, political rights)”.

Finally, it is important to recognize that spatial realm syntax varies from social realm syntax in the sense that the former applies mostly to the physicality (material) of the built environment, and the latter applies to the immaterial, individual and aggregated behaviours marked by relationships of trust, cooperation, desertion, and deterrence – the social glues of dynamic and complex human systems.
REFERENCES


ABSTRACT
This paper through a use of syntactic descriptive tools explores a presence of Catholic morphological implications that are discreetly woven into the organic spatial configuration of Bernardines cemetery – culturally and historically significant afforested scape. A case study is approached as a sum of internal connections, able to communicate attitudes to death and memory in the nineteenth-century Vilnius, Lithuania.

The article involves overlaying axial network, topography, burial directions and chronological occupation data over each other, aiming at understanding correlation between them, and how they help to explain the configuration of unplanned burial ground.

Bernardines cemetery functioned as a suburban branch of overcrowded churchyard burial ground that was in need of extension. A chapel was built 15 years after cemetery foundation. Even today chapel is a central figure in the spatial composition of Catholic cemeteries – in Bernardines cemetery the centrality of the chapel is not that apparent. After processing topographical and syntactical analysis it was possible to detect network's structural potential gathered around the chapel, its configurative relation to the burial directions and the location on the highest altitudes of the whole plot. In this case spatiality of religious hierarchy was implemented discreetly, but a tight dialogue with the natural terrain enabled Catholic cemetery to be identified with a pagan forest necropolis.

KEYWORDS
Cemetery, burial ground, organic development, small networks
1. INTRODUCTION

This paper aims at understanding the logic behind the unplanned cemetery that turned out to be one of the most significant nineteenth-century burial grounds in Vilnius. Pathway network in Bernardines cemetery in Vilnius do not show any planned logic. No project for cemetery design has been ever found in the archives. The only projects are for a chapel and for some tombstones.

However, through the set of beliefs Catholic Church structured cemeteries in a particular way different from other religious beliefs. This paper explores how much this unplanned morphology of the Bernardines cemetery corresponds to Catholic dogmas that are implicit in the structure though being unidentified at the first sight.

Therefore, together - Space Syntax theory, ArcGIS analysis and chronological research of cemetery occupation – were expected to unveil configurative relation between the entrance and the chapel, orientation of burial and their morphological links to the cardinal directions, the chapel, and understand the importance of terrain for location of the chapel and burial orientations.

Previously part of church precinct burial grounds acquired typological independence only by the end of the eighteenth-century. Territory of death was not just religious issue anymore - death became political and didactic. Modern necropolises were carefully designed and acquired either geometrical or organic shapes. Particularity of organic settings of nineteenth-century Lithuanian cemeteries set them aside from their contemporaries abroad - apparently their architectural expression had never been on political agenda and their development was left unplanned.

French revolution contributed to understanding death as educational device that besides religious meaning contained political value (Etlin, 1987 pp. 269–273; Oliveira, 2007 pp. 80–93). Cemeteries became public spaces celebrating memory of the great men - a privilege previously available only to the wealthy dead. Noble death even of the lowest social class members that exercised good morals or lived for the better of society, were attributed post-mortal honouring.

New typology was structured on the foundations of political connotations and hygienic worries. Its seclusion from the church precinct was managed by city councils, but the Church continued to be burial ground protagonist especially in those countries where liberal forces were suppressed or arrived later (Rugg, 2013 pp. 22, 25–26). New suburban cemeteries were set away from urban centres, but incorporated chapel on top of the structural spine. Cemeteries continued to serve only one particular religious faith, and the dead of the different beliefs were not buried in the same cemetery.

The spatial dimension of Lithuanian cemeteries and canonical Catholic cemeteries are quite different. Besides dissimilarities in the spatial layout, relations with buildings of symbolic importance such as chapel, volumetric scale of tombs and vegetation differ as well. Canonical Catholic cemetery is an enclosed territory, geometrical and organized hierarchically, with a temple as a core figure located on the axis of the main entrance, marking a visual and physical centre of necropolis. Burials, both underground and above the ground, are located along the pathways of different width, offering several options of burial with different price range, shaping a symbolically-ordered space, representing a city of the living in a territory of the dead.

On the contrary, traditional Lithuanian cemeteries have low walls; cemeteries’ plans represent features of organic development; only in-ground burial (inhumation) is practiced; in rare cases community mausoleums are available as well. Every citizen since his/her birth has a right for a little plot for the last resting place for free, and this right has been always exercised in Lithuanian territory.

Thus, it is possible to consider that Lithuanian cemeteries follow a symbolically-organic model while Catholic cemeteries are symbolically-ordered spaces, replicating different social contexts.

Lithuania spent nineteenth-century in the margins of Europe. It was as well in the margins of Russian Empire to which historical Lithuanian region was annexed in 1795 after the third division of the Commonwealth of Poland and Lithuania. In the sequence of these events
Figures 1 - Vilnius city churchyards and cemeteries in the nineteenth-century. The diagram is based on the city plan of 1840.

Vilnius became the third largest city of the empire. However, city’s nobility still lingered on political independence: intellectual elite, not without masonic influence explored local myths, contributed to fortifying memory of historical greatness and catalysed movements of liberation. Few revolutions followed, provoking Russian government and bringing a fame of being disobedient and unruly to Lithuania. Roman Catholic church functioned as a stronghold of Lithuania’s political independence, and in result of unsuccessful uprising of 1830-1831 a lot of Roman Catholic monasteries and churches were closed down or transformed into Orthodox shrines (Briedis, 2008 p. 128).

Probably more for the lack of space and less for scientific cautions or liberal philosophy, in 1801 - six years after the annexation - the first suburban cemetery was founded in Vilnius. Rasos cemetery served as a burial ground of St. Joseph and Nicodemus church - its churchyard cemetery was closed in 1799 by the government for not satisfying hygienic requirements. A new cemetery in the terrain was given by government to be managed by St. Joseph and Nicodemus church (Girininkienė, 2004 p. 64).

Bernardines cemetery was established few years later after the order and city council agreed on the conditions of land use and the fees that the order committed to pay to the city government. Established in 1810 the cemetery was first to be used only for burying the members of the order. Bernardines parish was founded only in 1814 (monastery had been functioning since 1469) and Bernardines burial ground became a cemetery of the parish to be used by all its residents, and not just members of the order. They were to be buried in all the territory - no part was reserved
exclusively to any social class. The cemetery was quickly filled up. In the middle of the century it started to require expansion. Bernardines initiated a new series of correspondence asking for the land. Cemetery was expanded in 1861, and functioned until 1966. Statistics count up to 30 000 people that had been buried in this cemetery during its active period.

During the period of functioning it was administered by Bernardines order - German Catholic St. Martin Congregation at the St. Ann Church, located 1.1 km away from the cemetery in the territory surrounded by the city wall. Parish in 1936 embraced 32 ha territory and included suburbs and villages as far as 6 km away from Bernardines church situated by St. Ann’s church. When Bernardines monastery was closed in 1864, cemetery continued to be administered by the same parish church that was handed to Roman Catholic priests.

Natural environments as spaces for afterlife are usual in Baltic mythology, and therefore a common practice to bury the dead in a forest or a meadow continued after christianization. Several Church reports describe the burial situation in 16th-17th century Lithuania – few people were burying their dead in the graveyards by church, most of them interred in the forests and meadows (Vėliū, 1996; Vėliū, 2003; Vėliū, 2005), in open spaces – not enclosed territories as Catholic cemeteries were meant to be, without a presence of priest and Catholic ritual.

Figure 2 - The first plan of Bernardines cemetery, drawn by Józef Danilewicz and submitted to the city council for approval on the 28th of April, 1810 (in Girininkienė, 2010 p. 141). Cemetery was open in October of the same year.

This spatial texture developed through informal movement was brought deep into the nineteenth-century, embodying the shapes of natural scape, organic pathway network and apparently undisciplined burial and tomb layout.
There are very few iconographical sources of Bernardines cemetery. The earliest one is a plan of the cemetery, drawn by Józef Danilewicz, dating 28th of April, 1810 (Fig.2). Another plan by Danilewicz is of the 7th of May, 1810, but it doesn’t include more data than the first one (Girininkienė, 2010 pp. 141–142).

A plan of the cemetery dating the 23rd of January, 1860, was prepared for the extension (Kasperavičienė, 1989).

2. METHODOLOGY

Cemeteries have not been studied through Space syntax theory. Nevertheless there are some attempts to the study organically developed natural landscapes, and using space syntax techniques to understand the types of affordances provided by them (Dalton & Hanson, 2007; Zhai & Baran, 2013; Mahmoud & Omar, 2014).

Following Hillier and Hanson (1984) approach, spatial patterns incorporate and give shape to social patterns. The topological structure is a primary element by which society creates and establishes roles to develop social patterns that shape social relationships. Accordingly, this paper is also an attempt to understand how this approach can contribute to cemetery analysis. The ultimate goal is to scrutinize the spatial texture of Bernardines cemetery and explore how social representations are reproduced in space.

Explorative spatial analysis of Bernardines cemetery was performed in four stages:

Firstly, axial network of internal movement in the cemetery is processed to retrieve integration HH data. Permeable tomb layout is approached as a city plan. Every tomb or tomb enclosure is seen a neighbourhood: axial lines pass in-between the tombstones as the routes of the movement. This study leads to understanding syntactic logic behind the pathway development identifying which directions were the most probable for pathway development.

Secondly, topographical map was produced by ArcGIS software using available data of cemetery’s terrain, retrieving data on terrain’s inclination and orientation. This enabled to see integration values in relation to topographical qualities.

Thirdly, burial directions were drawn in order to understand their relation to topography, chapel’s location and integration data.

Fourthly, chronological development of the cemetery was analysed by mapping all the burials from the early years of the cemetery throughout the nineteenth-century.

All four analyses were laid over each other in order to retrieve a complete portrait of the whole cemetery network configuration. Unplanned logic of cemetery configuration is dissected and questioned in the light of historical context, mythological data and genius loci. Overlaying few sheets of cemetery plan data aimed at finding correlations between terrain, burial directions and integration measure of cemetery network, retrieved from Depthmap software (Turner, 2001; Varoudis, 2012). Three layers of information proved to be an effective tool to understand the internal behaviour of Bernardines cemetery.

Archive of Vrublevskis library in Vilnius holds death registers of all the burials in the cemetery until 1965, when the cemetery was closed (Girininkienė, 2010 pp. 21–47).

Following available inventorial data, published in “Vilniaus Bernardinų kapinės 1810-2010” (Girininkienė, 2010 pp. 419–765), all the nineteenth-century burials in the cemetery were mapped, organising data for each decade since the cemetery foundation (Fig.3). It showed that Bernardines cemetery’s development embraced all its territory since the earliest decades: grave layout extended throughout the entire cemetery and became denser along the decades.

There are three main correlations that the article focuses on: 1) terrain and burial directions, 2) terrain and integration HH measures, 3) burial directions and integration HH measures. Some values correlated to others more, but most importantly such overlaps attracted attention to those parts of burial ground textures that are unnoticed without dissecting the network.
The premises of the syntactical study were set expecting confirmation of existent centralities gathered around entrance, shrine and main walking directions. Highest integration measures were expected to appear in the comfortable walking topography - the flattest and the least inclined. The densest texture of burials was to emerge in the least challenging topography, and therefore coincide with the pathways of the highest integration measures.

Cemetery, even when it assembles an image of city of living, functions more as a building or a park. It is a space that is entered, walked around or through and left in the relatively short period of few hours at maximum. Entrance therefore is most frequently walked through and this feature can be practically seen as cemeteries’ centre. A shrine - a chapel or a church - is often placed on the entrance axis becoming a focal point in the entire network.

What is more, cemeteries have different speed than the cities. What is considered a normal walking speed in the city where 400 m is walked in 5 minutes (Al Sayed 2014:72) wouldn’t happen in cemetery. Exploratory visits to the cemeteries showed that walking speed in there usually range around 1.33 m/min, that is about 200 m to be walked in 15 min, or even slower like in museums and galleries.

Cemetery as typology is a segregated walled network inside or outside the urban fabric, in many cases having defined visiting hours (Lithuanian cemeteries are open 24h). "Life” in the cemeteries consists of various types of motion: ceremonial (funeral), contemplative (grave visit, touristic walk) and functional (daily maintenance).
3. SYMBOLICAL LOGIC OF NETWORK INTEGRATION

3.1 ENTRANCES

Bernardines cemetery is more homogenous in its network than other nineteenth-century cemeteries, for example Rasos cemetery (Bazaraitė et al., 2016). Bernardines cemetery is filled with family graves, only a far Northeast contains more individual graves. The main and only entrance leads to a chapel through a curved line stretching Eastwards from the gateway. Integration value for the entrance is quite above the average (Table 1, Fig.4).

Bernardines cemetery has been accessed exclusively from the North side through Žvirgždyno street since its foundation (Fig.5), possibly an entrance from the South could have existed – a little pier is marked in the earliest plan drawn by Danilewicz. By the year 1828 it was finally enclosed and included a gateway with a bell tower. A gateway of the cemetery was not shaped with pompousness - Žvirgždyno street is a blind-end coming from Polocko street - a big route passing through the whole Užupis neighbourhood. The small street is discreet scenery for cemetery visitor. The city plans from 1840, 1859, 1871 and 1890 confirm that the cemetery has always been accessed through this narrow route, and no documents are found to refer to any spatial arrangements for funerals including public rituals of greater scale.

Traditionally an axis connecting entrance to the chapel serves as a structural spine of the whole network in Roman Catholic cemeteries (Auzelle, 1965 pp. 67, 94, 104), however integration values not necessarily show that: Depthmap reads the network not as a closed structure but as a clipping out of the bigger system. However, enclosure is a common feature for cemiterial typology.
Figure 5 - A view from the entrance where the pathways bifurcate (point A in Fig.4). Following the left pathway one arrives to the chapel that stands invisible looking out from the entrance.

3.2 CHAPEL CENTRALITY

The spine of Bernardines cemetery does not possess the linearity typical to Canonical Roman Catholic cemeteries. Organic nature of the cemetery development sets the chapel on the route of the curvy pathway, winding through the terrain dotted with naturally growing trees of local species.

Preparing axial map of the cemetery, it was expected to see the most integrated lines in the proximity with the chapel. In the case of Bernardines cemetery such correlation between the most integrated lines and the chapel exist. Besides high integration measure, chapel centrality is expressed in its position in cemiterial topography - it stands on the highest point of the terrain, with the altar facing South. In Canonical Catholic cemeteries the altars of the chapels face the entrances, and in the case of Bernardines chapel the altar doesn't stand on the entrance axis and it is turned to the opposite direction than the entrance - it is accessed laterally through a pathway stretching from West to East.

Figure 6 - A view from a South side looking Northwards in the direction of the chapel.
In comparison to Rasos cemetery - another unplanned nineteenth-century cemetery in Vilnius - access to the chapel is organised through the winding pathway, running along the Western side of the cemetery. The altar faces Southwest and has no tête-à-tête relation to the entrance.

![Rasos cemetery axial map with integration HH measures](image)

**Figure 7 - Rasos cemetery axial map with integration HH measures**

### 3.3 BURIAL DIRECTIONS

At the first sight burial fabric of Bernardines cemetery seems chaotic, obeying no regular rules, either geometric or symbolic. However, burial direction in the cemeteries since the earliest times of Christianity had been claimed to have symbolic and magic importance. “The orientation toward the east, toward Jerusalem, was retained for a long time in the burial of the dead” (Ariès, 1981 p. 14). Such orientation - head to the West and feet to the East - doesn’t make part of the Bernardines cemetery burial pattern. Even if there is one prevailing direction in some of the burial, it doesn’t mean a common rule for the whole cemetery. In the case of Bernardines cemetery perpendicular or parallel relation to the chapel is prevailing in those plots that lay closest to the shrine, and this configuration travels further away from the chapel as well, changing direction only in far West and East corners of the cemetery.

In Lithuania, a common notion suggests that burials should be oriented with feet to the nearest church, or with head to the North and the feet to the South (Dundulienė, 2005 p. 308). Such organisation (either church-wards, or Southwards) can be found dominant in small countryside cemeteries, but bigger cases - as Bernardines or Rasos - show a constant change of burial direction from one borough to another.
Besides the relation to the chapel, burial directions showed dependence to the terrain change, however it is more visible in more dynamic topography of Rasos cemetery - burials obeyed the terrain and adjusted to it. Natural terrain of Bernardines cemetery apparently had not been changed, and the burials occupied those patches of land where burying was less challenging. Therefore the most inclined slopes were not as densely covered with burials as flatter ones. In Bernardines cemetery the burials are laid perpendicularly to terrain altitudes. Burials accompany perpendicularly only some of the main walking axis, especially on the pathway leading from the entrance to the chapel that continues Eastwards. Probably the pathways were defined previously to the filling of the cemeteries with the graves, and therefore the pathways were accompanied by main façades of the burials. However, it could have happened that the pathways were defined later than the burials took place, and the land was cleaned and filled with correctly oriented and organised graves. Mapping of burial evolution in Bernardines cemetery didn’t show any particular staging of the cemetery burials, except the bifurcation at the entrance of the cemetery that appeared in the 1880’s, and the pathway stretching from entrance Southwards, had been planted with burials only in the twentieth-century. Different morphological structure could have existed here before.

All in all, in such organically ordered networks, official pathways maintain their integration superiority in relation to other movement lines, and in the case of Bernardines cemetery those most integrated pathways have burials facing them perpendicularly. Integration values along the softly winding pathway are all above network average going from entrance Eastwards as follows. The highest integration of the pathway is concentrated close to the chapel.

Bernardines cemetery was extended in the Northeast direction only in 1861. Burial direction North-South had been maintained in the extension. The extension has significantly more individual graves than family graves (or family graves are not grouped and enclosed). It doesn’t seem to be a result of the later development of the cemetery and different social conditions (less financial power to build bigger and better quality tombstones). It seems more plausible that the territory for its slight remoteness from the chapel was more used by the pauper.

Figure 8 - Burial directions of Bernardines cemetery laid over terrain inclination map, processed by ArcGIS software.
Even with careful study of burial chronographic sprawl, it is difficult to say which burial direction was in the beginning of the cemetery. About 30 tombs survived from the first 20 years of the cemetery (1810-1830), they are mostly located in the burial vault structures located on the Western and Eastern side of the chapel. Some of them have dates previous to cemetery’s foundation - these are the cases of reburials from other cemeteries, usually these are the graves of nuns. The core of the cemetery is laid in North-South direction, and at the first sight it is intuitively justified by their proximity with the chapel. However the chapel was only built 15 years after cemetery was founded.

The earliest photographs and engravings of the cemetery show it dotted with wooden crosses facing either North or South (a symmetrical nature of cross structure doesn’t allow to understand if they are facing South or North, such understanding is only possible seeing cross relation to grave, but that is not possible in the images where cemetery is showed densely covered with trees).

Bernardines cemetery’s burial directions homogeneously cover the territory either perpendicularly or parallel to the altitudes with very few orthogonal exceptions. Topography is constant, relatively flat, majority of the terrain is inclined around 0°-5,35°, and continues to be dense up until 10,43°. The texture becomes less dense when inclination of terrain gets closer to 16.69°. In the slopes of 16.69°-24.11° inclination burials continue, but not as dense as in flatter plots. Getting closer to the river, almost reaching the end of slope and entering a valley, network vanishes, and the scarce burials are grouped in lonesome islands accessed through long uninterrupted 20-30 m pathway lines of the average measures of integration or below. The flatter the terrain, the more constant and regular burial pattern emerges.
Terrain is slightly inclined and facing South. Closer to the valley of river Vilnelė, terrain falls down - there is very few burials here. In those parts where terrain faces Southeast, burial direction turn softly towards East. On the Western side of the section terrain turns slightly West - Southwest orientation: here the prevailing burial direction is West-East. However Bernardines terrain is not as expressive as, for example, Rasos, and it is quite small. Lacking topographical variation, correlation between terrain orientation and burial direction seems not as strong, as burials’ relation to the chapel - this looks like more plausible reason for cemetery’s settlement genotype.

Probably it was chosen to plant the chapel on the highest spot of the cemetery, and burials were laid in relation to the chapel and the terrain. This burial direction doesn’t match dogmatic Catholic principles, but corresponds to the common notion that Lithuanians have about burial directions. But this coincidence doesn’t confirm it to be a rule, as other cemeteries in Vilnius show more organic configurations than Bernardines. Probably, Bernardines cemetery for its size and flat terrain was suggestive for keeping the same burial direction without extra effort - practicality took over mythology and enabled a reproduction of previous pagan burial practice. When terrain becomes more complicated, even though still making part of the cemetery’s enclosure, burials become scarce and eventually vanish before getting close to the cemetery’s wall.

4. CONCLUSIONS

Overlaying few sheets of different data, aiming at finding correlations between terrain, burial directions and integration measures proved to make sense and bring forward deeper insights to cemetery’s morphological analysis. To sum up it is concluded that:

1. Chapel is situated on the highest point in the whole cemetery structure, surrounded by the graves set either perpendicularly or in parallel to the chapel. Organically symbolic paradigm of cemetery’s settlement maintains chapel as a central figure, but its location is encountered along the pathways, and not geometrically imposed on cemetery’s structure.
2. The dead of the highest social status are scattered through the oldest part of the cemetery. The extension has less nineteenth-century burials probably for lower quality tomb materials, that didn’t prove to be resistant to the damages of time (probably these were wooden crosses), and wiped them off the cemetery and its history.

3. Entrance doesn’t relate to the chapel symmetrically and directly, but the integration measures of the pathways are of the highest measures in the system (much above the average).

4. In terms of correlation between integration and burial directions: it has apparently more to do with the density of the grids, pathway length and straightness than with the changing burials directions.

5. In the case of Bernardines cemetery, burial direction obeys chapel’s location, and further away from it follows the terrain, keeping a constant dialogue with changing altitudes. Therefore this is not common for other cemeteries in Vilnius.

ACKNOWLEDGEMENTS

This paper was developed under the scope of a PhD scholarship funded by Fundação para a Ciência e a Tecnologia.

I would like to acknowledge Pedro Pinto for developing the ArcGIS work used in this paper.
REFERENCES


GENERIC FLOWS OF SUSTAINABLE URBAN FORM:

MOSTAFA BEHZADFAR
Department of architecture and environmental design, Iran University of Science & Technology, Tehran, Iran

YONES CHANGALVAIEE
Department of Art and Architecture, Science and Research Branch, Islamic Azad University, Tehran, Iran
Johna.urbanism@gmail.com, Corresponding author.

ABSTRACT

Urban form as an intermediate between human and its peripheral environment is embodiment of formative and transformative flows of built form. Energy flows of urban form production, operation and maintenance lead to generating and transforming of built form which is the transmitter of information flows as visual and perceptual flows between human as receptor and built environment. On this basis, continuous and integrated interactions between human and living environment have been considered as energy operational flows of environmental comfort (heating and cooling energy demand) and informational flows of perception, cognition and evaluation of built form (focusing on visual interaction) which are two generic flows of built form in relation with human. These relations and interconnections between energy and information flows have been excavated based on Eco Efficient Urban Form model (EEUF model). The present research aiming at exploring the relations between these two flows with built form and between them have been scrutinized based on two distinct state of Occlusivity factor, distribution of built elements in vertical plane (occlusivity factor for operational energy flows, Adolphe,2002: mean openness of urban spaces to the sky, reflecting the height distribution of built elements which presents horizontal perimeter cuts in vertical planes of built form;) and the length of the occluding radial boundary from each vantage point (Benedikt, 1979: 53) (Isovist occlusivity for visual information flows) It resembles the horizontal built elements perimeter map, which provides a comparative measure of the overall boundary of each isovist. Analytical context of the study has been chosen from the morphological aspects of Isfahan in the form of ten morphological types presenting general morphological trends of Isfahan. Regarding to these, results indicate that there is an Inverse correlation between the two state of occlusivity factor, occlusivity in vertical planes for energy performances and occlusivity in horizontal planes for sustainable visual information flows between built form and humans. The results demonstrate that the tissues with organic morphological aspects and structure have high value of energy performances occlusivisty factor especially effective for decreasing in heating energy demand in cold seasons and have low value of Isovist occlusivity factor which indicate high value of Isovist compactness leading to coherency in visual information flows. Hence, results depict that the integration between two generic flows of sustainable urban form is demonstrable for old tissues with old organic morphological patterns.
KEYWORDS
Occlusivity, Isovist, Energy demand, urban form, information flows

1. INTRODUCTION
The starting point of this study is presenting a clear understanding the gaps in our grasps of the relations between urban environment physical form and environmental performances such as material and energy flows and experienced physical qualities (in the form of information exchange between humans and environment). These relations exist and can be described and explained. They should be identified along with the methodological framework to support the evaluation of the city image and would be organized for the purpose of urban sustainability. The framework should also lead to more sustainable outputs of urban form design at all scales of the urban physical organization. Therefore, finding the interconnections and interactions between physical forms of urban environment and environmental performance, and filling existing gaps are important tasks of this study. Hence, environmental performance elaborates under the concept of urban metabolism and urban form system would be described in connection with this concept.

According to a systematic definition of urban ecology, a city is like a complex and open system including integrated flows and stocks which are exchanging between built structure and environment. For the first time in 1883, Karl Marx applied the exchanges between the material-energy flows and urban built environment under the concept of urban metabolism in industrial process criticism (Zhang, 2013). Then, Abel Wolman again applied urban metabolism idea in response to the decline in US cities water and air qualities. What Wolman was dealt with was on the basis of material and energy inputs of a hypothetical city in US (Wolman, 1965).

After that, urban metabolism studies have been considered the balancing between energy and material flows. Significant point in these analyses has been about the evaluation of energy and material input flows in urban system and evaluation, estimation of output flows in different procedures of urban system.

On the other side, information flows are considered as an important element of urban metabolism with the introduction of information exchanges concept within the urban built environment (Coward and Salingaros, 2004; Macfarlane, 2003). In this study, information as the third flow of urban metabolism is defined based on the initial interaction (visual) between human and built form.

On the other hand, the large volume of published studies in connection with the urban metabolism were considered the analysis and data processing of the input flows in the urban system and analysis of outputs, in the form of wastes, air and water pollution, heat islands, and etc. In continuation of these studies, in addition to codification and extraction of environmental sustainability indicators of urban ecology, socio-economic indicators related to metabolism have been entered to the cycle of urban metabolism studies (Chrysoulakis et al., 2013).

An urban ecosystem consisting of the elements and components which are permanently exchanging with its surrounding environment. Based on what has been said, materials, energy and information flows are considered as inputs of an urban system in its sustainability evaluations.

Human as the primary element of urban system interacts with the environment permanently and affected by energy and material flows in the forms of environmental indicators such as air and noise pollution, heat islands, greenhouse gasses, etc. The energy and material flows would be emerged in the form of informational flows such as urban ambience, perceptual and semantic processes (Osmond, 2008; Salingaros, 1999). Accordingly, information flows carry the ambient qualities of material and energy to the residents. It means that human expresses his/her sense to the material and energy flows of urban metabolism through information flows. Urban form, in terms of physical aspects, is built by using energy and material flows. Then, the initial interaction would be established between human and built form.
As a general idea of the research, urban form has been scrutinized as a built structure of urban system encompassing the urban metabolism flows. It has also been regarded as an evaluative context between inputs and outputs of urban metabolism. In addition, urban form as the context of urban metabolism processes embraces the inputs of information, energy, and material flows and reveals them in the forms of interactive processes as specific outputs.

So, the more stable interactions between inputs and outputs of urban metabolism lead to more sustainable urban form. It means that sustainable urban form describes energy, material, and information flows in the form of resource and waste management process and also quality of place (initial interactions of human with built form, cognition, and mental evaluation). Therefore, in this study, integrated interactions of triple elements of urban metabolism (energy, material, and information) are entitled Eco-Efficient Urban Form model (EEUF) in urban morphological context.

An analytical unit of urban morphological studies (urban tissue) (Kropf, 1993; Conigga and Maffei, 2001) is located in the core of EEUF model. This core is generated through the productive interactions between local resources of energy and material and external inputs. Urban tissue frequently exposed to operating and utilizing in formation and transformation processes of urban form. These operations and utilizations are defined based on temporal conditions, social and cultural needs and behaviours and accordingly, built form would be maintained or modified.

Hence, in both operational and maintenance modes, energy and material flows constantly are considered as metabolic inputs in urban form system. Meanwhile, the information flows streaming from the initial exposes between human and built form, is scrutinized as interaction, perception, cognition, evaluation and behaviour in environment (Nasar, 1998). But the main focus of present study (for describing information flows of urban metabolism in relation with urban form) has been founded regarding visual interactions between human and build form. It is what Gibson referred to as environmental perception based on environmental affordability (optic array) (Gibson, 1979; Osmond, 2008) and also indicated by Salingaros as information field of urban space (visual interaction between urban form as a transmitter and observer as a receptor) (Salingaros, 1999).

From a metabolic perspective for describing urban form system, urban form as a medium between human and the environment is located in balancing point between human activities and metabolic flows. Human activities are divided into two modes; production of form and living in built form. Metabolic flows are also divided into three modes; production, operational, and maintenance flows.

Therefore, urban form system which consists of physical form and function will emerge from sustainable interactions between generative and productive flows of human activities and metabolic flows. So, human’s generative activities and metabolic flows are two different interactive aspects of urban form phenomenon.

According to conceptual diagram of urban form system, energy and material flows are considered as inputs of urban form system in formation and transformation processes, and wastes, recycles and pollutants are considered as outputs. Operational mode (environmental comfort), and perception, cognition, and behavioural aspects are regarded as another kind of urban form system outputs. In this model, functional aspect of urban form system indicates the specific relations between human and physical form.
1.1. THEORETICAL FRAMEWORK (EEUF MODEL)

In view of all that has been mentioned so far, EEUF model has been considered as an analytical and evaluative model of sustainable urban form studies and design. This model has been delineated in accordance with Eco-Efficiency concept (Schaltegger and Sturm, 1990) and local resource model (Kropf, 2008, 2013).

So, in the first place, the main constituent of the model includes the urban tissue, resulting from aggregation of urban form elements. These elements are the components of multi-level generic structure (Kropf, 2014) which have been evolved from the Conzen and Coniggia to Kropf urban morphological approaches and methods (Conzen, 1961; Coniggia and Maffei, 1979; 2001; Kropf, 1993, 1996, 2009 and 2014). The elements in the hierarchical structure are as: materials, structures, rooms, buildings, plots, plot series, street and urban tissue (Kropf, 2014). moreover, Kropf points out: “Returning to the hierarchy of elements, there are three distinct types of void embedded in built form, each with a distinct role within the multi-level generic structure” (Kropf, 2014: 50), including: void in building, void in plots and void in street (Kropf, 2014).

Considering morphological unit and urban form system content, EEUF model consists of two levels of inputs and outputs. The inputs contain the two groups of resources, stocks and flows. The first group of inputs are the local resource bases such as, wind, topography, solar radiation, local material, soil, water bodies and etc. and the second group are external resources such as fossil fuels, electricity, imported material and flows and etc.

On the other side, the output levels could also be classified into two groups. The first group of outputs are the productions and services of the generative process of formation and transformation of urban form. Accordingly, referring to the urban form system, physical aspects and produced form would be considered as the production mode of the model. Furthermore, utilization, operation and specific services of produced form are the operational mode of EEUM model. The other outputs of the model are wastes, pollutants, recycles and also urban ambience; commenting on the issue, Osmond argues that urban ambience is: “the experienced physical and psychological qualities of the urban environment. Ambience is based on the premise that comfort, satisfaction and delight (or lack thereof) reflects inter alia the user’s perception and interpretation of the physical state of an architectural or urban space” (Osmond, 2008: 146).
Figure 2 - Eco-Efficient Urban Form model

According to the research aim and what have been mentioned, the primary concern of the research is analysing and evaluating the main parameters of generic flows of urban form (energy and information) in the form of an integrated framework.

One of the most significant issues of the present research is the nature of selected parameters of generic flows of sustainable urban form. So, the main emphasize of the paper is based on the two forms of occlusivity factor for the two main aspects of the research; occlusivity for environmental performances and occlusivity for information flows.

Lock Adolph (2001), introduced the occlusivity factor according to the relations between urban form and environmental performances which defines the height distribution of built form elements and urban openness (Adolph, 2001; 2014).

On the other hand, Benedikt (1979) introduced the occlusivity factor in his Isovist Method for describing and analysing the relations and interconnections between urban configuration and visual information flows (Benedikt, 1979; Batty, 2002). As Yu et al., notes: "Occlusivity is the total length of all edges that are not defined by building surfaces – thus they are the unknown or ill-defined part of the visual experience of a space" (Yu et al., 2016: 3), This factor has important role in evaluating the sustainability of visual information flows in the context of built form. Moreover, environmental occlusivity factor represents the volumetric demonstrations and three-dimensional structure of built perimeters. On the contrary, information flows occlusivity factor indicates two-dimensional attributes of urban geometry such as built form perimeters and areas.

Taken together, the specific objective of the research was delineated based on analysing the morphological patterns of Isfahan according to exploring the integrated interactions of energy and information flows of investigated morphological types. The research also examines the significant relations between environmental performances and Adolph occlusivity factor as well as the significant relations between sustainable visual informational flows and Benedikt occlusivity factor. Finally, the research assesses the significance of correlation between Adolph occlusivity factor and Benedikt occlusivity factor which is the verification test for EEUF model. For the purpose of the analysis, statistical significance is analysed using analysis of Spearman correlation and P-value null hypothesis as appropriate.
1.2. RESEARCH PARAMETERS

Following the research objectives Adolphe occlusivity factor and Isovist occlusivity have been considered as the analytical and comparative parameters of the research. The other parameters such as Isovis compactness, height ratio (L), floor space index (FSI) and coverage ratio (GSI) have been securitized as supplementary parameters.

1.2.1. ADOLPHE OCCLUSIVITY FACTOR (ENVIRONMENTAL PERFORMANCES)

The average of urban spaces openness to the sky, demonstrates the height distribution of built elements. According to Adolphe, distribution of built elements in vertical plane has an impact on solar radiation which has a great influence on heating and cooling energy demands during cold and hot seasons (Adolphe, 2001). He argues that the Effects of the distribution of built perimeter against building heights indicates the environmental performances based on solar radiation and air flows (Adolphe, 2001).

For better understanding of the confrontation between tissue/building height and perimeter, referring to the Martin centre et al. (1997), a number of horizontal cuts on urban tissue were used for each 3.5meter or for each floor (Adolphe, 2001).

![Figure 3 - illustrating the a tissue horizontal cuts, (Adopted from Merlier, 2015)](image)

\[ \text{Adolph Occlusivity Factor} = \frac{\sum N_{\text{horz. cuts}} \times \frac{1}{P_{\text{built}}/P_{\text{unbuilt}}}}{1} \]  

1.2.2. ISOVIST OCCLUSIVITY (VISUAL INFORMATION FLOWS)

The isovist occlusivity factor represents the relative proportion of occluded surfaces which limit the sights from specific observation point (Osmond, 2008; Batty, 2001; Benedikt, 1979). This factor measures the length of open edges according to build form and Isovists perimeters. Therefore, the high value of the factor indicates the high rate of vagueness and spatial navigation confusion (Yu et al., 2016).

With a view to the Gordon Cullen, serial visions are made by place properties. The place properties are the forces and pressures which create the movement structure on spaces based on geometrical configuration of built surfaces. The built surface is a medium (between masses and voids) which illustrates the visual organization such as material, colour, texture and etc. This visual organization is content of townscape (Cullen, 1961; Brodbent, 1990).

Returning to the Isovist-occlusivity, the higher value of open edges and ill-defined spaces lead to the lower possibility of making serial visions on a contiguous visual movement structure. Hence, these relations could be described through visual stability (a space quality deriving from place properties). The quality of visual stability of spaces and built surfaces was depicted in Isovist method and indicates that to what extent an observer is under environmental domination. According to the designed experiments by Psarra and McElhinney (2014), it seems that there is an inverse correlation between compactness and occlusivity factors, the reason is that the spaces with high value of convexity (compactness) have lowest possibility to create open and none-defined edges which are more sustainable from the aspect of visual information flows (Psarra and McElhinney, 2014).
2. DATASETS AND METHODS

At first, selecting the suitable case study is the important part of the research methodology. For this purpose, the typo-morphological method which was used and approved by Kropf and Changalvaiee (2014), has been considered to this study for presenting a holistic and inclusive perspective of urban morphological states of Isfahan urban morphological patterns. Therefore, five tissue types were selected as morphological units following as the below table:

<table>
<thead>
<tr>
<th>Tissue type 1</th>
<th>Plot type</th>
<th>General characteristics</th>
<th>General aspects</th>
<th>Tissue sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Courtyard</td>
<td>Old Historical Core</td>
<td>• Organic structure and configuration • Compact blocks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tissue type 2</th>
<th>Plot type</th>
<th>General characteristics</th>
<th>General aspects</th>
<th>Tissue sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Courtyard, Multi-story front court</td>
<td>The Transformed Centre</td>
<td>• Grid structure within organic pattern • Compact blocks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tissue type 3</th>
<th>Plot type</th>
<th>General characteristics</th>
<th>General aspects</th>
<th>Tissue sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated apartment</td>
<td>The Transformed Extensions</td>
<td>• Fragmented structure • Isolated block apartments</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tissue type 4</th>
<th>Plot type</th>
<th>General characteristics</th>
<th>General aspects</th>
<th>Tissue sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informal settlements, Central courtyard, Single family front court</td>
<td>The attached rural areas</td>
<td>• Organic structure and configuration • Compact blocks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tissue type 5</th>
<th>Plot type</th>
<th>General characteristics</th>
<th>General aspects</th>
<th>Tissue sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-story front court</td>
<td>The block apartments and grid Multi-story front court</td>
<td>• Grid structure • Front court block apartments</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 - typology of morphological patterns, the case of Isfahan

Then, two samples (100meter × 100meter) were selected from each type as the final analytical units of the research. As a general classification of the above table, the morphological types of Isfahan are classified into two general categories: 1- old and organic patterns (tissue types 1, 2 and 4) 2- modern, fragmented and grid pattern (tissue types 3 and 5). The tissue type 2 is turning point in urban form transformation of Isfahan with dominant characteristics of old and organic patterns. A tissue with old and organic plot types and regular semi-grid street pattern.

The second step of the methodological process is simulating energy performances (heating and cooling demand for buildings) and analysing the visual information flows. Hence, environmental performances were simulated in terms of theoretical energy demand. The purpose of theoretical demand is that all non-morphological factors such as utilizing factor, glazing ratio and etc. were kept constant (Salat, 2009). In order to simulating of environmental
performances, the CitySim model (Robinson, 2012; Kampf and Robinson, 2007) was employed to calculating and estimating the energy flows in the scale of an urban tissue or whole city based on geometrical and configurational aspects. The main important part of the model is using a simplified radiosity algorithm (Robinson and Stone, 2004) to calculating the solar radiations and their interactions with built form elements.

On the other side, for analysing the visual information flows the Isovist method from depth map software was used and the compactness and occlusivity factors were investigated (Turner, 1997; Batty, 2001). On this basis, the occlusivity as a morphological factor of visual information flows describes the change in sight lines within the built form. Accordingly, in order to control the occlusivity, the compactness factor was analysed which describes the stability of information flows of sight lines (Psarra and McElhinney, 2014).

3. RESULTS
Considering the research aim, objectives and also presented factors, the results have been focused on the correlations between Adolphe occlusivity and environmental performances. The research results have also emphasized on the Isovist -compactness and Isovist-occlusivity correlations for visual information flows. Eventually, the results have been scrutinized according to the integrated interconnections and interactions of generic flows of sustainable urban form (Energy-information) based on dual nature of occlusivity factor.

3.1. ADOLPHE OCCLUSIVITY FACTOR AND ENVIRONMENTAL PERFORMANCE CORRELATIONS
As an energy simulation method, the CitySim model is used to estimate the energy demands for heating and cooling (In this process the urban configuration has noticeable impact on building energy demands via solar radiation, heat transfer, natural ventilation, lighting and etc.) (Robinson, 2012). So, it is very important to determine the model inputs appropriately.

One of the most important inputs of the model is 3D configuration and geometrical attributes of each morphological samples. In addition, the other type of input is climatic data resulting from Meteonorm software (In .Cli and .Hor formats) (Perez, 2014). The climatic parameters are wind velocity, wind direction, global irradiances, relative humidity, air temperature and etc. The case study of the research, Isfahan, is located in hot and arid climate (Kampf, 2009).

Another important parameter of the model is determining the thermal comfort ranges in cold and hot seasons regarding the climatic conditions. Therefore, considering the related literature reviews (Nikolopoulou and Baker, 2001; Perez, 2014) and Iran’s national standards of building sector (energy saving 19th issue) (Ministry of road and urban development, 2010), 20 °C and 26 °C are determined as the minimum and maximum thermal comfort temperature for cold and hot seasons.

As noticed in methodology section, the parameters and inputs such as façade detail, glazing ratio, wall and roof material, infiltration ratio, plant and equipment model, utilizing factor and behavioural model have been kept for ten samples of the study.

On the other side, the morphological characteristics of the samples indicate the noticeable differentiations between old and modern patterns in terms of Adolphe occlusivity factor. Furthermore for better illustrating the morphological profiles of the sample tissues, the two factors of Floor Surface Index (FSI) and height ratio (L) are calculated. The results represent the higher value of occlusivity factor for old tissues (T1, T.1.1, T2, T.2.2, T4 and T.4.1) compared with modern tissues (T3, T.3.1, T5 and T5.1). The results, as shown in Table () indicate the lower ratio of FSI and L for old tissue in comparison with modern tissues.

The simulation results for old tissue samples demonstrate the lower value of energy demand for heating in cold seasons and very higher value of cooling energy demand in hot seasons. In explaining this characteristic, the higher ratio of occlusivity factor along with the lower values in height index and surface density index indicate the more exposure surfaces and urban masses to solar radiations leading to increasing in solar gains. On the other side, it could be inferred that
occlusivity factor represents the compactness and adjacency of the plots within the tissue. In old tissues, the higher value of occlusivity demonstrates the higher compactness and adjacency values in plot types (Central courtyard type) which lead to the lower heat transfer and loses between plot surfaces. By the same token, exposure to the solar irradiances and restriction on air flows for natural ventilation due to the compact plot types cause to increasing in cooling energy demand for hot seasons.

<table>
<thead>
<tr>
<th>Tissue type</th>
<th>Heating Demand-Kwh/m³/Y</th>
<th>Cooling Demand Kwh/m³/Y</th>
<th>FSI</th>
<th>L</th>
<th>Occlusivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>14.08</td>
<td>61</td>
<td>0.57</td>
<td>1.06</td>
<td>0.88</td>
</tr>
<tr>
<td>T.1.1</td>
<td>16.19</td>
<td>31</td>
<td>0.74</td>
<td>1.3</td>
<td>0.72</td>
</tr>
<tr>
<td>T2</td>
<td>21.73</td>
<td>50</td>
<td>1.31</td>
<td>2.27</td>
<td>0.54</td>
</tr>
<tr>
<td>T.2.1</td>
<td>18.31</td>
<td>48</td>
<td>1.5</td>
<td>2.7</td>
<td>0.41</td>
</tr>
<tr>
<td>T3</td>
<td>23.38</td>
<td>18</td>
<td>1.98</td>
<td>6.6</td>
<td>0.16</td>
</tr>
<tr>
<td>T.3.1</td>
<td>22.57</td>
<td>16</td>
<td>3.7</td>
<td>11</td>
<td>0.095</td>
</tr>
<tr>
<td>T4</td>
<td>10.16</td>
<td>56</td>
<td>0.51</td>
<td>1.11</td>
<td>0.81</td>
</tr>
<tr>
<td>T.4.1</td>
<td>11.21</td>
<td>57</td>
<td>0.69</td>
<td>1.15</td>
<td>0.77</td>
</tr>
<tr>
<td>T5</td>
<td>24.14</td>
<td>24</td>
<td>2.48</td>
<td>5.62</td>
<td>0.184</td>
</tr>
<tr>
<td>T.5.1</td>
<td>24.63</td>
<td>19</td>
<td>3.4</td>
<td>5.5</td>
<td>0.188</td>
</tr>
</tbody>
</table>

Table 2 - energy performances and morphological parameters results

Therefore, the Spearman correlation analysis results depict that a significant strong negative correlation is found between Adolphe occlusivity factor and heating energy demand (rho: -0.830, P-value: 0.003). Accordingly, for old tissues with higher value of occlusivity factor, the heating energy demand in cold seasons is lower than the modern tissues.

On the other hand, the analysis results indicate that a significant strong positive correlation is found between Adolphe occlusivity factor and cooling energy demand (rho: 0.939, P-value: 0.001).

2.3. BENEDIKT OCCLUSSIVITY FACTOR AND VISUAL INFORMATION FLOWS

For isovist-occlusivity factor results demonstrate that modern tissues with grid pattern and isolate apartment blocks have the higher average of occlusivity factor value and also higher standard deviation in comparison with old tissue with organic pattern. Thus, these tissue have the more open edges, ill-defined spaces and higher spatial changes intensity. The combination of results provides some support for the conceptual finding that there is a significant correlation between the morphological patterns with high ratio of ill-defended spaces and spatial change intensity (spatial vagueness and confusion) in terms of visual information flows.

Besides, for isovist-compactness the results represent that old tissues have the higher average of compactness value and also higher standard deviation compared with modern tissues. Therefore, the stability in visual information flows is the main characteristic of old tissues with organic pattern. The stability of visual information flows and diversity of spatial changes (convexity factor) could be scrutinized according to the serial vison and sequence of spaces in
old tissues. On this basis, conditions would be provided to attaching the secondary information flows such as texture, colour, proportions and etc.

Accordingly, the spearman correlation analysis show the significant negative correlation between isovist-occlusivity and isovist-compactness (rho: -0.733, P-value: 0.016).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>0.181</td>
<td>0.036</td>
<td>0.778</td>
<td>0.116</td>
<td>84.43</td>
<td>4.26</td>
<td>296.94</td>
<td>47.62</td>
</tr>
<tr>
<td>T1.1</td>
<td>0.134</td>
<td>0.28</td>
<td>0.577</td>
<td>0.069</td>
<td>79.28</td>
<td>0</td>
<td>225.93</td>
<td>47.76</td>
</tr>
<tr>
<td>T2</td>
<td>0.179</td>
<td>0.22</td>
<td>0.703</td>
<td>0.156</td>
<td>87.97</td>
<td>3.15</td>
<td>303.22</td>
<td>53.68</td>
</tr>
<tr>
<td>T2.1</td>
<td>0.129</td>
<td>0.031</td>
<td>0.503</td>
<td>0.117</td>
<td>117.73</td>
<td>1.69</td>
<td>318.38</td>
<td>77.90</td>
</tr>
<tr>
<td>T3</td>
<td>0.149</td>
<td>0.072</td>
<td>0.752</td>
<td>0.070</td>
<td>384.61</td>
<td>33.66</td>
<td>668.65</td>
<td>119.25</td>
</tr>
<tr>
<td>T3.1</td>
<td>0.169</td>
<td>0.049</td>
<td>0.451</td>
<td>0.044</td>
<td>327.38</td>
<td>32.42</td>
<td>760.005</td>
<td>117.90</td>
</tr>
<tr>
<td>T4</td>
<td>0.206</td>
<td>0.044</td>
<td>0.607</td>
<td>0.102</td>
<td>68.99</td>
<td>3.41</td>
<td>200.27</td>
<td>40.44</td>
</tr>
<tr>
<td>T4.1</td>
<td>0.271</td>
<td>0.112</td>
<td>0.660</td>
<td>0.082</td>
<td>14.76</td>
<td>0</td>
<td>57.36</td>
<td>10.86</td>
</tr>
<tr>
<td>T5</td>
<td>0.166</td>
<td>0.032</td>
<td>0.613</td>
<td>0.068</td>
<td>116.64</td>
<td>6.36</td>
<td>339.523</td>
<td>56.45</td>
</tr>
<tr>
<td>T5.1</td>
<td>0.257</td>
<td>0.089</td>
<td>0.522</td>
<td>0.037</td>
<td>52.6</td>
<td>11.40</td>
<td>213.51</td>
<td>20.99</td>
</tr>
</tbody>
</table>

Table 3 - Isovist occlusivity and compactness results
Figure 4 - graphical results of Isovist-compactness analysis, the case of 5 samples of Isfahan morphological tissues. The red, green and blue colors demonstrate high, medium and low value of Isovist compactness.
Figure 5 - graphical results of Isovist-occlusivity analysis, the case of 5 samples of Isfahan morphological tissues. The red, green and blue colors demonstrate high, medium and low value of Isovist occlusivity.
On the other side, the correlations between surface configurational aspect of urban tissues (GSI ratio) and iso-compactness and occlusivity indicate that the coverage ratio of plot and block types have significant impact on visual information flows. Results show the significant and negative correlation between iso-occlusivity and coverage ratio (rho: -0.790, P-value: 0.007) which emphasise the morphological configuration of plot types and the position of built area within the plot. The fragmented and regular plot types in modern samples have the higher value of occlusivity and more open edges in visual information flows. Accordingly, there is a significant and positive correlation between iso-compactness and coverage ratio (rho: 0.592, P-value: 0.048). This correlation emphasises the geometrical style of the plot and block types. The street and open spaces boundaries in old and organic pattern types are defined by courtyard plot and block types with built area around the central court or similar types. These well-defined boundaries and open spaces lead to the compactness in visual information flows.

**Table 4 - Isovist occlusisivty and compactness results comparing with coverage ratio**

<table>
<thead>
<tr>
<th>Tissue types</th>
<th>Isovist-compactness Average</th>
<th>Occlusivity-Isovist Average</th>
<th>GSI Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>0.181</td>
<td>84.43</td>
<td>0.54</td>
</tr>
<tr>
<td>T.1.1</td>
<td>0.134</td>
<td>79.28</td>
<td>0.57</td>
</tr>
<tr>
<td>T2</td>
<td>0.179</td>
<td>87.97</td>
<td>0.58</td>
</tr>
<tr>
<td>T.2.1</td>
<td>0.119</td>
<td>117.73</td>
<td>0.54</td>
</tr>
<tr>
<td>T3</td>
<td>0.149</td>
<td>384.61</td>
<td>0.30</td>
</tr>
<tr>
<td>T.3.1</td>
<td>0.169</td>
<td>327.38</td>
<td>0.34</td>
</tr>
<tr>
<td>T4</td>
<td>0.206</td>
<td>68.99</td>
<td>0.46</td>
</tr>
<tr>
<td>T.4.1</td>
<td>0.271</td>
<td>14.76</td>
<td>0.60</td>
</tr>
<tr>
<td>T5</td>
<td>0.166</td>
<td>116.64</td>
<td>0.44</td>
</tr>
<tr>
<td>T.5.1</td>
<td>0.257</td>
<td>52.6</td>
<td>0.62</td>
</tr>
</tbody>
</table>

**4. CONCLUSIONS**

In this investigation, the aim was to assess the interconnections and interactions of generic flows of sustainable urban form. Taken together, the results indicate that at first, there is a significant negative correlation between Adolphe occlusivity factor and Benedikt occlusivity factor. From the aspects of urban form geometry and configuration, the lower value of Benedict occlusivity demonstrates the compactness of built form perimeter in 2D built form boundaries and high ratio of space convexity. On the other side, the higher value of Adolphe occlusivity factor depicts the lower built form elements height and mass density.

Secondly, environmental sustainability of urban form in old tissues (cold seasons) and their sustainability of visual information flows indicates the interactions and interconnections between energy and information flows in the case of Isfahan old tissues with organic pattern. Therefore, it could be claimed that the research findings would be considered as a set of evidences to verifying the EEUF model and integrated relations between generic flows of urban form in production, operation and maintenance modes.
GENERIC FLOWS OF SUSTAINABLE URBAN FORM: An investigation on integrated interactions between energy and information flows in the context of urban form. The case of Isfahan.

The contribution of the study has been to confirm the relation and interconnection between generic flows of energy and information as the main contents of EEUF model. This research provides a framework for the exploration of the two states of occlusivity factor, as one of the important morphological indicators, in analytical context of urban form sustainability. The empirical findings in this study provide a new understanding of urban design strategies according to the existing morphological patterns in terms of the research approach: the integrity between energy and information flows as a new concept of sustainable urban form and design.

The research has been focused on the operational mode of energy flows (indoor energy demand) and also visual interactions for information flows. Finally, future research should therefore concentrate on the investigation of the integrity between perceptional aspects of urban form and outdoor environmental comfort as the main characteristics of urban form environmental performance in the form of EEUF model.

NOTES

The information contained in this research paper was extracted from the PhD thesis (in progress) by the corresponding author, Yones Changalvaiee.

Dr. Mostafa Behzadfar (First supervisor), Dr. Mahmud Mohammadi (Second supervisor) and Dr. Zahra Sadat Saieideh Zarabadi (Advisor).

1. Urban metabolism is an encompassing concept of sustainable settlements in terms of sustainable processes of inputs and outputs cycles of urban systems. The traditional dimensions of this concept were material and information flows, but the new dimension focusing on this research is information flows.
REFERENCES


Benedikt, M. L. (1979) to take hold of space: isovists and isovist fields, Environment and Planning B: Planning and Design, 6, 47-65.


‘WE WERE BUILDING A CAMP, THEY WERE BUILDING A CITY’
Refugee camps as a spatial laboratory for social inclusion

MARCO BUONOCORE
University of Pisa
m.buonocore1@gmail.com

VALERIO CUTINI
University of Pisa
valerio.cutini@unipi.it

ABSTRACT
Refugee camps are an issue where socio-cultural relations to space are more than a theoretical issue, but rather an essential requirement, if not even an ethical imperative. Despite their emergency purpose and their official qualification as temporary structures, yet the exceptional nature of the events refugees escape from and their persistence often make camps to stabilize and become permanent settlements, fully fledged cities destined to endure over time. It is hence evident that, when it goes at planning a refugee camp, the pressing requirement of an emergency structure, strictly aimed at receiving people and ensuring their survival, gives way to the wider need for an urban structure, whose spatial features actually correspond to the behavioural pattern of the population.

The recent experience with a large number of camps, whose original layout has been subjected to the relevant spontaneous transformation by the population, testifies to how the adherence of the spatial features to the behavioural pattern is needed by the hosted refugees in their progressive becoming inhabitants of the new city. In basic terms, this poses the question of the compatibility of an emergency response, entrusted to standardized planning solutions and subject to few basic regulations, with the flexibility of an informal settlement, destined to evolve according to needs of the population.

In this paper, we argue that a configurational approach could play a key role in facing this problem, and that space must serve as an essential reference for the development of refugee camps. Convinced that the social and cultural backgrounds of refugees should act as an essential framework for the development of their own lives inside camps, and assuming Za’atari refugee camp, in Jordan, as a case study, its grid configuration was analysed, as referred to the original layout and to the present state, and compared to the actual distribution of activities in order to appreciate the spontaneous adaptation the settlement has undergone. Besides, the configurational pattern of the refugees’ home cities was investigated, in order to point out the main spatial features they present and the behavioural phenomena they reproduce. The purpose is the proposal of a basic spatial layout the camp should comply with, suitable for matching the behavioural pattern of the hosted community while also available for any spontaneous development process.

KEYWORDS
Refugee camps, grid configuration, urban space, informal settlements
1. INTRODUCTION

Refugee camps are an emergency response to humanitarian crises determined by natural events or man-made disasters, fulfilling the urgent need to give shelter to masses of displaced people and provide them with decent and hygienic living conditions.

Nonetheless, despite the pressure of emergency, several reasons - in addition to ethical considerations - suggest the need of regarding the camp not as a mere issue of quantity, but as a real urban settlement, whose spatial features cannot be unrelated (or indifferent) to the social and cultural fabric of its inhabitants, and to the behavioural pattern it involves.

First, and most obvious, despite the stated purpose of favouring refugees to return to their home towns, yet it is not granted to know when the emergency that caused the displacement will end; as a matter of fact, the refugee camp will hence be likely to remain in operation for a long time, or even to stabilize and become a permanent settlement. Moreover, and less obvious, the provision of a standardized and alienating urban space negatively affects its efficiency, as it triggers disruptive reactions of refugees – including the physical modification of the camp and the disuse of the provided services – which eventually lead to second order consequences such as running cost increase and hardening of living conditions. Furthermore, transforming the camp into a viable social and economical alternative to the places refugees are fleeing helps their social cohesion, relationships, and behaviours to survive within the camp, making it a preparation laboratory for return and reconstruction.

In view of all those considerations, when it comes to planning a refugee camp, the pressing requirement of an emergency structure, strictly aimed at sheltering people and ensuring their survival, gives way to the wider need for an urban structure, whose spatial features ought to match the behavioural pattern of the population. Such issue will here be addressed by means of the space syntax techniques, hence regarding space configuration as the connecting element between the social context of the hometown and the spatial features of the camp, so that the latter can be shaped to meet the first and comply with it.

2. BACKGROUNDS: SOCIALITY AND SPACE IN REFUGEE CAMPS

Sectorial manuals refer to refugee camps as the least desirable option for the response to humanitarian crises (UNHCR, 2007, p.208; Corsellis and Vitale, 2005, p.57), a distrust that appears justified by their history and has led many scholars and aid workers to question their appropriateness.

Starting from the 1970s, well known aid expert F. Cuny revolutionized the practice of camp design by changing the way shelter were traditionally laid out – i.e. a uniform military grid – to obtain a more fragmented urban form made up of ‘communities’ or ‘wards’ (as he called them), small scale clusters of shelters laid out around a central square, used for shared facilities and socialization. This layout was first introduced in El Coyotepe refugee camp (Nicaragua, 1972) and then in Khulna (Bangladesh, 1973-74, where it was expressly adapted to the typical layout of Bengali villages); later field reports and academic studies presented these camps as economic and social successes, demonstrating how providing social and culturally sound spaces could radically improve the refugee experience (Cuny, 1977; Hartkopf and Goodspeed, 1979).

This approach is believed to have inspired sectorial manuals and other guidelines in their sections about site planning (UNHCR, 1982; 2007; Corsellis and Vitale, 2005; Norwegian Refugee Council, 2008; Sphere Project, 2011), even though those handbooks seem to elevate some particular solutions implemented by Cuny – e.g. the ‘community’ approach - to universally applicable norms, instead of following his general guideline of assessing socio-cultural peculiarities of refugee populations before defining camp planning strategies (Kennedy, 2008, p.106). Parallel
to this, since a small-scale element is taken as generator of the whole layout, the large scale – that is the camp’s city-like dynamics - is automatically overlooked, despite Cuny (1977) had already warned about the necessity of addressing camp planning issues in the same way usually followed in urban planning.

Given these considerations, it can be argued that the misinterpretation of Cuny’s work has made camp design policies tend towards over-standardized refugee camps, suitable for quick emergency responses but inefficient in the long run both economically and socially. The issues highlighted by scholars and aid workers about the cheapness of infrastructures (that need to be replaced with permanent ones as the crises endures), the cultural inadequacy of shelters, and the way they are laid out at a local scale (Cuny, 1983; Vannucci, 2013; Kennedy, 2005, p.100-104) only partially describe the problem, as they regard direct economic and social consequences. Nevertheless, as we will argue in our case study, inefficiency is also correlated to the layout of infrastructures and shelters at the urban scale, something that inevitably affects the way refugees use the camp as a whole and can trigger a vicious circle - of inadequacy, disruption, money waste, and policy stiffening – that yields high economic and social costs as indirect by-products.

3. CAMP SPACE AND SPACE SYNTAX

If (Hillier’s words) ‘the city is two things: a large collection of buildings linked by space, and a complex system of human activity linked by interaction. We can call them the physical city and the social city. Urban practice and theory must connect one to the other.’ (Hillier and Vaughan, 2007), space syntax analyses the physical city, calculating the relationships between its spatial elements, in order to understand, predict and manage the phenomena and the behaviours within it: that is the social city.

To the extent to which a refugee camp can be seen as a city, its space – that is the organization of shelters, the streets along them and their mutual intersections, the open spaces – not only responds to the need to collect and shelter people, but intrinsically expresses (or should express) the way the hosted community is expected to live and socially interact - what a configurational approach can reveal and make to emerge.

A vast amount of literature demonstrates how configurational values appear suitable for reproducing several significant aspects of human behaviour: for example integration as a reliable indicator of centrality, assumed in terms of accessibility and attractiveness towards activities, and choice as a useful value for narrowly describing the distribution of movement flows. Due to their correspondence with movement (Hillier, 1999, p.99) – and in a broader sense, ‘patterns of human co-presence’ Hillier (2005) - other social issues appear described by the configurational indices, such as, for instance, the distribution of crime events - burglaries or car theft (Hillier, 2004) -, or the location of major social activities such as cathedrals or municipal buildings in European towns (Cutini, 2010; Karimi, 1998), or mosques and bazaars in Muslim towns (Loumi, 1988; Karimi, 1998).

Coming hence to the matter of this research, the potential of space syntax with reference to refugee camps seems twofold. On the one hand, space in its purest form can be used as common ground for the comparison of two distant entities like a refugee camp and a formal city, disregarding the conceptual and factual distance between the two. On the other hand, development and improvement proposals can be objectively substantiated by the configurational approach, that in this sense can act as framework to overcome all accountability, economic, and political constraints that often limit practical action in such difficult contexts.
4. THE CASE STUDY: ZA’ATARI REFUGEE CAMP

Za’atari is a Jordanian refugee camp located some kilometres off the Syrian border, operational since summer 2012, few months after the beginning of the Syrian civil war. It has gained considerable notoriety, especially in the first year of its life, for a combination of factors. First, since its opening, it has steadily been one of the highest concentrations of Syrian refugees, but despite the demographic pressure, as former camp manager K. Kleinschmidt noted (2014), camp design and service provision standards were consistently met in Za’atari. Shelter space per person – usually hard to meet when facing high influxes of refugees - hit its lowest in May 2013 (UNOSAT, 2013a) with an approximate amount of 2.5 sqm per refugee, but rapidly increased to fall within the standard of 3.5 by the end of the next month (UNOSAT, 2013b), and have never decreased since then.

Secondly, protests and demonstrations by refugees (both pacific and violent) were very frequent in Za’atari, and have led to serious problems of security, with major negative consequences such as the death of a Jordanian policeman and injuries to refugees, policemen and aid workers (UNHCR, 2014k). As in many of these occasions refugees protested for standard-related issues (lack of electricity (UNHCR, 2014f), shelter (UNHCR, 2014b; 2014c), service provision (UNHCR, 2013a; 2014a) and work opportunities (UNHCR, 2014g; UNHCR 2014h)) and despite the meeting of standards: Za’atari was in this sense a powerful demonstration of the inadequacy of camp planning policies, as former camp manager K. Kleinschmidt noted (2014).

Last, Za’atari has brought to the international attention refugees’ resilience and active pursuit of autonomy and wellness, displayed through informal economic and spatial attitudes. Just some example of these are the creation of a complex wholesale-retail market system with an economic flow estimated at 14 million dollars a month (REACH, 2014c, p.24; Beiser, 2015); the institution of an electrician squad to illegally deliver electricity to standard houses (namely ‘caravans’ in Za’atari’s common lexicon); and the developing of a rudimental system for shelter transportation, by which caravans are moved from the assigned plot to join relatives or fellow citizens’ shelters in other parts of the camp (UNHCR, 2013b).

Nevertheless, these coping mechanisms are clearly not enough to guarantee social and economic wellness, and aid experts has warned about the dangers of considering Za’atari a functioning city (Crisp, 2015) and thus attributing it a normalcy that does not exist. Suffice it to say that in mid-2014, 75% of Za’atari’s population relied either on cash from charities (32%), begging (23%) or sale of household items (20%) as first source of income, compared to a ratio of only 2% prior to leaving Syria (REACH, 2014a).

As a matter of fact, Za’atari is far from promoting the well-being and autonomy of its inhabitants: this inadequacy clearly calls for a spatial and development oriented improvement plan to provide refugees with economic opportunities and an appropriate urban space where to use them. More precisely, since refugees’ coping mechanisms – modification, disuse, privatization - materialize into spatial actions (or inactions), the improvement measures we hereby propose draw from two main questions: Why is Za’atari camp’s space inadequate to materialize the social structure of Syrian refugees?; and how can this inadequacy be objectively described, and reduced?

5. THE METHOD AND ITS TEST ON ZA’ATARI CAMP

The research carried out on Za’atari camp consists of three main stages. First, the camp was analysed by means of the space syntax techniques. Then, three Syrian cities - Daraa, Izra, and As Sanamayn, main urban areas where Za’atari’s refugees comes from (UNHCR, 2014a) - were investigated in the same way. In these stages, urban grid maps were obtained thanks to the
combination of geographic data sets (OpenStreetMap, 2016), GIS databases (only for Za’atari camp, retrieved from UNHCR crises management website, 2012) and satellite photography (Google Earth Pro, 2015). Thanks to the software DepthmapX (Varoudis, 2015), each map was then converted into an axial map, and integration values were calculated for each axial line.

Leaving the purely morphological considerations to the following sections, we hereby seek to discuss how the configurational approach is capable of objectively describing the social dynamics that were only qualitatively introduced so far, by means of the mutual relationships of the configurational indices as well as their correspondence with human behavioural patterns.

![Aerial view of Za’atari at April 2015 and related axial map showing the global integration pattern.](image)
For instance, the spatial enterprise took on by refugees to modify the camp to their own advantage appears to be readable through the changes of two configurational ‘combined’ indexes during the first year of Za’atari’s existence, that are the correlations of global integration with connectivity (intelligibility), and with local integration (synergy) (Hillier, 1999). In fact, aerial images (UNOSAT, 2012; 2013c) document a set of spatial modifications – mainly creation of informal paths and closure of long axes – occurred in the first year of Za’atari’s life, reflected by a severe reduction of intelligibility and synergy (respectively from 0.641 to 0.249 and from 0.979 to 0.611) to meet values more similar to those of unplanned (or not entirely planned) cities [Figure 2].

Figure 2 - Evolution of the old town from September 2012 (left column) to September 2013 (right column): global integration (top), intelligibility (middle), synergy (bottom).
As for the correlations that regard human behaviours inside the camp, three remarkable correspondences can be observed [Figure 3]. The first one relates to Za’atari camp at September 2013 (UNOSAT, 2013c), providing the correlation between the local (R=3) integration patterns and the number of shops for each 25 m of axial line (Trigwell 2013) (with the total number of lines divided into 10 groups based on integration intervals of equal width). The diagram yields a remarkable coefficient of determination (R²=0.793, increasing to 0.931 if the two least integrated groups of lines are excluded), with the most integrated line, Al Souq (literally, ‘market’ in Arabic), being also the one crowded with the greatest number of shops.

The second diagram shows a similar correlation related to the situation at November 2014 (UNOSAT, 2014), having the global integration values in the x-axis, and the number of shops per 25 m in the y-axis. In this case, the only data available were the number of shops in the four main commercial streets (REACH, 2014b), but the correlation is still narrow (R²=0.950).

The third diagram, dating April 2015 (UNOSAT, 2015), compares the mean local integration of all the axial lines and the mean local integration of the axial lines where the 76 mosques of Za’atari were located (UNHCR 2015c), both grouped per districts. The rationale of this analysis is that the 12 districts in which Za’atari is ‘administratively’ divided [Figure 1] (except 1 and 2, belonging of the so called ‘old town) are effectively separated - physically and perceptually – by wider roads, according to site planning guidelines. The remarkable R² coefficient of 0.790 suggests that, even where mosques were not located on the most accessible lines of each district, a correlation between their location and the overall configuration of the district in terms of accessibility actually exists.

Figure 3 - Local integration pattern of Za’atari at April 2015, and correlation of integration versus commercial activities (left, middle) and mosques (mean values per district).
Apart from proving the efficacy of space syntax in a seemingly uncharted territory as the refugee camp, these findings show how the process of informal self-determination has affected both the spatial and the functional structure of the camp, and both its economic and social tissue. In fact, while commercial informality is well-established and evident from the large number of shopping stalls throughout the camp, a more subtle network of mosques is just as important, as it fulfils not only religious needs, but also other important functions like education and recreation (UNICEF, 2015), actually acting as social connective tissue of the camp.

Given the impossibility of retrieving quantitative data on spatial behaviours regarding the Syrian cities, the research focused on highlighting their similarities in terms of spatial structure and key functional features, also in relation to more general and acknowledged characteristics of Islamic urban environments. In the axial maps of Izra [Figure 4], for example, the pattern of global integration shows a tendency to limit the macro-scale accessibility to a main axis - with the souq (main city market) and the Friday mosque (religious reference point) placed in its proximity - with some smaller branches jutting out from it like the teeth of a comb. This kind of integration core is typical of Islamic cities (Loumi, 1988; Karimi, 1998), in contrast to the ‘deformed wheel’ structure common to many European cities (Hillier, 1999, p.137).

![Figure 4 - Global (top) and local (bottom) integration pattern of Izra, Syria.](image)
Contrarily, the most locally (R=3) integrated lines are spread in a quite uniform way across the city. Since the local integration pattern is highly correlated with pedestrian presence, this means that the city districts are linked via a ‘super-grid’ (Loumi, 1988, p.357) that homogeneously distributes pedestrian movement. From a functional point of view, district mosques and smaller commercial clusters have been correlated in Islamic cities with relatively highly integrated streets at a local level (Karimi, 1998, p.174-181). Predictably, also the 50% least accessible streets are homogeneously distributed across the city: This means that, even when walking along a poorly accessible street, pedestrians can find a well-integrated area (where mosques or local shops are likely to take place) within a few corners, that is to say that privacy is achieved without excessive segregation, coherently with the general tendency of Islamic cities (Hakim, 1986, p.24-27; Loumi, 1988, p.372).

The spatial structure of Za’atari shows substantial differences from the one of the typical Syrian city. First of all, part of the most globally integrated lines are grouped together to form an orthogonal grid of long axes, which clearly contrast with the ‘comb-like’ structure of the Syrian cities and intrude into the residential areas.

While accessibility seems so widely distributed at the global level, at a local level Za’atari fails to provide the ‘super-grid’ that should connect its districts and facilitate pedestrian movement. The 5% most accessible streets are indeed excessively clustered, leaving entire districts segregated. The combination of these discrepancies at the global and local scale leads to a total absence of privacy in the residential streets near the most accessible areas, while involving, at the same time, an undue segregation of large zones (50% least integrated lines can indeed be found in large clusters), which are cut off from the most populated (in terms of co-presence) areas. These discrepancies can be defined ‘morphological’, and can be blamed for spatial modifications such as the movement of shelters to obtain courtyards and semi-private areas (REACH, 2014b) – proof of the insufficient privacy provided by the initial layout.

Other differences between Za’atari and the Syrian cities can be defined ‘functional’, in that localization of key urban functions in the camp did not match the patterns of refugees’ hometowns. For example, Za’atari’s largest mosque (Trigwell, 2014) is located in a poorly integrated street, causing the weakening of an important feature – the Friday mosque – of refugees’ urban background. As for the other mosques, it should be noted that they are homogeneously distributed across the camp (UNHCR, 2015c), and so happens in Islamic cities (Fusaro 1984; Loumi, 1988). Nevertheless, while in the Syrian cities also local accessibility is well distributed, in Za’atari this does not happen, and so mosques are not linked to the super-grid that regulates pedestrian movement throughout the camp. Likewise, local shops are in some cases cut off from the most integrated streets.

6. URBAN SPACE IN CAMP PLANNING POLICIES

Given that camps are going to be the response (if only as the least worst option) to refugee crises for some time to come (Kennedy, 2008, p.117), rather than wishing them out of existence, the scientific community should tackle – and is actually tackling - the conceptualization of new policies that can effectively better the refugee camp experience and ease the strain on host governments and NGOs, reaching back into the very principles of aid provision: refugees’ right to autonomy and development (UNHCR, 2007, p.190) above all. Scholarly works in the fields of law (Deardorff, 2009), economics (Collier, 2015) and sociology (Grbac, 2013) support this hope for a shift towards developmental - rather than relief oriented - strategies to be implemented in a systematic (yet not standardized) way in refugee camps. Since refugees, by trying to improve their lives, actually modify or produce space, it is clear that these strategies should spatially suit their needs and habits, being at the same time capable of internalizing and potentiating their autonomous strive for self-development.
Development measures, as we seek to introduce them, can be seen as the third step of an analysis–diagnosis–cure process, where the first two are represented by the comparative spatial analysis (as previously introduced) of the refugee camp at its present state and the refugees’ hometowns, followed by the weighing up of analogies and discrepancies. The third step itself can be conceived as a process aimed at obtaining a new spatiality, closer to that of refugees’ hometowns, by the addition of new urban devices. These structures can be seen as ‘anchor points’ (Kennedy, 2008, p.214-215), that is elements that provide basic services and let refugees organize the space around them informally; Or, as an alternative, they can be purposely left incomplete, acting as ‘incremental spaces’ that represent opportunities for occupancy, utilization, and future informal expansion. As Stevenson and Sutton (2000, p.145) point out, this kind of strategies have already been implemented in slum upgrade or development.

Figure 5 - Intervention strategy of nodes and routes to reduce spatial inefficacies.

"WE WERE BUILDING A CAMP, THEY WERE BUILDING A CITY"
Refugee camps as a spatial laboratory for social inclusion
interventions, both at a small scale (for instance in a social housing project in Iquique, Chile, by architectural firm Elemental) and at an urban scale (for instance in the development of some slums in Bogota, Colombia).

Instead of being encompassed in zoning policies, these spatial devices are introduced in the camp in two ways [Figure 5]:

- construction of urban nodes, namely reference points around which refugees can develop commercial and residential structures;
- improvement of the existing route system, with the aim of establishing a network of active paths that function as the camp’s social and economic spine.

Figure 6 - Service centre urban node (above) and its possible spatial function.
Each device, be it nodal or linear, can be tailored to specific needs of the camp and solve specific problems – for instance waste management, provision of social spaces, etc. –, still maintaining its spatial aim, which means that its localization will help solving all those spatial discrepancies between the camp and the refugees’ hometowns, that had previously emerged.

Especially in the case of a large and populous camp like Za’atari, the introduction of nodes and the improvement of routes is intended as a process subject to continuous assessments and adjustments, at the end of which the urban layout will result more suitable to the refugees’ needs, with all the districts incorporated in the super-grid of most locally integrated routes and the new urban nodes distributed along it [Figure 9].

The most representative of these nodes is the service centre [Figure 6], a modular and flexible space suitable for working as production, commercial, and/or recreational venue. It features simple architectural typologies and open spaces for outdoor informal activities, with tailored architectural solutions such as the gender-based subdivision of the service centre into two

Figure 7 - Route interventions and their possible spatial functions.
Figure 8 - Proposed pedestrian and bus routes (above) and street lighting redressing plan (below).
Proceedings of the 11th Space Syntax Symposium

'WE WERE BUILDING A CAMP, THEY WERE BUILDING A CITY'

Refugee camps as a spatial laboratory for social inclusion

separate areas: one for the men, open towards the accessibility network and thus optimal for trading, and the other for the women, open towards the inner side of the district so as to provide more privacy to its users; given that women reportedly find it difficult to get authorized jobs within the camp due to cultural hindrance to work far from home (UNHCR, 2015a).

Another key urban node is the school, for which a cheap and efficient typology already implemented in Za’atari (Sinclair, 2015) has been taken as element to be reproduced along the main locally integrated routes. This would significantly improve children’s safety and hence school attendance, given that one of the main reasons for school dropout in Za’atari is the insecurity of routes (UNICEF, 2014, p.59).

The third proposed urban node is a Friday mosque to be realized in a large space along the main market road, used as distribution point but set for possible dismantlement and replacement with a daily market extension (UNHCR, 2014). The new mosque would be commissioned after an international design competition, under the constraint that the structure could be totally disassembled, and eventually replace one of the numerous damaged mosques, once return to Syria is made possible. Like in traditional Islamic cities, the Friday mosque would open onto the most integrated street and be directly related to the souq, resulting in the recovering of a key spatial feature.

As for the street network improvement, to be obtained via linear devices, several solutions can be proposed. The most important is the redressing of street lighting [Figure 8], which is currently unevenly distributed and has concurred in the disuse of many kitchen and WASH (water, sanitation and hygiene) facilities, too insecure to reach at night (UNICEF, 2015; Siren Associates, 2015). The redistribution plan, to be implemented in progressive steps and subject

Figure 9 - Local integration pattern of Za’atari after the improvement measures.

"WE WERE BUILDING A CAMP, THEY WERE BUILDING A CITY"
Refugee camps as a spatial laboratory for social inclusion
to assessments and optimization, would lead to the optimal scenario where the most locally integrated lines will be illuminated, meaning that the majority of pedestrians will be able to safely reach key facilities.

Other proposed routes improvements are the creation of a network of pedestrian friendly areas and a new bus network, the improvement of unused spaces with ecological areas, the implementation of the so called ‘incremental housing’ developments, and the ‘face lift’ of selected streets. The first proposal was hoped for by UNHCR due to numerous street accidents involving refugees (UNHCR, 2015b), and the fact that better transports were often indicated as key improvement by refugees themselves (REACH, 2014a). In the proposed network, streets indicated as pedestrian friendly are the ones belonging to the super-grid of most locally integrated lines according to the camp’s new configuration, while the bus network develops along central but less integrated routes, so as to limit co-presence with pedestrians. The second proposal aims at improving the camp’s space quality by introducing green features that can also serve as space structurers and ecological elements, limiting erosion and ground pollution. Examples of these are the desert trees planted in water-catching devices called negarim, widely used in the Middle East (African Development Bank, 2008), and gardens of reeds and other grey water cleaning devices, already widely implemented in Za’atari (UNHCR, 2014d; 2014e). The third proposed improvement is the implementation of ‘incremental housing’ in the most overcrowded areas (prevalently the ‘old town’), i.e. the replacement of caravans with improved temporary shelters that can optionally expand to the second story at the initiative of refugees, aimed at providing new open spaces for social and commercial activities where they are most needed. The last and ‘softest’ proposal is to apply face-lifting techniques (like wall painting, art decorations, and similar, all already implemented in Za’atari (UNHCR, 2014i)) in an extensive way along selected strategic routes which need to be revitalized and structured, following succeeding examples of Brazilian favelas upgrades (Boa Mistura 2012).

7. CONCLUSIONS

Decades of failed experiences with an amount of refugee camps, whose original layout has been subjected to the relevant spontaneous transformation by the population, provide motivation to the present research, which faces the problem of the analysis and improvement of refugee camps from a new perspective, relying on space syntax’s proven ability to link spatial features and social patterns of settlements. The assumption of a camp as a city, and not a provisional and temporary device, suggested to use space syntax to support its development in order to match its spatial layout to the behavioural pattern of the refugees, as they appear materialized within the configurational features of their respective hometowns. Tests on the case study of Za’atari camp have showed that strategies of adaptation actually implemented by refugees are objectively describable, as they materialize in spatial patterns that correlate with the analytically obtained indices: on such basis, they can be predictable with a reasonable degree of accuracy. What is even more interesting, through spatial adaptations refugees tend to reproduce social structures similar to those of their hometowns, and they do it by aligning the camp’s functional apparatus (such as commercial and religious buildings) to its morphology, as well as changing the morphology itself.

The proposed method appears suitable for addressing the question of the compatibility of an emergency response, entrusted to standardized planning solutions and subject to few basic regulations, with the flexibility of an informal settlement, destined to evolve according to needs of the population.

Although improvement measures have been proposed for an existing refugee camp, nonetheless the method hereby delineated can be as easily applied to the design of new camps: here the anchor points and infrastructural routes would be a set of spatial ‘suggestions’ – set in a top down
way to ensure safety and hygiene without giving up cultural affinity - from and around which refugees could start to auto-define space and development strategies from the very beginning. In this sense, further studies could lead to the definition of a design tool potentially suitable not only for refugee camps, but also for the reconstruction of destroyed cities, the urban upgrade of slums, and whatever situation that entails mass migration and fast resettlement.

This means transforming the camp into a viable social and economical alternative to the war-torn places refugees are fleeing, making it a preparation laboratory for return and reconstruction. Space can play an important role in this process, as the social ties it represents have survived war, have been living inside the camp, and will shape the future cities where refugees will eventually return.
REFERENCES


SEA AND CITIES:
Spatial Configuration of Brazilian Urban Beaches

LUCY DONEGAN
Universidade Federal da Paraíba
lucydonegan@gmail.com

ABSTRACT
This paper compares the spatial configuration of urban beaches in Brazilian cities – Fortaleza and Natal – and looks for patterns that might facilitate arenas of urban vitality. Beaches in Brazil are important leisure and socialization places, and are generally seen as democratic arenas, being federal properties legally accessible to all. The beaches selected in Fortaleza - Barra do Ceará, Praia de Iracema and Praia do Futuro - and Natal - Redinha, Praia do Meio and Ponta Negra - have some similar traits: swimmable warm waters all year round, fine sand and access via public transport. Nonetheless, all beaches are characterised - and seem to be used - differently, albeit Natal's beaches receive a somewhat stronger stereotyping than Fortaleza’s. Public spaces are essential assets of urban societies, having a role in fostering social diversity, and spatial form may help unite or separate people. This paper investigates the cities’ and beaches’ spatial configurations to understand how these might contribute to distinct characterisations and uses, and to qualities of urban vitality. For Natal, this was the subject of a doctoral thesis and showed that space, built form and social life interrelate. When we compare the spatial form of beaches in Fortaleza, we see that in both cities street patterns for each beach are very distinct, and that characterisations relate to space. However, in Natal natural boundaries help set the beaches further away from one another, and not well connected to the city’s main routes of movement. Fortaleza, on the other hand, has an overall less fragmented system and beaches are less detached from the main structure. This might help explain a somewhat weaker social distinction between beaches in Fortaleza. In both cities beaches that seem to be frequented by the poorest economically (Redinha and Barra do Ceará) are the least accessible. In Natal, Ponta Negra contrasts with the others as being more connected with the wider urban fabric, and bears comparison with Praia de Iracema in Fortaleza, showing recurrent overlaps between inhabitants’ and visitors’ potential movement. However whereas in Natal both Praia do Meio and Redinha are spatial enclaves, this applies in Fortaleza only to Barra do Ceará, as Praia do Futuro shows some confluence of movement. The beaches’ spatial configuration differences (and similarities) between the cities reveal some urban dynamics, and relate to apparently distinct social lives of beachgoers; further research can enlighten how these correspond.

KEYWORDS
Spatial Configuration, Urban vitality, Urban Beaches, Fortaleza, Natal.

1. INTRODUCTION
This paper compares the spatial configuration of urban beaches in the Brazilian cities Fortaleza and Natal, and looks for patterns that might facilitate arenas of urban vitality, as referred to in the literature.
Despite the role that urban beaches play in Brazilian cities and of what is revealed when studying relations between physical attributes and social life, there is a scarcity of studies focusing on analysing spatial configuration of different beaches, and relating them with urban dynamics.

Beaches in Brazilian coastal cities are major leisure and socialization places. Several factors contribute to this, such as: a historical coastal culture; the beaches’ public nature; the scarcity of other public spaces appropriate for leisure uses; and the attractive power of the sea. In the northeast region an all year round favourable climate and warm waters also contribute to beaches being intensely used. As in Brazil beaches are federal properties that legally allow free access to all, there is a general belief that these are democratic arenas.

Space configures fields of potential movement in the city (Hillier et al., 1987), thus shaping fields of potential encounters. Studies have identified that certain spatial patterns may help bring different people together, while others help segregate people (Legeby, 2013; Vaughan et al., 2013). Spatial configuration was pointed out as intrinsic to the appropriation of different areas in the city by different groups (Carmo, 2014; Vaughan, 2007), revealing processes of segregation.

Many cities – of which Brazil’s are a markedly strong example - reveal processes of social exclusion and segregation that characterize their urban dynamics (Villaça, 2001). In Brazil different residential neighbourhoods are occupied mainly by certain classes; and people’s mobility in the city result in limited spheres of co-presence amongst different classes (Holanda, 2000; Netto et al., 2015).

Urban beaches seem to reflect segregation patterns in the city, as different beaches are generally used by different people. This is expressed by beaches distinct locations and built forms, and by beaches generally having distinct reputations. Doctoral research showed close ties between spatial configuration, built form and social life in urban beaches, which helped reveal urban dynamics and societal spatial relations in Natal (Donegan, 2016; Donegan and Trigueiro, 2016). Beach neighbourhood spatial characteristics either aggravated (spatial enclaves) or eased (grids better embedded within the overall grid) social tensions. These also related to the beaches’ distinct reputations. Our master’s dissertation focused on a particular beach in Fortaleza (Praia do Futuro) and found out that the distribution of different groups was related to location within the neighbourhood and to building types (Donegan, 2011; Donegan and Trigueiro, 2012).

As shown by earlier research and personal observations, the chosen study cases - Barra do Ceará, Praia de Iracema and Praia do Futuro in Fortaleza, and Redinha, Praia do Meio and Ponta Negra in Natal - are all intensely and diversely used, and represent distinct locations in each city. This paper examines these cases, focusing on street patterns and on spatial configuration attributes – as referred to by the literature and previous research - shown to foster social mixture and ease legibility, as qualities of urban vitality.

1.1 BEACHES IN NATAL AND IN FORTALEZA

All studied beaches benefit from beautiful natural scenery, warm swimmable waters and fine sand, are equipped with waterfront promenades and served by public transport. In a more or less developed manner, all have stalls that function as bars/restaurants. However, they occupy distinct locations within the cities and exhibit different built scenarios and characterizations.

Natal is divided by the Potengi River estuary, on which the city was founded. Redinha beach is located on the northern corner of the estuary, with a coast facing the river, and another the sea (Figure 1). A bridge near Redinha was built recently (Ponte Newton Navarro, 2007). However it has hardly increased mobility to the area, as it passes over the neighbourhood; the ferry that linked both sides of the river and landed at Redinha ceased after the bridge’s completion. Praia do Meio is located in a more central position in Natal, closest to the Old Town Centre. Ponta Negra is located further away, at the extreme south, after Parque das Dunas preservation area, having Morro do Careca as its limit on the other side. With approximately 3 km, it is the longest Natal beach studied.
Beaches in Natal receive distinct descriptions, in terms of location and social aspects, in conversations with various people, conforming to impressions in the media, including Wikipedia. Although not so far from the old city centre (6 km, as opposed to 14 km for Ponta Negra), Redinha is described as a distant place that barely changed throughout the years, and frequented by ‘common people’ especially from the northern part of the town. Praia do Meio is described as a decadent area, formerly frequented by everyone but now mainly by locals; Ponta Negra as a middle-class beach in a middle-class neighbourhood, and as a tourism and leisure centre.

In Fortaleza the Ceará River marks the western limit of the city, by which Barra do Ceará is located (Figure 2). Praia de Iracema is situated closest to the old city centre and port. The coast continues east to Mucuripe port, after which it turns southeast, becoming the Praia do Futuro beach, at 6 km the longest of all studied beaches.

For beaches in Fortaleza, social distinctions in day to day and media descriptions seem weaker than in Natal, as they mainly address other issues. Although Barra do Ceará neighbourhood is described as a socially troublesome area (due to the highest density of people and level of criminality in the city), descriptions of the beach itself (Praia da Barra e Goiabeiras) relate to its history – as the first arrival place for European immigrants - and to its geography – as the estuary of the Ceará river. Praia de Iracema is usually described as culturally relevant and close to richer areas of the city. Praia do Futuro is described as a popular and touristic beach - one of the most well known in northeast Brazil - with a developed beach huts infrastructure. Although intensely used, the area is less densely occupied than others in Fortaleza due to its strong salt air impacting on building.
1.2 SPATIAL CONFIGURATION AND URBAN VITALITY

On the face of it, the city is two things: a large collection of buildings linked by space, and a complex system of human activity linked by interaction. (Hillier and Vaughan, 2007, p. 205)

Spatial configuration is a strong promoter of activities and uses in the city, by configuring probable fields of movement and co-presence, i.e., when people are mutually aware of each other (Hillier et al., 1987). Studies here address relations between spatial configurations and social life in the city, searching for patterns that promote qualities of urban vitality, as social mixture and legibility.

Physical attributes of the city have long been studied in relation to their impact on people's movement (Alexander, 1965) and on promoting more urban vitality (Jacobs, 1992). Jacobs (1992) interpreted cities as problems in organized complexity, and highlighted contributing factors to urban vitality, such as diversity of uses and buildings, natural surveillance (eyes on the street), density, and a street grid which allowed many different paths between an origin/destination (more streets).

Space is intrinsic to social life by people's tendency to move in lines, interact in convex spaces and see changing fields as they move in the built environment (Hillier and Vaughan, 2007). Studies comparing locations within the city focus on spaces of movement, relating characteristics of potential movement configured by the grid to different building types, activities, people's residence location and how they move about in their day-to-day business, thus facilitating or restricting co-presence. Such potential movement focuses on topological accessibility, although metric and angular parameters can be included.

In London, studies showed that poorest groups tended to locate themselves continually in most segregated streets, whereas the well-to-do tended to reside near most accessible streets (Vaughan, 2007). In Natal, a thesis showed that economically privileged groups appropriated themselves of highly integrated areas of the city (Carmo, 2014), and that this was a contrast to neighbourhoods with high demographic density. Complementarily, highly accessible streets in Natal also presented more tertiary activities and building renewals (Trigueiro and Medeiros, 2003).
In the USA, more connected areas hosted more social mixture (Carpenter and Peponis, 2010). In Stockholm (Marcus and Legeby, 2012), areas with more confluence between local (R3) and global (Rn) topological accessibility (synergy, axial analysis) presented more co-presence amongst local inhabitants and visitors from other areas of the city. Intelligibility relates to how well a global attribute (Rn integration) can be perceived on street level (connectivity). High intelligibility characterized older neighbourhoods of Brazilian cities, interpreted as more legible, as opposed to expansion areas, characterized as patchworks that did not connect well to each other (Medeiros, 2013). Strong local-global correlations in axial analysis (Intelligibility and Synergy) outlined areas functioning as independent systems throughout the years (Perdikogianni and Penn, 2005), characterising a well working diversity in Clerkenwell, London.

When considering results of measures mainly addressed by segment maps (e.g. angular segment analysis), to- and through-movement were associated to basic components of human movement (Hillier, 2009; Hillier and Vaughan, 2007), as types of topological accessibility. To-movement (integration) relating to visitors’ movement; and through-movement (choice) relating to inhabitants’ movement. Corroborating this, places with stronger overlaps of such values at different metric radii were characterized as having more diversity of activities, and promoting more co-presence amongst different users (Vaughan et al., 2013).

Normalized choice (NACH) and integration (NAIN) values facilitated comparison of different sized systems (Hillier et al., 2012). Neighbourhoods with recurrent overlaps of these values through metric radii were better embedded in the overall structure (Yang and Hillier, 2012), and exhibited more co-presence amongst different publics (Al-ghatam, 2015).

This overview summarizes a part of the research repertoire, and guides the methodology in answering the questions: What is the spatial configuration of the beaches within each city? Are there clear hierarchies of potential movement between them? How do they relate to their surroundings? Are there similarities and differences between the cities? Which spatial patterns are prone to facilitate encounters? How do these relate to the beaches’ characterization?

2. DATASETS AND METHODS

In order to compare the spatial configuration of the cities and their beaches, linear representations of the cities’ open spaces at different modes of analysis and scales were explored. Natal’s and Fortaleza’s systems considered all vehicular movement routes in the city, processed for axial analysis and angular segment analysis (ASA). For ASA normalized values were focused to compare systems of different sizes (Bill Hillier et al., 2012).

For Natal’s system the linear representation was modelled between the years 2013-2015 in GIS platform including the new airport (opened in 2014); the limits for the system encompassed continuous grids to those in Natal’s municipality and main routes to the airport. For Fortaleza the linear representation was created by Valério Medeiros (2009), updated by Fernanda Linard de Paula (2011) and by the author (2013); the limits for the system were Fortaleza’s municipality, which encompasses the airport.

Both systems were processed for axial analysis at varied topological radii (Rn, R3 and connectivity) and for angular segment analysis (ASA) at varying metric radii (400, 800, 1200, 2400, 3200, 5000, 7000, n); normalized measures of integration (NAIN) and choice (NACH) were processed at all metric radii. Accessibility values in this paper figures are expressed in a colour range varying from red - for the most accessible entities - to blue – for the least.

For both axial analysis and ASA, subsystems within approximately 400m from the coast of each beach were separated in GIS platform. Mentions of the beaches’ neighbourhood or system in this paper refer to this catchment area, seen to represent access routes to the beaches and close-by walkable surroundings. Separate layers allowed comparison of accessibility levels - and correlations between such measures - for the cities as a whole and for the beaches.
3. RESULTS

Main spatial configuration analysis results are described separately for Natal and Fortaleza, followed by discussion comparing the cities and beaches.

3.1 NATAL

Figures 3 and 4 show the distribution of accessibility for Natal in global radius for NAIN and NACH values (ASA).

In both axial analysis and ASA the integration core is close to the old city centre (and neighbourhoods of Petropolis and Tirol); it is also close to Praia do Meio, but accessibility does not spread smoothly here, as indicated by an abrupt colour change (Figure 5). Ponta Negra, further away, is still able to reach medium-high levels of accessibility. Redinha has a drop in accessibility (blue colours) as the area does not connect to the main set of grids in the north and the bridge passes over it. Natal’s main movement routes concentrate south of the river, and, inland, connecting portions further South and North, via the Igapó bridge.

NACH highlights a set of a few main routes that reach most areas, but do not interconnect so well. Igapó bridge has high NACH values and connects other main through-movement routes; towards the west it completes a loop through the access roads to Natal (BR 304) passing close to the new airport in São Gonçalo do Amarante. The loop connects to other routes with high NACH values that spread in different directions, and point towards Redinha and Praia do Meio but do not reach these areas, whereas high NACH values reach Ponta Negra through Av. Roberto Freire. In this measure Ponta Negra reaches highest average global accessibility (Table 2).

Comparing average accessibility measures (Tables 1 and 2), Praia do Meio exhibits highest global integration in axial analysis (Rn) and ASA (NAIN), relating to its central position in the system. However, at all other analysed radii, Ponta Negra presents higher accessibility (and global NACH). Redinha is the least accessible beach at all examined radii, reaching even lower levels than Natal.

However, Redinha reaches, overall, the highest correlation levels between topological radii (table 1), including intelligibility (Rn-con), suggesting it works well as an independent system (I. Perdikogianni & Penn, 2005), and a legible area (Medeiros, 2013). The settlement derived from an old fishermen’s village later swallowed by Natal’s urban grid, rather than an expansion area. On the other hand, Ponta Negra’s lowest topological correlations suggest it does not work well as an independent system.

<table>
<thead>
<tr>
<th>System (number of lines)</th>
<th>Average Accessibility</th>
<th>Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Con</td>
<td>Rn</td>
</tr>
<tr>
<td>Natal (13215)</td>
<td>3.832</td>
<td>0.631</td>
</tr>
<tr>
<td>Redinha (46)</td>
<td>2.957</td>
<td>0.502</td>
</tr>
<tr>
<td>Praia Do Meio (127)</td>
<td>3.992</td>
<td>0.687</td>
</tr>
<tr>
<td>Ponta Negra (108)</td>
<td>4.518</td>
<td>0.556</td>
</tr>
</tbody>
</table>

Table 1 - Axial accessibility levels for topological radii (average and correlations) for Natal and its beaches, highlighting top values;
Figure 3 - Natal’s segment map (ASA) showing normalized integration (NAIN).

Figure 4 - Natal’s segment map (ASA) showing normalized choice (NACH).
Comparing the beaches neighbouring street patterns (Figure 5), Ponta Negra’s grid is more continuous to surroundings, with similar sized blocks and a somewhat orthogonal disposition, accompanying the smooth sea bay curve. Roberto Freire Avenue (with an orange-yellow colouring), stretches through the area, approximating the 400m limit catchment area. At Praia do Meio, although the coastal avenue accompanies the sea line, its few parallel routes are short and discontinuous. Its streets form different size and orientation patterns: there are medium-sized blocks close to the sea, followed by smaller blocks and streets that do not connect well to neighbouring areas, and highly integrated routes forming the city’s integration core up the hill. Redinha presents a more organic street network accompanying the river and the sea, barely having neighbouring grids to connect with. Situated under the bridge, Redinha barely takes advantage of its potential movement.

Comparing overlaps between potential movement for visitors and inhabitants (NAIN/NACH) at different metric radii (table 3), Redinha and Praia do Meio correlations are strong only at local radii (400 and 800m), after which there is a steady drop for Praia do Meio, and a sharp drop for Redinha. Such restrictions point to potential to- and through-movement rarely meeting and characterize them as spatial enclaves, not well connected with surroundings. Ponta Negra is different, as NAIN/NACH overlaps are lower at local radii (400 m), however for all radii between 1200 and n it reaches markedly higher values.

![Figure 5 - Natal's beaches street patterns, showing NAIN values (ASA);](image-url)
Although metrically distant from the city’s integration core, Ponta Negra’s high average accessibility levels and to- and through-movement correlations show it well knitted to surroundings; albeit not working well as an independent system (low topological radii correlations).

Most of the city’s connections face the river rather than the sea, following the old town centre setting. The studied beaches are outside Natal’s integration core, and are set apart from each other. This is partly due to natural boundaries: as the Igapó River divides the north and central zones (and Redinha from Praia do Meio) and Parque das Dunas preservation area separates the main grid from the coastal route (and Praia do Meio from Ponta Negra). Fragmentation is also facilitated by its discontinuous grid, corroborating Medeiros’ (2013) description of Brazilian cities as patchworks.

### 3.2 FORTALEZA

Fortaleza exhibits higher average integration levels (0.919 for Rₙ, axial and 1.136 for NAIN, ASA) than Natal (respectively 0.631 and 0.863), being an overall less fragmented system. Main to- and through-movement routes in global radius spread out from the old city centre radially, whereas many grids maintain orthogonal connections.

The city’s integration core (Figure 6) spreads south and, to a lesser degree, south-east of the old town centre (through Benfica, Joaquim Távora and Aldeota neighbourhoods). The integration core approximates Praia de Iracema, with some drop in accessibility closer to the coast. High NACH values also represent a radial system stemming from the old city centre (Figure 7), with a few routes spreading towards extremes of the system - as Av. Santos Dumont reaching Praia do Futuro – and other more circumferential routes that interconnect the radial.
Figure 6 - Fortaleza's segment map (ASA) showing normalized integration (NAIN).

Figure 7 - Fortaleza's segment map (ASA) showing normalized choice (NACH).
Globally, Praia de Iracema reaches highest average levels on all investigated measures (table 5); it maintains highest levels in axial analysis for all radii and at most metric radii for NAIN and NACH. At some local to intermediate radii (ASA, NACH 1200m, NAIN 400m and 1200m), Praia do Futuro reaches higher average accessibility. Barra do Ceará maintains the lowest average accessibility levels at all examined measures and radii, lower than Fortaleza.

Praia de Iracema has highest correlations between topological radii accessibilities (Table 4), exceeding the other beaches significantly for intelligibility. This suggests it is a legible area that works well independently (Medeiros, 2013; Perdikogianni and Penn, 2005).

<table>
<thead>
<tr>
<th>System (number of lines)</th>
<th>NACH</th>
<th></th>
<th></th>
<th></th>
<th>n</th>
<th>NAIN</th>
<th></th>
<th></th>
<th></th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>400</td>
<td>1200</td>
<td>2400</td>
<td>5000</td>
<td>n</td>
<td>400</td>
<td>1200</td>
<td>2400</td>
<td>5000</td>
<td>n</td>
</tr>
<tr>
<td>Fortaleza (49427)</td>
<td>0.967</td>
<td>1.019</td>
<td>1.004</td>
<td>0.977</td>
<td>0.902</td>
<td>1.457</td>
<td>1.352</td>
<td>1.298</td>
<td>1.262</td>
<td>1.136</td>
</tr>
<tr>
<td>Barra Do Ceará (381)</td>
<td>0.931</td>
<td>0.945</td>
<td>0.902</td>
<td>0.866</td>
<td>0.785</td>
<td>1.194</td>
<td>0.995</td>
<td>0.977</td>
<td>0.992</td>
<td>0.928</td>
</tr>
<tr>
<td>Praia De Iracema (271)</td>
<td>0.974</td>
<td>1.046</td>
<td>1.035</td>
<td>0.997</td>
<td>0.912</td>
<td>1.438</td>
<td>1.504</td>
<td>1.633</td>
<td>1.627</td>
<td>1.305</td>
</tr>
<tr>
<td>Praia Do Futuro (210)</td>
<td>0.903</td>
<td>1.069</td>
<td>1.029</td>
<td>0.986</td>
<td>0.889</td>
<td>1.558</td>
<td>1.587</td>
<td>1.259</td>
<td>1.061</td>
<td>1.044</td>
</tr>
</tbody>
</table>

Table 4 - Average accessibility levels at metric radii for Fortaleza and its beaches (ASA), highlighting top values.

Street patterns show that all beaches are distinct in terms of catchment sizes, and that of its blocks and streets, as well as their continuity to the larger urban grid (Figure 8). Although Praia do Futuro is situated at an extreme of the system, its connections are more continuous to surroundings than Barra do Ceará, and it reaches higher accessibility levels. Contrasts in sizes of street segments and blocks can be identified clearly between these beaches, although Barra do Ceará encompasses a smaller area, it has more lines than Praia do Futuro (Table 4). Barra do Ceará exhibits the most irregular and organic distribution of all, working independently from the wider urban system (following Parham, 2012 studies of informal settlements). Praia do Futuro presents longer roads forming orthogonal connections and large blocks with two avenues accompanying the sea line. Praia de Iracema is somewhere in between these situations in terms of block sizes and orientation; there is continuity to neighbouring areas and routes following the coastline, while some smaller routes knit this fabric locally. Praia de Iracema presents a structure with more internal hierarchies than in Praia do Futuro’s case, while maintaining some continuity to surroundings.
Overlaps between NAIN and NACH values point to potential overlaps in movement for visitors and inhabitants, and was compared for various metric radii (Table 6). As a whole, Fortaleza presents higher values than Natal. Specifically, Praia de Iracema stands out with the highest correlations at all examined metric radii, pointing to various movements logics overlapping in its grid. For the other beaches, correlations are lower and vary, although not as much as occurs in Natal. Praia do Futuro maintains an over 0.3 correlation at most examined radii (and over 0.4 up to 1200m), pointing to some confluence of potential movement between inhabitants and visitors, and some embedding within the wider urban fabric (following Yang & Hillier, 2012). For Barra do Ceará strong overlaps concentrate at local scales – thus not well embedded - but still reach a wider range of metric radii than Praia do Meio and Redinha in Natal.
Table 5 – NAIN/NACH Correlations ($R^2$) at metric radii for Fortaleza and its beaches (ASA), highlighting top values.

Although Fortaleza also has discontinuous grids resembling patchworks (Medeiros, 2013), its system exhibits more continuity than Natal, and less significant natural boundaries. Although the beaches have distinct spatial configurations, in Fortaleza they are also less detached from the city’s main movement routes, which are closer to the coast (as is the old city centre).

4. DISCUSSION AND CONCLUSION

There are similarities amongst the chosen beaches relating to location hierarchies within the city. For each city one beach is closest to the old city centre and is the most integrated globally (Praia do Meio in Natal, Praia de Iracema in Fortaleza). Two beaches are at extremes of the city (Redinha and Ponta Negra in Natal; Barra do Ceará and Praia do Futuro in Fortaleza), and one of these is recurrently segregated (Redinha in Natal, Barra do Ceará in Fortaleza). Nonetheless, there are also some trends that differentiate spatial patterns in both cities, and in their three studied beaches.

Although public spaces of cities should foster mixture (Sennet, 2006), the studied cities and beaches point to spatial configurations revealing urban dynamics and processes of social exclusion. As a common trait in both cities, the least accessible beaches at all examined radii are frequented by the poorest economically (as is the case for Redinha and probably for Barra do Ceará); this reveals strong processes of exclusion and corroborates findings elsewhere concerning the location of marginalized groups (Vaughan, 2007).

Spatial form of beaches in Natal and in Fortaleza show that distinct characterisations relate to distinct spatial configurations. For Ponta Negra and Praia de Iracema, day to day characterization seem to be positive within each city, and seem to relate to a spatial configuration that allows for some intermingling of people and activities.

Ponta Negra is more continuous to the wider urban fabric as opposed to the other beaches in Natal; although metrically further away from the city’s integration core and the old town centre, its grid connects better to surroundings and reaches medium/high accessibility. It bears some comparison with Praia de Iracema in Fortaleza, as both show recurrent overlaps between inhabitants and visitors potential movement at different metric scales. Indeed they seem to accommodate more social mixture than the other beaches in each city, although at Ponta Negra earlier research showed that social mixture was still somewhat limited, and many frequenters were tourists (as depicted in its characterisation).

It seems that Praia de Iracema in Fortaleza might approximate more than any other studied beach our ideal situation of urban vitality, as it exhibits spatial patterns shown to facilitate legibility and encounters between people. The area has high accessibility levels at varied scales and modes of analysis, highest correlations across topological radii (axial analysis) and highest overlaps between potential to- and through-movement at all explored metric radii (ASA), implying potential intermingling of diverse people and activities. These spatial attributes are highlighted by the literature and previous research as facilitating urban vitality (movement,
legibility and social mixture). Indeed it seems very lively, as it hosts many local and large scale events, such as the pre-carnival bands and the city’s New Year’s Eve concerts and fireworks. At another level its promenade and beach seem constantly used by different people.

In Natal natural boundaries help separate the beaches from one another, and from the city’s main routes of movement. Fortaleza, on the other hand, has an overall less fragmented system and beaches are less detached from the main structure. This might help explain a somewhat weaker social distinction between beaches in Fortaleza, whereas in Natal the beaches receive stronger locational and social labels, especially those functioning as spatial enclaves. Whereas in Natal both Praia do Meio and Redinha are spatial enclaves – as potential to- and through-movement seldom meet - this applies in Fortaleza only to Barra do Ceará, and even there to a lesser extent. Praia do Futuro exhibits some confluence of movement and was shown to have a heterogeneous public in previous research (Donegan, 2011; Donegan and Trigueiro, 2012), which varied, however, within the beach itself.

Although there are hierarchies amongst the beaches, Fortaleza presents a less spatially reclusive grid than Natal; its beaches, globally and locally, are better knitted with surroundings and allow more overlaps between different potential journeys. Higher degrees of social mixture are hinted at in general descriptions of the beaches, and are perceived in our day-to-day experiences. We thus also suggest that there might be more tolerance between the socially diverse in Fortaleza, in spite of it also being a violent city.

To ascertain whether differences and similarities of spatial configuration do indeed relate to society, and if indeed Fortaleza harbours more social mixture than Natal, the next stage of research will be to survey and compare social life. As studies relating built form attributes and society at urban Brazilian beaches have been scarcely tackled, there are yet other avenues for future research, e.g. studying architecture-society relations in a finer grain and expanding findings to other coastal cities.

Relations between observed uses so far and spatial patterns at our urban beaches reinforce attributes pointed out in the literature as promoting more, or less, urban vitality. Despite the sea’s attractive role and the intensity of uses, beaches reveal urban dynamics. Research on this theme contributes to understanding the culture of beach use in Brazil and its relations with overall segregation patterns.
REFERENCES


ABSTRACT

The Jerusalem Light Rail (JLR), while used by all groups to commute between the northern parts and central Jerusalem, has been seen as a ‘conflict infrastructure’. The article studies to what extent the JLR has exacerbated the conflict between different ethnic-cultural groups because of the way in which it frames people’s everyday experience in the city. Through reading the work of Keller Easterling’s (2014), it is argued that that infrastructure possesses agency and thus may not perform according to the declared intent. In the case of the JLR, it was intended to portray an image of a ‘united city’ based on the Jewish-Israeli narrative (Nolte and Yacobi, 2015). The work will focus on how the JLR has performed in the transportation network of Jerusalem independent of this stated intent rather than how it represents the space and accumulates meaning through this declared intention. The spatial and statistical analysis, with the aid of the GPS tracking data derived from Raanan and Shoval’s (2014) work, are used to test to what extent the JLR, combined with the bus network, has reshaped the space and people’s mobility, and potentially the social relations among different ethnic-cultural groups, namely secular Jews, ultra-orthodox Jews and Arabs. The work finds that while the JLR has not significantly changed the spatial configuration of Jerusalem, it suggests three hypotheses according to the analysis results. First, the JLR has probably brought more people to the existing shared space. Secondly, the topology of the street network may draw passengers into ultra-orthodox Jewish neighbourhoods. Thirdly, the JLR has very likely increased the mobility of Jews and Arabs unevenly because of the unequal services between the Israeli and Palestinian bus system. Consequently, due to the way in which the JLR frames daily experience, such as daily routines and human co-presence, it has intensified the multi-ethnic/cultural conflict not only thanks to its declared intent.

KEYWORDS

Jerusalem, Light Rail, Bus, Infrastructure, Conflict

1. INTRODUCTION

Infrastructure space is used by Keller Easterling (2014) to describe contemporary urban phenomena that are generated by repeatable formulas of infrastructure. In Jerusalem, being a contested city with deep-rooted conflicts between Jews and Arabs, infrastructure space is more notable in a way that ‘produce[s] and reproduce[s] its own national space by means of segregation and its containment of ethnic minorities’ (Nolte and Jacobi, 2015, p. 30). One of the reasons is that the re-organisation of spatial forms can potentially reshape the patterns of movement and co-presence, and subsequently the integration and segregation patterns (Hillier and Vaughan 2007).
For Easterling (2014), infrastructure space behaves like software, which is operated by the interplay of ‘active forms’, instead of ‘object forms’ like iconic buildings or master plans. Active forms can be organisational, act as social stories or both. Organisational active forms include the notions of the ‘multiplier’, ‘switch/remote’, ‘wiring/topology’, and ‘interplay/governor’. ‘Multipliers’ like cars and elevators change the urban environment as well as society dramatically through propagation. ‘Switches’ suppress and redirect to modulate a flow of activities, such as a terminal in a transportation network. Multipliers and switches are assembled in relative position and sequence in a network, which is the ‘wiring/topology’ of an organisation, while the ‘interplay/governor’ can modulate the flow of information in infrastructure space by a set of instructions for the interplay between active forms (Ibid.). The operation of infrastructure space is unlike static objects and volumes in urban space which usually perform according to the designers’ or politicians’ desire.

These active forms prevail in Jerusalem. The local buses, most of which are operated by an Israeli company and Palestinian companies separately, running on the street network, and the Israeli neighbourhoods in East Jerusalem are the omnipresent examples of ‘multipliers’. The light rail stations act as ‘switches’ between the bus network and the Jerusalem Light Rail (JLR), which started connecting Mount Herzl in West Jerusalem to Pisgat Ze’ev, the largest Israeli neighbourhood in East Jerusalem, in late 2011 (Figure 1). At the same time, the JLR has reshaped the ‘topology’ of the network because of its massive passenger capacity and unique routeing that passes through neighbourhoods of different ethnic-cultural groups in Jerusalem.
Through interplaying with the active forms, the JLR has reshaped Jerusalem. Various forms of infrastructure in Jerusalem are believed to perform politically as assigned by architects, planners, urban designers and transport engineers, as recognised by urban theorists (Barghouti, 2009; Yacobi, 2012). As Nolte and Yacobi (2015) discern, the JLR is a tool of enforcing the Israeli authorities’ vision of the ‘united city’ through both spatial practice and in its ‘public discourse, depiction and symbols’. Their vision of Jerusalem is portrayed in the ‘hegemonic Jewish-Israeli narrative of a “united city”’ and ‘the Palestinian national claims to the city’ are ignored (Ibid., p. 33). In their point of view, it is actually a ‘conflict infrastructure’ (Pullan, 2013, p. 17) which ‘connects the city physically and segregates it politically at the same time’ (Nolte and Yacobi, 2015, p. 32). Through the routing of stations, and regime of security around the JLR, the one-sided narrative embodied in the JLR has intensified the conflict between Israeli Jews and Palestinian Arabs (Nolte, 2016).

The extension of the route beyond the Green Line to East Jerusalem (Figure 1), where is considered to be part of the future Palestinian state by Palestinians and the international community, has been considered as a gesture of permanent annexation of the land over the Green Line. Naming of the stations is another mean that reinforces the Israeli territorial dominance in East Jerusalem. Their names link historical and biblical narrative to Hebrew names while in Arabic, they are only named acceding to the geographic locations (Ibid.). This is very critical in a city of religious conflict because both Palestinians and Israelis ‘make extensive use of religious texts in an effort to substantiate their claims to sovereignty over the area’ (Cohen, 2013, p. 135). The last critical point is the regime of security around the JLR. For instance, if a circumstance is identified as a potential security threat, security personnel can check identity cards and request people to get off the JLR (Nolte, 2016). Hanna Baumann (2014) also discerns the Israeli territorial supremacy on a representational level through her observation in Shuafat. In her description, the JLR is like an Israeli enclave passing through the Arab neighbourhood, and it is so visible that it becomes a part of the everyday life of Palestinians. Because of the representation used with the infrastructural system and the symbols attached to it, the JLR has eventually become a target of attack when a conflict between the two groups broke out in 2014.

While urban theorists recognise these urban phenomena through empirical observations and policy review, the complex re-organisation of space on the ground brought about by the JLR may not be able to be detected through discursive techniques and people’s perception only. Owing to the immanent nature of facilitating and mediating interaction (Tonkiss, 2013), infrastructure possesses agency due to its relative position in networks. Infrastructure may not behave as declared by decision makers. This paper will look into the agency of the infrastructure space in Jerusalem. The JLR will be the main focus of the study as it significantly alters the topology of Jerusalem by linking various active forms in this infrastructure space.

The study area of this work will be Metropolitan Jerusalem. It covers about 125km2 inside the municipal boundaries (Figure 1). Around 829,900 people live in the area, including different ethnic-cultural groups, with secular Jews, ultra-orthodox Jews and Arabs being the major ones. In analysing the way in which the JLR transforms the spatial pattern with other active forms in Jerusalem, syntactic analysis and geographic information system (GIS) analysis are adopted. The analytical nature of space syntax and the propositional nature of Easterling’s (2014) argument are complementary to each other in this work. Syntactic analysis is used because Easterling’s notion of active forms is a concept which is so abstractly and metaphorically defined and explained merely through written language.

To explore how the JLR performs independent of its stated intent and its representation, the paper is divided into three parts:

- The first part explores the spatial background of Jerusalem by looking into the relationship between the configurational structure of the street network and the movement patterns of different ethnic-cultural groups.
- The second part studies how the JLR has reshaped the topology of the street network.
- In the third part, the interplay between the JLR and the bus system and how the JLR stations have modulated the flow between the two systems are examined.
The agency of the JLR is expected to be revealed through analysing how it frames people's daily experience with other forms of infrastructure by reshaping the spatial pattern of Jerusalem. It is also important to note that this work uses configurational data and academic sources. As a result, the study of these elements accounts only for the potential of space to affect mobility and social relations.

2. DATASETS AND METHODS

Space syntax analysis is the main method in studying the impact of the JLR, while GIS analysis helps study the interplay between the bus services and the JLR. In comparing the spatial information with the empirical data, Raanan and Shoval's (2014) source provides the movement patterns of different ethnic-cultural groups.

The segment model of Jerusalem is the major model used for the space syntax analysis. The segment model is generated from an axial model prepared by tracing the longest straight lines (axial lines) through every convex space bounded by buildings or road barriers. Normalised Angular Integration (NAIN) and Normalised Angular Choice (NACH) are the two measures used in the analysis. Integration and Choice represent the to-movement and through-movement potential respectively (Hillier et al., 2012). Values are normalised for the advantage of being able to compare across cities statistically (Ibid.). By comparing the spatial pattern and values of the system with and without the JLR, the influence of the infrastructure on the configurational properties of the network can be tested.

Metric depth and angular step depth analysis will find out the catchment of the JLR stations. Angular step depth is measured by the shortest angular path from the segments (those represents the stations in this work) to all other segments within the system (Turner, 2004). Metric depth analysis can help test how well residents of different neighbourhoods are served by the JLR because they are familiar with their territories and choose their routes based on the shortest distance between the origin and destination. On the other hand, angular step depth can help examine whether and in which locations the JLR has brought more people who are not familiar with the particular areas since human movement is better explained by the angular distance rather than the metric distance (Hillier and Iida, 2005). Therefore, it can also reveal the areas of high natural movement, and subsequently the potential of these areas to attract movement-seeking activities, such as retail (Hillier, 1996).

The theory of natural movement is robust but only if everyone has more or less the same level of mobility. However, in Jerusalem, where bus services support Israelis and Palestinians exclusively, then the theory will become relatively incapable of holistically explaining the phenomena. The analysis of the interplay between the JLR and the two separated bus systems can further reveal how the JLR has reshaped the movement patterns of these two passenger groups beyond the light rail route.

The data analysis of the bus network is mainly conducted through GIS. The details of the route and daily frequency of the Israeli bus system is built from the Israel's Public Transportation Info Centre (http://www.bus.co.il), with an aid of Jerusalem Bus Map (http://www.jlembusmap.com), while the data of the Palestinian bus system is collected from the map and timetable provided by the bus companies. Since a considerable number of bus routes do not run on the same streets in two directions, most routes will be represented by two lines in different directions in this work.

In studying Jerusalemites’ movement patterns, four groups of territories are mapped based on Raanan and Shoval's (2014) work. They studied the relationship between perceived territorial boundaries and actual spatial activity of different ethnic-cultural groups in Jerusalem. In their experiment, 18 female university students with six in each ethnic-cultural group, namely secular Jews, ultra-orthodox Jews and Palestinian Muslims, were interviewed to examine their perceived territories, while also their daily movements were spatially tracked. Their results prove that the territories indicated in the residential ethno-cultural division map highly correlate with the participants’ perceived personal territories and activity space. The four territories and their corresponding dominant ethnic cultural groups are listed in Table 1.
Proceedings of the 11th Space Syntax Symposium

THE AGENCY OF JERUSALEM LIGHT RAIL:
A 'conflict infrastructure' beyond its representation

<table>
<thead>
<tr>
<th>Territory</th>
<th>Arab residence</th>
<th>Jewish residence</th>
<th>Jewish ultra-orthodox residence</th>
<th>Abu Qatada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnic-cultural groups</td>
<td>Arabs</td>
<td>Secular Jews</td>
<td>Ultra-orthodox Jews</td>
<td>Mixed population of the two major religious groups of Jews</td>
</tr>
</tbody>
</table>

Table 1 - The major ethnic-cultural territories and their corresponding dominant ethnic-cultural groups.

However, it does not mean people are only active within their own territories. The residential ethno-cultural division map rather indicates the residential space of the respective ethnic-cultural groups. Secular Jewish territory is perceived as a shared space by the ethnic-cultural minorities, ultra-orthodox Jews and Arabs. By looking into where people go outside their residential territories, the locations in which there is multi-ethnic/cultural co-presence can be identified.

3. RESULT 1: COMPARING MOVEMENT PATTERNS & SPATIAL STRUCTURE

Raanan and Shoval’s (2014) study shows that there are apparently distinctive daily movement patterns among different ethnic-cultural groups. They found that secular Jewish individuals appeared to operate within their own territories while participants of the minority groups, ultra-orthodox Jews and Palestinian Muslims, were very active within the secular Jewish territories when they were outside their homes, due to the fact that minorities depend on the employment and services in the majority’s territory (Ibid.).

The spatial model of Jerusalem explains the society in a way that is different from other cities where people choose certain routes largely because of natural movement. In Jerusalem, the spatial model only projects a potential movement pattern that would be valid if the citizens would feel comfortable to visit any neighbourhood. However, it still effectively depicts movement patterns in another way in this contested city. Most routes chosen by the minority groups in secular Jewish territories are those with high NACH values. By extracting the GPS tracks which are outside the participants’ own ethnic-cultural territories, they mostly coincide with the 1.3 and 1.4 structure, except a few neutral spaces like university campus and shopping centres (Figure 2).

The results show that the streets with high NACH values are rich fields of potential encounter and the interface between different groups. In most cities, these spaces lead to the appearance of new social relations (Hillier and Vaughan, 2007). In Jerusalem, it may not be the case and they may possibly turn into spaces of conflict. On the other hand, the background network with low NACH values remains residential areas dwelled with homogeneous ethnic-cultural groups. In Jerusalem, the participants did not normally pass through the background network of other ethnic-cultural groups. Potential conflicts between groups is less likely to happen in these segregated spaces.

In comparing the daily use of space by different ethnic-cultural groups and the spatial structure in Jerusalem, the dynamics between space and society is presented. The spatial structure is only an agent of potential encounter (Hillier and Vaughan, 2007). The map shows that the participants chose their routes according to both intuition and their social understandings of space.
Figure 2 - NACH global, segment angular analysis (radius = 5000m), including the highlighted 1.4 & 1.3 structure, the location of ethnic-cultural territories and GPS tracks
4. RESULT II: THE JLR

The influence of the JLR is first tested with the bi-modal segment angular analysis by connecting the JLR system to the segment model (Figure 3a). Both NACH and NAIN values do not change significantly both in terms of the entire city and in each ethnic-cultural territory (Table 2). The JLR has not changed the configurational properties of the spatial structure because the tracks are on the segments which were already with comparatively high NACH and NAIN values before the implementation of the JLR.

![Figure 3 - NACH global, segment angular analysis in 5000m radius, with (right) and without (left) the JLR, in Damascus Gate Area.](image)

While the JLR has not significantly changed the spatial structure of Jerusalem, its huge passenger capacity and its unique routeing which passes through all ethnic-cultural territories should exert a greater impact than the spatial model illustrates. Its capacity is considered to be huge as it carries 130,000 passengers every day by only one route with 292 journeys per day, while 69 Israeli bus routes with 7,029 journeys per day only move 441,019 passengers every day (Jerusalem Institute for Israel Studies, 2015). It means that one light rail journey can transport 445 people while a bus journey can only handle 67 people.
Ethnic-cultural territories | Radius | Statistical measure | Without JLR | With JLR | % change | Without JLR | With JLR | % change |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Arab residence</td>
<td>800</td>
<td>mean</td>
<td>0.763</td>
<td>0.763</td>
<td>0.04%</td>
<td>0.761</td>
<td>0.762</td>
<td>0.09%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.543</td>
<td>1.543</td>
<td>0.00%</td>
<td>2.219</td>
<td>2.219</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>mean</td>
<td>0.736</td>
<td>0.736</td>
<td>0.05%</td>
<td>0.633</td>
<td>0.634</td>
<td>0.20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.484</td>
<td>1.484</td>
<td>0.00%</td>
<td>1.301</td>
<td>1.301</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>5000</td>
<td>mean</td>
<td>0.705</td>
<td>0.705</td>
<td>0.05%</td>
<td>0.572</td>
<td>0.573</td>
<td>0.26%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.453</td>
<td>1.453</td>
<td>0.03%</td>
<td>1.089</td>
<td>1.094</td>
<td>0.49%</td>
</tr>
<tr>
<td>Jewish residence</td>
<td>800</td>
<td>mean</td>
<td>0.797</td>
<td>0.798</td>
<td>0.08%</td>
<td>0.774</td>
<td>0.775</td>
<td>0.18%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.477</td>
<td>1.477</td>
<td>0.00%</td>
<td>1.768</td>
<td>1.768</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>mean</td>
<td>0.772</td>
<td>0.773</td>
<td>0.08%</td>
<td>0.701</td>
<td>0.703</td>
<td>0.25%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.468</td>
<td>1.468</td>
<td>0.00%</td>
<td>1.536</td>
<td>1.545</td>
<td>0.64%</td>
</tr>
<tr>
<td></td>
<td>5000</td>
<td>mean</td>
<td>0.741</td>
<td>0.741</td>
<td>0.08%</td>
<td>0.660</td>
<td>0.662</td>
<td>0.26%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.473</td>
<td>1.473</td>
<td>0.02%</td>
<td>1.168</td>
<td>1.173</td>
<td>0.40%</td>
</tr>
<tr>
<td>Jewish ultra-orthodox residence</td>
<td>800</td>
<td>mean</td>
<td>0.833</td>
<td>0.833</td>
<td>0.02%</td>
<td>0.856</td>
<td>0.857</td>
<td>0.03%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.537</td>
<td>1.537</td>
<td>0.00%</td>
<td>1.633</td>
<td>1.633</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>mean</td>
<td>0.813</td>
<td>0.813</td>
<td>0.03%</td>
<td>0.826</td>
<td>0.826</td>
<td>0.03%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.472</td>
<td>1.472</td>
<td>0.00%</td>
<td>1.553</td>
<td>1.553</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>5000</td>
<td>mean</td>
<td>0.776</td>
<td>0.777</td>
<td>0.03%</td>
<td>0.734</td>
<td>0.734</td>
<td>0.02%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.451</td>
<td>1.451</td>
<td>0.00%</td>
<td>1.156</td>
<td>1.156</td>
<td>0.00%</td>
</tr>
<tr>
<td>Jewish residence in transition</td>
<td>800</td>
<td>mean</td>
<td>0.760</td>
<td>0.760</td>
<td>0.05%</td>
<td>0.674</td>
<td>0.675</td>
<td>0.12%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.447</td>
<td>1.447</td>
<td>0.00%</td>
<td>1.489</td>
<td>1.489</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>mean</td>
<td>0.743</td>
<td>0.743</td>
<td>0.04%</td>
<td>0.619</td>
<td>0.621</td>
<td>0.17%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.427</td>
<td>1.427</td>
<td>-0.05%</td>
<td>1.348</td>
<td>1.352</td>
<td>0.27%</td>
</tr>
<tr>
<td></td>
<td>5000</td>
<td>mean</td>
<td>0.714</td>
<td>0.714</td>
<td>0.04%</td>
<td>0.575</td>
<td>0.577</td>
<td>0.24%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.416</td>
<td>1.417</td>
<td>0.03%</td>
<td>1.051</td>
<td>1.056</td>
<td>0.48%</td>
</tr>
<tr>
<td>All segments inside Municipal boundaries of Jerusalem</td>
<td>800</td>
<td>mean</td>
<td>0.777</td>
<td>0.777</td>
<td>0.03%</td>
<td>0.766</td>
<td>0.767</td>
<td>0.04%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.552</td>
<td>1.552</td>
<td>0.00%</td>
<td>3.104</td>
<td>3.104</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>mean</td>
<td>0.753</td>
<td>0.754</td>
<td>0.05%</td>
<td>0.675</td>
<td>0.675</td>
<td>0.03%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.590</td>
<td>1.590</td>
<td>0.00%</td>
<td>2.571</td>
<td>2.571</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>5000</td>
<td>mean</td>
<td>0.722</td>
<td>0.722</td>
<td>-0.01%</td>
<td>0.625</td>
<td>0.624</td>
<td>-0.19%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max</td>
<td>1.473</td>
<td>1.473</td>
<td>0.02%</td>
<td>1.168</td>
<td>1.173</td>
<td>0.40%</td>
</tr>
</tbody>
</table>

Table 2 - The influence of the JLR on NACH and NAIN values in Jerusalem and different ethnic-cultural territories.

While the JLR has not significantly changed the spatial structure of Jerusalem, its huge passenger capacity and its unique routeing which passes through all ethnic-cultural territories should exert a greater impact than the spatial model illustrates. Its capacity is considered to be huge as it carries 130,000 passengers every day by only one route with 292 journeys per day, while 69 Israeli bus routes with 7,029 journeys per day only move 441,019 passengers every day (Jerusalem Institute for Israel Studies, 2015). It means that one light rail journey can transport 445 people while a bus journey can only handle 67 people.
The JLR therefore can possibly bring plenty of people to the surrounding areas of the stations. However, as discussed, it should be noted that the JLR only creates potential encounter fields around the stations. People also choose their routes based on their social understandings of space. Through metric depth and angular step depth analysis, catchment areas of the JLR and potential encounter fields can be revealed. Metric depth analysis shows how well the JLR serves the residents (Figure 4). First, by comparing the total length of segments in each territory, the ultra-orthodox Jewish residence is the one with the highest proportion of segments in length within 800m radius of any JLR station ((4) in Table 3). Secondly, while the segments in the ultra-orthodox Jewish residence only accounts for 11.6% of all segments in length within the municipal boundaries ((8) in Table 3), they contribute to nearly a quarter of all segments in length within the 800m catchment of any JLR station ((9) in Table 3). If the context of the whole Jerusalem is not considered, then Jewish residence makes up of the highest proportion of segments in length inside the catchment area ((9) in Table 3).
Table 3 - The proportion of segment with low metric depth and angular step depth away from any JLR station in different ethnic-cultural territories.

<table>
<thead>
<tr>
<th>Ethnic-cultural territories</th>
<th>Arab residence</th>
<th>Jewish residence</th>
<th>Jewish ultra-orthodox residence</th>
<th>Jewish residence in transition</th>
<th>Other areas</th>
<th>All areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Total no. of segments</td>
<td>12,171</td>
<td>17,520</td>
<td>5,651</td>
<td>3,551</td>
<td>7,265</td>
<td>47,158</td>
</tr>
<tr>
<td>(2) Total length of segments</td>
<td>497km</td>
<td>619km</td>
<td>206km</td>
<td>119km</td>
<td>338km</td>
<td>1,779km</td>
</tr>
<tr>
<td>(3) No. of segments with metric depth &lt; 800m away from any JLR station</td>
<td>2,264 (17.19%)</td>
<td>3,638 (20.76%)</td>
<td>2,383 (42.27%)</td>
<td>449 (12.64%)</td>
<td>486</td>
<td>9,220</td>
</tr>
<tr>
<td>(4) Total length of segments with metric depth &lt; 800m away from any JLR station (compared to (2))</td>
<td>74.7km (15.04%)</td>
<td>121.9km (19.70%)</td>
<td>72.2km (35.10%)</td>
<td>16.5km (13.85%)</td>
<td>15.6km</td>
<td>301.0km</td>
</tr>
<tr>
<td>(5) No. of segments with angular step depth &lt; 3 away from any JLR station (compared to (1))</td>
<td>598 (4.54%)</td>
<td>1,319 (7.53%)</td>
<td>751 (13.29%)</td>
<td>158 (4.45%)</td>
<td>146</td>
<td>2,972</td>
</tr>
<tr>
<td>(6) Total length of segments with angular step &lt; 3 away from any JLR station (compared to (2))</td>
<td>32.6km (6.55%)</td>
<td>56.0km (9.06%)</td>
<td>28.5km (13.86%)</td>
<td>8.8km (7.37%)</td>
<td>10.4km</td>
<td>136.3km</td>
</tr>
<tr>
<td>(7) % of segment in total no. of segment in Jerusalem</td>
<td>27.9%</td>
<td>37.2%</td>
<td>12.0%</td>
<td>7.5%</td>
<td>15.4%</td>
<td>100%</td>
</tr>
<tr>
<td>(8) % of length in total length of all segments in Jerusalem</td>
<td>27.9%</td>
<td>34.8%</td>
<td>11.6%</td>
<td>6.7%</td>
<td>19.0%</td>
<td>100%</td>
</tr>
<tr>
<td>(9) % of length in total length of all segments with metric depth &lt; 800m away from any JLR station</td>
<td>24.8%</td>
<td>40.5%</td>
<td>24.0%</td>
<td>5.5%</td>
<td>5.2%</td>
<td>100%</td>
</tr>
<tr>
<td>(10) % difference (9) compared to (8)</td>
<td>-11.1%</td>
<td>16.4%</td>
<td>107.4%</td>
<td>-18.2%</td>
<td>-72.7%</td>
<td></td>
</tr>
<tr>
<td>(11) % length in total length of all segments with angular step &lt; 3 away from any JLR station</td>
<td>23.9%</td>
<td>41.1%</td>
<td>20.9%</td>
<td>6.4%</td>
<td>7.6%</td>
<td>100%</td>
</tr>
<tr>
<td>(12) % difference (11) compared to (8)</td>
<td>-14.5%</td>
<td>18.2%</td>
<td>80.3%</td>
<td>-3.9%</td>
<td>-59.9%</td>
<td></td>
</tr>
</tbody>
</table>
Angular step depth analysis tests the potential encounter fields and areas to attract movement-seeking activities. By overlaying the GPS tracks, which are outside the participants’ own ethnic-cultural territories in Raanan and Shoval’s (2014) experiment, with the segments located in less than three angular steps away from any JLR station, the analysis further reveals the potential encounter fields between different ethnic-cultural groups (Figure 6). Since Arabs and Jews are not familiar with each other’s spaces (Ibid.), angular step depth analysis will be more accurate than metric depth analysis in showing how people choose their routes outside their own territories.

Figure 5 - Proportion of segments with lower than three angular steps away from any JLR station in different ethnic-cultural territories.
Figure 6 - The segments with lower than three angular steps away from any JLR stations, the location of ethnic-cultural territories, and GPS tracks which are outside the participants’ own ethnic-cultural territories.
The result shows that a considerable proportion of GPS tracks scatter on the identified segments, even though the experiment was conducted before the implementation of the JLR. It suggests that the JLR has very likely intensified these spaces by bringing more people to these locations. There are two areas with notably high densities of both low angular step segments and GPS tracks outside the participants’ own ethnic-cultural territories. These are the Central Station area and East Jaffa Road - Damascus Gate area. These areas are where the major bus terminals of the Israeli and Palestinian bus systems are located respectively. The East Jaffa Road - Damascus Gate area is more interesting to investigate because it is the junction of three ethnic-cultural territories and people crossed the ‘borders’ and entered the neighbourhoods of other groups actively in Raanan and Shoval’s (2014) experiment. The map also suggests that the JLR may have introduced new spaces of potential multi-ethnic/cultural encounters along the tracks, especially the area with dense identified segments inside secular Jewish territories, which the Palestinian Muslim participants did not define as being part of any ethnic-cultural group (Ibid.). The secular Jewish area in the middle of the Central Station area and East Jaffa Road - Damascus Gate area is possibly a new potential encounter field between different ethnic-cultural groups.

The statistical study of the angular step depth analysis presents a similar result as that of the metric depth analysis. The ultra-orthodox residential areas are also the ones benefited most from the JLR (16) and (12) in Table 3. Similar to the result of the metric depth analysis, the Jewish residence constitutes the highest proportion of segments with lower than three angular steps away from any JLR station (11) in Table 3 and Figure 5).

These results help to conclude that ultra-orthodox and secular Jews are the two groups that can gain the highest level of accessibility more than Arabs do in different ways because of the JLR. It should also be noted that the areas around two major bus terminals, which serve Israelis and Palestinians exclusively, are the most prominent potential multi-ethnic/cultural encounter fields. Moreover, it is quite common among Jerusalemites to take the bus and interchange to the JLR in their journeys (Estrin, 2012). Therefore, because of the extensiveness of the bus network, the impact of the JLR should be beyond its route and the empirical observations on the train and around the stations.

5. RESULT III: THE JLR & THE BUS SYSTEM

The map shown in Figure 7 investigates the number of bus lines operated by the Israeli company and Palestinian companies. The extensive bus service network is represented on the map, and more importantly, a clear separation pattern is unfolded. The only segments with the buses run by both bus systems are in the Hebrew University of Jerusalem, Talpiot and around the Old City. The three locations are also identified in Raanan and Shoval’s (2014) experiment. The GPS tracks of Palestinian Muslim participants are so dense in the university and rest along the main road in Talpiot and the tracks of the participants of all ethnic-cultural groups scatter around the Old City (Figure 2 and 6). They not only lay along but also scatter around the identified segments. So the identified segments are probably not only the places where there is co-presence of the buses of two systems. They are likely the interfaces consisting of co-presence between people that takes place when they get off and get on the buses.

Since people are actively switching between two transportation modes, how the JLR is differently integrated with the two bus systems should also be studied. Generally, it is easier to interchange between Israeli buses and the JLR because more Israeli buses stop near the JLR stations. Over 90% of Israeli bus lines stop within 400m radius of any JLR station, while only less than two-thirds of Palestinian bus lines stop within the 400m catchment area of any JLR station (Table 4). It can be attributed to the fact that a considerable number of Israeli bus routes have been re-adjusted when the JLR was implemented to serve as the feeder network to the JLR. For instance, Route 48 has been changed from a circle route inside the campus of the Hebrew University of Jerusalem to a route that connects to Ammunition Hill station. Moreover, there are seven JLR stations with Israeli buses terminating within their 400m catchment areas, while Damascus Gate is the only station where Palestinian buses terminate within the catchment, even though the last stops of seven Palestinian bus lines have been relocated to a new bus terminal adjacent to Damascus Gate station.
In studying the JLR and the bus network together, it appears that the Israeli bus system is more integrated to the JLR than the Palestinian one. Still, because of the huge passenger capacity of the JLR, it is likely that more Arabs have come to the city centre, as identified in Figure 6, from the JLR stations in Shuafat and the extensive bus network that terminate in the Damascus Gate area.

**Figure 7 - The segments with bus services and the location of ethnic-cultural territories.**
<table>
<thead>
<tr>
<th></th>
<th>Israeli bus company</th>
<th>Palestinian bus companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total no. of routes</td>
<td>69</td>
</tr>
<tr>
<td>2</td>
<td>Total no. of routes</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>if sub-route counted separately</td>
<td>158</td>
</tr>
<tr>
<td>3</td>
<td>Total no. of lines</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>if two directions counted separately</td>
<td>30.4%</td>
</tr>
<tr>
<td>4</td>
<td>Total no. of lines</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>with at least one station next to (within 20m) any JLR station</td>
<td>70</td>
</tr>
<tr>
<td>5</td>
<td>Total no. of lines</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>with at least one station within 800m radius of any JLR station</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Total no. of lines</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>with no station within 800m radius of any JLR station</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

Table 4 - Comparison of the number of bus lines run by the Israeli company and Palestinian companies in the catchment of the JLR stations.

6. DISCUSSION & CONCLUSIONS

Nearly 12,000 bus and light rail journeys run in Jerusalem every day. They shape people’s daily lives as ‘multipliers’, and at the same time, their routes are determined by the other ‘multipliers’, the Israeli neighbourhoods in East Jerusalem. Whilst the JLR has not significantly changed the configurational properties of the street network, it has combined with the bus network so that two transportation modes integrate together through the improvement of ‘switches’, the JLR stations, especially those in Jewish territories. Consequently, a network of both the intensiveness in the city centre and extensiveness in the periphery has emerged. Then, the way in which passengers enter and leave this integrated public transport system is determined by both the ‘topology’ of the street network and their social understandings of space. Through the interplay between these active forms associated to the JLR, it works in its way that is independent of its symbolic meaning and its declared intent. It possesses an agency and becomes a ‘conflict infrastructure’. Three major findings in this paper try to explain how the social consequences have been resulted from the JLR by framing daily experience, such as daily routine and human co-presence.

First, it has probably intensified and created multi-ethnic/cultural co-presence in secular Jewish areas, like Downtown Triangle and Jaffa Road, and Damascus Gate area. More Palestinians are expected to be carried by the JLR to these areas from the stations in Shuafat and Damascus Gate station close to the Palestinian bus terminals. The hypothesis is recognised in the catchment analysis of the JLR (Figures 4-6), the GIS analysis of the bus lines run by two exclusive bus systems (Figure 7), and the application of Raanan and Shoval’s (2014) findings on the spatial models (Figures 2 and 6). In most cities, new social relations can appear in these spaces (Hillier and Vaughan, 2007). In Jerusalem, however, it may possibly amplify the conflict between different ethnic-cultural groups. Some right-wing organisations, such as Lehava, have placed posters and stickers warning Palestinians to ‘not even think of’ approaching Jewish women in these newly shared spaces (Baumann, 2014).

Secondly, the catchment analysis also shows that in general the JLR serve a higher proportion of ultra-orthodox areas compared to the other residential territories. Yet whether ultra-orthodox Jews are truly benefited in the political and religious context in Jerusalem is questionable.
Drawing more people of different groups may lead to conflict when strangers, such as tourists, enter the neighbourhood without cultural awareness. For instance, in Mea Shearim, an ultra-orthodox neighbourhood with less than three angular steps away from the JLR, visitors have to wear modest clothing. Additionally, during the Shabbat, cell-phone should not be visible as they might be a source of dispute (Sapir-Witz, 2006). And it is also possible that Arabs may enter these areas because of their lack of knowledge in Jewish spaces. As Raanan and Shoval (2014) recognised, the Palestinian Muslim participants failed to distinguish between ultra-orthodox areas and secular Jewish areas.

The third reason is less about multi-ethnic/cultural co-presence, but more about whether the JLR has supported all residents in Jerusalem as the Israeli authorities claim. If it would have served Palestinians proactively, its symbolic meaning could possibly be thinned out by its functional benefits. Nevertheless, as recognised in the bus network analysis, the Palestinian bus system is not as integrated with the JLR as the Israeli one. The JLR stations modulate the flow of Jewish passengers much more effectively. No facilities support the connection between Damascus Gate station and the two major Palestinian bus terminals. While the architect of the masterplanning consultant of the Damascus Gate area suggested an underground pedestrian connection between the terminals and the JLR station, the municipality insisted on an overland connection which is fenced off from the terminal side on the east (Rokem, 2006). Consequently, the neutral and functional image of the JLR, emphasised by the authorities, has been overwhelmed by its image of multi-ethnic/cultural conflict, because of its symbolic meaning, as identified by urban theorists, and the agency possessed in the public transport network, as studied in this work.

The paper has in general presented an overall picture of the public transport network in Jerusalem and of how various active forms constitute and affect the everyday life of different ethnic-cultural groups. These active forms include the ‘topology’ of the street network and the JLR; the propagation of buses, light rail trains and the Israeli neighbourhoods in East Jerusalem as ‘multipliers’; and the JLR stations that integrate the two modes of public transport as ‘switches’. The three major findings reveal how the JLR has intensified the multi-ethnic/cultural conflict by framing the everyday experience of secular Jews, ultra-orthodox Jews and Arabs in this contested city.
REFERENCES


SADAF SULTAN KHAN
Space Syntax Laboratory, The Bartlett School of Architecture, University College London.
sadaf.khan.11@ucl.ac.uk

KAYVAN KARIMI
Space Syntax Laboratory, The Bartlett School of Architecture, University College London.
k.karimi@ucl.ac.uk

ABSTRACT
Notions of identity and community like space consist of varying scales of definition and interaction ranging from concepts of nationhood and nationality through to local solidarities and affiliations of religion, trade, caste etc. Space Syntax research suggests that most people belong to communities that are both spatial and transpatial in nature where inhabitants of an area are bound not only to the people and spaces they physically inhabit but are simultaneously part of a larger transpatial community independent of the immediate physical context. In the context of Karachi’s Muhajir community, an ethno-political entity that has evolved through spatio-political constraints applied to an amalgam of assorted post-Partition urban minority groups, these socio-spatial variations in definition of identity can be studied across the changing scale of the city. Using space syntax methodologies, this paper examines the spatial definitions of identity, i.e. how affiliations and solidarities vary across the changing scales of the city and, how the use and positioning of communal tools of identification organize and articulate spatial clusters.

This study used a range of sources to map religious and political institutions as well as on-site documentation of political propaganda and related the location of these features to space syntax models of the city and four case study settlements. The intention was to analyse the accessibility and clustering of various communal spaces, how spatial configuration defines the social role communal spaces play within the community and how they may define the spatial limits of sub-clusters and internal social hierarchies of the community.

This multi-scalar analysis will show that not only does the nature of the Muhajir cluster change across the various scales of the city, the nature and scale of the interface between the community and the city changes too. At the city scale communal institutions articulate broad residential clusters often synonymous with political territories, indicative of spaces of dispute, at the scale of the settlement, the configuration of communal spaces describes and dictates the manner in which these communities interact, organize and define themselves internally. Identity is therefore multi-scalar; a group may present as one ethno-political entity at the scale of the city, it may simultaneously exist as multiple ethno-religious groups at the scale of the settlement. Whilst neither definition negates the other, analysis shows that broad political definitions hide richer, more nuanced definitions of identity that persist at the scale of the settlement.
KEYWORDS
Communal institutions, Spatial Clusters, Identity, Muhajir, Multi-scalar.

1. INTRODUCTION

Karachi today is one of many post-colonial megacities dealing with populations that are ethnically and politically diverse and not necessarily native to the city. As migrant populations outnumber the native populace issues of belonging, ownership and control of space, infrastructure and political capital become key points in the power politics and development of a city. As Simone states ‘For territory is the creation of space as a locus through which authority is exercised, an arena of command’ (Simone, 2013, p.274) hence it is through space that both identity and power are manifest.

In cities like Karachi, Jakarta, and Mumbai, major economic hubs in developing countries that attract considerable domestic in-migration, the urban middle class is comprised of a diverse array of communities. It is from this heterogeneous ‘in-between’ of varying occupations, incomes, religious affiliations and histories that often a lowest common denominator is sought out, highlighted and exploited thereby formulating a political majority (Simone and Rao, 2011). So whilst in urban environments socially similar communities often cluster in close proximity, distant commonalities are drawn upon to sculpt new, broader, often more powerful identities.

This manner of viewing and building affiliations and solidarities in many post-colonial megacities suggests that identity is multi-scalar where notions of identity and community relate to the local/neighbourhood scale, social networks tied to and the product of the immediate spatial environment, as well as having a transpatial element, whereby social affiliations “overcome spatial separation” (Hanson and Hillier, 1987. p.264). This particular paper tracks these shifting ethno-political definitions of identity and space through the Muhajir community in Karachi, Pakistan. It suggests that whilst broad ethno-political definitions serve a purpose at both city and national scales, the story told at the scale of the settlement is one that reflects the far more nuanced and persistent patchwork like nature of ethno-religious affiliations in the city.

The Muhajir community of Karachi is in essence an amalgam of smaller ethno-religious communities that migrated from various Northern Indian cities to Karachi shortly after the partition of the Indian sub-continent in 1947. For the purposes of paperwork regarding registration and rehabilitation, these refugees/migrants were all categorised as Muhajir – the Urdu term for refugee – a label that spoke of how they were perceived by the State as opposed to who they were and where they had come from. Subsequent state-sponsored settlement and rehabilitation projects ensured that many of these new refugee communities were housed together in peripheral areas of the city and infill and vacant sites in inner city areas (Hasan, 1999). As ethnic and religious affiliations coloured national politics, the various elements of the Muhajir community felt disenfranchised and marginalised resulting in political mobilisation and the eventual emergence of the Muttahaida Quami Movement (MQM) as the dominant political voice of the Muhajir community.

This process of migration, settlement, marginalisation and eventual political mobilisation is not by any means unique to the Muhajir community, in fact Vertovec argues that the establishment of the Indian community in the Caribbean went through a similar four phase process of “social and cultural development”, these were; (i) migration and settlement, (ii) the establishment of ethnic/religious institutions, (iii) the crystallisation of their aspirations in party politics and finally, (iv) after a period of decline, the identity went through a phase of rejuvenation (Vertovec, 1995). Similarly Coakley claims that most ethno-nationalistic movements go through three phases, i) asking for the rights of the individual ‘other’, ii) official acknowledgement of the distinctiveness of the group from the majority and finally, iii) the right to territory (Coakley, 2003).

Using the tangible elements of these processes of migration, cultural re-establishment and political awakening, this paper seeks to present a multi-scalar analysis of the multi-facetted nature of identity in space in one of South Asia’s largest post-colonial cities. The analysis here is divided into two parts; the first section focuses on how an overarching ethno-political identity...
Proceedings of the 11th Space Syntax Symposium

THE SUM OF THE PARTS IS GREATER THAN THE WHOLE:
Multi-scalar socio-spatial definitions of identity in Karachi’s Muhajir majority areas.

2. DATASETS AND METHODS

Pakistan is a difficult research environment where there is a dearth of up-to-date ethno-political data hence alternative and innovative means of mapping community presence had to be devised for this study. Waterman and Kosmin (1987) note that in the case of the migration of the Jewish community to north London, whilst the presence of a synagogue may not have been the initial catalyst for the emergence of a community cluster, once a critical mass was established, the presence of a synagogue, speciality food stores etc., became an eventuality and motivation for subsequent migration to the area and hence a means of locating a Jewish cluster. Keeping in mind both the processes of migration and resettlement outlined by Vertovec and Coakley previously and these documented observations, methods devised for this study resulted in the identification and mapping of communal institutions – specifically religious and political institutions serving the Muhajir community. These institutions included religious buildings related to the Barelvi and Shi’a sects of Islam (mosques and imambargahs respectively), and the various neighbourhood and regional scale offices of the MQM – the dominant political voice of the Muhajir community in Karachi today. These types of communal institutions were identified as particular to the community through literature documenting the migration of various communities from India and the subsequent evolution of the Muhajir political identity.

The political institutions mapped were MQM Sector and Unit offices; the former consists of 26 offices distributed city-wide, a regional scale complaint centre of sorts overseeing eight to ten Unit offices and reporting to MQM headquarters known as Nine Zero. The latter is a neighbourhood scale office, manned by young men resident locally and established to both disseminate the party agenda at the grassroots level whilst relaying neighbourhood information to the centre. Additionally Barelvi mosques and Shi’a imambargahs were identified and mapped. A significant proportion of practitioners of both the Barelvi and Shi’a schools of theological thought may be categorised as Muhajirs as sizable Barelvi and Shi’a communities migrated from the cities of origin of the Muhajir community. Using Google Earth, Wikimapia, municipal maps and on-site observations, the locations of these four kinds of communal institutions were mapped on a spatial network model of the city of Karachi in a geographical information system software.

This process of mapping allowed for two subsequent processes, firstly that the location of each individual feature could be related to the space syntax model thereby giving each feature the syntax values of the closest street segment to its location and enabling a comparative spatial analysis between communal institutions at both city and settlement scales. Secondly, by using the heatmap tool that allowed for the analysis of the density of features within multiple specified radii, it was possible to highlight clusters of mosques, imambargahs and political offices within these radii. It should be noted that these specified distances in the case of this part of the study were as the crow flies as opposed to network distances. The raster image produced through the heatmap analysis showed that where clusters appeared to be denser, hotspots or brighter areas appeared. These raster images were then converted into contour maps as a means of geographically visualising communal institution densities and thereby generating a mappable boundary to Muhajir majority areas within the city today.

3. AN ETHNO-POLITICAL IDENTITY AND THE CITY

As stated earlier, the Muhajir identity as it is seen today is an urban middle-class identity that has developed through processes of shared socio-political and spatial experiences that span the city’s history since the Partition of the Indian Sub-continent in 1947. Through a process of tracking the city’s various spatial developments which included infrastructure development, transport networks and housing, as well as political events that have had an impact on the manner in which both space and identity in the city have evolved, it has been possible to
identify five broad phases of socio-political and spatial transformation to ultimately take the form it does today.

The first phase included the arrival of Indian Muslim refugees in the city, their domination of early post-Partition civil services and their initial spatial clustering as a by-product of the refugee rehabilitation process. This was followed by a period of socio-political and spatial marginalization of these refugee/migrant communities firstly through the relocation of the federal capital away from Karachi to the purpose-built northern city of Islamabad thereby diminishing the migrants’ political reach. This was followed by the decantation of migrants still resident in the city centre to industrial satellite settlements 20km away from the city centre and the city’s primary economic reach. This systematic state-led spatio-political marginalization led to an ethno-political re-awakening first in the form of a Muhajir students’ union that later evolved into a political party, the evolution of the latter was further aided by the residential spatial proximity of its founding members in high density, middle-income neighbourhoods of the city. This led to spatial expansion into adjacent and proximate areas as the community’s numbers grew. The Soviet occupation of Afghanistan led to an influx of Afghan refugees and readily available arms that, in conjunction with the emergence of the MQM as a significant political player, resulted in growing ethnic tensions in the city. This led to a phase of state-led political suppression, socio-political militarization and spatial fortification of the Muhajir community and their spaces. 2002 onwards, the MQM finally found favourable backing from the federal government, in more recent times the Muhajireen have enjoyed a period of political control and spatial dominance.

This brief history of the community highlights both the need and the processes that led to the emergence of a broad Muhajir political identity in Karachi. In this case, by going back to the idea of varied ‘urban in-between’ formulating new and more powerful identities, it could be argued that various elements that are representative of the composite nature of the Muhajir identity could be mapped and correlated to describe this minority to majority transformation. These include language in the form of ‘mother tongue’ spoken by a household1, the location and number of religious and political institutional buildings and electoral results2.

Using the heatmap feature in a GIS it was possible to identify the clustering of communal institutions. Heatmap analysis was run across multiple local radii (500-2000m) on both religious and political features independently – all imambargahs, Barelvi mosques, and MQM Unit and Sector Offices. It was found that in the case of religious institutions several dense clusters across the city were identified at a radius of 800m. These clusters often coincided with historically Muhajir settlements such as Golimaar/Gulbahar, Liaquatabad, PIB Colony, and Martin Quarters, Shah Faisal Colony and Malir Colony (Jaffar Tayyar Society), and inner city areas like Soldier Bazaar, Kharadar and Lines Area (Figure 01). A distance of 800m in the Pakistani context is significant as mosques are generally located within a walkable distance of ones place of work or residence due to the frequency of use – up to five times a day.

A similar cluster analysis of MQM Unit offices showed that at a radius of 1500m, the clusters formed continuous district-wide contours that appear to incorporate most sector offices. This clustering is significant as the party structure encourages a direct link between the Sector office and the units under it with limited lateral interaction between units in the same sector. Therefore proximity of the unit offices to their area Sector office is important for operational purposes (Figure 02).

Whilst this process seems to begin to intimate that the two sets of features – religious and political – function independently at different local scales, as stated earlier the Muhajir identity in essence is a composite entity consisting of both religious and political elements. Hence the same analysis was run after combining both religious and political features thereby defining the community by both its religious and political affiliations, the subsequent feature generated was a large continuous boundary (Figure 03) that appeared to incorporate all the localities that are regularly referenced in literature and newspaper reports as centres of Muhajir/MQM presence and activity at a radius of 1000m. An earlier study has shown that occupation of these areas by

1 http://www.pbscensus.gov.pk/
2 http://www.ecp.gov.pk/
the Muhajir community has persisted since their earliest establishment in the city in the 1950s and this occupation has expanded to incorporate adjacent localities today as the community has grown (Sultan Khan and Karimi, 2015).

The Muhajir community is often colloquially known as Urdu-speaking, this nickname seems to imply a linguistic solidarity amongst its members. Additionally it should be noted that political affiliations in the city are often governed by such ethno-linguistic solidarities. Thus Urdu-speakers vote primarily for the MQM, Punjabi-speakers often vote for the Pakistan Muslim League, Sindhi and Balochi speakers in the city vote primarily for the Pakistan Peoples Party and Pashto-speakers have voted, until recently, for the Awami National Party (Hasan, 2005, Gazdar and Mallah, 2013). Hence to further corroborate these findings, the additional layers of language and recent electoral results was added.

At the time this study was carried out, Karachi was divided into 5 large administrative districts. If these are overlaid on the Muhajir majority areas defined by communal institution clustering and then data added pertaining to linguistics – specifically Urdu, the Muhajir ‘mother-tongue’ – it was found that language and the heatmap analysis begins to identify spatial overlaps. Similarly, by adding electoral results for 2002 and 2008, a similar spatial correlation appears; the city’s eastern and central districts showed concentrations of all Muhajir identity markers; linguistic affiliation, political presence and activity and religious congregations.

The use and correlation of multiple identity-markers to identify the spatial clustering of the ethno-political entity known as the Muhajir community seems to suggest that the making of a political majority lies in the piecing together of minority elements. This socio-spatial manifestation of majority political identity pieced together from multiple minority groupings has had significant impact on the infrastructure development of the city. Political power and majority presence has assisted in the sanctioning and execution of numerous transport and commercialisation projects that appear to facilitate movement and business between and for Muhajir majority areas of the city (Sultan Khan and Karimi, 2015). Additionally, this spatial and political control has impacted where, how and with whom inter-ethnic tensions play out in the city (Sultan Khan, Karimi and Vaughan, 2017).
Whilst this composite form relates to the ethno-political identity of the community at the scale of the city and projects a monolithic politically Muhajir spatial presence, the need to combine multiple elements to articulate a community’s presence seems to imply that perhaps internal sub-divisions persist at the local scale. This has been hinted at by the heatmap analysis of individual institution types where political and religious institutions appear to have different density areas; 800m for religious institutions, 1500m for Unit offices and 3000m for Sector offices. This variation in functional scale can be further explored through syntax analysis of the location and accessibility of political institutions city-wide. By assigning each Sector and Unit office the syntax values of the nearest street segment it was seen that of the 115 MQM Unit offices mapped, 40% were located on the top 15% of NACH_R1800m street segments whilst 14 of the 26 MQM Sector offices occupied the top 15% of NACH_R3000m street segments. This difference in the catchment and accessibility of communal institutions is perhaps indicative of the role these institutions play within the community they serve and the scales at which these various aspects of identity and community, i.e. religious and political, manifest themselves.

Figure 02 - Contour map at R1500m identifying high densities of MQM Units clusters in Karachi, Pakistan.

4. ETHNO-RELIGIOUS BOUNDARIES AND THE ROLE OF RELIGIOUS INSTITUTIONS WITHIN THE SETTLEMENT

When addressing the issue of Muhajir identity at the scale of the settlement, one should recap that upon their arrival in Karachi in 1947, the Muhajir community was in essence multiple smaller urban North Indian Muslim communities from diverse geo-linguistic backgrounds with a shared religious and political belief that motivated their migration to Pakistan. Simultaneously it should be noted that prior to the Muhajir exodus to Karachi, the city was a small cosmopolitan colonial port, home to a number of communities organised in residential clusters in the old city determined by ethnicity, religion and/or trade. And whilst the city has grown exponentially since in terms of population and area, it was into this existing socio-spatial environment that the Muhajireen had to adjust themselves.

Much of the earliest Muhajir settlement depended upon where they found vacant land or property, a lot of subsequent settlement was driven by locational solidarities or place based communities in that families from the same cities or localities in Pre-Partition India tended to
THE SUM OF THE PARTS IS GREATER THAN THE WHOLE:
Multi-scalar socio-spatial definitions of identity in Karachi's Muhajir majority areas.

Proceedings of the 11th Space Syntax Symposium

Figure 03 - Muhajir majority areas identified through high density clustering of Muhajir communal institutions.

Cluster. The wealthier of these communities established co-operative housing societies, whilst the economically less fortunate set up informal settlements often named after the city, town or village they had left behind. Thus in Karachi today we see the proliferation of neighbourhoods named after places in Pre-Partition India such as CP & Berar Society, Delhi Colony, Hyderabad Colony, Shah Jahanabad, and Sikanderabad (Ansari, 2005).

Alongside the existing pre-Partition communities, planned state-sponsored housing schemes and community sponsored housing societies established to resettle migrants of means in the 1950s and 60s, approximately 50% of Karachi's population today lives in informal settlements (Hasan and Mohib, 2003). These have developed along major thoroughfares, as infills to the city's planned areas and as large slum settlements at the city's peripheries. This tight clustering of communities of native residents, economic migrants and refugee has meant that Karachi spatially is an ethno-religious and political patchwork of communities.

Although the settlements identified and studied for the purposes of this project are located in Muhajir majority areas as defined earlier and vote primarily for the MQM, upon closer analysis they appear to be far more socio-spatially complex than this broad ethno-political definition suggests. Due to the manner in which the city has grown, the sub-groups that make up the Muhajir community and multiple waves of post-Partition in-migration, the settlement too in essence is often a microcosm of the city's diverse ethno-political composition.

Using information taken from on-site interviews with local residents and municipal maps of the areas, an in-depth socio-spatial analysis was carried out on two settlements located within the Muhajir majority boundary defined earlier. These settlements were Pir Elahi Bux Colony (PIB Colony), one of the oldest purpose-built Muhajir settlements in the city, located close to the old city centre, and Shah Faisal Colony, a later addition located in the city's eastern district (see Figure 03 for case study locations). Figures 04 and 05 show the presence of a combination of place-based Muhajir sub-clusters (e.g. ‘N’ Block and ‘J’ Block in PIB Colony named after Nagpur and Jabalpur respectively, both Indian cities), faith-based residential clusters (the Shi’a and Ismaili residential areas of Plot 14, Pak Sadat Colony and Amynabad), and ethnically non-Muhajir residential clusters (e.g. Nishtar Basti, Baloch Para and Green Town) all within the municipal boundaries of each settlement.
Here space syntax analysis has been used to measure the accessibility (NAIN) and location of the various sub-group clusters outlined above in both cases. By overlaying these known community clusters on to normalised Integration syntax models of PIB Colony and Shah Faisal Colony at radii of 250m and 3000m respectively (Figures 06 and 07), it can be seen that in both cases, the Shi’a and Pakhtun communities are the most segregated amongst the various sub-communities. Additionally, these particular sub-groups occupy peripheral locations and the sub-clusters appear to be unplanned as opposed to the grided planned nature of the main settlement presenting almost as infills to the main settlement. Other communities seem to be located in more accessible locations within the settlement. This perhaps suggests some kind of internal socio-spatial hierarchy.

By incorporating the various communal institutions used thus far as shown in Figures 04 and 05, it can be seen that there is at least one, if not more, religious institutions embedded within each residential sub-cluster whilst Unit offices are located much further apart. This perhaps says something about the role and catchment of both religious and political institutions within Pakistani society; i.e. the fact that religious institutions serve a small walkable neighbourhood radius (e.g.800m) and become local loci whilst political institutions serve a wider area.
THE SUM OF THE PARTS IS GREATER THAN THE WHOLE:
Multi-scalar socio-spatial definitions of identity in Karachi's Muhajir majority areas.

Figure 5 - Sub-community clusters and places of worship, Shah Faisal Colony, Karachi.

Figure 6 - Sub-community clusters overlaid on NAIN_R2500m, PIB Colony.
Although on the whole neighbourhood mosques are quite generic in their appearance, in the case of the Barelvi and Shi’a sects these buildings have a distinctive appearance; green domes for the former and a black pennant known as an *alam* seen atop the latter, making them easily identifiable within the urban fabric of the settlement. By isolating only Barelvi mosques and Shi’a *imambargahs* in these two case areas, we see that there is a high presence of both elements in the two study areas and that both features appear to be clustering potentially suggesting the clustering of multiple faith-based communities within the settlement. In both settlements, the Shi’a residential cluster (Plot 14 and Pak Sadat Colony) not only have names identifying them as neighbourhoods but also a distinctive spatial morphology as described earlier, that makes it possible to define neighbourhood boundaries.

By assigning each institution the NACH values of the street segment on to which their entrances face, and averaging these values for each institution type per settlement, it can be seen in Graphs 01a and 01b that there are patterns pertaining to the manner in which these institutions situate themselves within the settlement. Most notably Barelvi mosques seem to be located on street segments in most cases with higher NACH values than all other mosques present and *imambargahs* consistently show that they are situated on street segments with the lowest NACH values of the three religious institution types. This finding in conjunction with where certain sub-groups are located within the settlement perhaps is indicative of the manner in which communities and their religious institutions are situated within the larger settlement most particularly the Barelvi and Shi’a sects. Whilst Barelvi mosques are often located on high choice and therefore highly accessible street segments with the potential for high footfall, the Shi’a community is located within very segregated parts of the settlement with their religious institution embedded deep within the settlement as opposed to being located on major thoroughfares as seen in Figures 06 and 07.

The spatial segregation of the Shi’a sub-settlement and the introverted nature of the imambargah can perhaps be contextualized by the social space the community has occupied in Pakistan. The Shi’a community has been persecuted as a by-product of State sponsored Islamisation since the 1970s. This initially took the form of target killings of the community’s intelligentsia and well placed individuals and more recently has manifested in the form of bombings of *imambargahs* and public religious events and processions. This kind of persecution
has potentially led to the preference of this community to cluster in segregated, defensible localities with their religious institutions set deep within the settlement thus having limited accessibility to outsiders. Conversely, as the religious right becomes more vocal and popular, the Barelvi community – a right-wing Sunnī group - becomes more confident in both their religious and political agendas, potentially influencing the choice of location and subsequent accessibility of their religious institutions.

By similarly comparing the NACH values of these religious institutions and their political counterparts for both settlements another interesting pattern begins to appear (Graphs 01a and 01b). For this analysis, the local commercial area for each settlement has been included as a point of reference as in both cases commercial streets exhibit higher NACH values than their surrounding areas. In this comparative study it can be seen that yet again the imambargahs have the lowest Choice values, where Barelvi mosques perform better than imambargahs and not as well as the commercial streets in the area. Units show higher choice values at larger radii. In the case of PIB Colony, the Sector office performs as one would expect it to; as the public face of the political party in the area, it seems logical for it to occupy street segments with a higher choice value.

This process of analysis brings the discussion back to the notion that the broad scale politics of a community often fashions the global identity downplaying internal sub-divisions for the purposes of defining a majority. On the other hand, local scale identities are often governed and managed by much smaller, more specific social affiliations like religious and place-based solidarities.

5. CONCLUSIONS

This study has shown that although, through a process of identifying social similarities amongst the various entities that comprise the urban ‘in-between’ and utilising spatial proximity, minority identities can be consolidated and mobilised into an overarching political majority. These majority affiliations do not always override or wholistically replace prior ethno-religious solidarities. Whilst this very public, homogenous political identity appears to dominate and control both the physical space of the city and social perceptions of the urban other by those outside the group, upon closer investigation, it appears that finer grain socio-spatial solidarities persist at the scale of the settlement.

The analysis in this paper has shown that despite what appears to be a monolithic ethno-political entity, investigation of the everyday spaces of the community show that the Muhajir settlement is in fact a microcosm of the city where Muhajir, post-Partition non-Muhajir economic migrants, and pre-Partition native communities all live in close proximity to one another. Analysis of where these communities choose to locate themselves within the settlement is potentially indicative of internal communal hierarchies. The Barelvi community for example is more visible and
accessible where their communal spaces are located on main thoroughfares and high choice street segments. On the other hand, minority groups like the Shi’a and Ismaili communities occupy highly segregated, peripheral areas of the settlements where their communal spaces are embedded deep within the sub-cluster, entrances often protected and turned away from main roads to limit accessibility to non-members.

The clustering and proliferation of religious institutions within the settlement and the fact that each sub-group cluster has at least one place of worship of its own seems to suggest that religious institutions play a key role in community life and the way people identify themselves at the scale of the settlement. These appear to be the institutions that assist in building and maintaining community identities rather than political institutions which serve to identify the community at a wider scale, that of the city.
REFERENCES


#148

THE ASSOCIATION OF SPATIAL NETWORK WITH SOCIAL NETWORK IN THE HIGH-RISE SOCIAL HOUSING

JOO YOUNG KIM
Sejong University, Seoul, South Korea
kjyanna@hotmail.com

HOON-TAE PARK
MIM Institute, Seoul, South Korea
htpark@mim-institute.org

YOUNG OOK KIM
Sejong University, Seoul, South Korea
yokim@sejong.ac.kr

ABSTRACT

Interaction between built environment and social network has been a long research subject. Many researches have focused on interpreting social network in field of sociology. Even though they acknowledge the possible impact of spatial network on built environments, researchers lack a tool to incorporate spatial network in their research agenda.

Similarly in the space syntax community, many studies attempt to examine the interaction of using spatial network analysis. Spatial behaviour (i.e., space use pattern and cognition) is their primary concern to measure the degree of people’s social interaction. They thus explain the degree of social relation by measuring indirectly. Recently few studies explain the relation of spatial configuration with social interaction by measuring it with more direct manner. Based on these researches, we can apply social network analysis to examine the association given that the interaction of spatial configuration with social interchange.

In this context, this study aims to explain characteristics of association between spatial configuration and social network. A social housing in Seoul is selected for the case study. Using space syntax and social network analysis the association is examined statistically. Questionnaire and interview survey reveals the pattern of social network among residents. Social network analysis present the pattern numerically based on questionnaire. Netminer analysis describes social network of residents. Then, finally, we investigate the relationship between the properties of spatial configuration and the intensity level of social network. The result shows that spatial network properties can explain characteristics of social network. Once we understand the relationship of spatial configuration and social network we can have a profound understanding of the interaction between space and society.

KEYWORDS

Space syntax, spatial network, social network, social housing, space syntax and social network
1. INTRODUCTION

Permanent rental apartments as a type of social housing in Korea are constructed by the public sector in the form of large high-rise complexes. Low-income people live there collectively, comprising several hundred to several thousand deprived households. Social exclusion is a serious issue in these social housing complexes, not only from the outside of the complexes but also among neighbours within the complexes. Numerous researches have argued that social housing increases the level of isolation and conflicts among residents (Kim et al., 2008; Ha, 2007; Kim, 2004), particularly because they are mainly old, handicapped and unemployed people, deprived of social activities and interaction with their neighbours (Kim, 2002). These researches focus on the phenomenal aspects of the issue, that is, the exclusive nature of residents who do not want contacts with neighbours or of outsiders who believe they are superior to those social housing residents. However, few have dealt with the spatial aspects of the issue, which deem more important from an urban design point of view.

The social network of residents is embedded in physical environments, since the configuration of residential space cannot but affect the way in which people behave and interact socially (Francescato et al., 1989). Space syntax researches (Hillier and Hanson, 1984; Hillier, 1996) provide a set of ideas and methodologies to investigate such relationships. Through analysing the configuration of architectural and urban spaces, space syntax tries to establish the relationship between spatial structure and spatial behaviours. Hillier et al. (1993) have shown how the spatial configuration of urban streets could form natural movements within them, and Kim and Penn (2004) have explained how the configuration of streets in residential area, the density of spatial uses and the cognitive map of residents could be correlated to each other. Kim and Cho (2015) have explained the degree to which residents in a village of dosshouses interact to each other in the context of its spatial configuration. These studies imply an important hint at how spatial configuration can affect the formation of neighbours in residential areas. Also, although not about social housings, there are many studies which try to explain the relation of spatial configuration and social interaction by measuring it in a more direct manner. Sailer and Penn (2007) have reported that interaction pattern was examined by measuring social interaction between students and teachers in school. In a similar way, Wineman et al (2009) show the relation between the number of published research papers and space syntax properties of workplaces. Sailer and McCulloh (2012) also attempt to translate the relationship between spatial configuration and social relation in knowledge-intensive workplaces.

Based on those two kinds of previous researches, one about the social exclusion in social housing and the other about the effects of spatial configuration on the formation of social relationships, we try to investigate the relationship between the spatial configuration of social housing and the de/formation of social community within it. We assume that social network in residential area is a crucial factor for the formation of community. It is particularly the case for social housing where its residents are mainly old, handicapped and unemployed, because the absence of social network among them make it more difficult to form community in social housing.

More specifically, it is our aim to reveal how the spatial configuration of social housing may foster or impede the formation of social networks. There are not many previous researches found in this line of investigation. Some study about the social phenomena of isolation and exclusion but do not take into account the relationship between spatial configuration and social network. Others that have considered the latter relationship do not seem to have much interests in the formation of community required especially for social housing.

Also in space syntax, it is generally argued that the more integrated a space is, the more actively spatial uses and social encounters occur in it. However, those researches on the issue of social exclusion in social housing seem to argue the opposite, since they observe the more severe level of social exclusion and isolation among neighbours who are spatially more accessible to each other. In this respect, we are interested in verifying the presence of correlation between the space configurational properties of integration or accessibility and the level of social communication in the context of social housing. If the properties of spatial configuration are
found closely related to those of social network, we will further investigate how they are so. That is to say, we wish to confirm either if residents living in more accessible spaces are more interacted socially or it is the other way around.

This paper deals with the results of a case study. First, we analyse quantitatively the properties of social network based on empirical surveys. Second, through spatial analysis, we examine the accessibility of facility spaces which residents in social housing frequently use. Finally, we investigate the relationship between the properties of spatial configuration and the intensity level of social network. We have employed Depthmap for spatial analysis, Netminer for social network analysis, and SPSS for statistical analysis on their relationships.

2. SPATIAL CONFIGURATION AND SOCIAL NETWORK IN SOCIAL HOUSING COMPLEX

2.1 THE PROPERTIES OF SOCIAL NETWORK

Social housing in Korea has been provided by the government, from the early 1980s in a way to resolve housing problems for urban poor. But since then, the issue of social exclusion has emerged as social housing has the form of segregating socially deprived classes spatially at a collective scale (Kim et al., 2008). Residents in social housing are discriminated by middle-class people who live outside social housing complexes (Kim, 2004). Internally, residents are psychologically repressed so that they tend to avoid neighbours for themselves. Also, it has been reported that the high rate of senior citizens, the handicapped and the unemployed among neighbours in social housing causes naturally a lack of social activity and restrictions in communication among neighbours (Kim, 2002). These external and internal factors of social exclusion conjoin together to deteriorate the problems of segregation and the collapse of social network.

Although there are also some reports on the issue of slumism that causes distrust and avoidance among neighbours (Rankin and Quane, 2000), it does not yet apply to social housing in Korea. Instead, social housing in Korea has its own share of social problems, including high rate of suicides, conflict among neighbours, alcohol-related disturbances and noise issues, which hinder the formation of community consciousness (Kim, 2004). We regard these social problems in Korea cannot be explained by the progression of slumism, which is not yet present, but by a lack of social network within social housing complexes. It seems therefore necessary to investigate thoroughly the essential properties of social network, and particularly, its structure.

2.2 THE RELATION OF SPATIAL CONFIGURATION AND SOCIAL NETWORK

The idea of social network is often employed to explain the social behaviours of people who are included in a network following a particular protocol (Mitchell, 1969). Also, the idea of social network is useful as it is capable of expressing spatial relationships in cities (Butts, 1982). But few have examined the relationship between spatial and social networks. Sailer and Penn (2007) studied the interaction between spatial phenomena and communication among students at schools. It is among the first attempts to explain the correlation between spatial and social networks, and presents a guideline to approach the question at hand. Wineman et al. (2009) showed a positive correlation between the relative position of researchers in a spatial configuration and the number of publications through co-works. That is, it is found that the more accessible researchers are to each other in the spatial configuration of research institute, the more potential interactions they have and thus the larger number of publications they produce. In a similar manner, Sailer and McCulloh (2012) investigated spatial properties that help to generate social interaction in office spaces.

These relationships between spatial configuration and social interaction are also important in studying those in residential areas. The degree of social interaction among neighbours will have great impacts on the formation of community. We can expect that active social interaction would strengthen community consciousness and social solidarity and it would in turn contribute
to the reduction of social problems in social housing. Therefore, apart from schools and research institutes, to study about the relationships between spatial configurations and social interactions may well gain importance on its own.

3. RESEARCH DESIGN AND METHODOLOGY

3.1 RESEARCH MODEL

Based on the assumption that spatial properties can affect the degree of social interaction, this research attempts to define the key properties of spatial configuration and social network and test the following hypotheses:

- **Ho**: There is no difference in the average properties of social network among different spatial accessibility groups.
- **H1**: There are differences in the average properties of social network among different spatial accessibility groups.

![Figure 1 - Model of Analysis](image)

3.2 MEASUREMENTS

Our research model defines the space configurational properties of individual housing units as the independent variable. Individual households are represented by their entrance spaces and their accessibility is measured by integration indices in space syntax (Hillier and Hanson, 1984). Three groups of low, medium and high accessibility are classified to reflect the hierarchical space structure of a social housing complex. A social network is formed based on acquaintance relationships, so that it is assumed to be simple, unweighted and undirectional. Network properties of degree, closeness and betweenness are then measured for this social network.

3.3 CASE STUDY SITE

The study site was a high-rise social housing complex 'A' in Seoul, constructed and operated by the public sector. The complex 'A' was completed in 1991, with 7 buildings of 15 stories and 1,807 units in total. All buildings are of corridor access type, 6 of which are L-shaped and the other is line-shaped. Average unit size is very small, ranging from 25.2m² to 39.6m². Common facilities include stores, community welfare centre, senior citizens centre, maintenance office and walkways. As of 2015, 77% of the residents were 60 years or older; 21.4% were handicapped; 52.4% have been living in the complex 20 years or longer. The complex has its share of social problems, including high rate of suicides, conflict among neighbours, alcohol-related disturbances, and noise issues (Nakhyunjae, 2014).
3.4 METHODOLOGY

Firstly, the research carries out social network analysis based on empirical surveys. Respondents are asked to reveal which neighbours they meet frequently and where the meetings take place within the complex. Using Netminer, a social network is formed and its properties are further analysed. The spatial properties of meeting places are also examined. Second, the spatial configuration of the housing complex is analysed and the relative accessibility of households and meeting places. Each household is represented by its entrance space and its integration index is calculated using Depthmap. Integration values of meeting-places are averaged over the social sub-networks of respondents who have chosen them. Third, the correlation between the spatial and social network properties is analysed in a way to define the most salient variables. The defined spatial properties are taken to be independent variables and classified according to their intrinsic distribution. One-way ANOVA test is then employed to find out if there are significant differences in the average social network properties among the classified spatial groups. ANOVA test is particularly useful in distinguishing group differences. Finally, if there are significant social differences among the spatial groups, we try a post-hoc description of group differences in a qualitative manner.

4. RESULTS

4.1 SOCIAL NETWORK ANALYSIS

For analysis of the social network, 1,807 surveys were distributed (i.e., all units in the complex) and later collected through the maintenance office of the complex. 450 surveys were collected (response rate: approximately 24.90%), with 336 valid samples. 611 network nodes were generated from the analysis of the valid samples. The number of nodes is greater than that of valid samples because residents from non-valid samples are included in the social network.

Figure 2 is the spring map for social network analysis in the complex. It shows that 250 out of 611 nodes are isolated, while 360 nodes (59%) are connected. These connected nodes are concentrated around some particular nodes, which are Tong Jang (i.e. voluntary community head) and the complex administrative managers. Other connected networks without Tong Jang are of much smaller size and usually consists of less than 10 nodes. If we remove the complex administrative managers from the network, it is sub-divided into a group of small disconnected networks. This means that the social network in the complex depends a good deal on the presence of those managers.

Table 1 and Figure 3 shows the result of individual measures – degree, closeness, betweenness – for the social network. The distribution of degree is highly skewed in such a way that low degree values are extremely common. On the other hand, for the connected parts of the network, the distribution of closeness is skewed in the opposite way. Finally, only 12% of the total nodes (76 out of 611) have non-zero betweenness values, indicating that most residents behave as end-nodes and do not mediate any social relationships at all within the complex.
The graph in the figure 4 shows the results of multiple responses regarding the meeting places of the residents in the complex. It turns out that they meet mostly in their own or neighbours’ houses. The next frequent places are corridors or elevators. Community welfare centre, playgrounds and walkways follow in turn, while residents rarely choose maintenance office and parking garages as their meeting places. Analysis of Spatial Configuration
To study the spatial configuration, an axial map analysis of the complex was conducted. The result is presented in Figure 5, displaying its spatial accessibility. As it shows, the complex is separated by a stream in the south-west side and connected to main artery roads in the north-east side. This locational conditions result in the high accessibility in the northern and eastern sides and this affects the internal structure of the complex. In the Internal complex, the highest local integration value is 2.15, found on the road along the east and northeast side of the complex connected to the main entrance. It is followed by the east-west axis through centre of the complex at 1.71; the value for the north-south axis is 1.67. On the other hand, low values are found at walk trail, gym facility and community center, which are supposed to be functioning as interaction spaces.

Figure 6 shows the results for the space configurational properties of meeting places. The highest local integration value of 2.75 is found at maintenance office, followed by corridors or elevators at 2.65, within-complex stores at 2.48 and parking garages at 2.30. Walkways (1.49) and gym facilities (1.50) are those places with the lowest integration values. The results show that community facilities such as gym, senior citizen centres and welfare centres are rather segregated spatially against their intended function to increase the communication of neighbours.
We also have a look at the frequency distribution of local integration for the households participated in the valid samples, from Figure 6. It is possible to divide the samples into the three groups by their local integration values. This natural division reflects the hierarchical space structure of the complex in which individual buildings are connected to the outside of the complex.

That is to say, the complex is structured in a sequence of main roads connecting it directly to its outside, distributive roads diverging from the main roads, and local roads serving individual buildings.

Table 2 shows how meeting places for neighbours are differentiated according to the different groups of spatial accessibility. 27.5% of residents from the low spatial accessibility group meet their neighbours at their own or neighbours’ home, while the figure is much higher at 34% for residents from the high spatial accessibility group. A similar pattern can be found for meeting places such as hallways, elevators and maintenance office. This shows that residents from the high spatial accessibility group tend to meet their neighbours at highly accessible spaces where casual encounters are favoured. On the contrary, we find the opposite tendency for community welfare centre and walkway which 12.5% and 15% of residents from the low spatial accessibility group respectively have chosen as meeting places, while only 6.4% and 9.6% of residents from the high spatial accessibility group use them to meet their neighbours. Since community welfare centre and walkway are located at low accessible spaces, it may be taken to imply that residents from the low spatial accessibility group prefer places where long-lasting and intended meetings are facilitated.
4.2 CORRELATION ANALYSIS BETWEEN SPATIAL CONFIGURATION AND SOCIAL NETWORK

We have found that the most correlated variables are local integration values from spatial configuration and degree from social network. As mentioned earlier, it is the case that the local integration values of household are affected by the location of buildings to which they belong in the complex. From this natural distinction, we have classified the households into three categories by applying Jenks Natural Breaks algorithm. The results show that local integration values for the lower accessibility group ranges from 0 to 1.5, for the medium accessibility group it changes up to 1.8 and for the higher accessibility group it is greater than 1.8. Next, we turn to analyse social network properties for these different accessibility groups.

<table>
<thead>
<tr>
<th>Degree</th>
<th>Closeness</th>
<th>Betweenness</th>
<th>Local integration</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree</td>
<td>Pearson Correlation</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Closeness</td>
<td>Pearson Correlation</td>
<td>0.50</td>
<td>0.00</td>
<td>0.29</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Betweenness</td>
<td>Pearson Correlation</td>
<td>0.60</td>
<td>0.29</td>
<td>1.00</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Local integration</td>
<td>Pearson Correlation</td>
<td>-0.10</td>
<td>-0.05</td>
<td>-0.01</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>0.01</td>
<td>0.26</td>
<td>0.77</td>
</tr>
</tbody>
</table>

*significance level p<0.05

Table 3 - Correlation of spatial configuration and social network
Table 5 shows the results for the significance of ANOVA and permutation tests. Table 6 and Figure 8 show the average values of social network properties for each accessibility group. Firstly, ANOVA test shows that F-value is 7.79 with the degree of freedom of 2 and 608 for between-groups and within- groups respectively, so that there is insufficient evidence to accept the null hypothesis at the significance level of 0.05. Therefore, we confirm that there are differences in the average properties of social network among different spatial accessibility groups. The same result is confirmed also by permutation test, in which we have the probability of F-value greater than the test statistic is zero.

For the post-test descriptions of average degree of social network, we report that residents from the low accessibility group has 1.02 and those from the medium group has 1.17 and those from the high group has 0.68. The test result can be thus interpreted as evidencing that those residents who live at high accessible spaces has relatively weak social interaction.

Now we can safely interpret group differences. Residents who live in low accessible spaces have higher values of degree for their social network. On the other hand, those who live in more accessible spaces have lower values of degree and thus participate weakly in social networking. These results confirm that spatial properties affect the social networking of residents, but the reason why they are so contrary to previous studies shall have to be interpreted in the particular context of permanent social housing.

Table 4 - Results of ANOVA

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of Squares</th>
<th>D.F.</th>
<th>Mean Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>22.459</td>
<td>2</td>
<td>11.229</td>
</tr>
<tr>
<td>Within groups</td>
<td>1.132.105</td>
<td>608</td>
<td>1.831</td>
</tr>
<tr>
<td>Totals</td>
<td>1.143.564</td>
<td>610</td>
<td>1.881</td>
</tr>
</tbody>
</table>

Table 5 - Mean and standard deviation of the different accessibility groups

<table>
<thead>
<tr>
<th>Accessibility Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>106</td>
<td>1.0289</td>
<td>1.4735</td>
</tr>
<tr>
<td>Medium</td>
<td>309</td>
<td>1.2650</td>
<td>1.4865</td>
</tr>
<tr>
<td>High</td>
<td>106</td>
<td>0.6786</td>
<td>1.0247</td>
</tr>
<tr>
<td>Total</td>
<td>611</td>
<td>0.9836</td>
<td>1.3682</td>
</tr>
</tbody>
</table>

*100,000 permutations (significant the level of P<0.05)
Proceedings of the 11th Space Syntax Symposium

THE ASSOCIATION OF SPATIAL NETWORK WITH SOCIAL NETWORK IN THE HIGH-RISE SOCIAL HOUSING

5. CONCLUSION

This paper analysed the effects of spatial configuration on the social network of residents in social housing in Korea. The first results showed that there is a weak positive correlation between the local integration of spatial configuration and the degree of nodes in social network, but no significant correlations are found for such other social network properties as closeness and betweenness. We have then classified the position of households in the social housing complex into the three different groups of local integration and examined how these different accessibility groups have different nature in the degree formation of social network. It showed that residents who live in more integrated spaces have weak social connections with their neighbours, and vice versa.

The results seem counter-intuitive, since most previous researches have reported the higher frequency of social interaction in more integrated spaces (for instance, Hillier et al., 1993; Wienman et al., 2009). To fully understand this, we need to focus on the special circumstance in which social housing is placed in relation to other residential areas. The social housing complex we have studied in this paper is highly exclusive both internally and externally, in which residents do not want to meet not only their neighbours but also outsiders. It is a “socially marked” space (Ha and Seo, 2006; Hong, 2005), where its residents suppressed desires to interact with others. When no such desire is present, the common spatial mechanism is reversed. The results only reflect residents’ willingness to deny social interaction in any kind.

Even in this exclusive environment, however, the behaviour of its residents can be explained spatially. We have shown that residents who live in relatively more integrated spaces tend to meet others, if they should, at hallways or lobbies that are easily accessible but allow only temporary or transient encounters. They do not want any further interaction to unfold but rather look for permanent isolation. On the other hands, residents who live in relative less integrated spaces and have even less opportunities to meet neighbours choose such meeting places as community facilities where long-lasting relationships can be secured. Their segregated positions within the complex seem to turn their nature positively and these common facilities help them to form relatively strong social network.

Finally, this paper suggests that a new social model is required for exclusive residential areas where deprived people live collectively. According to such a model, we may need to increase the defensibility of individual households while allowing community facilities to be located at relative more accessible spaces. In this way could we be able to enhance both privacy and community consciousness in social housing complexes. In particular, for social housing where its residents are mainly old and handicapped, the placement of community facilities at more accessible spaces would make it easy to induce strong social network effects.

Figure 8 - Means plots of ANOVA
ACKNOWLEDGEMENTS

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2016R1D1A1B03935337).
REFERENCES


Ha, S. K. (2007), Housing Deprivation and Social Housing of Korean, Seoul: Jipmoon.


ABSTRACT

Evidence-based design aims to understand human behaviour so that strategic decisions are well-informed when creating a new space. Workplace research to date has provided interesting insights, but has mostly done so on a case-by-case basis. This approach does not yield generalisable patterns, making results problematic to use in an evidence-based design context.

This paper builds upon previous large-scale analysis done by the authors and focuses on two aspects of workplace behaviour – eating and interacting. We aim to understand the nuances of these behaviours, thus we explore them as independent phenomena, separate them into sub-categories and set out to understand the reasons behind these observations.

The examined dataset includes 23 organisations in the UK, with a wide variety of sizes, numbers of floors and buildings. It consists of human activity data collected through direct observation, Visibility Graph Analysis and organisational parameters such as industry and flexibility of desk occupancy.

The first behaviour we focus on – interaction – has already been explored in previous research and has been found to happen primarily in workspace and meeting rooms. In this instance we initially classify interactions according to the activity of the members and the type of space they occur in. The analysis of the second behaviour – eating – revolves around the activities and locations of people at lunchtime. We aim to discover where people choose to eat and how this is affected by the characteristics and availability of eating spaces.
For the two behaviours studied, we examine how each activity relates to the space it is happening in, taking into account a set of spatial and organisational factors. In the first case we test each interaction against proximity to circulation and local visibility of the space, while in the second we examine the popularity of different types of spaces, for example canteens and breakout spaces, against their proximity to workspace and what possibilities of inter-visibility they offer.

This paper provides detailed insights into the phenomena of interacting and eating, and reflects on limitations of traditional statistical analysis. It will also highlight further opportunities for handling these types of big datasets using different techniques such as Principal Component Analysis and machine learning.

KEYWORDS
Workplace, Interaction, Eating, Evidence-based design

1. INTRODUCTION: GENERALISABLE PATTERNS FOR EVIDENCE-BASED DESIGN

Evidence-based design aims to understand human behaviour so that strategic decisions are well-informed when creating a new space. This evidence comes in the form of patterns of human behaviour that are related to the many properties of space and the organisation occupying it. Understanding these patterns would be invaluable to designers, as it would allow them to make informed decisions to drive specific outcomes (e.g. greater collaboration) when creating new workplaces, but there has not been a sufficient amount of data to consistently predict where and how behaviours occur. The problem identified by sociologist Gieryn (2002), i.e. ‘scattered empirical evidence’ on the relationship between building layout and social interaction, remains unresolved today. In addition, applying research findings in practice has been found problematic. The concerns of confusing practitioners and a potential “misapplication of research findings that become popularised (…) to vastly different organisational contexts” (Heerwagen et al., 2004, p.525) resulting in mixed successes and disruptive behaviours was bemoaned more than 10 years ago.

Two things have changed however in the last decade: firstly, the appetite of architects for evidence-based design practices, and secondly, the availability of larger datasets to reproduce findings, or in fact, search for generalisable patterns.

Online surveys with architects and people who have worked with architects highlighted the general need for evidence-based design, but the lack of tools for this. It was found that 81% of the participating architects wanted to know more about new tools (Outram, 2015) and that 80% perceived a need for evidence in the design process (EBD, 2015). In contrast to these needs, the surveys point out that there is no substantial practice of evidence-based design, with 27% of respondents never having done a post-occupancy evaluation and 40% doing so but not formally capturing the results (Outram, 2015). Moreover, very few review literature as part of normal practice. A general lack of generically valid and thus ‘actionable’ insights might contribute to that.

Meanwhile, other scientific fields turn their focus towards reproducibility. The advent of big data has allowed for more, and more interesting insights, but has also highlighted inconsistencies when trying to reproduce experiments. From a brief online survey of 1,576 researchers in 2016, Nature magazine found that “More than 70% of researchers have tried and failed to reproduce another scientist’s experiments, and more than half have failed to reproduce their own experiments” (Baker, 2016, p.452). The research around human behaviour suffers especially in this regard, with multiple studies following multiple, and at times contradictory, theories, thus resulting in innumerable inconsistencies across them (for a discussion see Watts, 2017).

The aim of the study presented here was to examine multiple cases using a few clearly explained methods typically used in the literature. If the lack of consistent results in previous research was driven by the lack of sufficient amounts of data to be examined, then we should be able to identify patterns of human behaviour in this dataset. If on the other hand, the larger
dataset yielded similarly inconclusive results then other methods need to be tested that can take confounding factors into account more systematically.

Given that we are looking for generalised patterns that hold across all types and sizes of office spaces, the methods were initially applied across the whole dataset. They were then extended to focus on other properties of the dataset. We split the dataset in two ways, across industries and specific projects (where applicable) allowing us to examine the many differences between the cases or industries. This deeper analysis highlighted the nuances of the metrics we examined as well as the limits of the methods applied.

The paper is structured as follows: the next section is a review of existing research around the subject of human behaviour in the office and the various efforts, methods and metrics to understand it. A section will follow on the properties of the dataset used and a description of the metrics used in this analysis. The next three sections describe the analysis of the behaviours, the first two at the top-level, and the last digging into more detail. The last two sections discuss the overall conclusion from this analysis and the future direction this research intends to follow.

2. LITERATURE REVIEW: HUMAN BEHAVIOURS IN WORKPLACES

Workplace research to date has tried to frame the problem of understanding social processes and behaviours initially through purely psychological studies (Sundstrom, 1987) and latterly through empirical methods that take the properties of the workspace into account (Allen and Fustfeld, 1975). The emergence of Space Syntax (Hillier and Hanson, 1984) has given researchers theories and methods to analyse space in more systematic ways, some of which could be used to understand human behaviour in the workplace. Since then, a rich research field has emerged and multiple studies have created new metrics and methods to understand how interaction is affected by barriers (Hatch, 1987), the role of attractors such as photocopyers and water-coolers (Fayard and Weeks, 2007), and how face-to-face interactions can be created if paths of workers overlap (Kabo et al., 2015), to name just a few exemplary studies.

Interaction in the workplace was specifically studied by Backhouse and Drew (1992) who suggested that a moving member of staff may be seen as ‘available’ to initiate an interaction, and thus become ‘recruited’. Those recruited may eventually begin an interaction with someone seated and if they continue standing can be seen as ‘visiting’. The idea of a ‘visiting’ behaviour was initially expressed by Penn et al. (1999), as a way to understand how many people are visiting against how many people are inhabiting a space. They used an aggregate metric called ‘visiting ratio’ defined as the number of people standing to the number of people sitting for a particular area, but only utilised the metric to describe the activity of different floors.

All this research provided interesting insights for each case study examined, but has not shown whether their results can be generalised to other workplaces. One of the main problems identified by Sailer (2010), is the lack of a consistent methodology applied across cases. As each study uses its own methodology to study a few cases, the results identified in the literature stem from a fragmented collective dataset. This approach does not yield generalisable patterns, making results problematic to use in an evidence-based design context. A characteristic study is by Hillier and Grajewski (1990), where the authors examined seven buildings as an example of how Space Syntax methodology can be applied in workplace environments. They used mainly Pearson correlation and found that movement and interaction can be affected by a building’s integration, but this only happened in a few samples and not at the dataset as a whole.

3. DATASET AND METRICS

The dataset used in this study was provided by Spacelab, an architectural design and consultancy practice in London, UK, and has already been examined in two previous publications (Koutsolampros et al., 2015; Sailer et al., 2016). It has been collected over the last 6 years with the purpose of providing insights to the inner workings of each client company. The dataset currently includes spatial, social and organisational information as well as observed activity for approximately 50 companies, and continues expanding at a rate of almost ten projects per year.
A partial dataset was used for this study, with cases that were digitised as required for the analysis. It consisted of 20 companies, at 23 sites and across 45 buildings, with a total of 128 floors. The total number of desks in the study was 12,575. The partial dataset included four types of data:

- Visibility Graph Analysis (VGA) at eye-level and with a grid size of 45x45 cm. Two VGA metrics were specifically used:
  - Connectivity: The amount of cells another cell can 'see';
  - Metric depth distance: The length (in meters) of the path of fewest turns between two points;
- Functions of space in the form of polygons on the plan;
- Hourly snapshot observations collected by human observers (Vaughan, 2001).

The dataset also contains organisational parameters, of which one was used in this paper: the industry of each organisation. The cases examined were from eight different industries (see Table 1): Market research, Architecture, Legal, Financial services, Creative agencies, Technology, Media and Retail.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Number of desks</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market research</td>
<td>281</td>
<td>1</td>
</tr>
<tr>
<td>Architecture</td>
<td>373</td>
<td>2</td>
</tr>
<tr>
<td>Legal</td>
<td>507</td>
<td>2</td>
</tr>
<tr>
<td>Financial services</td>
<td>723</td>
<td>5</td>
</tr>
<tr>
<td>Creative agency</td>
<td>792</td>
<td>3</td>
</tr>
<tr>
<td>Technology</td>
<td>854</td>
<td>2</td>
</tr>
<tr>
<td>Media</td>
<td>2457</td>
<td>4</td>
</tr>
<tr>
<td>Retail</td>
<td>2897</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 1 - Case studies by industry

4. BEHAVIOUR ONE: INTERACTION IN OPEN WORKSPACES

The first behaviour examined was interaction within open workspaces and two different subsets of it were studied, 'Visiting' and 'Chatting'. This examination is an extension of a general micro-behaviour identification carried out in a previous publication by Sailer et al. (2016).

'Visiting' was defined as the interaction between a maximum of three people, where at least one is standing and at least one is sitting at their own desk (as shown in Figure 1), at a maximum distance of a meter and a half (for a discussion on this distance see Lopez de Vallejo, 2010). Chatting was defined as an observed interaction between any number of people, as long as all of them were sitting at their own desks (as shown in Figure 2).
These interactions were expected to happen under different circumstances. Visiting is a targeted interaction where a pre-existing relationship can be assumed to be the motivation, for example people working together, or having a personal relationship. On the other hand, chatting would almost always be triggered by co-location. Chatting does not exclude conversation about work or personal relationships, especially given the fact that people from the same team are very likely to be placed together. In both cases seats that were never occupied were excluded from the sample because no chance was ever given for interaction. Two different hypotheses were tested for workspace interaction behaviour: 1) Temporary visiting interactions tend to happen in more open spaces and closer to circulation, and 2) Temporary chatting interactions tend to happen in less open spaces and away from circulation. In both hypotheses the input metrics were desk connectivity and visual metric distance from desk to circulation for all cases.
Both hypotheses will now be explained in detail, and then tested against the dataset.

**Hypothesis 1:** Temporary visiting interactions tend to happen in more open spaces and closer to circulation.

Regarding hypothesis 1, the assumption was that availability plays a major role in the selection of desks for such targeted interactions. A person sitting in a more visible desk has more chances to see and be seen by others, and is thus more likely to ‘recruit’ passers-by into an interaction (Backhouse and Drew, 1992). Therefore, the first parameter examined was connectivity, i.e. the ability to see others locally. The same can be said for the desk’s distance to circulation. A desk closer to circulation is closer to the main funnel for movement and is thus easier to reach by many people passing by. Although not examined here, the main difference between the two is that connectivity would be expected to trigger more interactions with co-workers who sit in the same room (i.e. from the same department), while distance to circulation is more likely to attract interactions from people from other departments who just happened to pass by.

Three output metrics were examined: A) whether a seat was visited at all, B) how many times it was visited, and C) the amount of times visited grouped into categories. The rationale behind C is to examine if there are thresholds to how many times people are visited. If for example a desk is visited very frequently (for example on more than 4 rounds) one could argue that this is the typical mode of operation of the person or team. On the other hand, desks visited 1-3 times are more likely to be random interactions triggered by ‘recruitment’. The size of the sample was 8,884 observations of desks.

Two t-tests were carried out, one for how connectivity and one for how distance to circulation differed for desks that were visited in comparison to those that were not. None yielded significant results (p-value: 0.64 and 0.14 respectively). Four ANOVA tests were also carried out to test for significant differences in connectivity and distance to circulation for the number of times visiting occurred (as discrete count and grouped) (see Figure 3).

![Figure 3 - Times visited count and grouped VS connectivity and distance to circulation](image-url)
The results were inconclusive for all tests, yielding non-significant results. The relevant p-values and size of effects (R²) were:

- Times visited VS connectivity: R² = 0.000, p-value = 0.5110
- Times visited VS depth distance: R² = 0.001, p-value = 0.1363
- Times visited (grouped) VS connectivity: R² = 0.002, p-value = 0.0539
- Times visited (grouped) VS depth distance: R² = 0.001, p-value = 0.2002

Therefore, connectivity and distance to circulation are not, by themselves, factors that affect the number of times a desk is visited.

The second hypothesis deals with the second subset, ‘chatting’ interactions.

**Hypothesis 2: Temporary chatting interactions tend to happen in less open spaces and away from circulation.**

Three metrics were examined to verify or falsify this hypothesis: A) whether a person on a seat was observed to chat at all, B) how many times this happened, and C) the number of times happened categorised. The grouping is once again a way to distinguish cases where chatting is a normal mode of operation, for example due to an unusually cohesive relationship between the members and thus not the product of random encounters. The size of the sample was 8,884 observations of desks, as in the previous analysis.

Two t-tests were carried out, one for how connectivity and one for how distance to circulation differed for desks that saw chatting in comparison to those that did not. None yielded significant results (p-value: 0.702 and 0.2873 respectively).

Four ANOVA tests were also carried out to test the combinations between the input and output variables (see Figure 4).

![Figure 4 - Times chatted count and grouped VS connectivity and distance to circulation](image_url)
All results were inconclusive, yielding non-significant results. The relevant p-values and R² were:

- Times chatted VS connectivity: R² = 0.003, p-value = 0.2505
- Times chatted VS depth distance: R² = 0.001, p-value = 0.8764
- Times chatted (grouped) VS connectivity: R² = 0.001, p-value = 0.2318
- Times chatted (grouped) VS depth distance: R² = 0.000, p-value = 0.7766

Both hypotheses 1 and 2 could not have their respective null hypotheses rejected meaning that connectivity or visual depth distance are not alone responsible for fluctuations in the visiting or chatting behaviours, but confounding factors must be found and taken into account. A possible explanation for the lack of significant results in the visiting behaviour could be that a close distance to circulation acts as a recruitment opportunity, but not with the guest staying close to the seat, but instead them causing the host to get up so that they can have a quick meeting elsewhere.

5. BEHAVIOUR TWO: CHOICE OF EATING SPACES

The second studied behaviour dealt with the choices of people, or more specifically what places they chose to go to at lunchtime. Being social spaces, the spaces examined here are likely to be preferred for the amount of people that can be seen there. On the other hand, the selection can be purely utilitarian, i.e. people choosing to go to the closest space to minimise the time and travel needed to get there. Therefore, two more hypotheses were tested: 3) Canteens will experience highest usage rates when they are more visible locally and require less effort to go to, and 4) Break-out spaces will experience highest usage rates when they are more visible locally and require less effort to go to.

Again, both hypotheses will now be explained and tested, one after the other.

**Hypothesis 3:** Canteens will experience highest usage rates when they are more visible locally and require less effort to go to.

For hypothesis 3 the connectivity of each canteen space was tested against its average occupancy. Occupancy was defined as the number of people observed in a lunchtime snapshot divided by the capacity and the number of days of observation. The second metric tested was the average metric distance to get from every seat to any canteen space. The unit of analysis was a site and the total number of observations was 16.

Two correlations were tested (Figure 5) between canteen occupancy and connectivity, and canteen occupancy and average metric distance to desks.

![Figure 5 - Canteen occupancy VS Connectivity and Average distance to desks](image)
The tests provided non-significant results:

- Occupancy density versus connectivity: $R^2 = 0.091$, p-value = 0.2554
- Occupancy density versus average metric distance to desks: $R^2 = 0.0411$, p-value = 0.4513

Therefore, no direct relationship could be found between canteen occupancy and connectivity or average distance to desks. The fourth hypothesis asks the same question for break-out spaces:

**Hypothesis 4:** Break-out spaces will experience highest usage rates when they are more visible locally and require less effort to go to.

For this hypothesis, connectivity of each break-out space was tested against the average occupancy density. Occupancy density was defined as the number of people observed in a snapshot when the overall number of people at breakout spaces was highest (i.e. at peak usage, which is lunchtime) divided over the area of said breakout space and averaged over the number of days of observation. The second metric tested was the average distance from the specific breakout space to reach any seat. The unit of analysis is a breakout space and the sample size is 91 spaces.

Two correlations were tested (Figure 6) between break-out occupancy and connectivity, and break-out occupancy and average metric distance to desks.

![Figure 6 - Break-out space occupancy VS connectivity and average distance to desks](image)

The regressions provided non-significant results:

- Occupancy density versus connectivity: $R^2 = 0.0235$, p-value = 0.1469
- Occupancy density versus average metric distance to desks: $R^2 = 0.0002$, p-value = 0.8821

Hypothesis 4, just as hypothesis 3, yielded non-significant results meaning that connectivity and distance to desks did not alone affect occupancy of an eating space at lunchtime. This is very likely an effect of other factors, such as the quality of the provided food, the availability of external food, inter-team and intra-team communication and the look-and-feel and furniture provision of the canteens. Especially for canteens, this result could also be an effect of the smaller sample we have, since not all the examined companies have canteens, bringing the number of cases down to 16.

6. INTERACTIONS: A CLOSER LOOK

Given that the results were insignificant at the top level, we set out to apply the same methodology taking into account some other parameters, namely the industry each company belongs to. This section will describe the re-focused analysis to take the industry as a grouping parameter into account. The rationale behind this decision is that one may consider that companies in the same industry share the same intrinsic characteristics that allow for the same
patterns of behaviour to emerge. For the last level of the analysis the focus shifted to each site itself. While these shifts essentially created the same problems identified in the literature review (differences in case studies, non-generalisable results) it also created the potential to see the differences between the cases that did present these patterns and those that did not.

The available data comes from companies from eight different industries. With this split, the number of seats per unit of analysis drops considerably to a range from 281 to 2,897 seats. The number of cases per industry is also uneven (see Figure 7); an effect of the way the data was collected.

The analysis was carried out for each industry and for each case in the manner described above, starting with a t-Test (Table 2, Table 3) to assess whether seats that were visited were more visible or closer to circulation than the ones not-visited, followed by an ANOVA (Table 4), to examine whether these two metrics had any effect on the times visited.

The t-Test for the visiting behaviour and connectivity (Table 2, left) did yield significant results for five out of eight industries. While Legal, Financial Services, Technology and Media showed visited desks had a higher average connectivity than non-visited desks, the reverse was the case for Retail cases, where visiting tended to be attracted by smaller spaces, i.e. lower connectivity. Two industries (Financial Services and Technology) displayed a negative difference of over 200 grid cells (~40m²) between the non-visited and the visited desks. For these two industries (Financial Services and Technology) displayed a negative difference of over 200 grid cells (~40m²) between the non-visited and the visited desks. For these two industries connectivity was also influential in the amount of times a desk was visited (Table 4, left), although the effect was minimal (R²=0.02, 0.016). Distance to circulation was not found to significantly affect whether a desk was visited (Table 3, left), or how many times that happened (Table 4, right). In the few cases where the result was significant, the effect was negligible (0.19 metres difference between desks visited or non-visited, or an effect of R²=0.023).
## Table 2 - Per industry and case t-Tests: Connectivity differences between the desks that were visited and those that were not. Positive significant effects in yellow, negative in red, * significant at the 0.05 level, ** significant at the 0.01 level.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Sample Size</th>
<th>Mean 0 (Not Visited)</th>
<th>Mean 1 (Visited)</th>
<th>Difference (0-1)</th>
<th>p-value</th>
<th>ID</th>
<th>Sample Size</th>
<th>Mean 0 (Not Visited)</th>
<th>Mean 1 (Visited)</th>
<th>Difference (0-1)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Research</td>
<td>281</td>
<td>3.56</td>
<td>2.59</td>
<td>-0.97</td>
<td>0.030</td>
<td>16</td>
<td>181</td>
<td>3.56</td>
<td>2.59</td>
<td>-0.97</td>
<td>0.030</td>
</tr>
<tr>
<td>Architecture</td>
<td>373</td>
<td>2.68</td>
<td>2.58</td>
<td>0.00</td>
<td>0.680</td>
<td>19</td>
<td>197</td>
<td>2.68</td>
<td>2.58</td>
<td>0.00</td>
<td>0.680</td>
</tr>
<tr>
<td>Legal</td>
<td>307</td>
<td>2.24</td>
<td>1.94</td>
<td>-0.06</td>
<td>0.367</td>
<td>20</td>
<td>159</td>
<td>2.24</td>
<td>1.94</td>
<td>-0.06</td>
<td>0.367</td>
</tr>
<tr>
<td>Financial Services</td>
<td>713</td>
<td>3.81</td>
<td>4.16</td>
<td>-0.35</td>
<td>0.120</td>
<td>21</td>
<td>41</td>
<td>3.81</td>
<td>4.16</td>
<td>-0.35</td>
<td>0.120</td>
</tr>
<tr>
<td>Creative Agency</td>
<td>709</td>
<td>2.60</td>
<td>2.30</td>
<td>-0.30</td>
<td>0.067</td>
<td>22</td>
<td>159</td>
<td>2.60</td>
<td>2.30</td>
<td>-0.30</td>
<td>0.067</td>
</tr>
<tr>
<td>Technology</td>
<td>842</td>
<td>3.17</td>
<td>3.57</td>
<td>0.40</td>
<td>0.084</td>
<td>23</td>
<td>159</td>
<td>3.17</td>
<td>3.57</td>
<td>0.40</td>
<td>0.084</td>
</tr>
<tr>
<td>Retail</td>
<td>2897</td>
<td>3.21</td>
<td>3.65</td>
<td>0.44</td>
<td>0.007</td>
<td>24</td>
<td>159</td>
<td>3.21</td>
<td>3.65</td>
<td>0.44</td>
<td>0.007</td>
</tr>
</tbody>
</table>

## Table 3 - Per industry and case t-Tests: Distance to circulation differences between the desks that were visited and those that were not. Positive significant effects in yellow, * significant at the 0.05 level, ** significant at the 0.01 level.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Sample Size</th>
<th>Mean 0 (Not Visited)</th>
<th>Mean 1 (Visited)</th>
<th>Difference (0-1)</th>
<th>p-value</th>
<th>ID</th>
<th>Sample Size</th>
<th>Mean 0 (Not Visited)</th>
<th>Mean 1 (Visited)</th>
<th>Difference (0-1)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Research</td>
<td>281</td>
<td>2.56</td>
<td>2.59</td>
<td>-0.03</td>
<td>0.930</td>
<td>15</td>
<td>181</td>
<td>2.56</td>
<td>2.59</td>
<td>-0.03</td>
<td>0.930</td>
</tr>
<tr>
<td>Architecture</td>
<td>373</td>
<td>2.68</td>
<td>2.58</td>
<td>0.00</td>
<td>0.680</td>
<td>19</td>
<td>197</td>
<td>2.68</td>
<td>2.58</td>
<td>0.00</td>
<td>0.680</td>
</tr>
<tr>
<td>Legal</td>
<td>307</td>
<td>2.24</td>
<td>1.94</td>
<td>-0.06</td>
<td>0.367</td>
<td>20</td>
<td>159</td>
<td>2.24</td>
<td>1.94</td>
<td>-0.06</td>
<td>0.367</td>
</tr>
<tr>
<td>Financial Services</td>
<td>713</td>
<td>3.81</td>
<td>4.16</td>
<td>-0.35</td>
<td>0.120</td>
<td>21</td>
<td>41</td>
<td>3.81</td>
<td>4.16</td>
<td>-0.35</td>
<td>0.120</td>
</tr>
<tr>
<td>Creative Agency</td>
<td>709</td>
<td>2.60</td>
<td>2.30</td>
<td>-0.30</td>
<td>0.067</td>
<td>22</td>
<td>159</td>
<td>2.60</td>
<td>2.30</td>
<td>-0.30</td>
<td>0.067</td>
</tr>
<tr>
<td>Technology</td>
<td>842</td>
<td>3.17</td>
<td>3.57</td>
<td>0.40</td>
<td>0.084</td>
<td>23</td>
<td>159</td>
<td>3.17</td>
<td>3.57</td>
<td>0.40</td>
<td>0.084</td>
</tr>
<tr>
<td>Retail</td>
<td>2897</td>
<td>3.21</td>
<td>3.65</td>
<td>0.44</td>
<td>0.007</td>
<td>24</td>
<td>159</td>
<td>3.21</td>
<td>3.65</td>
<td>0.44</td>
<td>0.007</td>
</tr>
</tbody>
</table>
Proceedings of the 11th Space Syntax Symposium

BIG DATA AND WORKPLACE MICRO-BEHAVIOURS:
A Closer Inspection Of The Social Behaviour Of Eating and Interacting

Table 4 - ANOVA for times visited VS Connectivity and Distance to circulation. Significant effects in yellow, * significant at the 0.05 level, ** significant at the 0.01 level.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Sample size</th>
<th>R’</th>
<th>p-value</th>
<th>D</th>
<th>Sample size</th>
<th>R’</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Research</td>
<td>28</td>
<td>0.010</td>
<td>0.600</td>
<td>15</td>
<td>28</td>
<td>0.010</td>
<td>0.600</td>
</tr>
<tr>
<td>Architecture</td>
<td>273</td>
<td>0.007</td>
<td>0.710</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legal</td>
<td>607</td>
<td>0.010</td>
<td>0.600</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Services</td>
<td>773</td>
<td>0.007***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creative Agency</td>
<td>792</td>
<td>0.004</td>
<td>0.610</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>554</td>
<td>0.015</td>
<td>0.027***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Media</td>
<td>25</td>
<td>0.030</td>
<td>0.481</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td>28</td>
<td>0.005</td>
<td>0.187***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These results imply that in some industries there is a relationship between connectivity and visiting behaviour, specifically that visited seats tend to be in more visible areas. The industries highlighted (Financial Services and Technology) are the ones that are unlikely to prescribe interaction behaviour or have a culture that does. They lie between the strictly professional character of law firms and the noisy information exchange of a creative agency. Therefore, they are more likely to display genuine 'visiting' interactions as those would neither be discouraged nor the normal mode of operation of the firm.

The same analysis was carried out for each site separately. In this case the unit of analysis becomes even smaller, with a range from 41 to 1,600 desks. The aim of this analysis was to identify whether the aforementioned questions can be identified as intrinsic behaviours within the company that are lost when the data is aggregated.

Some parts of the analysis were indeed found to be significant, mostly for the relationship between connectivity and whether a desk was visited or not. The six cases highlighted in Table 4 (right) are significant at the 0.05 level, but the more interesting observation is that four cases revealed negative differences (i.e. visiting favoured larger spaces with higher average connectivity), whereas two cases showed positive differences (i.e. visited desks were in smaller spaces with lower average connectivity). This points to a fundamental problem of aggregating data into larger datasets, since positive and negative effects will cancel each other out. It also shows very clearly, how the data presented in this paper mirrors the existing state of the art with some effects to be found in some cases, but no generalisable patterns valid across cases and across industries.

In a similar vein, chatting was also examined further, on a per-case and per-industry basis. The initial per-industry t-Tests (see Table 5, left) were slightly less significant overall and showed smaller differences in connectivity (up to 169 cells, ~35m2). Connectivity was found to be a highly significant factor against the number of times chatted (Table 7), but the effect only occurred in four industries and was minimal, never rising above R2=0.06. Distance to circulation (Table 6 and Table 7, right) once again mostly provided insignificant results, or negligible effect sizes and differences.
### Table 5 - Per industry and case t-Tests: Connectivity differences between desks that experienced chatting and those that did not. Positive significant effects in yellow, negative in red, * significant at the 0.05 level, ** significant at the 0.01 level.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Sample size</th>
<th>Mean 0 (Did not chat)</th>
<th>Mean 1 (Did chat)</th>
<th>Difference (o-1)</th>
<th>p-value</th>
<th>ID</th>
<th>Sample size</th>
<th>Mean 0 (Did not chat)</th>
<th>Mean 1 (Did chat)</th>
<th>Difference (o-1)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Research</td>
<td>281</td>
<td>3339</td>
<td>3374</td>
<td>-35</td>
<td>0.560</td>
<td>25</td>
<td>281</td>
<td>3339.39</td>
<td>3374.55</td>
<td>-35.15</td>
<td>0.561</td>
</tr>
<tr>
<td>Architecture</td>
<td>373</td>
<td>1346</td>
<td>1081</td>
<td>265</td>
<td>0.464</td>
<td>13</td>
<td>265</td>
<td>1519.72</td>
<td>1411.44</td>
<td>78.28</td>
<td>0.481</td>
</tr>
<tr>
<td>Legal</td>
<td>507</td>
<td>731</td>
<td>654</td>
<td>77</td>
<td>0.011</td>
<td>4</td>
<td>4</td>
<td>988.79</td>
<td>692.09</td>
<td>-296.70</td>
<td>0.002</td>
</tr>
<tr>
<td>Financial Services</td>
<td>723</td>
<td>2373</td>
<td>1922</td>
<td>-169</td>
<td>0.011</td>
<td>1</td>
<td>1</td>
<td>1275.56</td>
<td>1325.65</td>
<td>-50.09</td>
<td>0.156</td>
</tr>
<tr>
<td>Creative Agency</td>
<td>794</td>
<td>991</td>
<td>996</td>
<td>-5</td>
<td>0.890</td>
<td>5</td>
<td>5</td>
<td>279.79</td>
<td>259.90</td>
<td>19.89</td>
<td>0.429</td>
</tr>
<tr>
<td>Technology</td>
<td>854</td>
<td>2327</td>
<td>2180</td>
<td>147</td>
<td>0.082</td>
<td>18</td>
<td>18</td>
<td>1281.44</td>
<td>1265.11</td>
<td>-16.33</td>
<td>0.919</td>
</tr>
<tr>
<td>Media</td>
<td>1457</td>
<td>1612</td>
<td>1711</td>
<td>-90</td>
<td>0.026</td>
<td>16</td>
<td>16</td>
<td>577.35</td>
<td>483.37</td>
<td>93.98</td>
<td>0.953</td>
</tr>
<tr>
<td>Retail</td>
<td>1897</td>
<td>1903</td>
<td>5984</td>
<td>-81</td>
<td>0.019</td>
<td>31</td>
<td>31</td>
<td>704.24</td>
<td>660.11</td>
<td>44.13</td>
<td>0.813</td>
</tr>
</tbody>
</table>

### Table 6 - Per industry and case t-Tests: Distance to circulation differences between desks that experienced chatting and those that did not. Negative significant effects in red, * significant at the 0.05 level, ** significant at the 0.01 level.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Sample size</th>
<th>Mean 0 (Did not chat)</th>
<th>Mean 1 (Did chat)</th>
<th>Difference (o-1)</th>
<th>p-value</th>
<th>ID</th>
<th>Sample size</th>
<th>Mean 0 (Did not chat)</th>
<th>Mean 1 (Did chat)</th>
<th>Difference (o-1)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Research</td>
<td>281</td>
<td>1.52</td>
<td>2.62</td>
<td>-1.1</td>
<td>0.590</td>
<td>15</td>
<td>15</td>
<td>2.97</td>
<td>2.73</td>
<td>0.24</td>
<td>0.613</td>
</tr>
<tr>
<td>Architecture</td>
<td>373</td>
<td>1.76</td>
<td>2.55</td>
<td>0.21</td>
<td>0.346</td>
<td>33</td>
<td>33</td>
<td>2.52</td>
<td>2.36</td>
<td>0.16</td>
<td>0.542</td>
</tr>
<tr>
<td>Legal</td>
<td>507</td>
<td>1.87</td>
<td>2.25</td>
<td>-0.38</td>
<td>0.011</td>
<td>4</td>
<td>4</td>
<td>2.21</td>
<td>2.28</td>
<td>-0.07</td>
<td>0.159</td>
</tr>
<tr>
<td>Financial Services</td>
<td>723</td>
<td>4.07</td>
<td>3.38</td>
<td>0.69</td>
<td>0.360</td>
<td>1</td>
<td>1</td>
<td>3.69</td>
<td>3.52</td>
<td>0.17</td>
<td>0.074</td>
</tr>
<tr>
<td>Creative Agency</td>
<td>794</td>
<td>2.18</td>
<td>2.51</td>
<td>-0.33</td>
<td>0.870</td>
<td>16</td>
<td>16</td>
<td>2.65</td>
<td>2.37</td>
<td>-0.28</td>
<td>0.115</td>
</tr>
<tr>
<td>Technology</td>
<td>854</td>
<td>3.48</td>
<td>3.27</td>
<td>0.21</td>
<td>0.376</td>
<td>21</td>
<td>21</td>
<td>3.10</td>
<td>3.00</td>
<td>0.10</td>
<td>0.768</td>
</tr>
<tr>
<td>Media</td>
<td>1457</td>
<td>2.68</td>
<td>2.83</td>
<td>-0.15</td>
<td>0.069</td>
<td>12</td>
<td>12</td>
<td>2.10</td>
<td>2.31</td>
<td>-0.21</td>
<td>0.168</td>
</tr>
<tr>
<td>Retail</td>
<td>1897</td>
<td>3.11</td>
<td>3.18</td>
<td>-0.07</td>
<td>0.468</td>
<td>20</td>
<td>20</td>
<td>2.67</td>
<td>3.38</td>
<td>-0.71</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Table 5 - Per industry and case t-Tests: Connectivity differences between desks that experienced chatting and those that did not. Positive significant effects in yellow, negative in red, * significant at the 0.05 level, ** significant at the 0.01 level.

Table 6 - Per industry and case t-Tests: Distance to circulation differences between desks that experienced chatting and those that did not. Negative significant effects in red, * significant at the 0.05 level, ** significant at the 0.01 level.
Table 7 - ANOVA for times chatted VS Connectivity and Distance to circulation. Significant effects in yellow, * significant at the 0.05 level, ** significant at the 0.01 level.

As previously, tables 5-7 also provide an overview of each case examined with the same methodology. While most cases yielded insignificant results or low effects, three individual cases stand out: IDs 7, 9 and 3. The first two display a p-value below 0.01 and effects of around $R^2=0.13$ when comparing connectivity in relation to the number of times that person chatted, while the last shows a slightly larger effect when comparing distance to circulation and times chatted. Thus, while the effect is small, for the first two cases the amount of visible space did affect how many times someone chatted, while for case 3, it was proximity to circulation that played that role.

These results highlight the pitfalls of small-scale analysis. From a set of 23 case studies, some were found to have significant effects, but overall there appear to be no over-arching patterns as a whole, when split by industry, or even on a case-by-case analysis.

7. CONCLUSION AND FUTURE DEVELOPMENTS

We examined ‘visiting’ and ‘chatting’ interactions across the whole dataset, but also within industries and specific cases, and found that local visibility and distance to circulation, on their own, play no major role in the occurrence of these behaviours. We also examined preference of eating spaces across the whole dataset and whether this was affected by local visibility and the average effort to reach each space and found no significant results.

Overall, it is apparent that even with a larger dataset cutting across many companies, buildings and floors, no strong correlations can be extracted between the various spatial metrics and human behaviour. There seem to be confounding factors, some of which are identified here, but also others that will not be visible until deeper examination is performed.

This study pointed to possible confounding factors that could affect the behaviours examined, but has not managed to take them into account systematically. These factors will be examined where possible and incorporated into the analysis to provide a more complete picture. Examples include taking opinions of staff into account for the quality of food at their canteen, identifying whether other eating options are available by looking at the location of the building, or by looking at overall team communication as a factor that affects ‘visiting’ and ‘chatting’ interactions.

While the paper at hand is limited in its scope for we only examined two behaviours and three metrics, there are many more workplace parameters that could be investigated. We expect that each parameter affects behaviour in different ways, therefore we intend to test more
metrics against these and more observed behaviours. One such combination to be tested is the relationship of the visiting behaviour to the global integration of the seat. The hypothesis in this case would be that integration positively affects visiting behaviour, given that seats that are easier to reach would invite more people to visit them. The reason this is difficult however, is that overall integration is subject to the intricacies of layout including the size of the building and number of floors, which renders this more complicated for cross-case analysis.

To summarise, this analysis has shown that the traditional methods used to identify patterns of behaviour in workspaces do not necessarily yield significant results when tested across different workspaces. Existing research has used these methods extensively and provided insights with all the aforementioned caveats. While in this study we tested not-previously-examined combinations of metrics, we aim to construct tests in future work that explicitly try to reproduce the results of previous studies. This process will provide clear and definitive answers to whether those insights still hold, and whether patterns can be found across cases. The study by Hillier and Grajewski (1990) will be the first to be examined. It has to be considered though that the study by Hillier and Grajewski examined working practices of the 1980s and the world of work has changed considerably, not least with the advent of electronic communication technologies, the importance of computing and the portability of devices.

Last but not least, we will develop new methodologies in future work. In its current form, only one single parameter was taken into account, although the problem at hand is extremely complex. New methods have to be tested that take into account multiple parameters, since it might be the combination of these parameters that provides a model that can strongly predict activity. These methods could be multivariate regression, Principal Component Analysis and perhaps machine learning methods. In the same spirit, biases such as spatial co-linearity that are inherent to the spatial nature of the dataset will be addressed.
REFERENCES


EBD, (2015). The Knowledge Problem As architects and designers, what do we know about people? EBD.


Hillier, B. and Hanson, J., (1984). The social logic of space.


Lopez de Vallejo, I., (2010). Measuring spatial and temporal features of physical interaction dynamics in the workplace. UCL (University College London).


#150
EMPLOYING VOLUNTEERED GEOGRAPHIC INFORMATION IN SPACE SYNTAX ANALYSIS

KIMON KRENZ
Space Syntax Laboratory, The Bartlett School of Architecture, UCL
kimon-vincent.krenz.12@ucl.ac.uk

ABSTRACT
The application of volunteered geographic information has rapidly increased over the past years. OpenStreetMap (OSM) forms in this context one of the most ambitious and promising projects, providing consistent global coverage of street network information. With a constantly growing number of participants and the implementation of governmental and proprietary based information is a complete coverage of global street networks within reach. The data allows comparative cross-country analyses and any method developed within its framework are transferable to other cases. This makes OSM a powerful and desirable data source for applied network analyses, such as space syntax. However, OSM data does not come without obstacles. Inconsistent representation of space, topological fragmentation and accuracy are just some of the problems that one faces when employing OSM data. In fact, without prior processing and simplification of the network, results differ significantly between case studies. This paper presents a method for OSM data set simplification as well as the theoretical and analytical reasoning behind it. The simplification is done by a series of ArcGIS workflows and algorithms. The outcome of this process is compared to an angular segment analysis (ASA) of a segment model, an Integrated Transport Network (ITN) Ordnance Survey data model and an OSM street network data model. The results show that a simplified version of OSM data is highly comparable to a segmented axial line representation and that such data sets constitute an appropriate alternative for situations where segment maps are not available, such as complex, large-scale regional models and cross-country comparisons. The simplification workflow is transferable to other cases and data sets and helps overcoming common problems while significantly improving computational time needed in the process.

KEYWORDS
Volunteered Geographic Information, Open Street Map, ArcGIS, Space Syntax, Street Network

1. INTRODUCTION
The aim of this paper is to present a workflow and methodology that allows the use of OpenStreetMap (OSM) data in space syntax angular segment analysis (ASA). The reasoning behind employing such data sets is the increasing scale of analytical investigations in the context of space syntax. This augmentation of scale has become particularly necessary due to the extensive global growth of cities and their urban hinterland into large complex urban regions. These urban structures are simply too vast to be mapped manually or generated by automated algorithms. This has created a situation in which the time and economic feasibility of traditional as well as algorithmically derived axial line maps needs to be revisited. Previous research proposed to make use of governmental so-called road-centre line data as an alternative for a segmented axial line, more commonly referred to as segment maps (SM). However, very little has been said about the disadvantages of such approaches particularly when global
comparability is needed, something in which space syntax is believed to be particular strong. OSM road-centre line data, on the other hand, I will argue, forms not only an appropriate alternative basis for models in these situations, but it also allows global comparability as well as being freely accessible on a large scale. Nevertheless, OSM data does not come without disadvantages either. Particularly concerning excessive information in such data sets, which makes a simplification prior to any ASA application necessary, caution needs to be exercised.

This paper consists of three parts; the first revisits the foundation of space syntax axial line models and the sequentially developed analytical method of ASA and its segment map (SM) model. An emphasis is placed on the model underlying the analysis and the difficulties arising in the model generation generally and in large-scale applications particularly. In this light, volunteered geographic information and governmental road-centre line data, such as the British Integrated Transport Network (ITN) are reviewed as alternatives for SM models. Finally, advantages as well as disadvantages of OSM data are discussed and the effect of these on ASA outcomes.

The second part presents the structure and particularities of the previously introduced OSM data, as well as the difficulties researchers are facing when employing such data in ASA. I discuss the three main difficulties, which are topological inconsistency, traffic management components and excessive or redundant nodal information. I propose different GIS strategies to simplify and remove such redundant information and explain the theoretical reasoning behind them. The result is a newly derived simplified OSM network model, termed 'SIMP'.

The third part evaluates the new SIMP model against OSM, ITN and SM models in ASA. I do this, using descriptive statistics, visual comparisons, as well as a Pearson and Spearman correlation analysis. The results show an overall high correlation between the four models, confirming previous findings. The new SIMP model exhibits higher correlations with the SAL model than both OSM and ITN network models, indicating that a simplified OSM network does not only form an appropriate alternative but one that presumably incorporates fundamental network characteristics of SM models.

2. AXIAL MODELS AND ANGULAR SEGMENT ANALYSIS

Axial analysis forms one of the fundamental techniques of space syntax. At the core of an axial analysis methodology lies the axial line map, a representation of the continuous structure of open spaces in urban settings. The first axial line model was introduced by Hillier and Hanson (1984, p. 17) during the early 1980's and defined as a system of fewest and longest intersecting lines covering all open spaces. These lines are the result of a two-step process where the spatial system under investigation is first represented through a two-dimensional organisation of convex spaces. Convex spaces are polygonal representations of continuous open spaces, in which each part of a space must be visible from every other part. The underlying rule for drawing a convex space is that each polygon must feature the best 'area-perimeter ratio', starting with the 'fattest'. In a subsequent second step, this system of convex spaces is covered by a one-dimensional set of axial lines. Axial lines are linear representations of longest lines of sight and/or movement. Each convex space must be covered by at least one axial line, while each line needs to be the 'longest straight' line possible (ibid., p.17).

Although Hiller and Hanson describe this process as reproducible and objective, there is some discussion and ambiguity about the comparability and making of axial maps. Problems arise for instance with differences in the level of detail or resolution in which convex spaces are produced, as this impacts the number and distribution of the resulting axial line map. Problems also arise with the difficulty to arrive at comparable reproducible solution for the same given urban context. Peponis et al. acknowledge in this regard ‘SpaceBox’1, a software that automated the generative process of convex spaces, but they criticise the mathematical

1 SpaceBox is a software developed by Sheep Dalton (1988) and includes several space syntax related functionalities one of which being the generation of an all convex space map. The software’s partitioning algorithm extends a walls surface area collinear until the produced line reaches another wall surface. See Carranza and Koch for more recent work on convex spaces (2013).
rigour of its computational algorithms to generate convex spaces (1997, 1998). According to Peponis et al. neither the initial principle of generating convex spaces based only on an economic partitioning, nor the extension of surfaces to the next opposite wall is a sufficient method. Both lead to multiple, conflicting solutions, implying that a more sophisticated set of rules is necessary. Interestingly, although the methodology of convex spaces is thought of in an urban context most of the discussions are set in the context of buildings. This might be due to the time-consuming process of producing convex spaces for entire cities, with the sole purpose of deriving an axial line map. The scale of the area under investigation and respectively the time necessary to produce such convex representations is certainly one of the most important influencing factors.

Moreover, Desyllas and Elspeth argue that not only the production of convex spaces, in general, is difficult, but that it constitutes a ‘mathematically impossible problem’ to link all maximal convex spaces with axial lines in an identically repeatable manner (2001, p. 27.6). The core problem here is that there are several solutions to axial lines that fulfil the criteria of being the longest as well as covering all convex spaces (Batty and Rana, 2004; Ratti, 2004). As a solution to this technical and theoretical problem Turner et al. (2005) – building on an initial but not ideal solution from Peponis et al. (1998) – proposed an automated methodology that produces a fewest line axial map. The starting point of their method is vector information of open space boundary polygons. Based on this, a so-called ‘all-line map’ is generated (Penn et al., 1997). The ‘all-line map’ is a map that features all lines that connect each vertex of boundaries and buildings with all other visible vertices, i.e. all possible lines of movement. In a following step Turner et al. employ an algorithm to reduce this ‘all-line map’ to a fewest line axial map. Their results are reproducible and strikingly similar to the original Hillier and Hanson axial map (2005).

However, his method of the fewest line axial map generation, does not constitute an appropriate way to produce models for cities and regions. There are two primary factors, which prevent the application in a citywide and regional context. The first starts with the source of data and its definition of open space, a problem that the very initial convex space methodology already inherited. What to include and what to leave out in a graphical representation of the real world is left to the individual cartographer or researcher and forms core challenges in comparative cartography and map-making in general. This challenge is of particular importance when investigating suburban or rural areas. Suburban and rural areas often lack a continuous urban form and hence a given limitation for movement and visibility. Consequently, the definition of what can be considered an ‘accessible open space’ becomes vague. A problem that researchers are also facing in the context of developing countries exists as roads are often not solidified and boundaries between public and private spaces are less established. In these cases, an alternative could be to rely on other sources of geographic data of open spaces that follow precise definitions. Such sources are for example governmental agencies for cartography, geodesy and planning or volunteered geographic information, both of which have precise definitions of what and how open spaces are mapped.

Computational time constitutes the second difficulty. With a rising number of mapped open space polygons and their vertices, the necessary computational time to generate the fewest line axial map increases as well. Turner et al. give an account of the computational time needed for their algorithm to compute fewest line axial maps. A model of the small town of Gassin took 119 seconds to compute and featured 5217 lines in its initially generated all-line map and 38 axial lines in the final result (ibid.). Thus, the computational process for an entire city or even a region, with far more than one million street segments will take significantly longer. While theoretically the algorithm could run for any time needed, in praxis this is limited by the software design dealing with large data sets. Currently the most commonly used software for this is depthmapX. Initial tests using the software on large urban systems generating fewest line axial maps have consistently produced application crashes. Varoudis et al. state the maximum number of segments that can be computed by depthmapX as <1.500.000 (2013), resulting in an axial line map of approximately 15000 lines. This makes an automated generation of axial lines for a metropolitan or regional system at the time not possible.

2 The total number of axial lines in cities with a population of 300,000 can range between 10,000 and 15,000.
2.1 ROADS-CENTRE LINES AS ALTERNATIVE FOR SEGMENT MAPS

Initially, the focus of axial line maps was to have a tool that allowed understanding complex urban systems in a simplified comparable manner. Over time the primary use of this morphological descriptive tool was to be found in investigations into the deep relation between human behaviour and space. From the development of the methodology, throughout the last 30 years, researcher have consistently found correspondence between the topological relationships of spatial systems and pedestrian movement (Hillier et al., 1993; Penn et al., 1998; Desyllas and Elspeth, 2001; Hillier and lida, 2005) as well as vehicular movement activities (ibid.; Turner, 2005; Law and Versluis, 2015; Serra, Hillier and Karimi, 2015) and even global transportation networks (Hanna, Serras and Varoudis, 2013). This is particularly the case since the introduction of ASA in space syntax as an extension of axial analysis (Turner, 2001). The emphasis thus shifted from a theory and tool to analyse spatial configurations to one of predicting the potential of human behaviour in the form of movement and flows. Four studies focus on alternatives that constitute possible models for an analysis of movement and flows in the build environment: The pioneering work by Thomson (2003), Dalton et al. (2003), Turner (2005, 2007) and following up on these studies most recently the work by Dhanani et al. (2012). All authors investigate the possible application of different types of so called road-centre line data. The reasoning is that their approach relies on replacing a segment map, which is used in angular segment analysis rather than the in traditional axial line model the SM is based on. This study will follow the path taken by the above named researchers and base the comparison on a segmented axial line model, rather than emulating an axial line model, which inevitably will later be segmented in order to perform ASA.

Road-centre lines ideally represent the geographic centre of the public rights of way network, a transportation network of all paths on which the public have a legally protected right to pass and re-pass. These transportation networks are based on vector line information and can be generated through a variety of GIS methods such as automated processes of on ground collected GPS data, generative processes based on cadaster boundary data or manual tracing of roads on aerial photographs. In a subsequent step, additional information can then be attributed to this line information such as road names, road type, travel direction, road geometry information as well as a large variety of other possible attributes.

This makes road-centre line maps a powerful tool for a variety of GIS based applications. The ones applied the most are transportation modelling and navigation routing. Road-centre line data was first provided for local governments, such as the TIGER3 data set by the United States Census Bureau or the ITN4 by the British Ordnance Survey, as well as commercial companies, such as the Dutch Company TeleAtlas5 or American-based Company Navteq.6 The latter provides mainly line-based data for navigational systems. With the rise of the Internet and Web2.07, publicly accessible road centre-line information became largely available through different sources. The most predominant sources are Google maps and Bing maps, both available under restricted license for non-commercial usage. In contrast to governmental and proprietary based information with restricted license stands volunteered geographic information (VGI). VGI describes all geographic data, which is created, assembled and disseminated voluntarily by individuals (Goodchild, 2007). Open source VGI projects such as OpenStreetMap (OSM) and MapQuest are available under a GUP license and hence freely accessible to anybody. Due to the increasing number of online participants all over the world these projects are on the rise and establish a commercially as well as academically meaningful alternative.

3 TIGER is an acronym for Topographically Integrated Geographic Encoding and Referencing and an American based format used by the United States Census Bureau to describe land attributes such as roads, buildings, rivers, and lakes, as well as areas such as census tracts. The TIGER format forms a base for the US part of the OpenStreetMap project.
4 The Integrated Transport Network, is part of the OS MasterMap and a format provided by the United Kingdom governmental Ordnance Survey.
5 TeleAtlas is since 2008 wholly owned by navigation system company TomTom.
6 Navteq is since 2011 fully merged into NOKIA.
7 Web 2.0, is a term describing the state of the Internet as a collaboration focused information platform, where the user produces content. The term is set against Web 1.0, where content was provided as ‘ready-to-use’ and no interaction with the user was aimed (O’Reilly, 2005).
In the context of space syntax analysis, Thomson (2003) pioneered when proposing to make use of street networks. His study focuses on theoretical and technical problems based on the model construction rather than an investigation on how different models effects the analysis. In the study, he highlights possibilities of generalizing road networks. Simultaneously, Dalton et al. propose to make use of TIGER data and present initial results of their analytical work (2003). TIGER is a data format only used in the United States providing road-centre line information among other geo-referenced spatial data. Dalton conducts a fractal analysis and compares a TIGER dataset with a traditional hand-drawn axial map of Downtown Atlanta, US. He highlights differences in the results of both models and concludes that the result is caused by the very different representation of space. While a long linear avenue with adjacent side streets is represented by one long axial line in a traditional axial line map in the TIGER dataset road centre-lines are segmented by nature and have a node at each intersection (this is the case for any road centre-line map). Any topological investigation would thus lead to a highly skewed outcome. Moreover, Dalton raises the theoretical problem of radii, emphasising the need for a ‘relativisation’ due to the differences within each system (ibid., p.9). While Dalton did not propose a solution to the problem his argumentation led to a series of investigations by Alasdair Turner.

In his study from 2005, Turner presents a methodology that overcomes this problem of segmentation and ‘relativisation’ by drawing on advantages of space syntax applying ASA to road centre-line maps in combination with a segment length weighted algorithm. The results of his 2005 and 2007 study indicate that metric radii in combination with weighted choice measures present not only a suitable alternative to SM models but, in fact, generate better correlations with flow data in the tested case studies. Turner emphasises that his measure holds configurational information while incorporating plausible cognitive and physical constraints (2007, p. 553). Turner’s findings are reasonable since road centre-line maps are fundamental representations of the accessible – rights of way – movement network and incorporate more detailed angular information than axial line models.

Dhanani et al. (2012) follow Turner’s findings and conduct a comparative study of an axial line model and two different types of road centre-line based models. As mentioned previously, there are different sources for road centre-line maps. Dhanani et al. studies’ focus on two very particular networks: the governmental ITN data set and the OSM VGI data. Their studies aim to understand whether a VGI-based data set constitutes a reliable alternative compared to governmental data sets in the light of space syntax analysis. Beside of Dalton’s (2003) and Turner’s (2005, 2007, 2009) work, there are no other comprehensive studies where space syntax measures are applied to governmental road centre-line data sets correlating results with empirical data. This is surprising as both of the studies rely either on the American TIGER data or the British Ordnance Survey data sets. The difficulty here is that governmental road centre-line maps are presented as a reliable and coherent source of data, yet, this is only true for information within one data set and very little is being said about their comparability in an international context.

Differences occur between governmental data sets not only on an international level but also within countries. The British Ordnance Survey for example provides three different road centre-line data products: the OS MasterMap layer Integrated Transport Network (ITN) layer, the OS Open Roads layer and the Meridian 2 layer. All these data sets provide comprehensive road network information and are designed for routing and road network analysis, yet, their level of precision and coverage differs. This means that the total amount of nodes and coverage of real world details such as roundabouts are not the same throughout the three data sets. More importantly such data sets are not available in every country. Germany, Italy and France—to name only some—do not provide freely accessible data sets. This is why, the question of comparability needs to be answered and investigated for each country individually and alternative sources

8 It shall be noted that errors do occur in governmental data sets as well, but they usually follow a random distribution.
9 See http://digimap.edina.ac.uk/webhelp/osdigimaphelp.htm#data_information/os_products/os_open_map_local.htm for further information on the data sets and examples of their application.
need to be found. The lack of comparable data makes it difficult for international comparative approaches making use of such data sets, particularly in the context of space syntax.

2.2 ADVANTAGES AND DISADVANTAGES OF OSM DATA

In the light of this lack of comparable data, OSM data becomes more interesting as an appropriate alternative to a segment map representation, which, in theory, provides a comparable representation of space all over the world. OSM data is produced according to a guideline indicating the level of precision and the handling of particular situations such as divided highways, roundabouts, intersections or bridges (OpenStreetMap Wiki contributors, 2016). This makes the data, in theory, globally comparable. However, differences in terms of data quality arise due to the nature of its production and its contributors’ heterogeneous understanding of street networks.

Understanding such differences in quality is a non-trivial task in the realm of OSM data. There is a set of ISO standardized quality measures to assess the quality of map-based VGI (OSM) data. These measures are of particular interest for routing and navigation application, namely positional accuracy and topological consistency (Senaratne et al., 2016, p. 6) and thus for a space syntax application. Positional accuracy is a quantifiable value reflecting the difference between a mapped location and its real world location while topological consistency measures how well topological relations (‘disjoin’, ‘meet’, ‘overlap’ or ‘equal’) are mapped. A simple example for low positional accuracy would be a mapped intersection, of which the GIS location is 20 meter further in the North than in reality. An example for bad topological consistency of an intersection would be the case, in which two streets, which in reality are connected and should share a common node, would not do so in GIS. To evaluate the two mentioned quality measures it is necessary to compare the data set under investigation with the real world. This is usually done by comparing the VGI data with ground-truth data. Ground-truth means data that represents the respective exact location in reality. This is a theoretical value, rather than an actually achievable goal for most GIS data sets. GPS systems feature on average a positional accuracy of 6-10 metres to ground-truth. The ordnance survey MasterMap ITN data states its positional accuracy with 1 metre in urban and 6 metres in rural areas against ground-truth. Throughout the past decade, several authors have conducted comparisons of volunteered geographic information with governmental as well as commercially produced geographic information (Flanagin and Metzger, 2008; Neis et al., 2010; Zielstra and Zipf, 2010; Ludwig, Voss and Krause-Traudes, 2011)° to measure their quality. In the context of road centre-line information the work by Mordechai Haklay was one of the first to evaluate the quality of OSM data (2010). Haklay used the British OS Merdian 2 road network as control measure to test OSM data quality, his findings indicated highest mapping qualities in urban and affluent areas and the lowest coverage in rural and poorer areas while positional accuracy ranges from over 70% to occasionally drop down to 20% (ibid., p.700). Overall OSM data covered 29% of England based on a network from March 2008. In a subsequent study conducted in October 2009 this percentage was already corrected to 65% of coverage (Haklay, 2009). This indicates a growth of the network coverage by 36% within one year. Another study by Neis et al. (2011) dealing with the case of Germany, compared the OSM network against the proprietary data set of TomTom (formerly TeleAtlas) and estimated a complete coverage of the German OSM data by the year of 2012. Moreover, already in 2011 the OSM data exceeded the topological consistency and completeness of the TomTom network by 27% including pedestrian path ways (ibid.). The continuous growth and its pace of the OSM data set, does not only make a coverage and quality assessment difficult, but indicates that it is only a matter of time that full topological consistency will be reached. The number of total users in the OSM community as well as their nodal contribution to the network shows a growth of the total user number to 2,9 million since the start of the project 2004 and gives insights in the pace of this process.

° See Sehra et al. (2013) and Senaratne et al. (2016) for a comprehensive review of studies dealing with quality assessment of VGI data.
EMPLOYING VOLUNTEERED GEOGRAPHIC INFORMATION IN SPACE SYNTAX ANALYSIS

Hakley et al. (2010, p. 11) investigate how many volunteers are needed to map an area thoroughly concluding that areas mapped by more than 15 contributors per square kilometre feature a very good positional accuracy of below 6 metres for resulting VGI data. In regard of the growing numbers of contributors this leaves us to expect an equal rise in topographic consistency and positional accuracy. An additional positive effect to the coverage of areas, beside the growing number of contributors, is the fact that governmental agencies increasingly provide their data for public usage. Likewise, are the American TIGER network as well as the AND Dutch road network fully implemented in the OSM network, aiding not only to the coverage but positional accuracy of the OSM data set. A visualised snapshot of the data and its topicality reveals updating intervals, as well as showing that Great Britain and Germany are part of the best-mapped countries of the OSM project (Figure 1). All of the above studies use ground-truth data for the evaluation of VGI quality. Still, such data is not available in every country and more difficulties for the assessment of VGI data arise due to the lack of ground-truth data for comparison (Senaratne et al., 2016, p. 6). To overcome this lack of ground-truth data, Keßler and de Groot (2013) propose a method to indicate quality of VGI via trust assessment models. Their approach is based on a trust assessment model of the independent contributions in an OSM data set. Albeit presenting promising results, the methodology is at an early stage of development and does not propose an applicable method for the field. At the present stage, this leaves the research with as-good-as complete network for some countries with reasonably accurate precision, but a manual control of the entire data set by the researcher stays a necessity. With regard to future research the OSM will very likely constitute the most coherent freely available data set.

Dhanani et al. (2012, p. 30), assess the usage of OSM in space syntax to be problematic and describe the data as lacking ‘of consistency [...] accuracy and coverage’. Their study calls on researcher to rely on governmental data such as the British OS MasterMap ITN, yet, as mentioned earlier, as data is not accessible in every country and level of detail differs throughout different data sets, this approach remains unsatisfactory: The OS MasterMap ITN network covers only the vehicular network disregarding any path or street that is only accessible to pedestrians. The resulting vehicular centred spatial representation can therefore only be used to evaluate vehicular structures. Space syntax segment map representation on the other hand sees space through the eye of an individual moving in space and constitutes a sharp contrast to a vehicular
only street network. There are also other difficulties within the ITN data set that render an ad hoc use impossible. Dhanani et al. note that the ITN network comprises all traffic management features including traffic islands, artificial cul-de-sacs or roundabouts (ibid., p.6). According to the authors, using such data creates a ‘disjoint and fragmented network’ particularly if a researcher is interested in other modes than a purely vehicular estimation. The usage of such data is not recommendable without any prior processing. Prior processing is also necessary for OSM data making it indispensable to develop a strategy to overcome said inconsistency and arrive at a comparable network for any given case.

3. OSM DATA STRUCTURES AND GIS SIMPLIFICATION PROCESSES

The following section gives an overview of the necessary components to create a road network based on OpenStreetMap data and the necessary steps of post processes to allow an application in space syntax ASA.

At present, OSM data sets are divided into four different elements: nodes, lines, surfaces and relations. For an ASA only line information is necessary, but not all of the available line information and categories are useful. The OSM wiki provides extensive accounts on all different key categories and their morphology (OpenStreetMap Wiki contributors, 2017), it is important for each researcher working with OSM data to make him/herself familiar with all categories and morphologies. Decisions about which category to exclude might differ for example in cities in developing countries. The following steps should to be considered as a general guidance: For the purpose of network analysis only components with the key highway=* shall be used. This key defines any kind of road, street or path and their respective importance in the network hierarchy (from the most important ‘motorway’ to the least ‘service’) and, thus, gives a good account of the rights of way network. The following list assess which are recommendable to be included in a network for an application in ASA: highway=motorway; trunk; primary; secondary; tertiary; unclassified; residential; motorway_link; trunk_link; primary_link; secondary_link; tertiary_link; living_street; pedestrian (ibid.). Particular care needs to be taken with the key pedestrian as it includes pseudo polyline information of squares and these need to be cleaned and subsequently broken into individual segments. Other sub keys such as highway=service; path or bridleways can be included but are not recommended, as they are of very small scale and might otherwise be eradicated in a subsequent simplification process.

With a view to this selected data there are three main difficulties that occur when applied in a space syntax context.

1. Topological inconsistency occurs if street segments are supposed to share a connecting node but due to positional inaccuracy fail to do so. This is often the case at intersections of different contributors. Even a small gap between two nodal ends of 1 cm can create a network fragmentation. It is, therefore, necessary to process and clean the data from these inconsistencies.

2. Traffic management components are network details that are necessary for vehicular traffic management but have no immediate impact on cognitive route decision-making. Such details are for example roundabouts, small traffic islands or motorway trunks. Ideally roundabouts are simplified into simple intersections whereas meandering trunk links are represented by single links. Moreover, this is also the case with regard to dual line representations. Space syntax analysis is a non-directional approach in the sense that the possible travel directions are not taken into consideration and each space is treated as equally accessible. A dual line representation constitutes only a reasonable option if directions are taken into consideration. Hence, the model needs to be cleaned from said dual line representations.

3. Redundant or excessive nodal information are often problematic when using OSM data. Although the OSM guide notes that nodes should be used in an economic manner, contributors often have different interpretations of what ‘economic’ means. This is particularly the case for curved roads, but also occurs on straight lines. Ideally each street is simplified to its fundamental segment.
In order to overcome these difficulties a series of GIS algorithms have been developed. The following proposed solutions are employing the GIS software ArcGIS Desktop 10.2 from Esri. I employ ArcGIS because it is the only software that provides solutions for all three said difficulties. At present, only a few of the solutions presented here can be achieved with open source GIS software packages. Due to the scope of this paper only a brief description of the applied core functionalities will be given. Figure 2 shows a workflow diagram for the proposed solutions, while Figure 3 gives an illustration of each obstacle and its favoured solution after the application of the simplification method presented here.
1. Topological Inconsistency

2a. Dual Line Removal

2b. Road Detail Removal

3. Line Simplification

Figure 3 - Illustration of each difficulty found in OSM data: 1. topological inconsistency; 2a. dual line removal; 2b. road detail removal and 3. line simplification as well as the condition after application of the simplification method.

1. Starting with the approach of solving topological inconsistency (Figure 2:1), it should be mentioned that a lack of network information, such as entire missing streets cannot be solved through automated processing and that the OSM data needs to be carefully checked by the research prior to any post-production. More so, this is a strategy to overcome small inconsistencies that are difficult to identify manually. The proposed process reconnects topological inconsistencies by a given tolerance distance and in a subsequent step merge segments that can be considered as independent streets (from intersection to intersection) together. This will leave the researcher with a street network of real segments and consistent topological information. The two core ArcGIS functionalities the workflow is based on are 'integrate' and 'unsplit'.

EMPLOYING VOLUNTEERED GEOGRAPHIC INFORMATION IN SPACE SYNTAX ANALYSIS
The *integrate* tool is applied to extracted nodal information, rather than the actual line information, to overcome misalignment at intersections. Integrate maintains the integrity of shared nodal feature information by making features coincident if they fall within the specified x, y tolerance. Features that are considered identical or coincident are merged. In a subsequent step the newly generated nodal point information is used as a basis for a snap command of the initial street network. This will consequently connect lines, which feature topological inconsistencies, at a new point based on the location of their nodal line ends.

The unsplit tool is then applied to the now topological consistent line network. The aim is here to aggregate single part line features into multipart features in order to arrive with continuous street segments. Unsplit merges lines that have coincident endpoints. This can be done by relying on any given attribute information or, as in this case, solely by geometric relationships. Merged lines are of particular importance with regards to further simplification processes.

2. The next difficulty is the existence of traffic management details and dual line representations in the data sets (Figure 2:2a & 2b). Not only do such details (roundabouts, traffic islands, etc.) create differences in angular movement, while the general journey direction stays the same, but more importantly they increase the total number of journeys (dual line highways) and skew analytical results towards an emphasis of such details. Especially in the light of none directed centrality analysis dual lines make little sense. This could be negligible if traffic management details were normally distributed throughout the street network. However, this is, not the case with most examples and particularly not with inter-city and regional scales. There are four main ArcGIS components, 'merge divided roads', 'collapse dual lines', 'collapse road details' and 'integrate' that help to remove such dual lines and reduce low-level street network complexity.

The *merge divided roads* is an algorithm that merges road segments, which are parallel along a significant distance into a single centre line. The merging process is based on common attributes that can be computed on the basis of the initial highway keys. It is fundamental that the merge field parameters are established properly to avoid conflicts during the process. The divided roads algorithm can be applied to entire data sets and maintains topological relations with adjacent streets.

The *collapse dual lines to road centerline* is an algorithm designed to derive with centre lines from a base of street perimeters. It is, therefore, a less sophisticated form of simplification and it is not recommended to perform the algorithm on large datasets including multiple-lane highways with interchanges, ramps, overpasses and underpasses. In individual cases where the merge divided roads tool does not arrive with satisfactory results, the *collapse dual line to road centerline* tool can form a useful alternative.

The *collapse road detail*, on the other hand is an algorithm that depicts small road segment details and open configurations that interrupt the general trend of a road network and collapses or replaces them with a simplified feature. The collapse distance on which the tool performs is defined by the maximum size of the largest road detail and can differ for each model. If the *collapse road detail* tool does not solve or remove some of the details the integrate tool explained earlier constitutes an appropriate alternative. Particular care needs to be taken when using integrate on road details as it can impact the topological consistency of the data and should hence not be performed on entire data sets but single cases.

3. Line simplification is usually applied when segment records feature far more data than necessary for computer analysis or visual representations (Figure 2:3). In the case of space syntax and the use of VGI street networks this poses a conceptual question aside of excessive data. While road-centre lines depict the centre of the road an axial line (as base for a segment map line) is based on the longest line of sight. A generic street usually features a much larger field of vision than that of a single line. While axial lines fundamentally connect convex spaces these lines naturally pervade more than one space.
at once. Road-centre lines on the other hand simply represent the centre of the road and, therefore, feature excessive angular information that does not impact the field of vision or accessibility and, thus, has no effect on the actual movement in space. This is why, a removal of such road details should be based on the field of vision of each street, i.e. the street width. Since road-centre lines give a precise account of the centre of each street segment a simplification process should allow the newly generated feature to deviate to at least the extent of the field of vision. Such processes can be performed by the Douglas-Peuker Algorithm (DPA) (1973). The DPA is broadly considered to deliver the best perceptual representations of the original segment and generates new segments based on a deviation tolerance. In ArcGIS this can be done by applying the simplify line tool.

The simplify line tool reduces and removes redundant nodes of line features. Among others, when applied with the POINT_REMOVAL functionality it employs the DPA. The aim of the algorithm is to extract the essential segment form based on a previously selected off set tolerance. The strength of the algorithm is its reproducibility and process speed, and that it arrives at the same solution to the same given problem.

If the above steps of the methodology are followed the simplified version of a road-centre line map (SIMP) looks visually as well as topologically much closer to an axial line representation.

4. MODEL EVALUATION METHODOLOGY

In order to test if the theoretically laid out version of a simplified OSM network (SIMP) constitutes a comparable alternative to a segmented axial line map and is, thus, suitable for the purpose of analysis of different scales and very large ones in particular the model will be analysed and correlated with results from an ASA of a segment map, ITN and OSM model. The comparison extends and the builds on methodologies by Eisenberg (2007), Turner (2007) and Dhanani et al. (2012).

Eisenberg (2007, p. 5) focused on comparison of different axial line models for the same cities. The different models that Eisenberg compares are developed as a by-product of variations in analytical scales (pedestrian, bicycle and vehicular) and variations in the detail of the base information used for the production of the axial line maps. Eisenberg highlights that three indicators are of interest for a comparison. First, the impact of base map scales; Second, different levels of detail; And, third, different city morphologies (ibid., p.5). All aspects are directly transferable to the different network models previously introduced. Eisenberg’s findings suggest that the analysis should focus on ‘rank correlation measures’ in order to have a meaningful comparison (ibid., p.8). Eisenberg’s ‘rank correlation measures’, are applicable to every kind of network representation. This measure simply compares values and their respective rank within the data set. With Eisenberg's measure an appropriate method for the aimed analysis is established where numbers of lines differ significantly and the resulting values do not form a comparable unit.

In addition to ‘rank correlation’ this comparison will draw on the methodology of Turner (2007). Turner proposed an angular based analysis in combination with segment length-weighting and the introduction of a metric length based radius. While an angular based analysis incorporates the cognitive dimension of route choices, the reasoning behind a segment length-weighting is to overcome the large differences in segment numbers between the different representations (ibid., p.541). Turner shows how his propositions are an advancement for space syntax analysis in general and in the context of road-centre line networks in particular.

Finally the above proposed methods will be merged with a methodology by Dhanani et al. (2012). Dhanani et al. conducted a comparison of road-centre line networks against axial line models using a general description of the network characteristics followed by a topological and metric step depth analysis from the most central segment. Although the outcome of the topological step depth showed interesting results the application of topology on a road-centre
line network remains inappropriate as road-centre lines topological information is highly skewed by its nodal information. The measure of topology in space syntax analysis is based on the cognitive and visual space in the sense that what is considered as one space in space syntax would result in several spaces in a road-centre line network. The analysis will only draw on the measure of metric step depth (MSD) for comparisons as MSD is not affected by nodal information.

In summary, the following comparison is based on four different road network models of the centre of the city of Leeds. The city of Leeds was selected because it features a variety of different network details such as motorways, traffic management details as well as local paths. The road network models are: the Ordnance Survey ITN network, the OSM network, a simplified version of the OSM (SIMP) and a segmented axial line model (SM). The ITN network and the OSM data are not simplified but instead used as they are provided by the organisations. Moreover, the ITN and OSM networks where controlled on topological consistence, yet, no irregularities were found. Some network categories, as those mentioned in the OSM data sections, have been removed from the OSM data set while traffic management details remained unchanged. The four models are compared in regard to their network characteristics and analysed on 14 different radii from 100 up to the entire system n using angular segment analysis with segment length weighting. The models are analysed on closeness and betweenness centrality. The resulting structures of three exemplary scales are visually compared. Then, subsequent correlations are conducted using ‘rank correlation measures’. To facilitate comparisons mean values of coincident segments of the ITN, OSM and SIMP with the SM model are plotted on each respective SM segment.

4.1 RESULTS

The applied scales are: 100, 150, 200, 300, 500, 800, 1300, 1800, 2500, 3200, 4100, 5000, 6100 and n.

Figure 4 - Detailed section of different network models of ITN, OSM, SIMP and SM.
Figure 4 shows a small section of each of the modelled areas. The section of the ITN network shows traffic islands as well as road interruptions. Some roads have significant angular turns just before their connection with the adjacent road. This is because for traffic management purposes rectangularity is preferred. In the light of angular segment analysis, Dhanani et al. (ibid., p.10) consider this preference an important aspect and the most detailed and ‘optimal’ account of the street network. The aerial photo of the area (Figure 4) shows that at this point a straight connection is a more reasonable account of the real world situation. Additionally, at the lower right there is a road divergence into two separate lanes. A noteworthy detail is also that roads, which could be considered as intersecting in reality do not share a common node in the road network, due to a 5-10 metre distance of their road-centre.

Table 1 highlights the network characteristics for the four models and how they differ numerically. The ITN network features the longest total network length with 283410 metres. This is particularly due to the several roundabouts and traffic management details within the model. The comparison of traffic management details with the length of the ITN and OSM networks enables a rough account of the effect on the length of the network. This account does not come to its fullest as the OSM network features streets and connections that are not represented in the ITN. The several multi line motorway roads, which are represented by a single segment in a segmented axial line and SIMP model cause a large difference of 40km of the ITN and OSM data in comparison to the segmented axial model. Comparing all networks, the difference in number of segments is striking. The ITN model has three times more segments than the segment map representation. This difference is due to the curved roads and roundabouts, which feature large numbers of segments in order to give precise accounts on the length of the lines. While this exemplifies the detailed account on angular changes in road centre-line networks, it also shows the inherent problem this data has when it comes to space syntax analysis. The computational time is O(n²) to the number of segments. Generally speaking, the ITN and OSM are similar in their measures and the difference in number of segments is as expected. With regard to the segmented axial line and SIMP model the question is whether the SIMP model, with 33% less segments, does also stores less information. The number differences can be explained by the ‘cleaning’ of intersecting spaces: Whenever three segments intersect with each other segmented axial line models tend to create clusters of very short segments. Additionally, when the axial line model is converted to a segmented axial line, stubs that fall over 40% of the line length are not removed and might also contribute to this difference. The SIMP model features almost the same length as the segmented axial line model pointing towards a similar degree of spatial representation.
These observations become more apparent with a look at the histograms for segment length distribution for each model type. While the ITN network exhibits an even increase of segment length with declining frequency, the OSM shows an initial increase indicating fewer stubs and curve segmentation than the ITN. Moreover, the short line cluster effect of the SM model becomes visible with almost thousand segments in the range of approximately 1-10 metres. Contrarily, the SIMP model has a steep increase of frequency with a peak at a mid range of approximately 30 metres indicating less of a short line information. The simplification range used during the simplification process has an influence on this peak.

Dhanani et al.’s (ibid., p.25) study shows that differences between road centre-line network and axial line models are consistent in their appearance and concludes that the different models do not form a fundamentally different structure of the spatial configuration. In the next step I will compare the new SIMP model with this assumption. Figure 6 shows the number of segments for nine different radii where the maximum is 2,5km as this is the distance at which the entire system was captured (in other words n). For the four models, the total number of segments reached per metric distance increases in relation to the total number of segments. The semi-log plot highlights these similarities and differences, especially at lower scales. The SM and SIMP model, exhibit a similar development, while the OSM and ITN, which were initially similar, disperse towards growing metric distances and due to the increase of network details. Unlike the values for the central segment the curve for the edge segment shows a slightly uneven development. This becomes clearer in the semi-log plot of the data. Here, particularly the development around the scale of 500 metres unveils that there are underlying differences in the complexity of the models that might have an effect on the analysis.
In order to arrive at a better and more detailed account of the impact of differences in the network morphologies, I conduct a comparison of betweenness and closeness centralities using a segment angular analysis with segment length weighting. The models are analysed on 14 different radii. The applied scales are: 100, 150, 200, 300, 500, 800, 1300, 1800, 2500, 3200, 4100, 5000, 6100 and $n$. Two of these scales, 800 and $n$, are visualised in order to understand the geographic distribution of differences. Figure 7 shows the results for betweenness centrality. Figure 8 shows the results for closeness centrality. The values of each figure are broken down using a quantile division. This is done to overcome significant outliers in the data sets that make a natural break highly skewed and the resulting maps illegible. These circumstances make it necessary to process the data in a GIS programme rather than applying the implemented symbologies of depthmapX.

Figure 6 - 1a: Number of segments for different metric step depth from the most central segment for ITN, OSM, SM and SIMP models. 1b: Semi-log plot of the same data set. 1c: Number of segments for different metric step depth from an edge segment for ITN, OSM, SM and SIMP models. 1d: Semi-log plot of the same data set.
Figure 7 - ITN, OSM, SIMP, and SM models analysed on ASA SLW betweenness centrality on radius metric 800 (1) and radius n (2).
Figure 8 - ITN, OSM, SIMP, and SM models analysed on ASA closeness centrality on radius metric 800 (1) and radius n (2).
The results show that all models exhibit comparable patterns on all of the two visualised scales and both measures of betweenness and closeness centrality. This confirms the initial findings of Dhanani et al. (2012). However, similarities in the results were much stronger between the OSM network and the SM than they were between ITN and SM. Nominal segment differences appear to have a higher impact on betweenness centrality than on closeness centrality. Models with large numbers of short segments and high degree of precision, such as the ITN network, are, thus, more likely to be affected by outliers and unexpected clusters, than models with fewer short segments. Moreover, the ITN network shows high values on all scales in the motorway network. The SIMP model showed patterns that were visually stronger related to the SM model than to the ITN or OSM and more similar to the OSM compared with the ITN. This is rather unexpected as SM models are thought to be intrinsically different.

After getting an understanding of differences and similarities in the geographical distribution of the data between the different models and the SIMP model in particular a final analysis of the statistical extent of these observations is conducted. This will give an account of how models behave in comparison to each other across all scales. As elaborated before, the analysis draws on Eisenberg's proposed 'rank correlation measure'. To give a more detailed account, differently to Eisenberg, this analysis will compare all segments that are intersecting rather than only 10% of highest values proposed by Eisenberg (2007). This is done by plotting mean values of the ITN, OSM and SIMP on the SM model. The SM model is used as a base and comparisons are only conducted with streets whose middle point falls into a 10-metre distance of a SM segment. These middle points are then snapped to the closest segment and plotted on the SM model. If more than one street segment of an ITN, OSM or SIMP model falls into this category, their mean is calculated and plotted on the SM model instead.

Eisenberg's rank correlation is based on Spearman's Rank correlation (ibid.). Spearman's Rank correlation coefficient is generally used to identify and test the strength of a relationship between two sets of data. It tests if the relationship of both variables can be described by a monotonic function. Ideally, the SIMP model could predict the segmented axial line model by such monotonic function. In addition to this, a Pearson correlation will be conducted. Rather than correlating the different ranks of each variable, a Pearson correlation works with the actual values of the variables and measures their linear correlation. Both correlations provide a coefficient R² indicating how related the variables are with each other. A coefficient of 1 indicates that the two models are identical. Any value below 1 describes the degree of difference. One can hence compare the differences between all models statistically and provide a correlation coefficient to describe the fitness of the SIMP model for the purpose of space syntax ASA. The analysis is based on 14 different scales for both space syntax measures of betweenness and closeness centrality. Figure 9 and Figure 10 show Pearson and Spearman correlations of ITN, OSM and SIMP compared with the segmented axial model and, subsequently, the same for all models correlated against the SIMP model.

Starting with Figure 9 the findings from the initial visual description becomes also statistically apparent. A first observation is that the Spearman rank correlation provides more consistent results across scales and measures with weaker differences and higher scores. The Pearson correlation on the other hand shows much stronger differences in the four data sets but features a significant outlier on the scale of 100 metres for closeness centrality. In regard to the single models the ITN model shows lower correlations across both Pearson and Spearman measures and on both betweenness and closeness centrality. Particularly interesting is the significant drop towards higher radii, with a lowest correlation of 0.56 on Pearson for betweenness and closeness. This increases at the Spearman's rank, however, the general tendency towards lower correlation at higher radii persist. In terms of the visual observations made earlier this is caused by traffic details and the strong representation of motorway features. The OSM and SIMP model on the other hand show very comparable correlation developments. An exception of this is the Persons correlation for betweenness centrality of the OSM model where similar to the ITN a sudden drop at higher radii is visible. The SIMP model correlates stronger across all measures with the highest scores of 0.983 for Spearman correlations of closeness centrality metric 1300 and 0.919 for betweenness centrality. Contrary to OSM and ITN the correlations for SIMP are very consistent.
Figure 10 shows the Pearson and Spearman correlations for 14 different scales and closeness and betweenness centralities. However, this time ITN, OSM and SM models are compared with SIMP. The general correlation developments are very similar to the ones we have observed previously, with a progressive drop of values towards higher radii. Interesting is at this point how ITN and OSM behave compared to the SIMP model. While the ITN networks shows a slightly weaker correlation, the OSM correlates much stronger. This was on one hand an expected result, as the SIMP model is entirely based on the OSM. On the other hand in the light of the overall comparison it seems as if the simplification process brought the simplified OSM model much closer to the segmented axial line representation than expected.
These differences become more apparent with regard to a log-log scatterplot of betweenness and closeness centrality of the global scale $n$ (Figure 11). The diagram shows a log-log scatterplot of each of the measures allowing a visual comparison of outlier distribution within each data set. The more dispersed the values are the less they correlate while linear consolidation implies stronger correlations. This is clearly visible for the log-log plot of axial and SIMP while both other models show stronger dispersion. The ITN model shows outliers across the values from low to high, which is particularly the case for closeness centrality. To summarize, the results
Figure 11 - Log-Log plots for the SM model compared to ITN, OSM and SIMP respectively for ASA SLW betweenness and ASA closeness centralities on radius n.
show that the four models differ especially in terms of the number of short length segments. This difference can be described by an exponential relation and has a significant impact on the computational time needed for the analysis. The results of the metric step depth analysis confirm the findings of Dhanani et al. (2012) and show that all models share a similar complexity in terms of their nodal distribution. However, the analytical space syntax analysis showed that, albeit, there is a similar distribution in the data in general the geographic location of these differences has an impact on the results. The ITN network is strongly influenced by its emphasis on vehicular movement and traffic management details. This makes it less comparable to the segmented axial line model than the OSM model or the SIMP.

5. CONCLUSIONS

Concluding, this paper elaborated the fitness of OSM data in space syntax analysis, it proposed an ArcGIS simplification workflow and presented the theoretical reasoning behind the method. The final fitness tests showed that the simplified OSM network (SIMP) exhibits very strong similarities with the traditional segmented axial line model across all investigated cases. It features the topological and angular information of the OSM network with the simplistic representation of a segmented axial line model. This is rather surprising, because the alterations in the model are mainly based on segment nodal reduction and minor topological alteration. The Pearson and Spearman correlation analysis showed that the SIMP model is in fact stronger related to the segmented axial model than to the OSM model. The strong similarity between SIMP and segmented axial also poses question to weather axial line models are such intrinsically different representations.

Overall the findings suggest that a simplified OSM network forms an appropriate model for space syntax analysis, particularly in the light of regional investigations where the production of an axial line model is not a feasible option.
REFERENCES


EMPLOYING VOLUNTEERED GEOGRAPHIC INFORMATION IN SPACE SYNTAX ANALYSIS


#151
THE SPATIAL CONFIGURATION OF MINORITY ETHNIC BUSINESS DIVERSITY IN LONDON’S HIGH STREETS

LAURA VAUGHAN  
Space Syntax Laboratory, Bartlett School of Architecture, University College London 
l.vaughan@ucl.ac.uk

SADAF SULTAN KHAN  
Space Syntax Laboratory, Bartlett School of Architecture, University College London 
sadaf.khan.11@ucl.ac.uk

LUSINE TARKHANYAN  
Space Syntax Laboratory, Bartlett School of Architecture, University College London 
lusine.tarkhanyan@ucl.ac.uk

ASHLEY DHANANI  
Space Syntax Laboratory, Bartlett School of Architecture, University College London 
ashley.dhanani@ucl.ac.uk

ABSTRACT
Previous research has shown that the local town centre can be a space of considerable socio-economic diversity, manifested in its being a place of work and community activity in addition to retail activity. The long-term sustainability of the town centre has been shown to correspond to its configurational spatial signatures. Where high streets exhibit a high ethnic diversity amongst proprietors, there appears to be a corresponding diversity of land use and goods, with a tendency to adapt and alter space for greater economic benefit. Small independent units are often further subdivided to accommodate a greater number of services and products. In the context of the local high street in the UK, the small independent Minority Ethnic Business (MEB) is a common feature, whether it is a halal butcher, an Indian chemist or a Chinese takeaway, serving both an embedded local minority community as well as often having a wider mainstream appeal. This paper seeks to examine the relationship between spatial configuration and socio-economic diversity of the local high street to investigate whether the potential for diversity is embedded in its contextual spatial characteristics.

For the purpose of this study using nationally defined town centre boundaries, ten town centre case studies were selected from around London based on their residential ethnic profile and the level of deprivation of the area. Building on the literature that shows that land use diversity is associated with the persistence of smaller town centres, we test the proposition that it is also associated with the presence of MEBs. Here we tested the degree of impact of MEB presence on commercial diversity across these case studies.

Additionally, the study examines the spatial and morphological signatures of these case studies and how these relate to the context of MEB presence and land use diversity, finding a strong relationship between spatial and urban form factors and a greater presence of MEBs. The study concludes that given the importance of spatial accessibility coupled with built form diversity to the presence of MEBs, greater attention needs to be given to the embedded social value in the spatial characteristics of town centres.
KEYWORDS
diversity, land use, morphology, minority ethnic businesses, London

1. INTRODUCTION

Previous research has determined that smaller town centres function best when they are sustained by local industry and the provision of a wide range of professional and community services in addition to office and retail employment. Such centres are enlivened by activities occurring at overlapping spatial scales, the outcome of journeys of different lengths which are most likely to be repeated where network accessibility is most effective. (Vaughan, et al. 2009) The diversity of land uses along the main high streets of town centres has been shown to constitute an ecology of mixed use. This ecology is supported by an ecosystem of built form and street network characteristics which allow for its long-term evolution. (Vaughan et al., 2015; Törmä et al. 2017) In this paper we present research which goes deeper in the relationship between land use diversity, and the contextual spatial and social characteristics of London's high streets, examining the relationship between spatial configuration, plot size and socio-economic diversity of the local high street to investigate whether the potential for diversity is embedded in its contextual spatial characteristics.

In a post-industrial time of mass transnational migration, the emergence and growth of the small independent, minority owned firms has become a phenomenon that has been seen to make a considerable contribution to local economies. It has been suggested that the emergence of minority ethnic businesses (MEB) has been the result of a convergence of circumstances; rising post-deindustrialisation unemployment amongst migrant communities, the resultant lack of cultivation of skills required for more conventional employment in their new environment such as language proficiency and adequate education and career skills, minority immigrant groups resort to self-employment as a survival strategy (Barrett et al. 2001).

Often due to the lack of skills required and low initial capital outlays, migrant businesses tend to occupy the lower end of the market in easy-to-enter businesses such as food retail, clothing and restaurants (Hall 2011). Whilst this trend of self-employment may be the outcome of initial shortcomings in skills and/or a degree of prejudice and exclusion on the part of the host community, this entrepreneurial mind-set has proven to be advantageous to minority communities in providing employment for co-ethnics over time, in the form of a "protected market" (Aldrich et al. 1985) for the ethnic businesses and access to speciality items such as food, clothing, music and entertainment to ethnic minority groups looking for products from home (Iyer and Shapiro 1999). MEB owners have been known to mitigate against financial risk by subdividing and subletting space. This can result in adding diversity of land uses and creating complementary services on one site (Hall 2011). Over time, certain ethnic products and businesses have found an emerging demand beyond their niche markets, resulting in ethnic businesses becoming cultural destinations where minority ethnic culture can be consumed by the mainstream (Barrett and McEvoy 2006), 2006) and in some cases, national grocery retailers might stock ethnic products for mainstream consumption (Jamal 2003).

Studies have shown that there appears to be some degree of correspondence between areas of ethnic diversity and deprivation (Hall 2013), and that deprivation is often related to spatial accessibility (Vaughan & Geddes, 2009) which in turn shapes a residential population's access to employment, services and a wider social network (Legeby 2009). This may in part be responsible for the relationship between high neighbourhood minority ethnic presence and higher MEB start-ups. In addition, people living in deprivation are most in need of locally accessible centres with a diverse set of activities, since these are the places in which the less mobile are often highly invested socially, culturally, and economically (Hall 2011).

This paper reports on part of a wider study which investigated MEB high streets in London. It focuses on one of its main hypotheses, that MEB high streets have distinct spatial characteristics that are measurably different from non-MEB streets. In other words, high streets which contain a large number of minority ethnic businesses are likely to be benefitting from factors such as local
accessibility and narrower frontages. To this end, the following sections first describe the study methods, then describe the research statistics and subsequently analyse these statistically.

2. DATASETS AND METHODS

London is a city where 179 nationalities are represented and 300 languages are spoken city-wide (Knowles 2013) and exhibits high levels of ethnic diversity, particularly in inner London boroughs (Paccoud 2013). It has also been shown to be made up of a well-structured network of centres and sub-centres (Hillier 1999) and that there is an association between longevity of a town centre, land use diversity and spatial adaptability (Vaughan 2015a; Törmä et al. 2017). It is for these reasons that London was chosen as a focus for the study, which considered a sample of ten commercial streets (or in the UK terminology, high streets) and their immediate environs. The streets are located in a range of London neighbourhoods selected to obtain a range of types defined by residential ethnic composition, level of deprivation and land use diversity.

The sample (see Figure 1) was chosen to represent a cross-section of socially deprived/affluent and ethnically diverse/homogenous London neighbourhoods. It used the following sources of data, from which it selected cases which ranged from low deprivation and low ethnic diversity to high deprivation and high ethnic diversity:

- The index of multiple deprivation (IMD), using data at the level of Lower Layer Super Output Area (LSOA) geographical areas comprising 1000-1500 population size.
- The eighteen categories of ethnicity as defined by the Office of National Statistics (ONS) based on responses from the last census (2011).

The town centres were further filtered by using land use diversity as the control variable, selecting only those within the top 30% of land use diversity, defined using UK standard business classes, of which there are thirteen categories.
Cases were also varied geographically to cover inner and outer London, spread around the points of the compass. The study areas themselves were determined using UK national town centre boundaries, which define the peak office and retail activity in an area (Astbury and Thurstain-Goodwin 2014). Each study area was then analysed to determine its primary commercial street (high street), defined by its having peak non-residential activity, lying between two major intersections, and being morphologically similar, namely terraces with a ground floor plus two stories above with a predominance of commercial activity on the ground floor, and normally a maximum of two lanes of traffic.

A diversity index was constructed based on data available for each high street block in the case study areas. This type of index is commonly used in ecological studies to measure the diversity of species in a community. In this study we adopted this measure to identify the composition of high street blocks in terms of their land use types and MEBs. Hence, for every high street block, the land use diversity and MEB diversity was calculated using Shannon Wiener Diversity Index. Higher scores of diversity are indicative of greater and more diverse land use/MEB presence in the given block and a score closer to 0 indicates the presence of a small number of land use types (i.e. a single building with one land use type within a block face) or in the case of MEB, a block face where no MEB business is present.

3. DESCRIPTIVE STATISTICS

Summary data for each high street are presented in Table 1. Note that the first column indicates the characteristics of the local residential population. Here, diversity is a measure of the presence of many different non-British groups – hence the somewhat counter-intuitive result for Southall, which has a high South-Asian residential population, but not many other minority groups within its local population.

<table>
<thead>
<tr>
<th>Socio-economic category of background population</th>
<th>Name</th>
<th>Length (m)</th>
<th>No. of Blocks</th>
<th>No. of units</th>
<th>Avg. area of units</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Dep-High Ethnic diversity</td>
<td>Deptford High Street</td>
<td>417</td>
<td>11</td>
<td>114</td>
<td>114.39</td>
</tr>
<tr>
<td>High Dep-High Ethnic diversity</td>
<td>Watling Avenue, Burnt Oak</td>
<td>318</td>
<td>8</td>
<td>92</td>
<td>99.61</td>
</tr>
<tr>
<td>Low Dep-Low Ethnic diversity</td>
<td>Putney High Street</td>
<td>673</td>
<td>11</td>
<td>136</td>
<td>158.14</td>
</tr>
<tr>
<td>Low Dep-Low Ethnic diversity</td>
<td>Wimbledon Village High Street</td>
<td>496</td>
<td>14</td>
<td>109</td>
<td>112.50</td>
</tr>
<tr>
<td>High Dep-Low Ethnic Diversity</td>
<td>Walworth Road</td>
<td>503</td>
<td>12</td>
<td>136</td>
<td>179.96</td>
</tr>
<tr>
<td>High Dep-Low Ethnic Diversity</td>
<td>Bethnal Green Road</td>
<td>450</td>
<td>14</td>
<td>114</td>
<td>111.98</td>
</tr>
<tr>
<td>High Dep-Low Ethnic Diversity</td>
<td>The Broadway, Southall</td>
<td>470</td>
<td>12</td>
<td>164</td>
<td>149.15</td>
</tr>
<tr>
<td>High Dep-Low Ethnic Diversity</td>
<td>High Street, Romford</td>
<td>505</td>
<td>8</td>
<td>65</td>
<td>232.32</td>
</tr>
<tr>
<td>High Dep-Low Ethnic Diversity</td>
<td>St. John’s Wood High Street</td>
<td>454</td>
<td>10</td>
<td>97</td>
<td>117.50</td>
</tr>
<tr>
<td>Low Dep-High Ethnic Diversity</td>
<td>Station Road, North Harrow</td>
<td>404</td>
<td>11</td>
<td>83</td>
<td>140.17</td>
</tr>
</tbody>
</table>

Table 1 - Case study spatial characteristics
The land use characteristics for each high street were then observed and recorded in a GIS, where the commercial activity or business class, built form character and visible ethnic affiliation were recorded. Rather than using national classifications for ethnic affiliation (which are quite limited for our purposes; for example, grouping all African ethnicities in one class), we recorded the individual country affiliation. If a retail unit was part of a national chain, ethnicity would not be recorded, if it was an independent where the services or goods are aimed at a particular ethnicity or ethnicities/religions, ethnicity would be recorded, and finally if it was an independent where the ethnicity of the proprietor was identifiable yet the services or goods offered are generic, ethnicity would not be recorded.

Of the 1,108 units recorded across ten cases, 266 or 24% of the total number of recorded units were recorded as being minority ethnic businesses (MEBs). Further analysis of these businesses showed that MEBs seem to be of two types: those that provide a generic service such as the shop selling cheap plastic household products and luggage, and the other being those businesses supplying products such as clothing and fashion accessories for a specific ethnic group. This seems to be happening within the background of generic/non-ethnic services; i.e. banks, florists, funeral directors, and pawnbrokers. Keeping this in mind, MEBs on the high street are found primarily in three business classes – retail, retail food and food and drink. Of all the MEBs recorded 51.2% were retail, 19.4% were in the retail food category and 27% were recorded to be in the food and drink category leaving only 2.4% of MEBs in other categories.

There were varying degrees of MEB concentration across the ten sites (Figure 2). The percentages range from MEBs comprising over 50% of all units as is the case on Southall’s Broadway to just over 4% of all units in the case of St John’s Wood High Street. Within this distribution it should be noted that North Harrow, Deptford High Street, Burnt Oak and Southall all have over 25% of recorded units visually identified as MEB. Three of the four cases were found to have a local population with a high degree of ethnic diversity: North Harrow, Deptford and Burnt Oak. The fourth, Southall, has a primarily South Asian presence and over 50% visible MEB units. This variation in concentration of MEB units appears to confirm the proposition by (Vaughan 2015b) of there being three broad types of ‘ethnic marketplace’:

1. Locations with a high UK British presence, with a small presence of mainly food and drink outlets or other small MEB businesses, ranging from 4% to 9.3% (St. John’s Wood, Putney, Romford and Wimbledon Village);
2. High ethnic mix of local residential communities (Walworth Road, North Harrow, Deptford and Watling Avenue; though not Bethnal Green Road) with a paralleled diversity of MEB functions, ranging from 14.7% to 31.5%;
3. The ‘ethnic marketplace’, where a single category of MEB businesses dominate, as in Southall with over 50% units classified as MEBs, with a paralleled high presence of people from a South Asian background.

![Figure 2](image-url) - Percentage of high street units that are MEBs

THE SPATIAL CONFIGURATION OF MINORITY ETHNIC BUSINESS DIVERSITY IN LONDON’S HIGH STREETS

151.5
4. RESULTS

Our first hypothesis, that high MEB presence and diversity has a positive impact on the commercial diversity of a local town centre was supported by the evidence (and will be published in a forthcoming paper dedicated to the subject). We found that high streets which contain a large number of minority ethnic businesses with a wide range of business types correspond to greater availability of a range of products and service types within a given high street. The main hypothesis to be explored in this paper takes this finding and poses the question of whether high streets which contain a large number of minority ethnic businesses are likely to be benefitting from factors such as local accessibility and narrower frontages, which (as mentioned in the introduction), have already been shown to contribute to the presence of land use diversity.

The hypothesis that MEB high streets have distinct spatial characteristics that are measurably different from non- MEB streets was explored from a series of different spatial angles. In order to study whether high streets which contain a large number of minority ethnic businesses are likely to be benefitting from relatively high street accessibility and smaller units, MEB high streets were examined at both local (800m) and wider-scale (2000m) levels of accessibility, additionally the size of building units was examined in relation to the level of commercial diversity.

4.1 SEGMENT ANALYSIS

Space syntax analysis of the model of London’s street network was created using the Ordnance Survey Meridian 2 map source. The standard space syntax measures of segment angular integration (which models the amount of angular changes required to access all other street segments in a given network) and segment angular choice (which models the centrality of a street segment on routes between any two street segments). A range of metric search radiuses ranging from 400 to n (all segments within the model) were computed for each of the two measures. All town centres were plotted against local (800m) and wider-scale accessibility (2000m) – the two scales were chosen to approximate a normal distance of everyday walking (the former) and a maximum distance of walking (the latter), to test for variation in the ten case study locations. This can be seen in the following two Figures, which plot average integration radius 800 against radius n and radius 2000 against radius n, respectively (Figure 3 and Figure 4). Bethnal Green, Walworth and St John’s Wood high streets are in the higher band of accessibility both locally and at the wider scale in comparison to other case studies, followed by Putney and Deptford high streets. Romford’s high street is the least accessible from all case studies both 800 and 2000 metre scales.

![Figure 3](image1.png)  
**Figure 3** - A plot of all town centres within London, highlighting the ten cases as well as London’s commercial heart (West End, Central London) for comparison. The X axis shows average for all segments within a town centre at radius n (city-wide); the Y axis shows integration radius 800 metres

![Figure 4](image2.png)  
**Figure 4** - A plot of all town centres within London, highlighting the ten cases as well as London’s commercial heart (West End, Central London) for comparison. The X axis shows average for all segments within a town centre at radius n (city-wide); the Y axis shows integration radius 2000 metres
In the following analysis we defined a perimeter of 2000m around each high street to capture data on the extents of its maximum catchment on foot. We then compared the space syntax characteristics of the ten high streets with their surroundings, to see if they were significantly different in measures of integration and choice at radius 400, 800, 1200 and 2000.

**Table 2** shows the results of this comparison measured by counting how many standard deviations (SD) away the average syntactic value of accessibility for each high street is when compared to its wider setting for both Choice and for Integration (which have been shown to be predictors of through and to-movement, respectively). Low SD is indicative that the accessibility level of the high street is very close or similar to the average accessibility level of the surrounding area. High SD means that the high street’s accessibility values are more spread away from the mean, which is indicative of the high street being more accessible than the surrounding areas.

Overall, it can be seen that the majority of the high streets are more integrated than the average for their surroundings; at least 1 standard deviation higher than the average value of accessibility of the surrounding area. The results suggest that some high streets such as Bethnal Green Road, Deptford High Street and Southall Broadway have a very strong core both at local and wider scales of movement (up to 3 standard deviations higher than the mean value for the surrounding area), suggesting they act both as a destination to and a place to move through. Others, such as St John’s Wood high street and Walworth Road act as a local destination only for up to 10 minutes of walking, after which it could be said that they fade into the background of trips of longer lengths. For the Burnt Oak, Wimbledon Village and Putney cases, the high street remains the core of the neighbourhood across the different scales of movement. Romford High Street peaks at an approximation of 10 minutes (800) and 25 minutes (2000) of walking. North Harrow’s high street acts more as a destination through the area.

<table>
<thead>
<tr>
<th>Locality</th>
<th>Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R400</td>
</tr>
<tr>
<td>Bethnal Green Road</td>
<td></td>
</tr>
<tr>
<td>Burnt Oak</td>
<td></td>
</tr>
<tr>
<td>Deptford High Street</td>
<td></td>
</tr>
<tr>
<td>North Harrow</td>
<td>-</td>
</tr>
<tr>
<td>Putney High Street</td>
<td></td>
</tr>
<tr>
<td>Romford High Street</td>
<td>-</td>
</tr>
<tr>
<td>Southall Broadway</td>
<td></td>
</tr>
<tr>
<td>St John’s Wood High Street</td>
<td></td>
</tr>
<tr>
<td>Walworth Road</td>
<td>-</td>
</tr>
<tr>
<td>Wimbledon Village High Street</td>
<td>-</td>
</tr>
</tbody>
</table>
THE SPATIAL CONFIGURATION OF MINORITY ETHNIC BUSINESS DIVERSITY IN LONDON’S HIGH STREETS

4.2 BUILT FORM ANALYSIS

Analysis of the built form characteristics of the high streets measured plot size to see if it affects levels of MEB diversity (namely, whether smaller plots were associated with a greater number of different minority ethnic businesses). Figure 5a shows that the median score of MEB diversity for the ten case studies is around 0.5 and the middle 50% of scores fall between 0.3 and 1.2. However, the distribution is quite skewed, with the top 25% of diversity scores stretched over a wider range. The skewness of the distribution suggests that MEB diversity varies markedly across the urban blocks of each high street. Whether these differences hold when comparing between the high streets is examined as follows.

When the individual high streets are examined (Figure 5b), the scores vary in their distribution across the high streets. For example, both Walworth Road and Southall Broadway have a tight cluster of diversity scores which is indicative that all their blocks have similar levels of diversity (despite the fact that Southall Broadway has overall a much higher score of diversity than the Walworth Road. In contrast, in the case of North Harrow and Bethnal Green Road, the blocks have the whole spectrum of MEB diversity present along the street.

Table 2 - Standard deviation of the average syntactic values of the high street in comparison to the average syntactic values of its surroundings up to 2000 meters from the high street centre point

In fact, all high streets with a recorded MEB presence of greater than 20% are more integrated with respect to their surrounding areas than their low-MEB counterparts across scales – integration often increasing as scale increases. Moreover, all high MEB high streets have a large amount of Retail, Retail Food and Food and Drink functions. Bearing in mind their high rates of large scale integration, this suggests that they function not only as local high streets, but are also able to make the most of their spatial configuration to serve people making trips from farther afield. It should be noted that in the case of both Southall Broadway and Bethnal Green Road, these high street spaces are in fact arterial routes through the city in these areas (in the case of Southall Broadway, it seamlessly changes name as it transforms from a local high street to an arterial route both to the east and to the west). On the other hand, low-MEB high streets (Walworth Road, Putney High Street and St John's Wood High Street) appear to be functioning primarily as local centres.

The findings in this section tie in with Hall’s claim that minority ethnic commercial centres are located ‘physically near to the centre but perceptually distant from it’ (Hall 2011, p. 2572). Their high spatial integration allows for the footfall required for commercial viability whilst their perceptual location in the ‘urban margins’ provides an environment conducive to the emergence and presence of alternative cultures and economies.
In order to test whether MEB diversity is supported by the built form character of the available units, the average area of MEB units across the ten sites was compared. It was found that the average for MEB units was 112 square metres as opposed to an average of 149 square metres for non-MEB units.

When the building blocks are broken down by MEB presence (see Figure 6), it can be seen that across the high streets overall, MEB units are much smaller in size than those building units that do not have MEB. The exceptions to that rule - Wimbledon Village High Street and St John’s Wood High Street – were cases with low ethnically diverse and low deprivation areas, where restaurants and bars were pushing up the average building footprint of MEB units and Watling Avenue Burnt Oak, an area with a population with high rates of deprivation, who are served by large supermarket units with specialized food offerings, such as Polish and Turkish food and fresh fruit and vegetables at cheaper prices than the local chain supermarkets.
Since, the MEB diversity index is derived from the both abundance of a particular type of land use and the number of land uses within a block, it is plausible to suggest that the density of buildings within a plot has an indirect effect on how much MEB diversity variation is potentially offered across the high-street (namely that the built form structure of the high street blocks influences MEB diversity). Figure 7 tests this proposition. Whilst only showing a marginal trend towards smaller units being associated with a diversity of MEBs, it opens the way for further research to see the extent to which land prices and land economics in general help shape the relationship between the availability of smaller units and an increase in the diversity of MEB units.

5. CONCLUSIONS
This paper set out to examine the spatial character of high streets with a presence of minority ethnic businesses. It has found that in London’s super-diverse context, almost a quarter of the 1108 units recorded across the 10 cases were visibly identifiable as such. While the cases were sampled with care to represent the full range of cases, it is perhaps unreasonable to draw too strong a set of conclusions from the findings. However, analysis of both the background residential population and MEB presence on the high street seems to support the idea that there are in fact three distinct types of MEB presence on the high street, ranging from low ethnic population areas, where MEB presence is limited to three primary functions of retail, food and food and drink; areas that exhibits a high ethnic mix of communities, and a third category of mono-ethnic areas. This finding begins to indicate that where there is an embedded minority ethnic neighbourhood presence there is a more diverse MEB presence. Further research needs to consider the extent to which this also corresponds to the presence of deprivation within the wider neighbourhood – namely, is there a secondary benefit from an MEB presence to populations living within the surroundings of such centres? However, when the three MEB groups (ethnic market, mixed and UK British) were tested statistically, no difference was found in their background ethnic diversity, yet our analysis found that there is a marked relationship between MEB presence and background ethnic diversity: high ethnic diversity leads to high MEB presence on the high street. We elaborate on this analysis in another forthcoming paper.
From the point of view of the built form and space syntax analysis, the results suggest that the morphological structure of the high street blocks affects how much MEB diversity variation can be found on the high street. This suggests that the MEB diversity is quite different both across the urban blocks and across the high streets. MEBs tend to occupy smaller square metre area units within the blocks in comparison to non-MEB units. Smaller average building blocks unit size appears to support and promote not only higher MEB diversity, but brings more commercial activity to the area overall.

High deprivation areas have a tendency to attract a greater MEB presence. This may be attributed to the ethnic make-up of the background residential presence in an area and the fact that in many cases minority and migrant communities gravitate to high deprivation areas. However, what is clear from these findings is that given the right spatial network and built form settings: namely relatively high local integration and a larger number of smaller business units, a population that suffers from relatively greater deprivation can gain the benefit of the greater range of shops and businesses within easy reach of their area – providing not only opportunities for cheaper goods, but increased sociability and access to work. Arguably, our findings suggest that even a small number of units can bring an additional dimension and character to the High Street beyond the offerings of national chains. The relatively ramshackle, shabby premises that prevail in some of the case studies are a crucial way both for the temporary and impromptu sort of uses necessary for contemporary living but also for ensuring that local businesses can have access to affordable and flexible space and thus to the wider market at all stages of the economic cycle (Dobson 2016), but also for building the early stages of businesses that both serve local needs, but also to test its economic viability. As we have argued elsewhere, the spatial configuration that supports a local, diverse town centre to be connected to the wider city network allows for a range of people to move, encounter and interact in the most beneficial way.
REFERENCES


ABSTRACT
Integrating social and spatial networks will be critical to new approaches to cities as material systems of interaction. In this paper, we propose a way of doing so by focusing on the spatial and temporal conditions of formation of social networks – namely, on ‘encounters’ as a key social event. Drawing on classic approaches such as Freeman’s concept of segregation as ‘restriction on contact’ and Hägerstrand’s time-geography, and recent explorations of social media locational data, we analysed the space-time structure of potential encounters latent in the urban trajectories of agents differentiated by income levels in Rio de Janeiro, Brazil. This approach allows us to estimate agents’ urban trajectories examining geographic spatiotemporal positions in tweets, visualise income groups as potentially overlapping class networks, assess spaces of potential encounter and levels of social diversity on the streets. Finally, we discuss our findings and the utility and limitations of this approach in grasping a temporal ‘geography of potential encounters’ and segregated networks.

KEYWORDS
Social networks, spatial networks, encounter, segregation, mobility, Twitter locational data.
Cities are social networks of people and institutions, whose physical organisation allows the exchange of artefacts and information. If linking the social city to the physical city is a major challenge in urban studies (Hillier and Vaughan, 2007; Batty, 2013), the problem of relating social networks to built environments as spatial networks lies at its very centre. In other words, if we are to advance our understanding of the relations of the social city to the physical city, we need to get closer to the very foundational elements of those relations: the city as "sets of actions, interactions, and transactions . . . patterns of flows, of networks of relations, pertaining to both physical-material as well as ethereal movements" (Batty, 2013:9). In this sense, we propose to approach the very material conditions of formation of social networks. Social networks are of course formed through opportunities of contact, encounter and interaction as ‘social events’ in time and space. The city has historically had the role of producing such events.

We will examine in this paper the relationship between forms of social networking and the mobilities of different agents in a city. Closer to a more recent trend in sociospatial studies focused on the positioning of agents in urban space rather than location, our approach explores ways in which the formation of networks is shaped by the potential of encounter within the trajectories of bodies in urban space where co-presence is likely to happen – or not. In fact, this aim involves entering an elusive fabric of movement and encounter. This paper develops a method to capture such fabric, using ideas from Linton Freeman’s (1978) view of segregation as ‘restrictions on contact’ to references to the time-geography of Torsten Hägerstrand (1970).

We will develop these ideas in order to achieve a clearer understanding of (i) the role of encounter in the formation of networks, and its opposite, in segregation as a real time phenomenon, and (ii) the role of mobility in the opportunities of encounter, and its relation to social differences, especially in unequal societies. Then we shall (iii) develop a concept of sociospatial networks able to represent movement and potential encounters in time and space; (iv) explore the methodological use of social media locational data to grasp movement and infer potential encounter; (v) apply this framework in an empirical study of networks of trajectories and encounters of different income groups in Rio de Janeiro; and finally (vi) discuss our experiment and findings on sociospatial networks and their levels of superimposition.

2. THE ROLE OF ENCOUNTERS IN THE FORMATION OF SOCIAL NETWORKS

Cities may be seen as a fluctuating balance of density, mobility and social connectivity (Bettencourt, 2013). Connectivity is of course highly dependent on how encounters are generated by density and mobility. Encounters can be dispersed in the streets or polarized in places of work, leisure and consumption, at bus stops, subway stations, institutional buildings and so on. These factors may have an impact on our interactions, like sparks to a dense web of daily movements from residential locations. If movement could leave visible traces in space, such web of movement could reveal the potential to encounters and opportunities for social network formation unfolding in urban space.

Mapping these webs of movement in the city where encounter may or not happen is one of the aims of this paper. In fact, the idea of mapping trajectories is far from new. The work of Hägerstrand (1970) was the first systematic attempt to capture trajectories and restrictions spatiotemporal hanging over actions. Although Hägerstrand’s approach – fashionable in the early 1980s – has lost interest since then, recent empirical approaches have taken the spirit of that work (e.g. Lee and Kwan, 2011), making use of technologies capable of recording the movement of agents and identify patterns of mobility. We propose to add new layers to this idea, and evaluate how the mobilities of agents shape opportunities of encounter. Webs of movement are of course evanescent features of our effective presence in space. If we could capture at least some of them, we could have a picture of how social groups materialize their actions.

1 A method developed by Gonzales et al (2008) uses an extensive database recorded through mobile phone communication in American cities to map spatial paths, showing that actors have a remarkable tendency to recursivity.
We would like to explore an alternative definition of ‘social network’ intended to get closer to the web of encounters through which networks may emerge. We consciously opt to not use the concept as an arrangement of agents as in Social Network Analysis (SNA). The SNA tradition focuses on the analysis of phenomena varying from the microstructural, like epidemics or power relations or the spread of information within groups, to the large-scale, such as the small-worlds networks – frequently involving graph theory and a space without physical and temporal dimensions, an abstract space of pure topology. We choose to employ a definition of social network as an open and potential set of contacts changing over time – one able to take into account the social positions of the agents and the precise circumstances of time-space where contact may occur. Graphically and mathematically, we do not represent agents by vertices and relationships by links. Instead, we invert this representation, seeing agents as “lifelines” (as in Hägerstrand), with the important factor of the passage of time – which allows us to retain the dynamic property of a social system. The possibility of agents encountering each other is represented by the intersections of the agents’ lifelines. Encounters are the vertices, and agents’ lifelines, the potential links between them. This non-standard representation is favoured by a principle of homology in which lifelines correspond to urban trajectories, and circumstances of encounter correspond to converging positions (figure 1). This model seeks to add the temporal and spatial dimensions as inherent dimensions of social networking, and render the spatiality of encounter more intuitive. In short, it is intended to account for the potential of encounter as a key factor in social network formation.

Once we map agents’ lifelines in space-time (via the trajectories between collected positions), we leave a purely ‘social’ representation of networks. We are looking at sociospatial networks: the places of overlapping trajectories are the connections of potential visual contact and encounter. We do not wish to equalise ‘sharing space’ with ‘encounter as interaction’, however. We cannot claim to grasp the passage from encounter to interaction, for that would require observations of agents in their actual exchanges, which are outside our methodological scope. Following the work of Goffman (1961), Giddens (1984) and Hillier and Hanson (1984), we understand ‘encounter’ as the presence of an agent in one’s perceptual field in circumstances of co-presence. As the raw material of social life, the importance of encounters can hardly be over-emphasised.

3. CONTACT BETWEEN SOCially DIFFerent AGENTS

An interesting view of the role of encounters in social networks is found in Freeman (1978: 413): “All restrictions on interaction, whether they involve physical space or not, are forms of segregation – in social space.” We wish to explore Freeman’s view in order to understand the delicate fabric of encounters and interactions that keeps local social systems together. Mapping movement can allow an understanding of the spatiality of presence and absence as active

Figure 1 - Principles of homology between networks in time and social space (left), diagrammatic spatial translation (centre), and agent’s paths in space-time (right).
features of social networking and the emergence of segregated networks. In this sense, our approach shares the focus on social spheres and routinized activities found in a number of more recent works (e.g. Schnell and Yoav, 2001; Lee and Kwan, 2011; Selim, 2015).

What is the chance to meet someone from a different social group? We shall first examine a number of conditions of encounter reasonable from a material standpoint.

- First, social contact in cities depends on circumstances of encounter.3
- Second, cities are historically produced and spatially structured so as to make social situations in principle accessible. In fact, city-making processes are consistently related to patterns of location and accessibility. In a tradition stemming from Hansen (1959) to Glaeser (2010), approaches in spatial economics have been able to identify agents’ preferences and location patterns amidst the apparent randomness of location.
- Third, activity places tend to increase the potential for convergence of agents who share similar interests and mobilities.4
- Forth, income may play a role in this process. People with smaller budgets face further restriction in mobility. In turn, limitations in mobility enhance localism – the dependency on proximity to enact one’s social life (Fischer and Shavit, 1995; Lee et al., 2005). In these cases, the density of encounters would tend to increase especially around home, and agents would tend to use places in the neighbourhood to create and maintain relationships.5

Our hypothesis is that similarities in patterns of mobility and appropriation of space (the spaces we are likely to relate to, use or pass by) would lead to increases in the potential density of encounters especially between socially similar agents. In turn, this spatial trend toward both higher levels of homophily and different degrees of connectivity in personal social networks, both generated by differences in income, lifestyles and mobility, may have strong implications for contact between the socially different. We need to clarify how contact is effectively performed spatially, involving circumstances of co-presence and absence. For instance, could mobility – and not proximity – be the key factor in generating potential co-presence between the socially different? Approaches to mobility that make use of geographic information derived from digital data (say, the data usage of mobile phones) are still restricted to capture spatial patterns of behaviour (e.g., Gonzales et al, 2008) – with little connection with the social conditions of spatial behaviour, such as the influence of income and class.

Mobility and income seems associated in a circle that leads to increases or decreases in the potential to create, maintain and expand personal networks. But how so? If networking depends on situations of encounter, we need to understand how mobility matters in the structure of urban encounters. How (and where) does the potential of encounter between the socially different materialize? In order to answer these questions, we need to examine the superimposition of trajectories of different social groups. Income groups related to class, i.e. large-scale groups with common economic features that strongly influence their actions and lifestyles (Giddens, 1993) and other forms of social grouping are shaped by probabilities of encounter.

Space matters here. Even though we do not usually think about it, our daily trajectories constitute the backbone of our encounters and shape the elusive structure of social life in the city. The distance between locations in a city, associated with differences in mobility, income and lifestyle could bring inequalities in the capacity to participate in social situations. Inequalities and incompatibilities in patterns of movement are forms of disjunction of encounters – a way of disrupting the possibility of encounters that otherwise could happen. The disjunction of encounters may be especially active among socially different people. Simply put, there would be a greater chance of encountering and networking with those who share similar mobilities.

3 The heart of this idea may be found in Jacobs (1969); see also Giddens (1984), Hillier and Hanson (1984), Bettencourt (2013), and Batty (2013).
4 Bettencourt (2013) has recently theorized the effects of linear paths over the density of encounters.
5 See Marques (2012). Empirical data on transport expenses in Brazil show that higher income groups not only spend more than low-income groups, they spend more than proportionally (POF, 2009).
These ideas begin to portray the complex material fabric of encounters in a city. However, how can we understand in detail its volatile spatiality?

4. THE METHODOLOGICAL USE OF TWITTER LOCATIONAL DATA

It seems almost impossible to see the spatiality of the tremendously complex flows of convergences and divergences of our actions and paths in the city. So a key methodological question is how to grasp the panorama of an entire city. The answer is that we can track the movement of a large number of agents exploring the potential of social media locational data. In fact, a number of works has recently emerged using social media locational data in order to extract information of human patterns of movement. On a substantive level, Liben-Nowell et al (2005) related geography and online social networks (a community of bloggers) to find that one-third of relationships are not dependent on geography. Lee et al (2011) examine how the use of mobile communication channels of information affects just-in-time choices in consumption travelling behaviour. On a methodological level, Li et al (2011), Ribeiro et al (2012) and Zielinski and Middleton (2013) developed forms to infer indirect locations from Twitter geotag and timestamp, whereas Veloso and Ferraz (2011) and Takhteyev et al (2012) inferred spatially reliable information through regression models correlating tweet frequencies with real world events. Sakaki et al (2010) filtered georeferenced tweets, whereas Boettcher and Lee (2012) applied density-based spatial clustering.

In the spirit of these works, we conducted an empirical study in the city of Rio de Janeiro. This study is intended as a proxy to the actual dynamic scenario of trajectories of socially differentiated agents. Twitter offers particularly attractive possibilities in this sense, as it makes its metadata bank public through a principle of anonymity and the possibility of inferring characteristics of the spatial behaviour at the individual level, involving potentially large samples – although risks of generalizing from self-selecting users to the populations from which they are drawn must be carefully taken into account (Longley et al, 2015). The set of variables provided by Twitter API includes user IDs along with a spatiotemporal signal, the timestamp and geographic coordinates for each tweet posted by users who opted for having the GPS location in their mobile phones turned on. Considering the relation between tweet location and the actual street network, our study points to an accuracy within 10 meters, adjusted to the street network via shortest distance to the nearer street segment mapped in GIS software.

We collected metadata from tweets with spatiotemporal positions posted in Rio through the official Twitter streaming API between November 12th (0:07:13 am) and 14th (2:36:45) during a period of 56 hours, generating a database of 20,192 users and 333,407 tweets. Then we tested this time frame against a 241 hours database, with 70,403 users and 2,252,348 tweets collected along 18 days, and found a Pearson linear correlation of 0.976 (p-value 2.2e-16) between the datasets regarding the spatial distribution of tweets according to census blocks.

Automatic tweeters posting for commercial purposes (bots), identifiable by the large number of tweets posted from the same position, were also excluded. A statistical analysis of average distances between tweet positions of same users via quantile classification showed that the threshold between (high frequently) short distances and long distances between tweets was 106 meters (step 2). We identified the repetition of location of the first tweet in the morning during the period of observation (first in a sequence of tweets), since the night position brings limitations to the sample regarding tweeting behaviour (Longley, 2015). The first tweet was taken as the origin in the generation of shortest paths to following tweets posted during the day (step 3). Shortest paths between tweet positions within Rio’s street network were performed topologically through GIS software, using Open Street Maps (step 4) as predictors of routes between actual positions.6

6 Empirical evidence from fields like space syntax and urban network studies suggests that shortest paths are reliable predictors of actual routes (e.g. Hillier et al, 1993).
Figure 2 - Methodological procedure
Finally, Twitter users were differentiated according to income (step 5). We assigned income levels to users through a procedure that required crossing residential locations inferred from tweeting behaviour (step 3) with economic data referred to the census blocks (2010 Census, Brazilian Institute of Geography and Statistics, IBGE). The census block unit used to infer income levels was the smallest available. Our methodological procedure to select users according to posting behaviour, spatial behaviour and income levels can be summarized as follows (figure 2):

Of course there are risks of ecological fallacy in interpreting individual users’ income from the average of residents from each census block. We statistically assessed such risks looking for the coefficient of variation (CV) for income. The average CV for income within census blocks in Rio is low, about 9.3%, so we could say that there is enough homogeneity of income values between residents of the same block to use average income as a proxy of individual income. We analysed the exponential distribution of income per capita and proposed a classification by quantile which suggested the following levels: less than R$ 750; R$ 750.01 to R$ 1,600; R$ 1,600.01 to R$ 2,500; R$ 2,500.01 to R$ 3,400; R$ 3,400.01 and above.

These values were identified as low, lower-middle, middle, upper-middle and high-income users (differentiated by colours in figure 3). For the sake of this experiment, a methodological test involved assessing how representative are inferences about Twitter users in relation to the actual population of Rio de Janeiro. We compared the distribution of the average per capita income in Rio’s population from census data and from Twitter users inferred through residential location.

The first histogram (population income – figure 3, bottom left) suggests an exponential distribution with a long tail for higher income values (over R$ 10,000 per month), the same threshold observed for the estimated income distribution of Twitter users. Linear regression brings an adjusted R squared of 0.67, showing that the inferred income distribution of users has a reasonable degree of similarity with the income distribution of the population in general (figure 3, bottom right).

This also suggests that the use of Twitter does not seem to be associated with specific income levels, confirming previous findings about the high penetration rate of Twitter in Brazil (Graham and Stephens, 2012). A geographic analysis in figure 3 shows two readings: residential patterns of income levels (top in figure) and the pattern of distribution of users’ estimated location according to income level (below in figure 3).

5. NETWORKS OF ENCOUNTER IN TIME AND SPACE: A DIGITAL EXPERIMENT

We may further analyse the spatial and temporal structure of potential encounters between Twitter users. Using as databases the OSM street network and the tweets dataset with timestamps and geo-location to rebuild the shortest paths between consecutive tweets, we also temporalized such trajectories assuming an average speed between tweet locations. We inferred ‘potential encounter’ as crossing trajectories within a single street segment, of course, and within a ‘temporal buffer’ of five minutes. In other words, we computed as potential encounter situations where two users were in a same street segment within a 5-minute interval.

---

7 Within the city of Rio de Janeiro, the census block unit has an average number of 210 households and 616 inhabitants and a median area of 33,017 squared meters (a considerable variance is found for area).
8 The exchange rate between American Dollars and the Brazilian currency Reais is: U$ 1 = R$ 3.30 in 30th September, 2016.
Figure 3 - Income levels in census blocks units (blue to red, top), and estimated locations of Twitter users (below). Below, histograms of average per capita income in Rio’s population (left) and Twitter users (centre); regression between users (Y) and population (X) in urban districts (right).
Figure 4 - Space-time prism for the varying intensity of inferred encounters between Twitter users in Rio (top). Number of potential encounters in time (bottom left) and an analysis of their clusterization in space (tK-Function, bottom right).
We may assess the space-time structure of encounters through a time-geography-inspired representation and complementary graphic analyses (figure 4). Not surprisingly, the number of potential encounters peak in the early morning, around midday and around 6pm, to drop considerably in the evening, as agents tend to find themselves in more static positions in space (figure 4, bottom left). In order to understand the spatial pattern of potential encounters, we applied Ripley’s K-function to summarize spatial dependencies interactively as clustering or dispersion processes over a range of distances randomly selected. As first stated by Getis (1984) and revisited as an analytic tool by Mitchell (2005), the K-function was calculated as:

\[ L(d) = \frac{A \sum_{i=1}^{n} \sum_{j=1, j \neq i}^{m} k_{i,j}}{\pi \times n(n-1)} \]

Where

- \( d \) = distance between places of potential encounters
- \( n \) = total number of places of potential encounters
- \( A \) = total area comprehended by potential encounters
- \( k_{i,j} \) = weight (number of potential encounters in each place).

The blue line in the graph for the K-function (figure 4, bottom right) indicates the average distance between encounter places is randomly selected sets. The red line indicates all observed encounters (in our case, inferred encounters). The X-axis represents the distance between encounter places and the Y-axis represents the average distance between encounter places weighted by the number of encounters. The difference between the lines indicates that observed encounters are clustered. As the curve for the observed K is above the confidence envelope, it is statistically significant.

What does our experiment show about the dynamic of potential encounter as the superimposition of class networks as revealed by Twitter users’ trajectories in the city? We counted the number of agents’ trajectories classified by income level for each street segment (between corners) where there were trajectories. We also quantified the length of streets covered by users with the same metric length of street segments. This information was registered for each agent and accumulated for her/his income groups. Then we calculated the overlapping of income groups, using the number of agents for each group passing through each street segment. Maps in figure 5 show the dominant income group in the streets that make up their trajectories. The criteria for determining visually the dominant presence of a single group over a street segment is ‘the group with the higher number of paths overlapped in a street segment provides the colour for that segment’ – i.e. once we consider the proportion of income groups in actual numbers, when a group has one person above that percentage, it has dominant presence. Results of the analysis seem to grasp the spatiality of potential encounter along with traces of dynamic segregation. These visual overlaps will be assessed quantitatively below.

We first notice strong evidences of residential segregation related to income. The poorer spread more broadly over the cityscape. Low-income and lower-middle income groups show considerable overlap, but low-income users are dominant in areas farther from the sea and the CBD, located in the East. Landscape amenities related to proximity to the sea are a clear factor in defining land values and higher income location (and both territorial and dynamic segregation) in Rio. Geographical topography adds complexity to residential location patterns in Rio – including the favelas scattered in the landscape, allowing the poorer to live in hills near richer areas, closer to the sea and the CBD. Such unusual cityscape enmeshes the lines of movement, as we can see in areas in South Rio, increasing the potential of encountering the socially different. Complexities considered, an overall pattern emerges, as higher income users are more likely to be found in South and Southeast Rio, near to the sea, and a gradual shift in users income levels becomes visible in trajectories as they spread farther, towards North.

We can also assess how isolated is the presence of a single class in Rio’s streets, and how the proportion of trajectories income groups share with one another (table 1). Lower-income
groups (IG1 and IG2) are much more segregated in their movements across the city, with 19.2% and 29.9% of their trajectories occurring in non-shared streets, respectively. They also show the highest degree of sharing spaces (10.4%). Richer groups (IG4 and IG5) share more of their trajectories with other groups.

The poorer and the richer (IG1 and IG5) share only 0.8% of users’ trajectories. IG2 displays a more socially integrative spatial behaviour – but also has a larger share of users (46.7%). IG1 and IG2 trajectories display less social diversity – they are easily the dominant group (i.e. their presence in a particular space is above the average of its proportion in the total number of agents, all groups considered). The fact that IG1 consists of 23.6% of total users and are dominant in 30.5% of streets where they pass through suggests they are more segregated than other groups in their movements.

Figure 5 - A picture of segregated networks: blue (low income), green (lower-middle), yellow (middle), orange (middle-upper) and red (high income) groups. The larger map shows the dominant class network.
Where are exactly the spaces that different social groups share? Poorer income users (IG1xIG2) share much more spaces when appropriating the city, mostly in North and West Rio. Pairing the poorer and the rich (IG1xIG5), map show that the world-famous South Rio (Ipanema) is not merely a segregated area marked by the dominating presence of the rich. It is a major area for mutual visibility. Now considering the relationship between dynamic segregation and residential segregation, how much do other income groups actually pass through territorially segregated areas? We assessed this relation crossing the average income in residential sectors (census blocks) with the average income of the dominant group passing through those areas (table 2). However present in richer sectors, poorer groups (IG1 and IG2) strongly concentrate in poorer areas: 72.1% of IG1 trajectories happen in low-middle income sectors (S2). Richer users (IG4 and IG5) still appropriate rich sectors (S5): 58.58% of IG5 trajectories happen in S5 areas. In turn, middle-income and middle-upper income sectors (S3 and S4) are open to more diverse income groups (table 2).

What does this pattern of overlapping imply in terms of potential encounters between socially different users? What are the effects of different patterns of spatial trajectory on encounter opportunities? We generated a social network analysis of agents grouped according to income. Links show the number of potential encounters identified between pairs of income groups (vertices in figure 6). The shorter and thicker each link is, the higher the number of encounter between income groups. Encounters are seen as more likely between socially similar agents.
Finally, where do class networks converge more intensely? What are the streets with more social diversity, where ‘the other’ is more likely to be seen? We measured social diversity on the streets, i.e. the level of superimposition of networks, through Shannon information entropy, calculated as the participation of each class over the total number of agents (spaces with the presence in equal shares of all income groups contain the highest entropy), and associated different entropy levels with colours from blue to red (figure 7). Entropy was calculated for every street segment; intervals were defined via natural breaks.

\[ Entropy = - \sum_i P_i \log_2 \left( \frac{P_i}{P_t} \right) \]

where \( P_i \) is the total number of users with income i and \( P_t \) the total number of users passing by every street segment.

There is a small network of socially convergent streets, an interesting superimposition of trajectories of users of all income groups around South Rio (Copacabana and Ipanema) and the CBD (on the East). Spaces of social convergence are to be found in denser, busier areas like the CBD and South Rio, or major centralities like Tijuca and Jacarepaguá, a little to the North. These are the most likely spaces to find socially different agents.
6. CONCLUSION: SPACE, TIME – AND SEGREGATION – IN SOCIAL NETWORKS

Changing the focus from social networks centred on agents to the networks of ‘encounters’ performed in daily trajectories as a key spatial and temporal event in the formation of social networks, this approach must be seen as an experiment in identifying a ‘geography of overlapped networks’ in urban space – and, following Freeman’s definition, into segregation as ‘restrictions on contact’. Of course such intent poses a number of questions: can poorly overlapping networks be interpreted as segregation? Is ‘space sharing’ enough to depict social integration? Unlike previous works, our approach is geared to trace movement, relate it to patterns according to social differentiation (in this case, based on income) and assess their role in inferred trajectories of agents in urban space. As a proxy to the scenario of potential encounter and segregated networks, this experiment based on Twitter locational data can only show trends within the trajectories of a limited number of agents. Nevertheless, it suggests that different patterns of mobility lead to less opportunities for encounter, as seems to be the case between poorer and richer users. If Freeman (1978) is right in asserting that segregation operates through restrictions on contact, (the lack of) space sharing and co-presence are an essential part of the experience of segregation.

Is a study based on Twitter data enough, however? Due to difficulties in generalising conclusions from samples of self-selecting users (Longley et al, 2015), procedures assigning location and income to users must be seen as a proxy rather than an actual scenario, as we insist. As such, our study suggests that Twitter data is an invaluable means of identifying patterns of movement of agents, with strong possibilities for understanding matters of social integration and equity. Social media data are also a potential source for generating a precise ‘geography of encounters’ in a city, including the temporal dimension – a previously virtually impossible achievement. Graphic and quantitative analyses of overlapping networks seem to add another layer to the understanding of segregation through static maps of income levels and segregated activity or

Figure 7 - Entropy map showing in red the spaces with the highest social diversity
residential location in Rio (in that spirit, compare figures 3 and 5). This is the very purpose of our proposition: to get closer to a temporal geography of potential encounters and segregated networks of movement and the public spaces with different potentials for overlapping socially different agents, for the first time monitoring and measuring through locational data spatiotemporal differences in the appropriation of a city by members of different income groups. Neither segregated movement nor potentials for overlapping networks is inferable from income, activity or residential distribution maps alone.

In this sense, our approach suggests that the probability of encounter is impregnated with spatiality, interacting actively with the structure of the street network to generate potentials of convergence and co-presence of social groups. The odds of finding ‘the other’ seem distributed according to the spatial and temporal frames of action of different groups within a city. The paths of Twitter users suggest greater compatibility between certain users – and, by extension, greater potential for interaction. On the other hand, differences in urban trajectories in daily life may lead to the reduction of opportunities of encounter. This view into the space-time structure of potential encounters also allows a form of bringing to the forefront the complexity of segregation captured as a highly dynamic ‘disjunction of encounters’ at the level of trajectories of agents, close to Freeman’s seminal definition of social segregation as ‘restrictions on contact’.
REFERENCES


LEARNING FROM VILA PLANALTO:
The Limits of Segregation and Urban Diversity in a Gentrified Neighbourhood

MATÍAS OCARANZA PACHECO
Faculty of Architecture and Urbanism, University of Brasília
matias@aluno.unb.br

FREDERICO DE HOLANDA
University of Brasília
Faculty of Architecture and Urbanism, University of Brasília
fredhol@unb.br

ABSTRACT
This paper discusses the scope of the concept of gentrification with regard to the current urban transformations in Vila Planalto, located at Brasilia's central area. The neighbourhood was the first provisional contractors’ camp to house workers, architects, contractors, and politicians who participated in Brasilia's construction. In 1988, after a long struggle of the residents to stay, it became a historic heritage site, which started a process of constant changes and real estate appreciation. Due to unforeseen circumstances, Vila Planalto became a fascinating site in Brasilia's socio-spatial landscape. Class conflicts are present here, threatening the right to the city for underprivileged population.

The research aims to understand the process of Vila Planalto's urban transformation, the causes and effects of social displacement, and the limits society imposes to resist market forces. As a hypothesis, we argue that public policies are determining factors for the physical and social elitism of the place, whereas the transformations the residents introduced have been fixing limits to the gentrification process. We examine the case under three aspects: socioeconomic, configurational, and ways of living. We use a survey of quantitative and qualitative data, and two years of ethnographic research, participant observation, and interviews. The study contributes to Spatial Syntax by incorporating other analytical disciplines such as ethnography. The urban configuration indicated the potential spaces of encounter and the ethnography allowed to observe the daily life of those places.

The results indicate that public policies and infrastructure projects carried out in the area and surroundings were decisive in the historical periods identified. In Vila Planalto, the displacement of the original and lower-income residents has been taking place gradually over time. There are no large-scale private investments. Conversely, small entrepreneurs, newcomer residents, and retired people came to believe that it is promising to invest in real estate here.

The statistically observed social diversity conceals a reality of polarized social differentiation that dates from the origins of the settlement: shacks built near posh villa-like buildings represent two segregated classes which, in spite of their proximity, do not interact. In the same manner as Vila Planalto is an urban fissure in Brasilia's dominant order, conflicting uses of space withstand gentrification and space disciplining inside its borders.
KEYWORDS
Gentrification, Urban Diversity, Limits, Vila Planalto, Brasília.

1. INTRODUCTION
In several cities of Latin America and the world, the processes of ‘elitization’ of the urban space have evicted the lower income inhabitants and users. This is the process of urban transformation in which the original population of deteriorated or impoverished neighbourhoods is progressively displaced to places further away from city centres and replaced by a population with greater economic, cultural and social capital. This process is defined as gentrification (López, 2015).

Gentrification is urban transformation of a poor or low-income neighbourhood into a higher income or middle class neighbourhood, either residential or commercial. This socioeconomic change produces displacement, understood as the phenomenon that occurs when an economically or culturally fragile group must move to a less valued location and be replaced by a stronger group. However, gentrification is much more than a process of change in the social structure of a neighbourhood, it also transforms different aspects of everyday life, especially for the vulnerable population, which ends up being expelled (Janoschka & Sequera, 2014).

Inzulza (2012) examines cases in Latin America and proposes the concept of “Latin-gentrification”, relating the processes to more local patterns inside a context of global strategies of urban revitalization. In the same direction, Janoschka and Sequera (2014), discuss the decentralization of the debate in the European context and the necessity to consider the specificities of each site, by recognizing three key elements: 1) the role of the State in the definition of official policies; 2) the symbolic value of the gentrified spaces; and 3) the formalization of the economy and the effort to discipline spaces. Leite (2007) adds a fourth relevant factor: 4) resistance against gentrification and the counter-uses of the city (Leite, 2007).

López (2015) emphasizes that the gentrification of Latin American cities denies the right of the urban poor to occupy central and pericentral spaces. Gentrification is related to the loss of use value against exchange value of space, which means that less favoured population are denied the rights to certain sectors of the city. We understand the right to the city not only as a right to centrality, but also as the right of the inhabitants to think, decide, build, and transform the city and the rhythm of urban life, collectively, according to their wishes.

The case of Vila Planalto in Brasilia is a paradigmatic example of the relationship between architecture and segregation. The neighbourhood has a privileged location in the Federal District, located 1.5 km from the Three Powers Square and 3 km from the Central Business District (CBD) (Figure 1). It began in 1956 as a temporary constructors’ camp for the companies that built the main buildings in Brasilia. After a process of resistance, in 1988, the neighbourhood obtained permanence by being declared a Historical Heritage Site of the Federal District. In 1992 the residents received an allotment of the properties. This intensified physical and social changes, and the neighbourhood began to lose the characteristics behind its classification as a heritage site, as well as some of its original inhabitants.
During the period that it was a contractors’ camp, Vila Planalto was populated by workers, engineers, and businessmen of the construction of Brasília as well as politicians who sporadically passed through until the inauguration of the new capital. Currently, this neighbourhood is the result of the merged remnants of five contractors’ camps: 1) Tamboril, 2) DFL (Department of Force and Light), 3) Pacheco Fernandes, 4) Rabelo, and 5) nine lots of EBE camp (Brazilian Engineering Company), plus a Sector of small farms (Figure 2).
Features, such as the declaration of historic heritage site (set of laws that protect some physical characteristics), the condition of land tenure (impossibility of formal sale), the restrictions imposed by the “force of architecture” (Holanda, 2013), and certain mechanisms used by the inhabitants to stay in their space (Zarur, 1991) limit the process of gentrification in the neighbourhood. Nevertheless, these factors have not prevented the neighbourhood from becoming a middle-class sector because of changes in the built environment and especially the elitism of uses and users of the public space.

In Vila Planalto, the great spatial diversity is related to a great social diversity. The spatial configuration has been, in part, responsible for the stability of the population for more than fifty years. Five decades after the city was inaugurated, market forces were not able to expel all the low-income residents; manual workers continue to rent residences and move there (Holanda, 2013). However, the picturesque character and the location close to the CBD have increased the prices for sale and rent of the properties as well as the restaurants and bars by outsiders. Thus, many original inhabitants have moved, sold, or rented their houses, which has pressed part of the older residents to move or to transform houses and local businesses into gourmet establishments.

Before this process, a new phase of potential transformations was seen in the spatial configuration, the socioeconomic structure, and the way of life of the inhabitants. The delivery of property titles in 2014 and the formal sale of lots opened commercialization and access to real estate loans, which further increased prices and generated the definitive replacement of the poorest population by a higher income population. Thus, the main question of this paper is: are there limits to the process of gentrification in Vila Planalto? The second question is about the particularity of the neighbourhood, considered as an exception or fissure inside the Brazilian capital: how is gentrification and its limits a product of local or global relations that affect the city?

Our first hypothesis is that Vila Planalto is undergoing a process of gentrification with local characteristics, but in a context of global urban policies. We start from the premise that the neighbourhood is experiencing a process of gentrification of its space, but with limits, due to the conflict between the legislation and the transformations introduced by the residents.

A second hypothesis is: public policies that operate in cultural heritage transform urban space into a place of consumption and real estate speculation, which segregates and excludes low-income residents. Therefore, the process of gentrification is accompanied by transformations in the urban configuration (form-space relations) in the socioeconomic structure of the neighbourhood (cultural and social characteristics) and in its inhabitants’ way of life (system of coexistence and social relations).

The main goal of this paper is to discover and explain the process of urban transformation in Vila Planalto, a case study for the analysis of gentrification in Latin America. Another goal is to observe the different social practices that take place in the public spaces of Vila Planalto to analyse the relations between physical form and society. In the context of the study of gentrification, we incorporated a configurational approach and the application of urban anthropology methods to understand the existing movements, pressures, and disputes that could lead to displacement or expulsion.

2. THEORIES AND METHODS

2.1 SPACE SYNTAX THEORY

Among the various theories of urban space, the Space Syntax (Hillier and Hanson, 1984) is a valuable analytical tool for the relationship established between social and spatial aspects of urban configuration. Space Syntax Theory (SST) establishes relationships between categories or attributes of two areas: 1) space (public or private) organised for human purposes, and 2) social structure or modes of interaction of individuals and groups, social strata, and their power structures (Holanda, 2001; Medeiros, 2006).
The main focus of SST is the relationships between space and society. The theory highlights the relationships between the spatial structure of the city and its buildings, the spatial dimension of social structures, and social variables as an effort to reveal the logic of architectural space and the logic of societies (Holanda, 2002).

For Hillier and Hanson (1984), space is constructed according to the forms of social solidarity, which, at the same time, are products of the structure of society. For the authors, different spatial forms are reflections of each society, because just as society has a spatial logic, socially organizes space also has an intrinsic social logic to it.

The field of reasoning of SST are the relations between architecture and behaviour. The theory studies potential movements of people and spatial life understood as a system of encounters and avoidances. Space Syntax Theory establishes itself as a “bridge” between social life, understood as a set of socioeconomic attributes that relate to spatial patterns; and spatial life understood as a system of potential movements.

2.2 GENTRIFICATION

The theory of gentrification studies the processes of urban transformation in central and pericentral areas of cities and how these transformations relate to other global and local economic and political processes. Smith (2012) comments that the term ‘gentrification’ has evolved from describing aspects of residential changes to the study of capital reinvestments in urban centres as a mechanism for producing space for progressively more affluent users.

According to Lees et al. (2008), gentrification is deeply rooted in social dynamics and economic trends. Characteristics, effects, and trajectories are determined by a variety of reasons, such as local context, physical configuration, social characteristics of neighbourhoods, local actors’ positions and objectives, city functions, the nature of economic restructuring and policy of local governments (Lees; Slater; Wyly, 2008).

The literature about gentrification organises theoretical formulations into two main trends. The first is by the supply of private space producers, who try to create, in urban centres, points of interest for the high-income population in partnership with strategies of public authorities. The second is the perspective adopted in this study, of the demand of the middle classes to recover territories and to return to the centres, after having lived in gated communities in the peripheries, mainly in waves stimulated by the real estate market.

The main axioms of gentrification explain how these processes are related to real estate markets, constituting a return to urban centres, but a return of capital and not necessarily of people (Smith, 2012). In Latin America, López (2015) recognises that three aspects are connected to the causes of gentrification: 1) public policy macro-transformation in the city to the repositioning of the metropolitan economy in the global market (city marketing); 2) public investments in accessibility and mobility, through macro-scale transformations; and 3) micro-economies in the land market, where the higher-status private agents restructure and capitalise revenues, which assure certain continuity for the location of popular housing, fostering or accelerating the expulsion process.

In the gentrification of Latin American cities, the action of local and national governments is fundamental. The ambition of some socioeconomically high classes is not enough, it is also a result of complex pro-business public policies that maximise the economic value of urban land. The result of gentrification in Latin America is land and housing markets that increase access to the restructured spaces for the upper classes, while restricting the access to housing for lower-income segments that end up displaced, evicted, or segregated from the location (López, 2015).

2.3 HUMAN ECOLOGY

The transformations affecting large cities in the early twentieth century prompted sociologists at the University of Chicago to undertake innumerable investigations and became the main heritage of urban anthropology. Robert E. Park and Louis Wirth represent two of the leading exponents of Human Ecology – they study the sociological structure of the city.
In his text The City: Suggestions for the Investigation of Human Behaviours in the City Environment (1915), Park considers large-scale urbanism but also notes the city details, especially in neighbourhoods. On a larger scale, the city can be defined, first, as a material organization, with its physical form, its geometry, or from a spatial perspective, as the relations between the “fulls” and “voids” – or solids and spaces; and second, as a moral organization, an expression of human nature and of a particular culture, which possesses customs and traditions (Park, 1999).

Wirth, on his part, in Urbanism as a Way of Life (1938), formulates a scientific definition of city. He concentrates on identifying the characteristics of urbanism as a differentiated form of life with a focus on the inhabitants. For the author, cities shape the character of social life in a specifically urban form, which dominates and influences a space (hinterland) sometimes larger than the city itself (Wirth, 2005).

One of the main formulations of urbanism as a way of life is to acknowledge three points of view to observe the city: 1) physical structure (ecological order); 2) system of social organization (structure, institutions, and social relations); 3) set of attitudes and ideas (different personalities that result in a collective behaviour subject to mechanisms of social control).

Human Ecology defines its main axiom as: large cities represent laboratories of collective behaviour and are in constant tension due to conflicts over space. These conflicts create boundaries, demarcated within the city, that delimit the natural areas of groups and their patterns.

2.4 METHOD

The field of research on gentrification has no defined methodology, and the research paths are diverse and respond to each case. In this work, the case is studied with a mixed design, which is considered adequate for investigations that relate to the phenomenon under study and the social context in which it happens. The mixed design includes quantitative and qualitative techniques in data collection that control a reduced number of variables. The hypothetical-deductive method and observational procedures are also used. The method starts from a problem, for which an attempt is made to explain the theory, and then to test and eliminate possible errors, giving way to new problems (Gil, 2008).

For the development of the socioeconomic analysis, it was necessary to reconstruct the history of the neighbourhood from the events raised in previous surveys, official documents, judicial and legislative proceedings, census data, and 15 surveys in the Tamboril camp. The configurational analysis of Space Syntax allowed the examination of the possible relations between the inhabitants and their space from the analysis of current and historical global integration axial maps and correlations with surveys of land use and others. The ethnographic research, used to analyse the way of life, is a research method in which the daily life of a specific social unit is perceived, through direct observation and interviews. We analysed more than 30 interviews with residents in public spaces and two years of participant observation as a resident of the neighbourhood.

3. RESULTS

The urban history of Vila Planalto allows us to identify four periods: 1) provisional (Coêlho, 2011), between 1956-1964; 2) abandonment, stigmatization, and resistance, between 1964 and 1988; 3) official declaration as historical site, colonization, and urban transformations, between 1988-2010; and 4) Vila Planalto gourmet, real estate valorization and consumption of cultural heritage, between 2010-2015.

The first period is the boom and, immediately after, the dismantling of the camps. With the departure of the companies from the camps in 1961, the Vila was abandoned. The majority of the population lived in a precarious situation and a minority had better conditions.
The second period begins with the military coup (1964) and continues through long years of resistance against removals, until the recognition as a heritage site in 1988. This period can be understood as a first phase of the process of gentrification, a stage of apparent abandonment and stigmatization.

The third period begins with the legalization of the neighbourhood (1988) and extends until 2010. The legalization began a second stage of gentrification, a phase of speculation that resulted in a notable increase in property and living costs. In 1992, with the granting of use concessions, real estate speculation increased. Since the end of the 1990s, with the installation of basic infrastructure, the neighbourhood has experienced raising costs of living, which increased after 2000, with the construction of gated communities, luxury hotels, and nightclubs on Lake Paranoá’s shores, nearby.

It the fourth period, since 2010, the number of bars, restaurants, and shops has increased. In 2010, the government tried to strengthen the neighbourhood by making it a place of consumption and leisure with a gastronomy pole project. This period corresponds to a third stage of gentrification, with the commercialization of the space and the displacement of the poorest original inhabitants.

The four historical periods are strongly determined by the public policies implemented, which mark pivotal points in the history of the neighbourhood. The periods are similar to the steps described in the global gentrification literature. With the delivery of the first property title in 2014, a new stage in the gentrification process was expected. Land regularization contributes even more to the valorization of the land and the building standards are modified, losing what remains of the architectural, urban, and social attributes of the historical site.

The replacement of the original residents has been constant since the official declaration as an historical (heritage) site. However, the displacement of the lower-income population (pioneers or otherwise) has been greater in recent years, with the increase of commercial establishments and the sale and rent of houses. Several houses had selling prices over 2 million reais (USD 560,000). In interviews at the Tamboril camp, owners comment that they would only sell above 3 million reais (USD 850,000). This could incorporate new agents and larger capital in the process of gentrification of Vila Planalto.

Analysis of the 2000 and 2010 censuses in Vila Planalto shows an increase in residents who are renters (from 24% in 2000 to 36.3% in 2010). For the head of household’s income, the lowest incomes increased - up to 2 minimum wages (MWs) (from 35.5% to 47.9%) - and all the highest wages fell (more than 20 MWs from 5.3% to 2.5%).

Graph 1 - Income of the head of household in Vila Planalto and surroundings.
When we consider the surroundings of the neighbourhood (Graph 1), the situation is the opposite, incomes above 10 MWs increased (from 18.2% in 2000 to 32% in 2010) and all the lower ones fell. These results could have a correlation with the inhabitants’ race or colour: in 2010 there were more mixed-race residents (pardos) in the Vila (47.7% in the Vila as opposed to 41.5% in the Vila and its surroundings) and blacks (8.3% vs. 7.4%); when we consider the surroundings, there were more whites (42.3% in the Vila, and 49.3% in the Vila and its surroundings). Between 2007 and 2010, within the neighbourhood, whites increased (from 34.1% to 42.3%) and blacks decreased (from 14.3% to 8.3%), along with mixed-race residents (from 51.5% to 47.7%) (Figure 3).

In Figure 4, it is possible to observe the internal differences in the distribution of rents by encampments and in the surrounding census sectors. There is a contrast in the income ranges between the lakeside condos (Sports Clubs Sector - SCEN and North Hotel and Tourism Sector - SHTN) and the camps of the Vila, with the exception of the Tamboril camp.

Figure 3 - Map of population distribution according to race or colour in Vila Planalto and surroundings. Source: based on the IBGE Census, 2010.

Figure 4: Map of the distribution of household income in Vila Planalto and surroundings. Source: based on the IBGE Census, 2010.
The configurational analysis allowed us to recognize some important points in the urban evolution of Vila Planalto. The diachronic analysis of the axial maps illustrates how the road network was transformed by the inhabitants according to their needs. The transformations made by inhabitants make the road network even more irregular and fragmented. Those conditions are expressed in the reduction of connectivity, the average line length, and the increase of the number of lines in the system (figure 5).

Within the time-span under study (1965-2012), three periods can be considered. The first one, concerning which it was not possible to prepare a map, corresponds to the time of greatest rhythm in the construction of Brasília. Between 1956 and 1964, the Vila was structured by the State, and up to 22 camps were organized, in which segregation and control of space use were extreme.

A second stage took place between 1965 and 1988, with the departure of the builders. They reduced control devices over space and daily life, at the same time that the dismantling of the social equipment began. The Vila went through constant removal attempts. The structure of the urban layout was fragmented, the global lines disappeared, and the axes were concentrated in the space corresponding to four camps.

The third period occurred after the official declaration as an heritage site, from which the legalization of the settlement occurred and the transformations have speeded up (Coêlho, 2008). There is a densification process and an increase of the urban settlement through the occupation of empty spaces in between the ancient contractors’ camps. The result was an extremely fragmented and irregular layout.

The analysis of the axial maps revealed the transformation of the urban configuration, towards a greater urbanity. For Medeiros (2006), urban structures and their resulting forms, on the one hand, are the formal, planned, regulated, legal, and, on the other hand, are informal, organic, illegal, and spontaneous. For Holanda (2002), it is possible to recognize two historical trends, what he calls the “paradigm of formality” and the “paradigm of urbanity”. “Formality” concerns what is not spontaneous and something conventional that represents a hierarchy and a sense of authority. “Urbanity” alludes to qualities such as the courteous, affable, and continuous social exchange. Thus, with the transformation of the urban network, which adapts towards an increasingly scarce, irregular, and informal layout, the neighbourhood acquires greater urbanity.
Informality is also expressed in the fragmentation of the plots, new land occupied in irregular areas, the ‘verticalization’ of the buildings, and the consequent loss of the physical characteristics that had led Vila to be declared as a historical site. Becoming a legalized settlement, no longer an irregular borough as far as urban norms were concerned, was important to make Vila Planalto a more desirable place to live. Because it was forbidden to change the features of houses, one of the mechanisms that people used for their stay was to conceal eventual changes through varied devices. The structure to control the space of the camps was corrected by the dynamics of the social processes, which modified the space by the needs of the population and by pressures of land rising values (Kohlsdorf, 2010).

Between 2009 and 2013, commercial uses (from 2.3% in 2009 to 4.7% in 2013) and mixed use – residences + commerce and services – have increased (2.5% to 6.7%). Consequently, the use of single-family homes decreased (82.7% to 71.9%) and multi-family housing increased (from 7.9% to 14.8%). The appearance of commercial premises, as well as the increase in the height of the 2-storey buildings (18.4% to 28.2%) and the decrease of the lots with a constructed floor (79.6% to 68%) confirm the increase of irregular constructions (just one storey building is permitted by law), and show the potential growth of intensity in the urban dynamics of the neighbourhood (graph 2, 3).

The configurational analysis showed how society changed its space from social formality and control, during the construction of Brasilia, to an informal space with an irregular road network, intense commercial activity, and a strong condition of urbanity, which reflect the different relations that took place in Vila Planalto.

Studying the way of life made it possible to recognise some important aspects of the daily life of the residents. The legalization meant the beginning of the process of gentrification, with the arrival of the middle class sectors, mainly civil servants and professionals. The case study would fit into the concept of symbolic gentrification (Janoschka; Sequera; Salinas, 2013), as it has happened in other neighbourhoods in which cultural heritage is involved with tourism and leisure in Latin America.

The interviews revealed that the relationships between the older residents of the neighbourhood and the new residents are almost non-existent, just as their ways of life do not seem to mix in the urban space. However, some significant spaces in cultural practice are recognised, such as some squares and Geraldo's Warehouse, a place where individual trajectories coincide and the daily needs of the most diverse inhabitants are fulfilled (Certeau, 1996).

We identified several types of residents: 1) original residents (pioneers); 2) colonisers arrived after the declaration as a historical site (civil servants); 3) new middle classes (young students or professionals); 4) Counter-gentrificators, popularization (manual workers).

The former residents come from two different stages in the history of the neighbourhood. The original inhabitants correspond to the pioneers, who have been present for more than 50 years,
since the time of the construction of Brasilia. They are made up of retired civil construction workers or of families who have moved from the removed Vila Amauri to Vila Planalto.

Another group corresponds to the first gentrifiers or settlers of the neighbourhood, composed of public service employees or professionals from other areas who arrived in the neighbourhood twenty years after its declaration as a historical site. They bought the concessions of use from the original inhabitants. Then began a slow arrival of other middle- or upper-middle-class inhabitants and the gradual appearance of commerce and restaurants oriented to a higher-income population.

New residents come from different social classes and different lifestyles. On the one hand, there are immigrants coming from the northeast of Brazil or from other countries, including students and people working in the same neighbourhood. Most popular sectors arrived from the satellite cities to rent informally in the backyard lots, contributing to the popularisation of the Vila. This contrast can be observed in Figure 6.

Figure 6 - Brasilia Street, Rabelo Camp, Vila Planalto 2014.

The urban space of Vila Planalto represents a space of routine and transgression of the individual life story of its inhabitants, where streets, squares, bars, and markets are potential places of social engagement and conflict (Giannini, 2013). Despite the strategies of elitism, there are certain transgressions or visual nuisances such as: street people drinking cachaça and enjoying playing cards in Nelson Corso Square, young people smoking marijuana under the shade of a tree in Church Square, or selling drugs in the Mechanical Workshops Sector, among others. These actions form the counter-uses that transform space into contested places and conflict.
Figure 7 - Map of visual integration and security cameras in Vila Planalto

However, the subversion of illegal acts is repressed by the police and by surveillance devices – as in the large number of security cameras installed in the houses that watch part of the public space (Figure 7).

4. CONCLUSIONS

Several cities around the world have simultaneously experimented with various forms of gentrification with asymmetrical processes of capital restructuring, significant flows of people from high and medium incomes, and the displacement of lower income residents through the privatization of central urban areas.

In the southern hemisphere, there have been multiple gentrification processes. The examples of Latin-gentrification (Inzulza, 2012) affect mainly patrimonial areas. The life story of the people who live in these neighbourhoods is affected by the rise of neoliberal policies aiming at sustaining or stimulating gentrification. Gentrification policies are part of global urban revitalization strategies, but there are - in most cases of symbolic gentrification - local patterns. In these cases, gentrification transforms, in addition to the constructed landscape and the socioeconomic structure, the daily life of the residents who manage to remain, reinterpreting the significance of and re-appropriating places.

As to the first research question, we can say that the potential limits to the process of gentrification in the neighbourhood, created by the appropriations and practices of the inhabitants in the occupation of urban space, are limits to gentrification or counter-gentrifying fissures.

The history of the neighbourhood and the practices of its residents create spatial and symbolic demarcations that limit the advance of spatial elitism. However, these boundaries are circumstantial and can be modified or eliminated by legislation or the disciplining of space.

Regarding the second question, we conclude that the process of gentrification of Vila Planalto, despite its peculiarities, is similar to other cases of symbolic gentrification in Latin America, mainly in historical centres.

To conclude, we refer to the hypothesis of the work. After the analysis, we can affirm that the gentrification of the neighbourhood is a silent process that occurs in a small and local scale. We did not identify large investments of capital acting in the physical transformations.
The neighbourhood offers real estate development, commerce, and services that are differentiated according to the demands of each social class. On the one hand, kitchenettes, rooms, and open spaces with more popular activities; on the other hand, apartments, houses, and commercial activities for high income layers, constituting a socio-spatial polarisation. This polarisation is observed in social relations, in the use of public space and in the structure of the road network. From the correlation between Space Syntax analysis and ethnographic research, we recognise that Vila Planalto is divided into two parts. First, an edge of longer routes and connected with the rest of the city, with an offer of more elitist uses. Second, an internal centre of short and difficult access roads, with more popular uses.

In relation to the second hypothesis, we can affirm that the policies implemented in the territory, considered as a cultural asset, were relevant in the different periods of physical and social transformation. The official declaration as a heritage site was based in a renewal project developed by technicians, academics, and residents; but this was ultimately transformed according to the interests of politicians who generated a clientelist relation with the population. The declaration as historical site was important to consolidate the neighbourhood as a desirable place to live, initiating its process of gentrification. At the same time, the law was not able to preserve the attributes of the neighbourhood as a cultural heritage site, which was mischaracterized by real estate speculation. New laws and decrees have sought to foster tourism and leisure, and bills seek to increase the building potential and the height of buildings in the neighbourhood. The delivery of property titles to longstanding residents, which responds to an old desire of the inhabitants, can foster significant increases in real estate values and finally cause the total displacement of the poorest population. Will Vila Planalto become extensively gentrified?
REFERENCES


Coelho, C. M. (2008), 'Utopias urbanas: o caso de Brasília e Vila Planalto'. In: Cranos, v. 9, p. 65–75.


Hanson, J.; Hillier, B., (1984), The social logic of space. Cambridge: Cambridge University Press.


#154

**DIACHRONIC ASSESSMENT OF CULTURAL DIVERSITY IN HISTORIC NEIGHBOURHOODS USING SPACE SYNTAX:**

Studies of three neighbourhoods in Istanbul

---

**ILGI TOPRAK**
Istanbul Technical University & Faculty of Architecture, TU-Delft
ilgitoprak@gmail.com

**ALPER ÜNLÜ**
Istanbul Technical University, Faculty of Architecture
aunlu@itu.edu.tr

**AKKELIES VAN NES**
Department of Civil Engineering, Western Norway University of Applied Sciences & Faculty of Architecture, TU-Delft
AVN@hvl.no & a.vannes@tudelft.nl

---

**ABSTRACT**

This paper investigates the mutual effects of cultural diversity and neighbourhood change in three historic neighbourhoods in Istanbul. Through history, some neighbourhoods in Istanbul have been home for people from different cultural and religious backgrounds. In some of these neighbourhoods, cultural diversity still exists. Some other neighbourhoods lose cultural diversity over time. The main reasons of this loss are socio-economic and cultural change, due to gentrification, decay or renewal. The study puts forward a comparative diachronic analysis of the three neighbourhoods, inspecting the relations between cultural diversity and neighbourhood change using space syntax. The change takes place in three levels: the level of socio-economic change, the level of physical change and the level of cultural diversity.

The results of the study show that historic neighbourhoods process continuity and change in their own ways. Samatya and Fener, undergo partial neighbourhood decay resulting in downgrading, decay on the built mass and segregation. They respond to cultural diversity differently. Kuzguncuk, is an example of neighbourhood gentrification, which maintains cultural diversity in a more balanced way due to high aesthetic qualities of the buildings, high local integration of the main street, and highly integrated main routes through the neighbourhood.

**KEYWORDS**

Diachronic research, Space Syntax, cultural diversity, historic neighbourhoods, urban transformation

---

1. **INTRODUCTION**

The aim of this paper is to examine the long-term effects of the change of cultural diversity in three historic neighbourhoods in Istanbul. Three case studies from Istanbul are examined to answer two research questions. How can cultural diversity contribute to historic neighbourhoods’ continuity or change? What are the effects of historic neighbourhood change to cultural diversity?
The study first provides an in-depth literature review of cultural diversity in the context of historic neighbourhoods. The paper further investigates the effects of cultural diversity over neighbourhood continuity and change. It explains and exemplifies the formation and development of historic neighbourhoods and contributions of cultural diversity. It also tackles various scenarios that may happen in historic neighbourhoods, such as ethnic or cultural segregation, gentrification, neighbourhood decay and regeneration issues.

The proposed methodology consists of a comparative diachronic assessment of cultural diversity for three historic neighbourhoods in Istanbul: Kuzguncuk, Fener and Samatya. On a neighbourhood scale, axial and visual graph analyses are combined to make a diachronic interpretation on isovist levels and integration of cultural hubs and settlement patterns of different cultural groups in the neighbourhoods.

2. CULTURAL DIVERSITY AND NEIGHBOURHOOD CHANGE

The neighbourhood, as a unit of dwelling has a cultural signification. Mills (2004) defines the contemporary “mahalle” as an “urban cultural space created by social practices of neighbouring”. The concept of neighbourhood in the context of Turkish “mahalle” encloses collective memory, and familiarity. It also promotes common values and needs creating bonds between all neighbours (Fisher, 1984 in Choguill, 2008). Recently, cultural change has been effective on Istanbul, but historic landscapes such as the old “mahalle” still signify the collective memory of its residents. However, Mills argues that these social practices are decreasing in contemporary Istanbul (2004).

Two main reasons are stated to promote this decrease in Istanbul’s historic neighbourhoods:

• The loss of cultural diversity caused by the displacement of minority groups to newer areas in the city,
• The change of socio-economic factors in the city causing circumstances such as gentrification, decay and renewal.

Cultural diversity in neighbourhoods has been a factor in forming the socio-cultural balance of a neighbourhood. Cultural diversity involves neighbourhood heterogeneity (Cheung & Leung, 2011) as a result of dense city living (Lees, 2008). Cultural diversity also enables expressing group identity on the urban pattern, architecture, commemorative sites, street names and also forming collective urban memory through tangible and intangible traces as a result of everyday life interactions (Hebbert, 2005). In the historic neighbourhoods of Istanbul, usually several ethnic and cultural groups reside together due to Istanbul’s multi-cultural past. Istanbul houses several minority groups, mainly Armenian, Greeks and Jews who are settled into many historic and newer neighbourhoods, as well as migrant groups as a result of a major domestic migration movement from Anatolia to Istanbul and other major Turkish cities in the 1960s.

Cultural diversity has effects over neighbourhood continuity and change. Neighbourhood change is an economic, physical as well as a socio-cultural issue. Cultural segregation and economic upgrading/downgrading of the neighbourhood is effective on how migration patterns are formed. These migration patterns, in-migrants, out-migrants as well as non-migrants (Teernstra, 2013) determine the physical and socio-cultural consequences.

Various urban issues such as displacement, ethnic or cultural segregation, neighbourhood decay, gentrification, illusion, renewal and regeneration inevitably happen in historic neighbourhoods, which go through a loss of socio-cultural balance. These issues result in migration scenarios and change in the residential composition (Hochstenbach & van Gent, 2015) like white flight or out-migration of people due to a traumatic event (displacement), in-migration of the lower income migrants, in-migration of gentrifiers and out-migration of the lower income migrants.

The out-migrants leave the neighbourhood they live in, as a result of displacement due to a traumatic event or white flight. The in-migrants are those who arrive as a result of neighbourhood change: This replacement can be economically downgrading such as in the example of rural incomers to decayed neighbourhoods. Such “disadvantaged neighbourhoods—
including decaying infrastructure, lack of services and institutions, and a lack of organizations that foster social connectedness—can hamper residents’ abilities to maintain ties or form new relationships” (Cornwell & Behler, 2015). This change can alternatively be economically upgrading such as in the example of gentrification, a process of urban migration pattern that promote higher-income population to move into a neighbourhood, while lower-income residents are gradually displaced. First-wave of gentrification has lower impact on upgrading market values, however mature gentrification results in waves of gentrifiers with higher-income to move in (Hochstenbach & van Gent, 2015).

As well as incremental changes in neighbourhoods such as gentrification and neighbourhood decay, top-down and abrupt processes are also present, such as urban renewal or implementations of illusory urban spaces. However, Massey (1995) argues that the identity of a place is not necessarily subject to change and destruction by new importations. The identity of a place is primarily formed by urban memory. Cultural hubs play a primary role in determining how a historic neighbourhood is dealing with change. They provide an environment for cultural groups to integrate in the neighbourhood, place attachment, and in long-term local values that promote cultural diversity.

3. DATASETS AND METHODS

As discussed in the previous section, neighbourhood change and cultural diversity are interrelated concepts in the context of historic neighbourhoods. Previous studies on spatial capital and urbanity show that there is a strong correlation between accessibility, density and diversity in urban settlements (Marcus, 2010). The paper tries to uncover to mutual effects of cultural diversity and neighbourhood change, measuring visual accessibility of cultural hubs and social and physical interrelations of cultural groups on three different case studies.

The paper attempts to answer the following research questions:
• How does cultural diversity contribute to historic neighbourhoods’ continuity or change?
• What are the effects of historic neighbourhood change to cultural diversity?

The methodology of the case study attempts to answer the first research question by measuring the cultural diversity of the neighbourhoods using a diachronic approach. The approach is based on the spatial-locational histories (Griffiths, 2012) of three neighbourhoods and the mutual relation of morphological (syntactical) history and the “history of events” (Hanson, 1989; Griffiths, 2012) that occur in these spaces. The “history of events” is illustrated on a timeline that draws the major events and changes for the neighbourhoods. Some distinctive historical maps are chosen to infer the effects of historical events and change of cultural diversity on morphologic-syntactic change of the neighbourhoods. The morphologic-syntactic change also explains the socio-cultural alterations and issues such as decay, gentrification, renewal or illusion.
The comparative space syntax analysis puts forward the alteration of the integration levels of cultural hubs and dwelling patterns formed by cultural and ethnic groups (especially minorities) in different periods in history to determine how cultural diversity is affected by change.

Cultural hubs can be defined as buildings or landmarks having historical and cultural significance for the neighbourhood. They play a role in creating place attachment for communities and local touristic values for visitors. The spatial features of specific locations can be measured with the space syntax' visual graph analysis. The integration value of a specific location on the grid determines the level of visual perception and accessibility of that location in relation to all other points on the grid. Centrally located, perceivable buildings found on longer streets tend to be more integrated in the neighbourhood. Buildings found on secondary streets tend to be more segregated. The isovist values determine if the cultural hub has a higher perceptional level in terms of the area and the perimeter of the isovist. That means, if the building is opening to a larger street or a public square, its isovists tend to have a larger area and perimeter than those opening to a smaller and segregated street.

Settlement patterns are measured with global and local integration analyses of cultural groups' physical footprints. This analysis determines cultural groups' juxtapositions on neighbourhood level. The axial analysis gives the results of how cultural groups settled and integrated into the neighbourhood throughout history. These results give ideas about the inclusion of the groups in the area. If they are globally integrated, it means that they are more visible in the totality of the neighbourhood, and that they are placed on main roads, socio-economically integrated areas. If they are locally integrated, they are included into the neighbourhood on a social level. Locally integrated areas are mostly successful in social inclusion and liveability.

The answers to the second research question are given in the conclusion as an interpretation of the space syntax study findings. Space syntax interpretations are comparatively made according to three parameters: the level of physical change, the level of social change and the level of cultural diversity. For each parameter, the study provides findings based on observation and qualitative research, additionally to the space syntax findings. There are two indicators of physical change: first is the alteration in the integration and isovist value of the cultural hub, and second is the change in the physical condition of the building. The indicators of socio-economic change are the alteration in the settlement pattern integration levels, socio-cultural and economic conditions of the inhabitants, and property prices. The indicators of cultural diversity are the interrelations between settlement patterns of different cultural groups and the events causing a change in the cultural diversity of a neighbourhood.

<table>
<thead>
<tr>
<th>Space syntax indicators</th>
<th>Other indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical change</td>
<td></td>
</tr>
<tr>
<td>VGA integration and isovist value of the cultural hub</td>
<td>physical condition of the building</td>
</tr>
<tr>
<td>Socio-economic change</td>
<td></td>
</tr>
<tr>
<td>alteration in the settlement pattern integration levels (axial analysis)</td>
<td>socio-cultural and economic conditions of the inhabitants, property price</td>
</tr>
<tr>
<td>Cultural diversity</td>
<td></td>
</tr>
<tr>
<td>interrelations between settlement patterns of different cultural groups</td>
<td>events causing a change in the cultural diversity of a neighbourhood</td>
</tr>
</tbody>
</table>

4. RESULTS

The study explores the issue of cultural diversity and neighbourhood change over three cases studies in Istanbul: Kuzguncuk, Samatya and Fener. These are historic neighbourhoods, which has been home for a variety of cultural and ethnic groups. Currently, all of these neighbourhoods are experiencing change related to urban issues such as renewal, gentrification or decay.

Kuzguncuk is a neighbourhood in the Asian coast of Istanbul. It is known as one of the most welcoming neighbourhoods to different ethnic and cultural backgrounds. Kuzguncuk has been home for Armenians, Greeks and Jews of Istanbul for a long time as a mixed neighbourhood.
(Akın, 1994). Many sources refer to Kuzguncuk as Chrysokeramos. However, many historians have not agreed this idea (Bektaş, 1996). Incicyan supports the view that the name Kuzguncuk is a derivation from “Kosinitsa”, the old name of the district (Incicyan, 1976; Bektaş, 1996).

Kuzguncuk was known as a Jewish neighbourhood. When Jews settled in the neighbourhood is still unknown. Armenians started to settle into the area in 18th century, and started to grow their community in the 19th century (Bektaş, 1996). Jews, Greeks and few Armenians were residents of Kuzguncuk up until 19th century.

“Minorities left Istanbul in response to the frightening political climate between the 1940s and the 1960s. During this same period, rural-urban migration from Anatolian villages created a cultural shift in the old mahalle (neighbourhood)” (Mills, 2004). A tangible and intangible offense towards Istanbul’s non-Muslim people is realized towards especially Greek residents during 6th and 7th of September 1955. It caused a trauma followed by a displacement of minorities in Istanbul 1. There had been also minority groups moving to newer areas in Istanbul as a result of this incident. Today, the majority of Kuzguncuk residents are formed mostly by Black Sea migrant community, caused by mainstream migration to larger cities in late 1930s until 1960s. Non-Muslims residents decreased in number (Mills, 2004).

![Figure 2 - Photos of the Kuzguncuk area](image)

1 The Istanbul riots (or September events) were organized attacks towards Istanbul’s Greek minority on 6–7 September 1955. The events were a result of the false news that the Turkish consulate in Thessaloniki had been bombed the day before. The riots assaulted Istanbul’s Greek community during 6 September evening until 7 September morning. Over a dozen people died, although killing was not aimed. Armenians were also harmed. Riots continued until the government declared martial law in Istanbul and called the army force. Istanbul riots increased the emigration processes of Greeks from Turkey, especially in Istanbul region. The Greek population of Turkey decreased from 119,822 in 1927, to approximately 7,000 in 1978. In Istanbul, the Greek population decreased from 65,108 to 49,081 between 1955 and 1960.
With the first wave of gentrification in Istanbul in the 1980s, Kuzguncuk became one of the popular places (Ergun, 2004) where architects, poets and artists started to live. Famous architect Cengiz Bektaş, who played a part in the gentrification of the area, buying a house for his family and making participative planning and renovation processes without charge (Ergun, 2004; Uzun, 2002), has inspired them to move to the neighbourhood.

Samatya is also a multi-cultural neighbourhood situated in the European coast of Istanbul. Samatya was named Psomathia, which means sandy lands (Türker, 2010). In its ancient name, Psomathia was one of the prestigious neighbourhoods because of its location near the Golden Gate (Hrisi Pili) of Constantinople in the Byzantine era. Victorious emperors were coming back to the city through this gate.

After the Ottomans conquered Istanbul, the Ottoman Empire made a call for other non-Muslim groups to settle in the area. Especially, the Ottoman Empire encouraged the settlement of the Armenian citizens in the neighbourhood by assigning the old Byzantine church to the Armenian community. It functioned as a Greek Orthodox Church in the Byzantine era. A short time after conquering Istanbul, the Ottoman Empire converted this church to the Armenian Patriarchate of Istanbul. Armenian community still resides around the church currently named as Surp Kevork Armenian Church, after the Armenian Patriarchate moved to Kumkapı.

During centuries Greek, Armenian and Jew communities formed the majority of dwellers in Samatya. The Jew community had to leave the neighbourhood, as their houses were completely wiped out in a fire in the mid-1700. During and after the westernisation processes in the 1800’s, many renovations have been made to maintain cultural heritage. These renovation and revitalization processes are also a result of many uncontrolled fires that happened in the 18th and the 19th century. An orthogonal plan in Samatya was designed and implemented, after a long period of organic incremental planning. This new plan reduced the fire risk. The largest effect was that the neighbourhood’s spatial layout changed radically (Çelik, 1986).
Samatya was one of the places where 6th and 7th September 1955 incident was devastating because of its high number of non-Muslim residents. Many houses, shops, cultural buildings such as schools and churches have been destroyed. Non-Muslim women and children have been abused. Many Greek residents left the area after this incident (Mills, 2004). The neighbourhood suffered for a long time from a trauma caused by this incident. This incident was significant in terms of the balance of non-Muslims and Muslims residing in the area. A major part of the minorities, especially the Greeks left the city because of the trauma. A large amount of Kurdish and Turkish residents settled in their places in the neighbourhood.

Fener is the third case involving a multi-cultural neighbourhood environment. The neighbourhood is in close relation with Balat where a large Jew community resides. The neighbourhood existed in the Byzantine era. It has been home of the Greek Patriarchate and the centre of the Orthodox Church. Fener was an upper-class Greek neighbourhood in the Ottoman period until the 1960s (Belge, 2003, Akkar Ercan, 2011). Fener has also important historic buildings designed by Greeks. Wealthy people moving out of the neighbourhood, replaced by poor immigrants and the contamination of the Golden Horn caused the rapid decay of Fener as well as Balat (Özbilge, 2005, Akkar Ercan, 2011). The coastline was cleared. However, the measures taken have not been sufficient to stop deterioration. Fener is under threat of decay losing the integrity of its nineteenth-century grid plan, ornamented facades and important buildings such as churches, mosques and synagogues (Akkar Ercan, 2011). Fener underwent a regeneration initiative that was possible due to HABITAT II proposing ‘integrated rehabilitation’ for historic neighbourhoods of Istanbul based on simplistic measures taken by the inhabitants to preserve heritage and decent life standards (Altinsay Özgüner, 2009, Akkar Ercan, 2011).

A timeline concerning the major changes and events in these neighbourhoods is given in figure 4 to illustrate the comparative timeframes of the case studies.

Cultural hubs of the three neighbourhoods are analysed comparatively and diachronically (figure 5–6–7). According to the findings, Kuzguncuk Mosque (4) has increased in local integration and isovist area starting from the 1990’s. Neighbouring ritual places, Beth Ya’akov Synagogue(3) and Hagios Georgios Greek Church(2) are showing approximate values throughout the history. However, a slight increase is seen in all the cultural hubs situated on the main street perpendicular to the shoreline as well as in Hagios Panteleimon Greek Church(4). All five cultural hubs in Kuzguncuk maintain their integrity and their physical conditions are excellent. All of these ritual
places culturally contribute to the development of the area, with a religious community taking care of the buildings and vicinities. Many of the hubs, especially Hagios Panteleimon Greek Church(1) being visually distinctive, have a positive effect on local tourism.

### Kuzguncuk Cultural Hubs

<table>
<thead>
<tr>
<th>1930s-1960s</th>
<th>1990s-2010s</th>
</tr>
</thead>
</table>

![Figure 5 - Isovist analyses of Kuzguncuk with the location of cultural hubs.](image)

Comparing Samatya’s cultural hubs values from the years 1930-1960 to 1990-2010, all integration values except Analipsis Greek Church(2) have dropped. Some values decreased drastically. Surp Kevork Armenian Church(10) and Abdi Çelebi Mosque(8) are two of them, due to the decrease of integration in the main avenue (Marmara Avenue). However, the physical conditions and the maintenance of these two cultural hubs remain excellent. Their isovist values are steady, as Marmara Avenue has not changed in shape between these years. The integration value of Hagios Minas Greek Church(5) decreased a small amount. A reason for this result is that although the church is centrally located, its entrance is found on the upper street, which stays segregated throughout those years. The building is not maintained and is used as a shop.

The Armenian Catholic Church’s(5) integration and isovist area both decreased, the building is in very good condition and is gated. Hagios Nikolaos Greek Church’s(3) all values dropped, unlike Analipsis Greek Church(2) that has all its values increased. Both hubs are in decent condition. Hagios Georgios Greek Church’s(7) integration and isovist values decreased, as it is located in a street gradually more segregated. The building is badly renovated. Sahakyan-Nunyan Armenian High School(11) and Anarad Hiğutyun Armenian Primary School(1) show the same spatial structure as Hagios Georgios Greek Church(7). Hacı Kadın Mosque(6) values remain steady. However, Ağa Bath (9) integration and isovist values decrease dramatically. Currently, Armenian hubs that are clustered together around Surp Kevork Armenian Church(10) contribute both culturally and economically to the area. Many shops, schools and religious ceremonial organisation companies are gathered around the church. However, Greek hubs lost their meanings as most of them became unused, as well as their configurative values.
Fener’s cultural hubs are mostly constituted by Greek properties. The first cultural hub, Marasli Greek school (1) had a slight increase in terms of local integration value. However, the building lost its functional importance and is unused at the moment. Greek Church Hagios Yorghis(2) has a great imprint on the neighbourhood as well as great cultural value, as it stands also as the Orthodox Patriarchate of Istanbul. Its local integration value had a slight decrease. However, the building still maintains its physical integrity and spiritual importance. Greek school Yoakimion for boys (3) can be stated as the signature building of Fener. It has a great imprint on the area and strongly contributes to local tourism. The building has a high integration value and is as integrated as before. Greek School Yoakimion for girls on the opposite side (5) of the building has similar integration values between 1930s and 2010s. However, the building has decayed and is unused at the moment. All students are now part of Fener Greek School (3). Between the two school buildings, the Byzantine church (4) maintains its integration levels with a slight increase. The building still functions as Church St. Mary of the Mongols.
Settlement patterns of different cultural and ethnic groups and in-migrants are illustrated on a diachronic and comparative analysis (Figure 8-9-10). According to the findings, in Kuzguncuk between the years 1930 and 1960, Turks living along the coastline are wealthy people. The integration of the streets along the coastline is the highest in the area. Jew and Greek settlements have similar integration values, although Armenian settlement has the lowest integration value in the area.

In the recent years in Kuzguncuk, the number of minorities has dropped because of the 1955 trauma. After 1955 a high number of migrants moved in to the area. These migrants establish themselves along streets with a lower integration than the former multi-cultural residents. It is a result of the increasing economic gap between the new migrants and the residents. The gentrifiers prefer places that are more integrated than the migrants, but lesser integrated than the residents. They rejuvenated more segregated places, but still are globally integrated and close to the main street. They have a place preference: Üryanizade Street. The street is famous for its renovated houses of renowned people who came to Kuzguncuk after Cengiz Bektaş. There are quite significant differences regarding the dwellings’ prices and sizes, especially the location of the houses on the shoreline (north of the map) are 10 to 15 times more expensive then a regular old-renovated gentrifier house in a street with average degree of integration. Apartment houses preferred by the migrants in segregated streets are mostly very accessible in price, and cost in general a quarter of an old-renovated gentrifier house.

For Samatya, the comparison between the 1930s and 1960s shows that the Armenian community uses the most globally integrated areas. The most integrated area shifts towards the south between Armenian and Greek Communities from 1930 to 1960. This implies that areas where Armenian and Greek communities intersect each other are very integrated in the neighbourhood. In 2010’s, the Armenian Community and especially their main street Marmara Avenue becomes highly integrated. The Greek community is not a part of Samatya community anymore as they decided to a displacement. There are not more than 3-4 Greek families in Samatya. They were replaced by low-income in-migrants who prefer settling on the west part of the main street and its secondary streets. Generally, the streets are in worse conditions that the Armenian community area. There are many new constructions, including high-standard ones, which are aimed to attract the middle-class. These new constructions are concentrated around
the west side of Marmara Avenue and around Merhaba Street, they are expected to have higher standards and higher market prices. Property prices for old renovated houses seem lower than the ones in Kuzguncuk ranging between half and a third of its equivalents. Seemingly, this fact results in larger in-migrant groups with lower income to settle in the neighbourhood.

SAMATYA SETTLEMENT PATTERNS

1930s-1960s

1990s-2010s

Figure 9 - Global integration analyses of Samatya with the location of various ethnical groups.

FENER SETTLEMENT PATTERNS

1930s-1960s

1930s-1960s

Figure 10 - Global integration analyses of Fener with the location of various ethnical groups.
In Fener, there is still a small Greek community. However, a quite large part of the neighbourhood belonged to the Greeks in the 1930s and 1960s with a relatively small Turkish community and a Jew community in neighbouring quarter Balat. In the 1990s and 2010s, a big change in the inhabitant profiles can be seen from the records. This resulted as an effect of the 1955 trauma and its consequences such as physical decay and loss of social interaction in Fener neighbourhood. The abrupt change resulted in the in-migration of lower-income migrants in the place of Greeks. Comparing the axial maps, the integration values increased significantly around the area close to the shoreline. That is the planned renewal area of Fener and currently some buildings are destructed in that area. This area houses properties with a variety of market prices, most of which are old-renovated Greek houses. A few of these houses are also found in the orthogonal street pattern where lower income in-migrants settle, with market values ranging lower than its equivalents in Kuzguncuk, but higher than those in Samatya.

5. CONCLUSIONS AND DISCUSSION

All three neighbourhoods had different cultural diversity experiences, and responded to neighbourhood change quite differently. Each neighbourhood is interpreted individually and comparatively.

The gentrification case: Kuzguncuk

The first case Kuzguncuk is defined to be a gentrified neighbourhood. It has an internal balance, even after gentrification processes. Gentrifier in-migrants are located at a favourable place and do not interfere with the entire residential composition. Cultural hubs are still physically intact and did not show severe decrease in the integration and isovist values during the last five decades. The residential emplacement of different groups is economically justifiable. These findings show that the neighbourhood is physically in good condition, socially balanced and economically favourable. However, its cultural diversity and being able to locate various cultural and ethnic groups decreased as a result of the political climate.

The neighbourhood decay and illusion case: Samatya

Samatya is unique because of the unprecedented continuity of a minority settlement. The Armenian community maintained their emplacement around their cultural hubs during the century, and accordingly, their integration value for cultural hubs and community footprints stayed at a high level. However, the Greek community was displaced and in-migrants with lower-income caused decay in the neighbourhood. The same structure applies for their cultural hubs. However, the integration values for their footprint had not changed. At present, newer constructions and high-standard housing complexes are implanted to attract new-middle class as potential gentrifiers. However, these illusions are insufficient to provide such a movement.

The neighbourhood decay, rehabilitation and renewal case: Fener

Fener provides an interesting case as some of the cultural hubs became completely disused. However, some of the cultural hubs are still as important as in the beginning of last century. Greek community left its place to low-income migrants who could not have the means to look after historical buildings. These circumstances caused decay as in the case of Samatya. Although, integration values are slightly increasing or decreasing during the century, a noticeable change appears on the shoreline where the renewal project will be implemented. Market values remain unsteady due to the on-going change.

In general, various cultures through history shape the physical layout of the built environment. Conversely, various in-migrant groups seek for places to settle for maintaining their culture as well as interfering with the economy of the host city. Seemingly, depending on economic resources/capacities and lifestyles of cultural groups influence where various communities will settle. Some cultures seem to prefer a more locally integrated local street pattern, whereas others prefer to settle along segregated streets.

From another perspective, the gentrifier in-migrants seek for places where they can exchange ideas and inspiration with others. Mostly, they prefer urban areas with a high diversity of various...
ethnical groups combined with a built mass containing architectural qualities with a high degree of collective memory from the past. In most cases, it consists of old neighbourhoods with some highly locally integrated streets that are connected to the rest of the city. Their adaptation to the neighbourhood also tends to increase property market values.

Seemingly, a neighbourhood’s gentrification process depend on high aesthetic qualities of the buildings, high local integration of the main street, and to have well integrated main routes through the neighbourhood. In addition, a strong unique local place identity seems to play a role. Conversely, a downgrading of a neighbourhood is influenced by decay on the built mass, the significant old iconic buildings disappear or are located along segregated streets, and the area is segregated and poorly connected to the rest of the city.

ACKNOWLEDGEMENTS

The authors would like to thank TÜBİTAK-BİDEB Research Fellowship Programme (2214-A) for providing a research fund.
REFERENCES


İncicyan, P. G., 1976. 18. Asırda İstanbul [İstanbul in 18th Century], İstanbul: İstanbul Enstitüsü Yayınları


#155

**AFFILIATION SPATIALLY EXPRESSED**

How Social Networks Structure Residential Mobilities in London

---

**ANNA TUONONEN**  
University College London  
anna.tuononen.15@ucl.ac.uk

**STEPHEN LAW**  
University College London  
stephen.law@ucl.ac.uk

---

**ABSTRACT**

This work investigates the relationships between residential location choice and social networks. Building upon the idea that social networks are key to how cities and peoples’ movement are structured (Hillier 2016a), this work suggests they likely participate in urban residential choice behaviours.

It is suggested here, fundamentally, affiliations require a spatial structuring so they can be produced and reproduced. Put in other words, the choice of our residential location implies a choice of whom we want to affiliate with - that space participates in the dynamics of strengthening, maintaining or dissolving social networks - and that we consciously deploy this dynamic. This study’s aim is to examine if people’s residential mobilities relate to their social networks and what forms these relations might take.

To do so, this paper discusses the interdependencies between space and social networks, based on results from an MSc project released in autumn 2016. Its findings suggest that social networks are locational attractors but work in a wider reading than simply amenities regarding residential mobilities. This work proposes that the networks we have, not only direct our preference of choice in location but constitute our knowledge of suitable options within the housing market.

**KEYWORDS**

Social networks, residential mobility, residential location choice, housing economics, social economics

---

**1. BACKGROUND**

A number of reasons highlight why the intersection of socio-spatial networks and residential mobilities is relevant to study. Hillier identified the relationship of social and spatial networks to be a key priority in space syntax research (2016b). Considering that the research approaches within space syntax are predominantly from a static perspective, there is room to primarily explore the dynamicity of social networks against the background of space. Another aspect calling for this study is a gap between literature in socio-spatial theory and housing economics that explain decision-making concerning residential choice. To date, studies in residential choice theorise renters and buyers without social liabilities (Schirmer et al. 2014) which follows the historic economic tradition in which peoples’ everyday decisions are rendered as predominantly economic considerations. While the influence of social networks is recognised in economic theory (a.o. Dutta and Jackson 2003) it has not been directly discussed in relation...
to the functioning of property markets. Currently, up-to-date economic conceptions are not capable of fully describing significant phenomena in urban migration, such as the pull of skilled people into the major cities (FT Data 2016). Neither are current models able to explain why many urbanites in precarity chose to stay in places with a region’s highest living costs.

Sociologists such as Akerlof (1997) and Granovetter (2005) have argued that social and economic lives are interwoven as process and its consequences. Additionally, some elements within social theory provide the grounds to believing that there could be empirical evidence to people seeking proximity to their social networks. Urry (2012) describes networking as a resource-intensive activity and thus the ability to network, ‘social networking capita’, is finite - one that enables or constrains an individual’s mobilities based on their access to emotion as labour, time, and money among others. Hillier and Netto (2002) presented that copresence and distance are inversely related to the probabilities of meeting, which is the creating and recreating of social relations. These elements together would suggest the proximity to one’s social fabric does matter, and that a spatial choice to social networks is made via residential location, implying a social choice.

2. RESEARCH METHOD

2.1 RESIDENTIAL LOCATION CHOICE DATA COLLECTION

A feasible way to capture a social choice being exercised was by observing the spatial relations to person’s social networks before and after they moved. With no available datasets to compare several necessary social, spatial and economic parameters, a new dataset was collected.

To achieve this, 125 residents in case areas of London were approached via structured interviews to ask on their residential needs, current and last residential location, and important members in their social networks. Questions were asked about affiliations that are regularly part of respondents’ lives and also meeting places where these relations were reinforced. Respondents were inquired about several types of affiliations, individuals and communities, and the distances respondents regularly travelled to enforce their relationships.

2.2 CASE AREAS

Interviewees to this study were to be chosen among residents that had moved to a few different comparable areas. London was picked as the case city due to its benefits of having high residential mobility (Landlord Today 2016) and diverse neighbourhoods.

Figure 1 - Areas Seven Sisters and Deptford overlaid on a submarket division proposed by Law et al. 2015.
The control factors by which areas were chosen were the diversity of population measured by social networks (Hristova et al. 2016), belonging to the same submarket when accounting for features of the street grid (Fig.1), similar accessibility values (NAIN, NACH), and demographics by age, ethnicity and occupation to portray a range of narratives that join in location choice. Applying these criteria of similarity, Seven Sisters in Haringey and Deptford in Lewisham were chosen as the case areas to this study.

2.3 SPATIAL ANALYSIS

Space syntax theory and analysis, GIS and statistical analysis were used to derive tendencies from the structural interviews.

**GIS:** All map representations were created with the help of open-source GIS (geographical information systems) software QGIS. Specific techniques used are geocoding and heatmaps.

**Transport analysis:** To calculate the distances and travel times between each respondent and their closest contacts, a transport network analysis using the Google Maps API (Application Programming Interface) was conducted. Google Maps API is essentially an app that allows users to calculate spatial distance indices using the Google Map engine and its database.

The database includes:

- the pedestrian network data to calculate walking distances between the origin and destination
- detailed public transport network and time-table data to calculate travel times between origin and destination.

A python-based function was developed to calculate spatial measures in a respondent’s egocentric graph (marked in orange, Fig 2.).

![Figure 2 - An ego-centric network graph illustrating the respondent (orange) and the respondent closest affiliations (green). The length of the edge corresponds with the social distance between the respondent and their contacts.](image)
These measures are the metric distance, travel time and angular distance between the interviewee and their closest contacts.

\[
\text{Dist} (ij) = \text{network walking distance between } i \text{ and } j \\
\text{where:} \\
i \text{ is the interviewed correspondent} \\
j \text{ is each of its closest social contacts}
\]

\[
\text{Time} (ij) = \text{public transport travel time between } i \text{ and } j \\
\text{where:} \\
i \text{ is the interviewed correspondent} \\
j \text{ is each of its closest social contacts}
\]

\[
\text{Ang} (ij) = \text{network angular distance between } i \text{ and } j \\
\text{where:} \\
i \text{ is the interviewed correspondent} \\
j \text{ is each of its closest social contacts}
\]

Heatmap of Seven Sisters’ and Deptford’s NAIN and NACH values for radii 800, 2000 and N.

<table>
<thead>
<tr>
<th>Min.</th>
<th>SEVEN SISTERS</th>
<th>DEPTFORD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radii</td>
<td>NAIN</td>
<td>NACH</td>
</tr>
<tr>
<td>800</td>
<td>1,748</td>
<td>1,338</td>
</tr>
<tr>
<td>2000</td>
<td>1,433</td>
<td>1,423</td>
</tr>
<tr>
<td>N</td>
<td>1,380</td>
<td>1,528</td>
</tr>
</tbody>
</table>

Table 1 - Space syntax: Two commonly used space syntax measures were calculated for central street segments of each case area.

One of the measures is the segment angular integration (1) (Hillier and Hanson 1984; Hillier et al. 2012), which measures the reciprocal average shortest path between every origins (i) to every destination (j) - or more simply its to movement potential to reach all nodes in the system (Hillier and Iida 2005). The segment angular intergration is also known as closeness centrality in the network science literature.

\[
\text{CC}_i (r) = \frac{N (r) - 1}{\sum d_i (r)}
\]

\[
\text{BC}_i \text{ is the Betweenness centrality at } i \\
N_{st} \text{ is the overlap between } s \text{ and } t \text{ on segment } i
\]

\[
\text{BC}_i = \sum_{s \neq t} \delta_{st}
\]
3. RESULTS

3.1 INTRAURBAN MIGRATION - A GEOGRAPHICALLY CONFINED PHENOMENON

Unravelling the direction of the analysis, this section shows a visual overview (Fig. 3) of where respondents had previously moved to either case area.

Figure 3 - Point density clusters of respondents’ previous residential locations by case area.
The overview suggests that the River Thames notably is a divisive element for people re-settling from either side of the city. A previous research to residential choice (Zondag and Pieters 2005) yielded that its participants’ new residential location was strongly related to the site of their last residence. The visual study of Fig. 3 confirms this partially, but also that there is variation in the relationship. A significant share of participants had moved locally (Fig. 3) which is shown as bright, dense clusters around both case areas. Moreover, the number of those moving declines when exceeding locality to greater distances. These aspects suggest that distance and spatial configuration would influence the mental maps of the city and the choice of residential location.

3.2 LAYING FUNDAMENTS TO RESIDENTIAL MOBILITY: MOTIVATIONS AND IMPROVEMENTS OF HOUSING CIRCUMSTANCES

It is more commonly formulated in studies on residential mobilities, that the decision to relocate stems from a housing arrangement not meeting the occupant’s expectations (Clark and Onaka 1985). Considering the historical tradition in which housing needs have been quantified in terms of economic or physical utility, this study brings to light the social choices that have not been considered in detail.

Taking Clark and Onaka’s argument as a starting point, respondents of this study were asked to name one or multiple reasons that triggered the choice of their current frames of housing - Table 2 gathers their responses. It indicates, that the access to one’s work or study location (31), social opportunities (22) and price (20) are most prominent coherent factors in the location choice for the interviewees of this study. The term ‘social opportunities’ is used to combine a few named motives describing the same aspect but in more practical terms. These comprise the presence of outdoor places to meet people (new and known), experiencing a sense of community and that people of similar demographics are residing in the same area.
Table 2 - The opportunities and improvements claimed by the new dwelling and location, by frequency of mention.

Then, results were categorised by the degree to which each influences peoples’ social behaviour and social networks:

- no effect (economic or physical improvements)
- an implicit or likely effect to social networks
- aware motive to directly affect one’s social networks.

Doing so helps to distinguish that only 27% of motives had to do with solely physical or economic improvements of housing, as opposed to mainstream conceptions in residential choice literature. Again, 72% of named improvements had consequences on social networks either explicitly or implicitly. An example of an implicit effect of is moving to a safer environment, in which a person may be inclined to spend time outdoors and be exposed to more social contact.

Together, the motives listed (Table 2) uncover a multi-faceted sociality in the improved living circumstances chosen by the participants. The many ways social networks are considered - as current or potential, close or distant – reveal how social networks work in more intricate ways than any of the quantitative methodologies that follow would suggest.
3.3 SOCIAL NETWORKS - A FACTOR WORTH NOTING IN HOUSING ECONOMICS

This section aims to provide a sense of scale and the importance of social networks as a factor in the decision of distance to their contacts – and thus location. To do so, this section deploys quantitative means to explore the urban migration of the study’s interviewees in relation to their social contacts. Continuing from there, this work goes on to examine how social networks perform as a spatial attractor in relation to the workplace, often named an eminent factor for residential location (Schirmer et al. 2014).

We begin by observing how the distance to respondents’ personal networks changed when respondents relocated. This paper finds a trend (Fig. 4) among respondents staying within same distance (29% saying within +/- 1.25 km distance) or shifting closer (65% moving more than 1.25 km closer) to their affiliations in the urban sphere. One in three (35%) moved more than 1.25 km away from their affiliations. A look at the symmetry of the results show a spatial attraction of social networks: there is a significantly greater deviation among respondents moving closer to their contacts (94.24) than among those moving away (3.27). This difference is constituted of people moving closer to their affiliations over a large scale of possible distances.

To ascertain that the results narrate a spatial preference towards social affiliations, a comparison between work and social networks was made. Among a subset of working participants, via linear regression, changed distances to social contacts as well as work were analysed. Following this, choice behaviors were observed by socioeconomics defined by professional groups and the level of education they require.
Table 3 - The linear regression model coefficients on the spatial preference among working participants. The occupational categories in use are applied from Census definitions (2011).

The coefficients indicate (Table 3) that affiliations were as influential as work regarding the change of distance for all respondents except for those working in professions not requiring formal education. The gap among working participants in groups 1-6 and 7-9 demonstrates both that there is a tendency to exercise the choice to be closer to affiliations, but also that there are circumstances to allocate notably more proximity towards work than to social affiliations. With reference to Urry’s proposition (2012), the gap likely corresponds to how the maintenance of networks is dependent of societal privileges, to which socio-economic opportunities, Urry argued, are key.

3.4 AREAL SELECTION: ACCUMULATING SPATIAL MEMORY, AND THE FOLLOWING PHENOMENON

Asking respondents what their relationship to their current living area was before they moved revealed that a majority of 59% had contacts that resided in the area already (Table 4).
In their direct meaning, the results imply that among participants there was a tendency to move where their close relations already lived. Indirectly, there are a few ways in which affiliations likely have a role in the location choices here. Firstly, by providing trusted information and by thus directing preference as Granovetter (2005) argues: '[...] social networks affect the flow and the quality of information. Much information is subtle, nuanced and difficult to verify, so actors do not believe impersonal sources and instead rely on people they know.' (ibid., p. 33). Secondly, affiliations may work as destinations to participants’ everyday mobilities. Through this, one can experience their area and areas in-between first-hand without obligations. Griffiths (2016) suggests attractors and everyday trajectories equate to areas and accumulate the experience of the lived city: ‘Mundane mobility practices also have effects on identity, belonging and understanding of place (as often understood to be the case of exotic journeys to far-away destinations).’ (ibid., p. 242). One respondent of the study mentioned specifically knowing their new neighbourhood, Deptford, as a previous switch point on their commute.

### 3.5 PERCEIVING THE NEARNESS TO ONE’S SOCIAL FABRIC

This part explores how residents in Seven Sisters and Deptford interacted with the distance incorporated to their social networks when they moved. Two parameters are used to describe perceived distance; this section will examine which of them may better explain the logic by which people move close to each other. To elaborate on the parameters used, spatial distance is considered influencing the likelihood of one’s spontaneous and planned meetings (a.o. Hillier and Netto, 2002), whereas the second parameter, travel time, is considered as depicting the mobility costs to meet one’s social contacts.

![Figure 5](image.png)

**Figure 5** - The changes in route distance and travel time to respondents’ social networks.

The above-lying regression analysis (Fig.5) illustrates different behaviour among those relocating further to those moving closer to their affiliations. With increases in both distance and travel time, the results comply to a linear trend; again those who relocated with decreased distance and travel time behaved with lesser uniformity. These participants appeared to an extent ‘drawn towards’ saving in route distance over travel time. It suggests, that nearness and presence of social networks – if carrying priority – are rather perceived in terms of spatial distance than associated costs to meet.
Results in which there is spatial nearness while travel time is not declining accordingly may also indicate a change of travel mode, where walking locally becomes the fastest means to meet. Considering that most of peoples’ trips are short and the likelihood of meetings increases with proximity, the benefit of spatial nearness enables an organic encountering along everyday travel – an aspect that may be a decisive consideration in choosing a distance to one’s closest contacts.

3.6 GRASPING THE SPATIALISED MARKET: AFFORDANCES OF THE STREET GRID VERSUS THE SCALES OF RESIDENTIAL MOBILITIES

Section 3.1 (Fig.3) displayed the rapid decline of the number of people moving to either case area the further away they moved from. By examining the same effect numerically (Fig.6), this study observes divergent residential patterns to each case area. Compared to Seven Sisters, Deptford attracted an unexpected number of people further away, as far as approximately 7.5 -10km and from its immediate vicinity. In Seven Sisters the same tendency is inverted, where a majority of participants relocated from within 2.5-7.5 km.

![Bar chart showing change of residential location measured as route distance.](image)

Figure 6 - Change of residential location measured as route distance. Here notable is the difference between the distributions of distances from which residents have located to either case area.

We reflect these results together with the case centers’ NAIN and NACH measures (Section 2.3 Table 1) that indicate how likely each of the centres is known in its surrounding area. This comparison highlights a discrepancy, in which in all radii Seven Sisters possesses higher centrality values than Deptford, yet Deptford attracts participants from a greater geographic area. What the pull to Deptford within a larger urban area could potentially mean, is that Deptford is included in the mental map to a more widely spread population despite what the spatial affordances suggest (Table 1) – and since it was chosen possibly implies a better relative option among the areas in people’s mental maps. What motivates and characterises someone moving long distances?

Moving distances of the study participants were compared with how far they regularly travelled to maintain their social lives (Fig.7). The scales of moved distances were shown to link to the geographical spread of one’s contacts - again indicative of one’s capacity to network (Urry...
The resulted moving distances may be a multiplied result of networks’ influence: contacts informing and directing preference, following contacts where they live to be close to them, and mental maps accumulated through travel practices.

In any of the cases, spatially spread networks seem to allow accumulating knowledge of a larger pool of suitable areas than those whose networks are local – thus allowing a greater freedom to relocate within the housing property market as Fig. 7 suggests. Again those with local social networks showed something to be described as residential ‘immobility’. This translated into their new residential choice likely having remained local.

4. DISCUSSION

This paper provided an account of multiple approaches to investigating the link between residential location choice and social networks. Combining the several qualitative and quantitative observations seem to arrive at the same effect – that social networks are incorporated in the notion of space, and that they entail the choice of distance to them.

In the analysis, participants were shown to arrange their spatial circumstance to maintain or strengthen existing relations, but also to dissolving them. Interestingly, for a section of the interviewees, their locational decision was motivated by the potentiality of new encounters. Another key take-away to this work is that the link between social networks and housing choice works in subtler ways and with an expanded notion than indicated in previous interpretations. The analyses accumulated insights to how residential choice is influenced by the interdependence between spatial and social networks. This study highlights some of the findings from both sides.

Findings on the role of space:

- The spatial configuration of London was shown to structure the mental perception of the city, and thus to influence residential mobilities of people of this study.
- Among the subjects of the study choosing proximity to social networks, somewhat more significance was placed on gained spatial proximity than in saving on mobility costs (measured as travel time). This would suggest that proximity is more strongly perceived in spatial terms.
Findings on the role of social networks:

- Social networks are interwoven into residential decision-making, both directly and indirectly:
  
a. Directly: as providers of material everyday support, and an interface to enforce distinct identities.
  
b. Indirectly: by providing information advantage, directing preference and providing a well-trusted source of information unlike for example universal media (Granovetter 2005). Also, enforcing relationships entails the expectation of presence that induces mobilities; through these people become acquainted with areas.

- Social networks appear to play a key role in explaining the variation in the scale of residential mobilities, highlighting how variable the knowledge of the housing market among this study's participants was. This is suggested to be the result of networks influencing people’s varying capability to interact with space - and overcoming it.
REFERENCES


Hillier, B. and Hanson, J., 1984. The social logic of space. Cambridge: Cambridge University Press.


Landlord Today, 2016. Average tenancy is now 18 months. Available at: https://www.landlordtoday.co.uk/breaking-news/2016/5/average-tenancy-is-now-18-months [Accessed June 14, 2016].


#156

URBAN INTEGRATION OF REFUGEE HOMES
Spatial potential for integrative social processes

LUKAS UTZIG
University College London
lukas.utzig.15@ucl.ac.uk

ABSTRACT

While local integration as a solution to forced migration was widely disregarded in the past decades, it regains importance amidst the current refugee crisis in Europe. The socio-spatial and syntactic research on the built environment about movement and interaction in space offers a new approach to this topic. This research follows the acknowledgement of urban co-presence and encounter as a contribution to social cohesion, and links it to computational model building and fieldwork on the process of arrival. Three case studies were selected in Bremen, Germany, and studied throughout all scales from the building site to the whole city. The methods are derived from the space syntax theoretical framework, and combined with Gravity analysis into a new formula using the UNA toolbox for Rhinoceros software. Furthermore, Grasshopper software is used to create multi-layered visual models for analysis of privacy and interaction patterns. The conducted fieldwork involved ethnographic description, behavioural observations and interviews.

The findings suggest, that a less active environment with fewer access to sociability leads to longer journeys to areas of high sociability such as the city centre. These areas were identified using the Gravity of Sociability measure as a combination of syntax and Gravity. Also, higher accessibility to jobs relates to more employment through local businesses approaching homes. The special contribution of this research is the synthesis of integrative social processes and studies of the built environment through parametric and computational tools, as well as offering a new perspective on migration and cities.

KEYWORDS
Space syntax, refugee homes, urban segregation, una toolbox

1. INTRODUCTION

The current geopolitical conditions have created large scale forced migration towards Europe, which each country has different approaches to dealing with. This research looks at ‘Transitional Residential Facilities’ for refugees in Germany, which form a connection between the ‘Reception Facilities’ and the normal housing market. In the following, the influence of urban form on the potential for social integration and movement patterns are studied. It will be examined how segregation can be overcome and what the role of public space and the built environment is in the specific case of newly arrived migrants. Furthermore, the integrative potential of public transport as well as job opportunities is included in the analysis. This will then be related to the larger picture of refugee integration.

For that, three case studies have been selected in Bremen, Germany. Computational methods from the space syntax theoretical framework have been used in this research and were also combined with the Gravity method for metric urban land use accessibility. In addition to the
computational analyses, on site semi-structured, qualitative, and anonymous interviews were conducted with 23 inhabitants in total, revolving around their daily routine, activities, use of amenities, and movement in the city.

The findings suggest that a less active environment with fewer access to sociability leads to longer journeys to areas of high sociability such as the city centre, which were identified using the Gravity of Sociability measure as a combination of syntax and Gravity. Higher accessibility to jobs relates to more employment through local businesses approaching homes. The special contribution of this research is the synthesis of analyses of integrative social processes and studies of the built environment through computational tools. Its results are part of a Master of Science dissertation (Utzig, 2016).

1.1 CURRENT REFUGEE SITUATION AND THE ROLE OF THE BUILT ENVIRONMENT

The United Nations High Commissioner for Refugees (UNHCR) has stated in their most recent Global Trends report for 2015 (UNHCR, 2016) that 65.3 Million people worldwide are currently displaced from their homes. In the year 2015 alone, two Million people have applied for asylum, while only 204,400 returned home. The largest country to receive the applications being Germany with 441,900, followed by the US, Sweden and Russia (172,700; 156,400; 152,500).

In their policy, the UNHCR described ‘local integration’ as one of their three ‘durable solutions’. It contains three prerequisites as discussed by Crisp (2004). First, the refugee population must be equalised in law with the host population. This includes basic human rights such as the right to work, to education, to free movement and to property as well as the access to public services and entitlements. Second, the refugee populations’ living standard must be matched with the host population. They must then be able to become progressively less reliant on welfare and re-establish economically self-reliable, independent lives. Thirdly, the social and cultural environment of the host population must enable the refugee population to live free of fear, discrimination or exploitation. The UNHCR policy thus acknowledges the importance of social integration as a solution to refugee crises.

Since Europe became a focal point in recent crises as a place where large scale isolated camps do not seem acceptable to political leaders and the host population, the matter of local refugee integration is a very important one. The contribution of the built environment to this social process has not yet been discussed, despite the fact that there are numerous works on the technical aspects of the camps (Herz, 2007). There is however an extensive body of work on the role of architecture and urban planning in producing and reproducing an integrated society.

As Hillier and Hanson (1984) argued, space is not only a reflection of society, but a set of strategies to achieve its actual form. Space is used to order social relations by means of spatial relations. In the urban society of cities, the street network, or public realm, is the main tool for that. Its configuration is the generator for human movement (Hillier et al., 1993). The resulting co-presence of individuals from all different groups of society is the primary source of social cohesion (Hillier, 1996). It has been shown, that social network and friendship relations are often segregated from other groups of society, while everyday life activities in public and work spaces overcome this social division (Schnell and Benjamini, 2005).

With a new, significant part of society joining the host population, it is important that a special emphasis is put on societal integration. This can only take place if there are aspects in daily life that connect the different parts of society, which cities are traditionally very suitable places for. Durkheim (1893) describes them as places of organic solidarity, which is based on economic interdependence and division of labour. It is opportunistic and depends on the differences of individuals. The resulting co-presence and encounter produces high exchange and mutual tolerance among people (Simmel, 1921; Jacobs, 1961; Senett, 1970). If the local integration of refugee populations is being investigated, the body of work that connects social theory to the built environment of cities can provide answers on explaining interactive and integrative patterns of behaviour.
1.2 URBAN INTERPLAY AND MATTERS OF SEGREGATION

The overall function of built form on a larger city scale is to bring and hold together the different parts of society, and enable the newly joined members to choose their place in a diverse variety of urban solidarities. Legeby (2009a; 2009b) described the problem of interplay segregation as the missing opportunity of seeing others and being seen in public space. This can be measured employing the space syntax framework as established by Hillier and Hanson, since movement is a mathematical function of the spatial configuration of the street network (Hillier and Hanson, 1984; Hillier et al., 1993; Hillier, 1996; Hillier, 2003). Co-presence is thus a collective urban resource, and its distribution has, together with other common resources, to be considered regarding matters of inequality and disadvantages (Legeby, 2009a; 2009b; Legeby et al., 2015).

The term activity segregation has been used by Franzén (2009) to describe patterns of behaviour of different groups of society, which rarely overlap and thus pose a threat to the overall coherence of society. Franzén uses activities such as going to work, for shopping, or leisure as examples, which may not be shared with members of other social groups than one's own. This concept ties in with Schnell and Benjamini's (2005) notion of territorial segregation, as the separation of groups in their routine everyday life spaces has proven to be very low compared to residential and social segregation. People thus do not necessarily have to establish social network connections to members of other groups as long as their co-presence and casual interaction maintains societal peace and coherence. The term 'encounter' is crucial at this point and it will be used in this research to describe momentous contact, verbally or visually.

For these interconnections, the urban form and positioning is of great importance, as it influences not only to which workplace people attend but less urban accessibility to jobs also relates to unemployment of recent immigrant population (Legeby, 2013). Similar results have also been suggested by the research of Vaughan (2005; 2007), who found that historically, immigrant settlements were located in close proximity to active economic centres. This was to avoid high travel costs but also due to the fact that new, unskilled labour immigrants relied and still rely on informal job hires through contacts in their group of ethnic origin. Vaughan argues furthermore, that concentration happened without segregation, in order to benefit from full integration into the host society, while still being able to let the own culture flourish, which has been defined by Marcuse (2001) as an 'enclave' through voluntary clustering. ‘Ethnic segregation’ in this research however does not necessarily mean enforced or hierarchical grouping as Marcuse (2001) described it, but any kind of disproportionate concentration of contact among one and lack of contact with another group.

Finally, Jacobs (1961) also suggested that the presence of anonymous flows of strangers which move through the streets plays an important role for neighbourhood policing and the feeling of reciprocal safety. It furthermore provides the basis for social interaction by forming the ‘animated background’ which encourages for social interaction in the public realm (Peatross and Peponis, 1995) and forces individuals into a state of tolerating diversity in order to be able to live in a city (Simmel, 1921; Senett, 1970). Urban integration and co-presence of different groups in everyday life is thus an important aspect to social integration into the host population. The mutual tolerance arising from that is crucial to repression free living and the achievement of local integration.

1.3 ORIGIN AND CULTURAL BACKGROUND OF STUDIED INHABITANTS

The large majority of inhabitants during the study period came from Syria, followed by Afghanistan, with smaller numbers from Iran, Iraq, former Soviet states as well as Africa. This implies a significant influence of Islamic religion on daily life and cultural habits in the inhabitants’ home countries. Abu-Gazzeh (1995) argues that the built environment in Islamic countries strongly follows religious behaviour principles such as privacy and gender rules. These rules also mediate the public interaction of strangers (Abu-Gazzeh, 1995; Tomah). Furthermore, a significant amount of public spaces in Arabic countries has been created during the colonial ages to express the occupiers’ superiority, which often makes them unsuitable for leisure activities by the local population, either by design or symbolic meaning. In addition to these traditional
influences, the recent developments towards authoritarian forms of government and police surveillance have an impact on the perception and use of public space (Rabbat, 2012). Long before people decide to flee from their country, the entirety of public life was controlled by the government to suppress civil uprisings. This forced social interaction as well as public debate into the private realm such as non-governmental mosques or people’s homes. These aspects may also have an underlying influence on the behaviour and urban movement for newly arrived refugees in Germany.

2. METHODS

2.1 CASE STUDIES

In this research, three recently built transitional refugee homes are studied in the city of Bremen, located in the North-West of Germany. All of the homes have been designed by the same local architects and use the same container modules and two-storey building blocks, but are different in terms of the arrangement and number of blocks. They are also situated in very different parts of the city [Figure 1], with one in Bremen-Grohn, another in Bremen-Walle and the third in Bremen-Arbergen. Each of the two and four bed apartments is autonomous with their own front door, kitchen and sanitary facilities. Next to communal facilities with rooms for activities, the non-profit organisation’s management office is also located on site with two to six staff during working hours. They are providing help with the bureaucratic procedures of the inhabitants as well as their papers, financial organisation and everyday-life problems. After working hours and during the weekends, security personnel is present on site to supervise access control and overlook the inhabitants. All homes have been publicly perceived as well built, clean and safe.

![Figure 1 - Map of the city of Bremen with the three case studies](image-url)
2.2 MEASURING URBAN SOCIABILITY AND TERRITORIAL INTEGRATION

In the previous paragraphs it has been referred to several descriptions of segregation in everyday life. The contact and mixing of refugees with the German host population is crucial due to several reasons. First, unlike migration patterns to the United Kingdom for example, there is little networks with connections to migrants that have already established a self-sustaining life in the new country. Second, the access to the job market is very controlled and relies almost exclusively on a good German language proficiency which can only be acquired through regular contact with proficient or native speakers. Third, the migration as well as integration process is overseen widely by the state which restricts the agency of individuals but on the other hand provides a high degree of help and security which has been perceived very positively by the inhabitants of the three case studies during the conducted interviews mentioned above.

Since the financial means of the newly arrived refugees are mostly scarce, they rarely visit locations with entry at the door, the need for a ticket or the obligation to consume, such as cultural institutions or cafés and restaurants. This increases the importance of public space as an affordance to encounter, as being co-present with others is crucial to urban life and several inhabitants have even made loose friends with the host population in that way. To determine the degree of accessibility to co-presence, and on the other hand the ‘interplay segregation’ (Legeby, 2009a; 2009b) several measures of urban centrality and topological street network analysis are used in this research. First, the concepts of angular choice and angular integration from the space syntax theoretical framework as established by Hillier and Hanson (1984) will be compared as indicators for human movement activity. Angular choice, which is based on the betweenness measure of graph theory, indicates the through-movement intensity on a certain segment in the street network. Angular integration acts as a measure for to-movement to a specific segment (Hillier, 1996; 2003). The angular distance measurement means that those routes are the shortest that have least angle turns from start to end segment. This has been shown to produce the highest correlation with human perception and movement patterns (Hillier, 1996). Both analyses have been limited to the radii of 2,000 meters to determine local, i.e. pedestrian and bicycle movement and 10,000 meters for the global structure and car movement in the city.

Hillier’s (1996) argument of the movement economy shows, that the physical shape of the street network and with it the intensity of pedestrian movement gives rise to economic activity along these segments. This allocation of land uses then acts as a multiplier effect to the expected footfall that is already been generated by the street network.

To calculate an absolute measure that takes account of all these multiplier effects, the land use based Gravity measure as used by Sevtsuk (2010) has been modified with a weight formula. It measures the impact of a set of destination land use points on an origin point. For each destination, the metric distance (d) of the walk along the street network is calculated and put into the decay formula that has been determined empirically by Sevtsuk and Mekonnen (2012). The destinations that have been selected as most suitable to indicate street activity, as they themselves rely heavily on it, are retail points as well as locations of the food and beverage service economy.

\[ G = \sum \frac{1}{e^{0.004xd}} \]

Original, unweighted Gravity formula

\[ G = \sum \log \left( 1 + \frac{1 + Int2000m}{NACH2000m_{max}} \times \frac{NACH2000m}{NACH2000m_{max}} \times (1 + \frac{n}{d}) \right) e^{0.004xd} \]

Weighted formula for ‘Gravity of Sociability’
The first part of the weight is the angular integration value with a radius of 2,000 meters (Int2000m), as it accounts for the intensity of pedestrian to-movement. Secondly, the normalised angular choice (NACH) with a radius of 2,000 meters is used to account for through-movement (NACH2000m). Both values are normalised with the maximum measure of the entire map, producing a relative value from zero to one. Finally, the density of land uses per meter is taken into account by dividing the number of points (n) by the length of the segment (L).

This metric analysis will be calculated for the three case studies and for all 260,000 buildings in the map extent around the city of Bremen to create a complete map of the distribution. As limiting radii for this analysis, 800m and 3000m will be selected for pedestrian and bicycle distances, which are also considered as the two scales of the neighbourhood each location is surrounded by. The software used for the calculation is the MIT una-toolbox (Sevtsuk and Mekonnen, 2012) for CAD and modelling program Rhinoceros 3D. All land use data as well as the base map data for streets, buildings and points has been taken from the Openstreetmap website (www.openstreetmap.org).

To compare the findings with urban movement behaviour of the inhabitants, the conducted semi-structured, qualitative interviews entailed questions about habitual movement destinations in the city as well as the amount and type of contact with the host population. Furthermore, questions were asked about the desire to be in contact with German people and the preference for spatial clustering in the event of moving into a private apartment.

The distribution of public transport connections throughout the city is not only an economic one, but also a matter of equal distribution of common resources (Legeby, 2009; Sá et al., 2016). Especially in this case, that people are not able to use other means of transportation for longer distances since the driving licenses from their home countries are not valid in Europe, and travels have to be made to distant bureaucratic institutions and learning centres on a regular basis, the significance of a well-developed and equally accessible transport network is very high. Public transport however is not just to be seen as a means of transport but also as a public space in which all, or at least many different groups of society are co-present (Rokem, 2016). It is thus an important aspect to overcome ‘activity segregation’ (Franzén, 2009) or ‘territorial segregation’ (Schnell and Benjamini, 2005). For this analysis, the unweighted Gravity formula will be used so that each public transport stop will be of equal importance independent from the frequency, only the distance to the origin point is determining its influence.

Since the case studies in this research are transitional refugee homes, with inhabitants that have been in the country only for a short time, the opportunity to learn the language and acquire job qualifications is very limited, and also often legally restricted. It is thus that the types of businesses that have been looked at, is from a low- to medium-skilled labour background. This incorporates the service industry with for example logistics and storage jobs, as well as crafts and other manual labour. Legeby (2013) has shown, that reduced urban accessibility to job opportunities relates to rates of unemployment in social housing estates. In the same way, it will be investigated in this analysis, if a better accessibility to businesses, that may theoretically be a potential employer, relates to inhabitants having a job or apprenticeship or the outlook of starting one in the near future. For that, in the interviews with them, it will be assessed in a qualitative manner to what degree this economic activity takes place. As data source for business locations, the voluntary company archive of the city of Bremen was used (www.bremen.de/branchensuche), which is similar to the yellow pages. In an automated process using Grasshopper, the addresses have been extracted from the HTML-documents and geocoded. Then, the Gravity value has been computed in the same way as it has been done for the public transport accessibility.
3. RESULTS

Figure 2 - Integration (radius 2000m) angular segment analysis

Figure 3 - Gravity of Sociability analysis results (radius 800m)
3.1 SPATIAL POTENTIAL FOR URBAN CO-PRESENCE

In the semi-structured interviews with inhabitants, it has been observed that not only the city centre, but in Grohn also the Vegesack town centre and parks Vegesack Park and Bürgerpark [Figure 4] were popular destinations in the city to spend time. In Walle and Arbergen, the movement patterns were more local, also due to the low distance to the city centre. People in Arbergen however focused more on their immediate surroundings, with destinations for shopping and leisure at the river. While in all three case studies, errands such as grocery shopping were done in the most convenient, local radius, it has been mentioned predominantly in Grohn that destinations are visited regularly with the explicit aim to seek interaction with strangers, preferably Germans. Furthermore, the average frequency of leaving the site is the highest in Grohn and the lowest in Arbergen [Table 2]. In all sites, the wish for more interaction with people from the host population was expressed, despite initiatives such as the ‘contact café’, a weekly tea time with inhabitants and German neighbours in each site, about every two weeks. Especially middle-aged and older inhabitants have found this very helpful. Asked about whether they preferred to live among neighbours from their own cultural background and language once they move into private accommodation, the large majority clearly stated they preferred to live surrounded by predominantly German culture. Two families that were about to move out were particularly happy to have found a suburban home in a traditional German neighbourhood.

Mosques were mentioned as frequented destinations in the city by some inhabitants, but less than possibly expected. It seems logical however, as the majority of inhabitants expressed the wish to form connections with the culturally traditional German host population, which is more likely to be encountered in public spaces of the city centre or parks. A small number of inhabitants even stated that they prefer to not have contact with people from their home culture because they would like to avoid bringing up conflicts that divide the people, as there are supporters of opposing sides fleeing at the same time.
Looking at the immediate and wider neighbourhood, it can be seen that Walle is located in more urban surroundings with higher building and land use density, while the other two show suburban features [Figure 1]. This is confirmed when comparing the streets that can be reached within three turns from each place (lSD3) [Table 1] with Walle being the most walkable and Grohn the least. Within this distance, Grohn shows the highest pedestrian through-movement (NACh_2000SD3) and Walle the highest to-movement (Int_2000SD3) potential, with Arbergen in both analyses with the lowest values [Figure 2] [Table 1]. This is explained by the juxtaposition of Grohn to Vegesack town centre and Walle to the city centre.

The Gravity of Sociability analysis shows that Walle has the highest access to sociability in its immediate surroundings (3.57) and the wider neighbourhood (5.95), with a large increase from one to the other through the impact of the city centre [Figure 3] [Table 1]. In Grohn however, the lowest values have been recorded, with a low increase of 0.57 (from 2.21 to 2.78), suggesting a low impact of the adjacent town centre. Despite lower syntax values, Arbergen thus has higher access to urban co-presence. Upon comparison of the city wide map for Gravity of Sociability [Figure 3] with the destination mapping from the interviews [Figure 4] it can be seen, that the majority of trips are made to areas with high sociability. This is particularly the case for Grohn, which has the least active sociable neighbourhood and the highest frequency of leaving the site. In addition to that, it was the least active and quietest of the three homes during the visits and interviews.

### Table 1 - Urban analyses results

<table>
<thead>
<tr>
<th>Name</th>
<th>Gravity of Sociability</th>
<th>Gravity of Public Transport Stops</th>
<th>Gravity of Jobs</th>
<th>ISD3 [km]</th>
<th>NACH_2000 SD3</th>
<th>NACH_10000 SD3</th>
<th>Int_2000 SD3</th>
<th>Int_10000 SD3</th>
</tr>
</thead>
<tbody>
<tr>
<td>R [m]</td>
<td>3000</td>
<td>800</td>
<td>3000</td>
<td>800</td>
<td>3000</td>
<td>800</td>
<td>3000</td>
<td>800</td>
</tr>
<tr>
<td>Grohn</td>
<td>2.78</td>
<td>2.21</td>
<td>1.51</td>
<td>1.22</td>
<td>0.18</td>
<td>0.09</td>
<td>15.25</td>
<td>1.20</td>
</tr>
<tr>
<td>Walle</td>
<td>5.95</td>
<td>3.57</td>
<td>4.42</td>
<td>4.02</td>
<td>2.19</td>
<td>1.99</td>
<td>58.82</td>
<td>1.15</td>
</tr>
<tr>
<td>Arbergen</td>
<td>3.05</td>
<td>2.66</td>
<td>2.61</td>
<td>2.53</td>
<td>0.01</td>
<td>0.00</td>
<td>35.38</td>
<td>1.09</td>
</tr>
</tbody>
</table>

### Table 2 - Interview results from site visit

<table>
<thead>
<tr>
<th></th>
<th>Average times per week that inhabitants leave the site</th>
<th>Most frequently named destination (Nr. of occurrence)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grohn</td>
<td>9.8</td>
<td>City Centre (4)</td>
</tr>
<tr>
<td>Walle</td>
<td>5.2</td>
<td>City Centre (3)</td>
</tr>
<tr>
<td>Arbergen</td>
<td>2.8</td>
<td>Local Supermarket (4)</td>
</tr>
</tbody>
</table>

3.2 SPATIAL POTENTIAL FOR TERRITORIAL INTEGRATION

Public transport was described by the inhabitants during the semi-structured interviews as easily and frequently used, even in Grohn as the farthest from the centre. The differences in the Gravity of public transport analysis [Figure 6] [Table 1] do not seem to influence the behaviour, as long as a decent level of service is provided. The questions that revolved around the inhabitants’ job situation however have shown that this is a highly sensitive topic. Very few people have jobs in general, due to their early stage of arrival and bureaucratic obstacles. It was hard to distinguish sometimes between if job positions are held, about to start or only a vague plan. Every person however strongly expressed the wish to obtain a job as soon as possible. It was found however, that in Walle several local companies approached the management looking for low- and medium skilled workers. The same happened in Grohn with one company.
Looking at the Gravity of Jobs analysis [Figure 5] [Table 1], Arbergen has almost no access to local businesses (0.00, 0.01), while Walle achieves very high values (1.99, 2.19) with Grohn in between (0.09, 0.18). While the sample size of these values is too small for any correlation, the logic of local business approaching the homes in search for low-skilled labour is strengthened by them.

Figure 5 - Gravity of job accessibility (radius 800m) analysis results

Figure 6 - Gravity of public transport accessibility (radius 800m) analysis results
3.3 DISCUSSION

These findings suggest that ‘interplay segregation’ (Legeby, 2009a; 2009b) through a neighbourhood with less co-presence, motivates inhabitants to go longer distances towards centres of high sociability. While this improves the co-presence of different groups of society and thus increases awareness and potentially tolerance among their members, it may exclude people of less confidence or reduced mobility, such as the old or disabled, as well as in the war injured people. It furthermore requires a cheap and easy to use public transport system with good level of service, such as the one in Bremen.

The built environment thus contributes to facilitate social interaction as the urban form generates movement and co-presence of people. The street layout of the city shapes the level of human activity which has been shown to be unequally distributed, and concentrated in and around central locations in the city. The presence of people not only generates social land uses alongside it, it also acts as an attractor to people from further afar to enjoy the co-presence with others in public space, as has been the case for the inhabitants in Grohn.

The relation between jobs and their accessibility is however differently working as described by Legeby (2013), as it is not individual agency of the inhabitants, but initiative by local businesses that is the main factor. As this is not a clear bottom-up, but neither a top-down approach, it has a place somewhere in between.

Furthermore, the absence of the desire to form clusters with people from the same cultural background is of interest as it seems to contradict other research on migration and cities (Kershen and Vaughan, 2013; Vaughan, 2005; 2007) that suggests the need for a certain degree of spatial clustering for new immigrants. This is however not the case, as in forced migration it is not so much an existing social network that is being used for the arrival process, as it does not exist very often. Instead, the state agencies and charitable organisations lead the integration process. For that, a high degree of assimilation and language proficiency is needed, especially to access the job market. As most people want to avoid marginalisation in this process, the desire to learn German in everyday contact with locals and build social ties with them is very strong. In addition to that, a few inhabitants have mentioned that they do not know and do not want to know what role was played by fellow refugees in the conflicts they fled from, so they rather avoid contact in general and focus on building a new life in Germany.

In summary, it can be said that local ‘interplay segregation’ does not necessarily lead to marginalisation, as long as urban movement is taking place towards centres of high sociability. At the same time, the desire to see and be seen by others in public space is important to the inhabitants. Being co-present with other groups is part of the integration process and offers a large potential. Job accessibility has proven to be of importance to employment, as businesses search for local low-skilled labour.

4. CONCLUSIONS

In this research, three transitional refugee homes in the city of Bremen, Germany, have been studied regarding their potential for social integration in the city. The built environment was examined for the influence of urban form on the level of interplay segregation and access to sociability. Together with semi-structured interviews with 23 inhabitants, space syntax and Gravity of Sociability analyses were employed to look at urban movement patterns and behaviour. The Gravity measure was also used in a similar way to analyse the accessibility to jobs. This was done to see if there is an influence of urban low- and medium-skilled job and business accessibility on employment.

The findings suggest, that seeing others and being seen in public space (Legeby, 2009a; 2009b; Legeby et al., 2015) is an important part of the inhabitants needs, whether consciously or subconsciously. Many people also have expressed the wish for more interaction with people from the host society, especially concerning their prospective location of residence. This differentiates this specific forced migration process from other research on urban space and migration, which suggested the tendency to form residential clusters or enclaves (Vaughan,
2005; 2007; Kershen and Vaughan, 2013). It has been observed that in places with less access to co-presence in the surroundings, the explicit visit of destinations for sociability including parks, even if they were further away, was more important. This implicates a certain necessary level of desire for co-presence, which is either fulfilled in everyday life errands or otherwise by visits to places of sociability. It is important to note that since the financial possibilities of most inhabitants are limited, destinations with entry at the door or obligatory consumption are rarely visited. It also places a certain importance on the cheap availability of public transport, to overcome those distances for integration with the wider society. Especially in the case of the home in Grohn, which has the lowest Gravity of Sociability, the observed journeys go either to the workplace or to destinations for sociability. In Walle on the other hand, which has the highest Gravity of Sociability and potential for co-presence in the surroundings, the interviewees rarely mentioned explicit visits to these destinations. This points towards the existence of a spatial-social interdependent aspect and underlines the importance of co-presence in public space.

The relation that was found between higher job accessibility and more employment relates to the findings of Legeby (2013) was not so much based on the agency of individual inhabitants, but on the initiative of local companies from the neighbourhood, that approach the management of the home with open job positions or offers for collaborations. Those businesses often recruit in a very local radius unlike the process for higher-skilled jobs which rely on more global recruiting. Since it is neither state-led nor individual-driven, this process is a mixture of top-down and bottom-up processes.
REFERENCES


