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SPATIAL ACCESSIBILITY AND COMMERCIAL LAND USE PATTERNS

Planned Versus Unplanned Areas in Cairo

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ABSTRACT

This paper shows the research results from a research project investigating the relationship between spatial configuration and the distribution of commercial activities in throughout planned and informal urban environments. The research methodology uses space syntax analysis as well as statistical calculations. The spatial accessibility model is combined with commercial activity data from three different types of settlements in Cairo: The throughout planned Al-Sharekat, and the informal areas Ezbet Al-Nasr and Abu Qatada. As a contrast to Cairo's informal areas, the throughout planned Al-Sharekat area is a typical example of modern urban areas with a planned modern urban shopping centre.

The results demonstrate that micro scale businesses, run and owned by low income people, are sensitive to having high degree of spatial accessibility to potential customers. This spatial feature is missing in the throughout planned Al-Sharekat. Accordingly, unplanned areas are not chaotic in terms of commercial activity patterns. Finally, superficial insights that distribute activities on the principle of abstract geometric distance, such as putting the service centre of the neighbourhood in its geographical centre should be revisited.

KEYWORDS

Commercial activities, economic gain, throughout planned areas, informal areas, Space syntax

1. INTRODUCTION

How are commercial activities distributed in throughout planned areas? How does their location pattern differ from the unplanned urban areas? Here we wanted to compare research results of a throughout planned urban area with research results from informal urban areas. Rapid urbanisation of Cairo metropolitan area has resulted in massive urban expansion the last 20 years. Throughout planned as well as unplanned settlements are built on the peripheries of the city on a privately-owned ex-agricultural land and on a state-owned desert land (GTZ, 2009). The high-income dwellers are facilitated with high quality dwellings inside throughout planned neighbourhoods and with provision of inward oriented shopping centres with luxury goods.

On the other hand, low-income groups seek for the spatial opportunities of the settlements to generate any kind of income for surviving. There is a social logic in both the geographical location of unplanned urban areas and the structure of the spaces between buildings inside these areas (Mohamed et al, 2015).

Many planners and high-level decision makers share misconceptions of informal areas as being unstructured and chaotic whereas the planned areas have a clear spatial structure (Shehayeb, 2009). This paper, using evidence-based approach, demonstrates that informal areas, unlike planned quarters, are not chaotic in terms of commercial activity patterns as shops are structured along the shortest possible paths to minimize travel cost. This is exactly what environmental design strategies, economists, and sustainability policies are calling for.

This research, using space syntax method as well as statistical analysis and the Gini coefficient of inequality, focuses on revealing the extent to which the dispersal of commercial activities is influenced by the spatial accessibility model. The key question is: what is the logic behind the way commercial activities are distributed within a polycentric metropolis such as Cairo?

The throughout planned Al-Sharekat neighbourhood in Nasr city (belonging to the Cairo metropolitan area) is used as a case for revealing the location pattern of various types of commercial activities as contrast to two informal areas: Ezbet Al-Nasr in Al-Basateen, and Abu Qatada in Boulaq El-Dakrour district. Importantly, the land on which Nasr city was built is a desert formerly attributed to the ministry of Defence. The establishment of the city was initiated in 1960s by President Gamal Abdel-Nasser who aimed at building a socialist country based on Arab nationalism and cultural and spiritual values (Herzog et al, 2009). Conversely, Ezbet Al-Nasr is established on a state-owned desert land close to the city centre, while Abu Qatada is built on private former agricultural land illegally built on the fringe of the city. Moreover, the two cases are all self-organized and relatively similar in terms of size and age.

2. PREVIOUS RESEARCH RESULTS

Current theories and approaches concerning location of economic activities within the urban environment lack integration between the various disciplines. In an earlier research focusing only on informal settlements, various contributions from geography, economy and urban morphology showed that patterns of economic functions cannot be understood only in terms of market mechanism as geographic distance is not the only variable for allocation and organization of economic activities. Consequently, a theory of space-economy still represents as a major gap to be tackled in different perspectives.

As space syntax research has shown, when commercial activities are concentrated along most accessible routes, they get the optimum benefit from the movement and this in turn facilitates urban consolidation. The percentage of commercial functions (shop, workshops and kiosks) on outward edge of a settlement influences the degree of urban consolidation. This percentage is called 'Edge Oriented Commercial Activity' or EOCA[1] (Hillier et al, 2000; Shafiei, 2007).

Another study (Porta et al. 2009) examined the relationship between street centrality and intensity of retail and service activities in Bologna city using Kernel density tool to transform the original data of centrality and commercial and service activities to one scale unit to do regression analysis between them. The findings indicated that activities are most likely to concentrate in more central, easy accessible, locations.

However, it is not clear whether the outcomes of previous researches can be demonstrated in medium size settlements or whether they are peculiar to small size areas, where internal commercial streets are not expected to be found (Mohammed et al 2015). Moreover, It is not clear whether such findings can be extended to informal areas in other regional context such as Cairo.

In an earlier research project on informal settlements, we investigated the relationship between spatial variables and the pattern of internal and edge commercial land use by applying various tools, such as space syntax analysis, Inter-visibility between private and public space (van Nes & López, 2010), and statistical calculations. The cases used in this study were three informal areas in Cairo that are predominantly self-grown and have not been influenced by city plans or land use regulations.

1 The formula for calculating this ratio is as following: EOCA= 10(shops/plots) + 10(edge shops/ plots) + (edge shops/ shops) (Hillier et al, 2000)

Importantly, the results have demonstrated that commercial activity pattern follows the spatially most accessible, most distributed and most inter-visible parts of the settlements in relationship to the wider urban context. The findings enhance better understanding of a theory of an optimal distribution of plots, in which optimal land use is defined by two main variables: inter-visibility and street network accessibility. The next question is then, how does an optimal distribution of plots occur in a throughout planned urban area?

Remarkably, Lerman and Omer (2013) investigated the role of spatial and functional built environment attributes in shaping pedestrian movement in pre-modern and modern areas in the centre of the city of Tel-Aviv. The results indicate that in pre-modern environment, the spatial distribution of pedestrians has stronger correlation to spatial accessibility parameters than in modern in environment. Differently, the research presented here focus on understanding the effects of the spatial-configurational properties of street network in shaping commercial and service activities in planned and unplanned urban environments.

3. METHODOLOGY

The through planned Al-Sharekat in Nasr City is a home for 8900 inhabitants living over 41 hectares (UNDP, 2008), while Ezbet Al-Nasr is inhabited by 60,000 people living over 30 hectares (IUSD, 2013). In addition, Abu Qatada hosts 27,016 people occupying 28 hectares (CAPMAS, 2006). The space syntax method is used to study the relationship between the spatial structure of urban environment and economic activities.

This paper is structured in two parts. The first part analyses the spatial structure of the three cases at global and local scales. In the second part, statistical analysis and the Gini Coefficient are employed to investigate of the relationship between spatial attributes and the pattern of commercial uses.

3.1 SPACE SYNTAX

The axial map, progressively, was developed into a segment map where the street segment between junctions is the spatial element (Hillier and Stonor, 2010; van Nes, 2011). The structure of the urban grid, then, shows the potential movement of people since spaces with high syntactic values will generate co-presence and interaction higher than spaces, which are syntactically segregated.

There are two measures of potential movement: to-movement potential (closeness or syntactic integration), or the potential accessibility of a segment regarding to all others; and through-movement potential (betweenness or choice), or how likely a space will be crossed with respect to all other pairs of segments (Ibid.). The syntactic measures of each segment can be applied at different radii from each segment to show potential movement for different scales from local to global. More simply, spatial analysis at a global scale takes into consideration all street segments comprising the whole urban system, while analysis at a particular radius, confines calculations for each segment to the defined catchment area. For example, spatial accessibility at radius 1200 meters measures spatial proximity of a segment within only 1200 meters.

Importantly, the radius of analysis can be defined by three weights of distance: the metric distance which defines a street network by the shortest physical distance, the topological distance which calculates a street network in terms of the fewest number of direction changes, and finally the geometrical distance which measures a street network by the least angle change path (Hillier &Iida, 2005).

Normalising the angular choice measure was introduced by Tao Yang in Hillier et al. (2012). Normalisation enables comparing urban systems with different sizes with each other. Consequently, a neighbourhood could be compared with the whole city and with smaller urban systems as well. Actually, it is more important to normalise on the local scale than it is on the global scale (radius n), because radius n is a constant. Normalisation can be problematic in areas where there are huge variations between sparse and dense grid.

Space syntax method is used in this research to investigate the degree to which the case study areas are accessible at both local and global scales. On the other hand, statistical correlations are made to test the spatial model of the street network configuration as a background of distribution of economic activity.

3.2 STATISTICAL ANALYSIS

The number of dwellings on a street segment affects commercial activity rates that increase with more buildings on the segment. We have learned that using the band analysis, developed by Hillier and Sahbaz (2005), to compensate this logarithmic function might give misleading regression results with a fine-resolution dataset due to that grouping commercial activity data into bands according to the total number of plots on the segment will significantly smooth the sample thereby normally producing significant correlation results.

Accordingly, we did regression analysis between each commercial street segment and the number of shops on that segment. Complementary, a method independent of segment length and plot count on a segment, the Gini Coefficient, was conducted.

The Lorenz curve is used in various disciplines such as economics, ecology and in studies of biodiversity to see whether a particular aspect (e.g. income) is equally or randomly distributed. It correlates the accumulative proportion of a factor to that of another (Duclos and Araar, 2006). 'Gini coefficient' is obtained by dividing the area sandwiched between the line of maximum equality (a line of 45 degrees) and the Lorenz curve by the total area under the line of equality (see figure 1). Similarly, if the ratio of commercial uses, captured by a particular class interval of accessibility rank, is calculated and plotted on y axis against the percentage of accessibility on the x axis, then a Gini coefficient can be obtained and the degree of equality in shops distribution can be revealed.

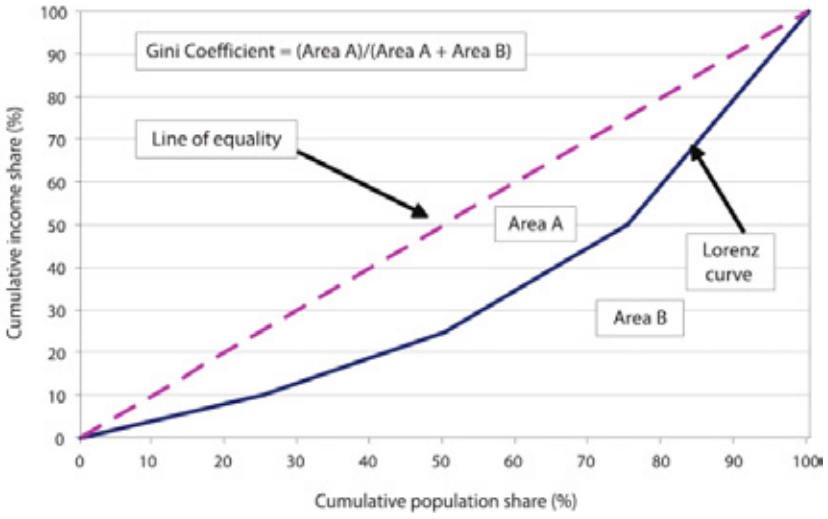


Figure 1 - Graphical representation of the Lornez curve and Gini coefficient. Gini= A/(A+B) (source: van Koppen and Cullis, 2007).

4. COMMUNITY'S GENERATING ACTIVITIES IN THE CASE STUDY AREAS

Informal areas in Cairo have emerged without any kind of planning. Mixed-use of functions is a frequent phenomenon in informal areas, where the ground floor is often used for micro-economic activities. Commercial activities exist over outer roads as well as internal streets and alleyways. In the two informal areas there are two types of community's economic activities:

a) Local shops such as groceries, bakeries, restaurants, coffee shops, clothing, street vending and hairdressing salons. Such activities are usually located along alleyways to provide essential daily goods. Daily markets exist within informal areas, where street vendors share the street with shop owners and passers-by.

Like informal areas of Abu Qatada and Ezbet Al-Nasr, supermarkets and other kinds of local shops are situated in the ground floors of apartment blocks in Al-Sharekat neighbourhood in Nasr City.

b) Vocational activities such as car-repair, carpentry, iron-work, building material, junk trading, and marble processing are mainly located along external streets to facilitate service for outsiders, who are usually middle and upper class. Here, residents of informal areas try to generate any income through establishing their workshops along active edges of their settlements.

Unlike the two unplanned areas, light manufacturing activities such as workshops are missing in Al-Sharekat settlement. Rather there are global integrating activities that provide services to non-local as well as local residents such as hotels, cinemas, car Expo and banks. Notably, governmental buildings are commonly walled and located on the neighbourhood borders, while unaffordable activities such as car Expo are usually inward oriented.

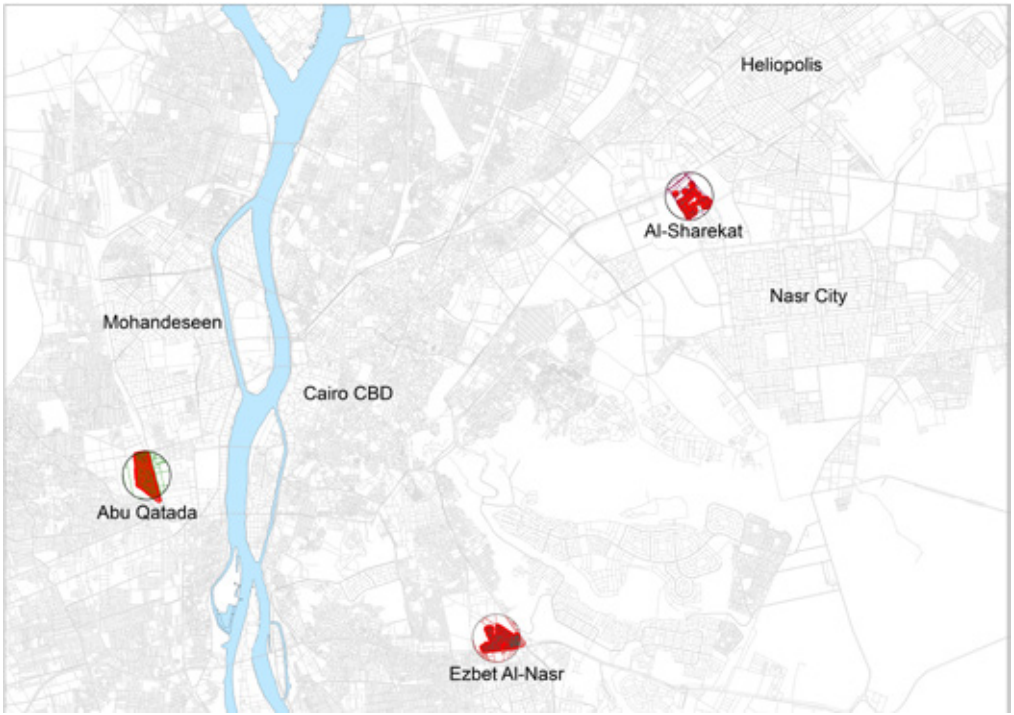
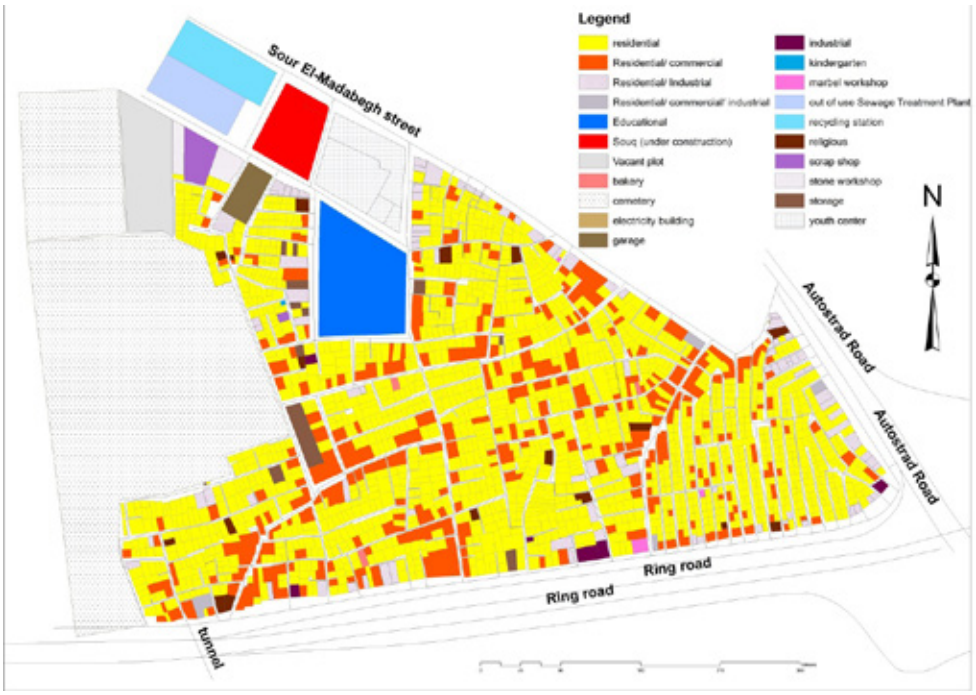
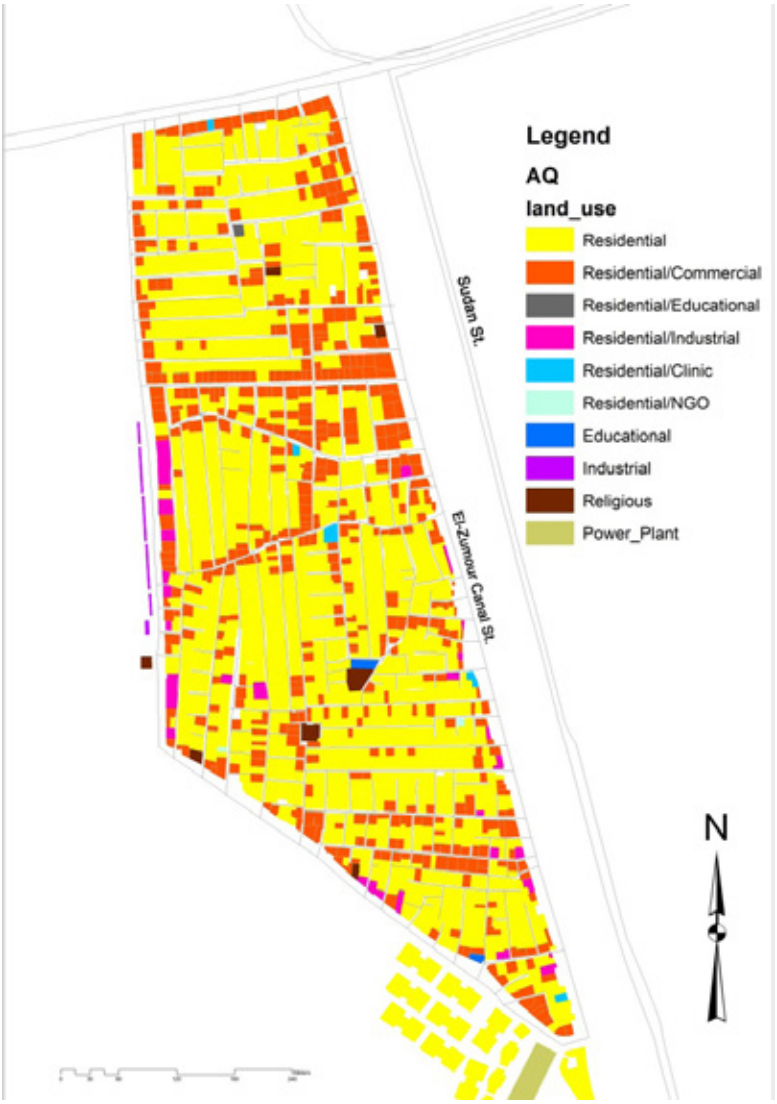


Figure 2 - Locations of the case study areas within the context of Cairo Metropolitan

a)Land use in Al-Sharekat



b) Land use in Ezbet Al-Nasr



c) Land use in Abu Qatada

Figure 3 - Spatial location and land use patterns in case study areas (source: Authors)

5. MORPHOLOGICAL ANALYSIS

In order to understand the influence of spatial configuration on movement and land use pattern, we need first to grasp the case study areas within the context of whole Cairo. Figure 4 shows the normalised angular global integration Rn of the three cases. The black lines show the highest values, while the light grey streets are the lowest ones. Apparently, Al-Sharekat neighbourhood is the most integrated globally, while Ezbet Al-Nasr is the most segregated.

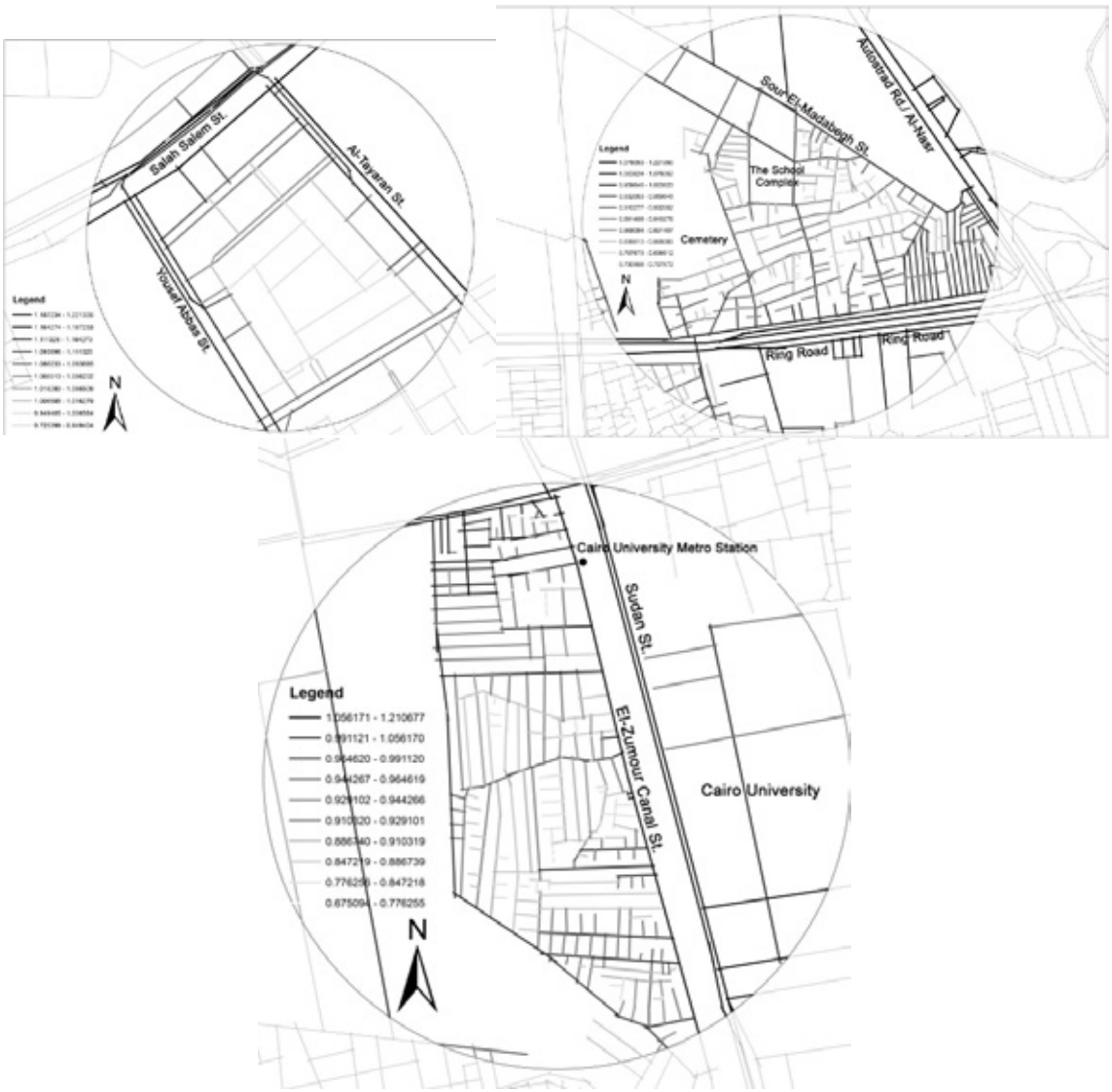


Figure 4 - Normalised angular global integration Rn in Al-Sharekat (top left), Ezbet Al-Nasr (top right), and Abu Qatada (bottom).

At a local scale measure, morphological differences can be captured between the three case studies (figure 5). Syntactically speaking, Abu Qatada has the highest local potential movement/ normalised angular integration R400 meters, while Al-Sharekat has the lowest value. This reveals that unplanned areas function properly at a settlement level, but has introvert behaviour within the wider context. Conversely, throughout planned areas function poorly on a local level, but is strongly connected to the wider metropolitan area.

Figure 5 - Normalised angular integration R400 in in Al-Sharekat (top left), Ezbet Al-Nasr (top right), and Abu Qatada (bottom).

The map of node count 400m reflects the degree of intensification of urban grid in the case study areas (figure 6). Unplanned areas have larger number of street segments (node counts) in short metric distance than planned ones. In Ezbet Al-Nasr, the urban grain structure is small in the central area and eastward where black lines are dominating, while western parts have larger sizes in light grey segments. The school complex, the cemetery, the vacant plots, and the sewage treatment plant are shown in the light grey spectrum. The large block size in such places might explain why pedestrian movement is low around. Slaughterhouse and cemetery blocks seem to segregate the neighbourhood from north and west respectively. Similarly, Abu Qatada has a small grain compared to surrounding parts (e.g. Cairo University campus) with coarse grain urban structure in the light grey range.

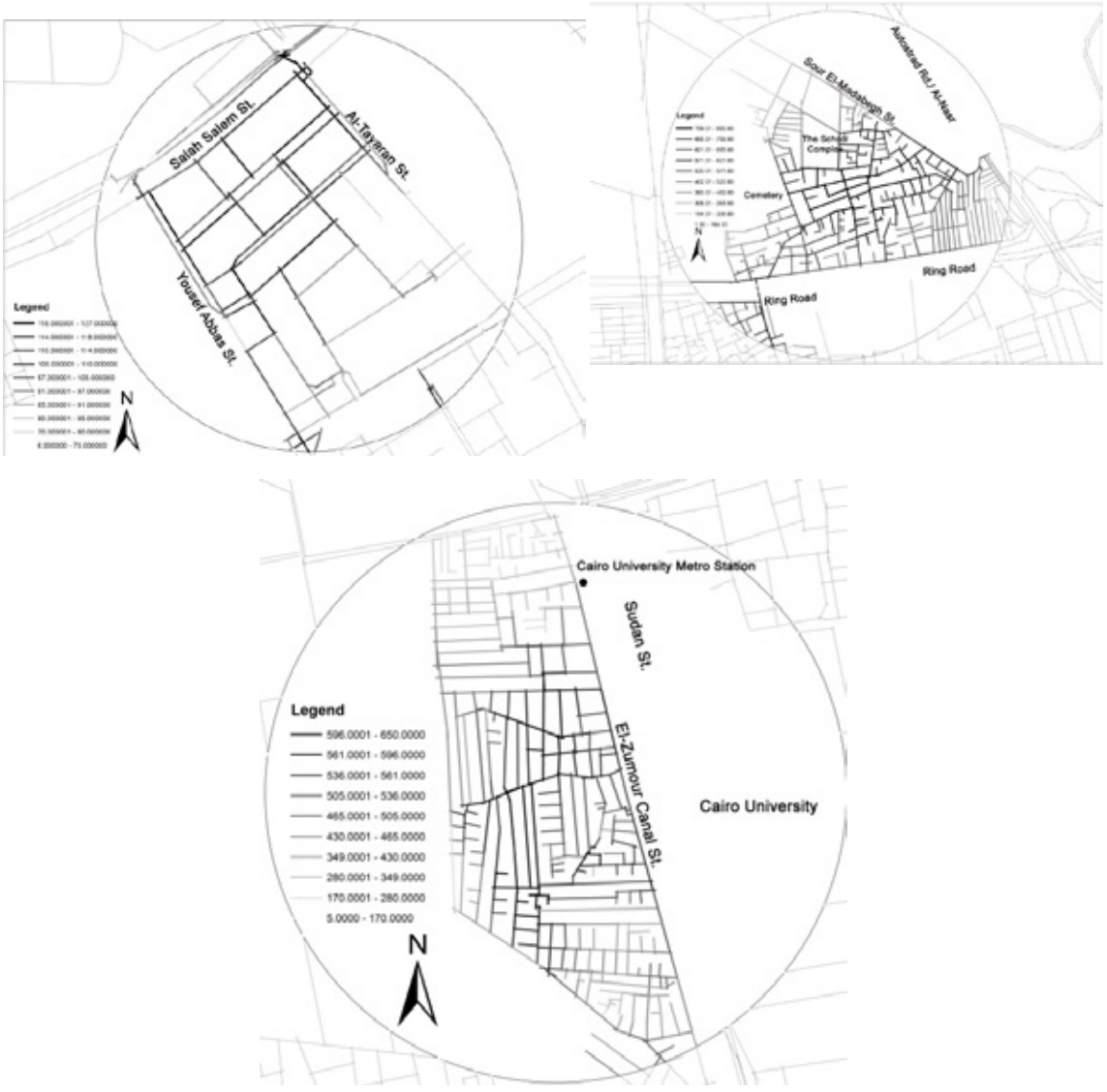


Figure 6 - Node count R400m in Al-Sharekat (top left), Ezbet Al-Nasr (top right), and Abu Qatada (bottom).

Table 2 summarizes the spatial parameters of the case study areas. It shows that Al-Sharekat is more globally and locally integrated than the three informal areas.

	Al-Sharekat	Ezbet Al-Nasr	Abu Qatada
Mean normalised angular integration Rn	**1.071119**	0.917675	0.927512
Mean normalised angular integration R2000	**1.015857**	0.8695	0.849059
Mean normalised angular integration R400	0.619937	0.690948	**0.738241**
Mean Node Count 400m	93.323615	**515.689922**	421.120629

Table 1 - Values of syntactic attributes for each case study.

Figures 7, 8 and 9 show the visualized angular choice for the three areas at radius 2000 meters, which is the best urban context radius of the neighbourhoods' surrounding areas. A radius of 2000 meters highlights the main route network that is running through or between various neighbourhoods. An angular choice analyses show how good or bad a neighbourhood is connected to the local main route system, in which show the spatial potentials for a degree of contact possibilities between locals and random through travellers. The maps are coded thematically including ten equal quintiles with a spectrum that goes from dark black (for the 10% most accessible streets) to light grey (for most segregated ones). In the two informal areas, a visual interpretation of syntactic maps implies possible correlations between syntactic parameters and commercial uses distribution (shown on the maps as dots). It implies that shops and workshops are mainly located along the most accessible segments. Furthermore, residential buildings tend to cluster along the most segregated streets.

In contrast to the informal settlements, Al-Sharekat has the highest value on the local level as well. This planned area has much larger blocks and the local streets are more directly connected to the main routes than the informal areas. Unlike the informal areas, commercial activities in Al-Sharekat are distributed more randomly. The ratio of the plot with commercial activities located on the boarder to the total number of shops in Al-Sharekat is remarkably lower than the two informal areas. Furthermore, residential buildings tend to cluster along the most segregated streets. However, statistical analysis is needed to demonstrate the existence of such relations.

Figure 7 - Al-Sharekat's normalised Angular Choice R2000m overlapped with the distribution of commercial activities.

Figure 8 - Ezbet Al-Nasr's Normalised Angular Choice R2000m overlapped with the distribution of commercial activities.

Figure 9 - Abu Qatada's normalised Angular Choice R2000m overlapped with the distribution of commercial activities.

6. THE CORRELATION BETWEEN COMMERCIAL RATE AND SPATIAL ATTRIBUTES

In order to quantify the configurative findings, regression analysis method is employed. Table 2 shows the relationship between commercial activity count per segment in the case study areas and segment length as well as the normalised angular choice (NACH), weighted by segment length (SLW), at different radii. There are significant positive correlations between patterns of commercial activity and segment length as well as normalised angular choice in the unplanned areas, but not in Al-Sharekat. Further, the analysis demonstrates that segment length and NACH R2000 (SLW) are the best predictors of commercial segments in informal areas. In other words, economic activities in unplanned areas are distributed efficiently along routes with the highest potential through-movement at local, medium and global scales to capture local residents and vehicular movement as well.

Conversely, commercial activity in Al-Sharekat is distributed randomly. A potential explanation is that the service centre of the neighbourhood, and so all modern urban areas, is planned on the basis of pure geometric distance so that many activities are buried in the geographic centre of the area. Nonetheless, another statistical method independent of segment length and number of plots per segment is needed to complement the previous findings.

		Al-Sharekat	Ezbet Al-Nasr	Abu Qatada
Segment Length	Pearson Correlation	**.557****	**.373****	.227
	Sig. (2-tailed)	.000	.000	204
	N	302	308	33
Combined angular Integration and Choice	Pearson Correlation	**.279****	**.196****	-.034
	Sig. (2-tailed)	.000	.001	.851
NACH_Rn (SLW)	Pearson Correlation	.273**	.182**	-.004
	Sig. (2-tailed)	.000	.001	981
NACH_R2000(SLW)	Pearson Correlation	**.283****	**.247****	.052
	Sig. (2-tailed)	.000	.000	.772
NACH_R800(SLW)	Pearson Correlation	**.282****	**.238****	.084
	Sig. (2-tailed)	.000	.000	.642

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2 - The relationship between commercial activity count per segment and the local and global normalised angular choice weighted by segment length in the case study areas.

Complementary, looking at the percentage of commercial buildings captured by the top decile of accessibility can provide a numerical evidence for testing the hypothesis that commercial activities are unequally distributed and are placed along the most spatially accessible locations. Table 3 shows the percentage of commercial parcels in the top deciles of accessibility at medium scale radius (Choice R2000m). In the two spontaneous settlements, the results reveal that the commercial activities are structured along spatially accessible street segments to benefit from potential through movement. Similarly, the results of the calculated Gini coefficient values of the two informal areas indicate that the distribution of commercial activity is not random.

Unlike the two informal areas, the largest proportion of commercial activity in Al-Sharekat is captured by the top 30% most segregated buildings. On the other hand, the outward facing edges in Al-Sharekat have lower economic activities than the two informal areas of Ezbet Al-Nasr and Abu Qatada. Accordingly, economic activities in Al-Sharekat do not have the benefit of passing trade (see table 3 below).

	Al-Sharekat	Ezbet Al-Nasr	Abu Qatada
Top 10% (Choice 2000m) Com.	8.6207	13.6824	**15.1515**
Top 20% (Choice 2000m) Com.	12.931	**38.5135**	37.1901
Top 30% (Choice 2000m) Com.	27.5862	56.0811	**61.5702**
Gini (Choice 2000m) Com.	0.18	0.39	**0.39**
Edge Oriented Commercial Activity (EOCA)	**2.9790**	3.2802	**4.0151**

Table 3 - Gini coefficient, EOCA, and Commercial activity distribution in the case study areas according to the upper percentages of accessibility (Choice R2000m).

As shown in figure 10a, the Lorenz curve of Al-Sharekat neighbourhood indicates that commercial activity is unevenly and randomly shared regardless of the percentile of spatial accessibility. Conversely, figures 10b and 10c show that commercial activity in both Ezbet Al-Nasr and Abu Qatada is influenced by the degree of spatial accessibility as the greatest proportion of shops tend to cluster along the most accessible buildings. Such findings are in line the Pearson correlations conclusions.

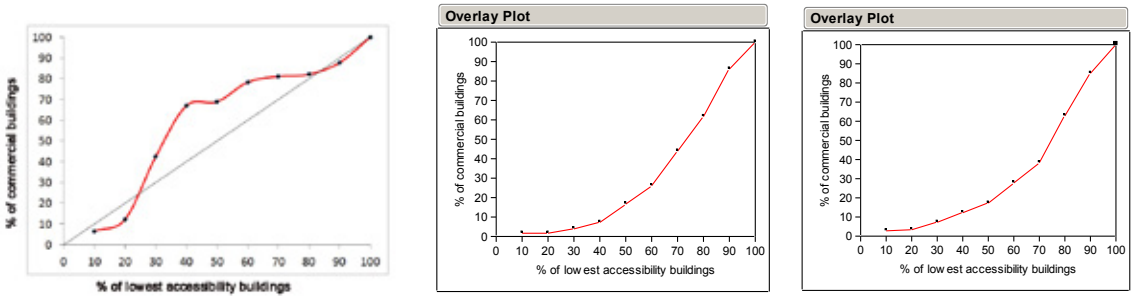


Figure 10 - The Lorenz curve of commercial activity distribution amongst all the plots in in Al-Sharekat (left), Ezbet Al-Nasr (middle), and Abu Qatada (left) based on the rank of spatial accessibility rank (NACH R2000m SLW).

7. DISCUSSION AND CONCLUSION

This study has presented the relationship between spatial configuration and the distribution of commercial activities of planned and unplanned settlements in Cairo. Notably, through planned areas lack opportunities for the establishment of micro scale businesses which often tend to lack a vibrant street life and large variation of all types of enterprises. Furthermore, economic activities taking place in the planned area of Al-Sharekat are located along internal routes with poor spatial accessibility. This minimises the economic gain as a result of time-consuming travels.

Conversely, in the spontaneous settlements, commercial activities are usually concentrated along higher-accessibly street segments and not just limited to outward facing edges. Apparently, residents of informal areas seem to have a local knowledge of their neighbourhoods, specifically a proper knowledge of spatial conditions that can get the chance of capturing passers-by. Expressed differently, possibilities of urban economics are very much dependent on spatial configurations of street networks.

There exist several studies on a natural location pattern of commercial activities in unplanned urban areas. These cases are useful for finding explanations on how of commercial activity takes place in urban space with a lack of regulations. In Hillier et al (2000) and Greene (2003) research on 17 small-sized (about 4.83 hectares) Chilean informal settlements, the axial analysis showed some correspondence between the concentration of commercial activities and the pattern of topological integration. Because of the small size selected cases, the results demonstrated that locally well-embedded settlements develop commercial activities on their busy borders, 'an edge economy', rather than within the internal routes. Studies on large informal neighbourhoods (about 172 hectares) in Zahedan city in Iran clarifies that there is a clear positive relation between the overall distribution of commercial uses and the degree of spatial accessibility at global scale (Shafiei, 2007). In an earlier research focusing only on informal settlements in Cairo, the use of the Gini Coefficient was a starting point for developing a theory of an optimal land use distribution, were the spatial accessibility is a key variable. We tried to reveal how the Gini Coefficient can be used to explain the distortion factors on the relationship between spatial accessibility and the location of commercial activities. As it turns out, often throughout planned areas lacks buildings with active frontages towards streets, the whole area tends to be inward or centrally orientated. To put it another way, commercial activity is generally buried in the internal urban structure of the selected planned area.

At present, we have focused on only one case study as regards the throughout planned areas. However, there exist examples on other similar cases throughout the world. The work of Ye and van Nes (2013) and van Nes and Lopez (2013) show that new towns in China and the Netherlands also have a lack of active frontages on a micro scale level, that there is a dis-correlation between local and global angular integration and hence affect the degree of variation of types of commercial activities.

What are then the first implications of a guidance that can be given to urban planners in such a rapid expanding city as Cairo? What we have learned so far is that a natural urban transformation process for aggregating micro scale commercial activities in informal settlements is at least depending on the following:

- Informal settlements strongly linked to motorways have better potentialities for generating retail opportunities than the poorly linked ones. The vehicular movement is a key element in connecting local residents to their workplaces and generating informal public destination economic businesses, which non-local residents can reach, along outward facing edges. In other words, such greater destinations are the threshold that links the formal parts with the informal ones.
- Locally accessible streets create micro-private destinations that meet the local population's daily needs.

- A mixed land use pattern fosters a wide range of economic premises. Sub-centres of informal areas, well connected to the wider urban context, transport investment from planned settlements and create economic opportunities for the metropolitan's various quarters.
- Commercial activity should generally be planned on the basis of spatial accessibility that minimizes time consuming travels and maximizes economic gain and social interactions. Superficial insights that distribute activities on the principle of abstract geometric distance, such as putting the service centre of the neighbourhood in its geographical centre should be revisited.

Put in a nutshell, this approach itself can be used as a guide to the regeneration of unplanned areas and transferring investors and economic generating activities to deprived parts of the city. Many decision makers report unplanned areas as an explicit example of urban failure. Differently, another look at such settlements shows that they have some values and lessons to be learned. This research has approved that commercial uses in spontaneous settlements are orderly distributed along routes with the highest potential local and global movement patterns. This economic strategy is missing in a typical example of planned neighbourhoods in Cairo where movement-seeking activities are placed superficially at the geometric centre of the quarter with on attention to the urban structure of the quarter itself. Lastly, studying urban values in unplanned areas should be a source of inspiration for learning how to plan vibrant urban areas shaping opportunities for all kinds of people – whether they are shoppers or shop owners.

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BIBLIOGRAPHY

Adedokun, M. (2011), 'An analysis of spatial pattern of urban activities in a traditional African city: a case study of Ilorin, Nigeria', *European Journal of Humanities and Social Sciences*, Vol.10, No.1 (Special issue), p.408-421.

Al-Ghatam, W. (2009), 'The village and the city: A diagnostic study in villages absorbed by cities in Bahrain'. In: Koch, D., Marcus, L. and Steen, J. (eds.), *Proceedings of the Seventh International Space Syntax Symposium*, Stockholm: Royal Institute of Technology, p. 002:1-002:13.

Alonso, W. (1964), Location and land use: toward a general theory of land rent, Cambridge: Harvard University Press.

Budiarto, L., (2007) 'Reshaping urbanity: economic rescaling, urban transformation and the shift of locations of service firms in Amsterdam'. In: Berghauser-pont, M.Y, Haupt, P.A., Budiatro, L., et al. (Eds.), Urbanism Laboratory For Cities and Regions: Progress of Research Issues in Urbanism, Amsterdam: ISO Press, p.28-45.

Census of Egypt 2006/ CAPMAS (2007), 'al-Taadad al-am li-l-sukkan wa-l-iskan wa-l-munsha'at, Cairo, Egypt'. [Unpublished preliminary results, headcounts for Census enumeration districts (shiyakhat and qura) of Cairo, Qalyubia, and Giza governrates]

de la Barra, T., (1989), Integrated land use and transportation: Decisions chains and hierarchies, Cambridge: Cambridge University Press.

Duclos, J.-Y., and A. Araar (2006): *Poverty and Equity: Measurement, Policy and Estimation with DAD*, New York: Springer.

Fales, R. and Moses, L. (1972) 'Land-Use Theory and the Spatial Structure of the Nineteenth- Century City,' Papers of the Regional Science Association 28, pp.49-80.

General Organisation for Physical Planning (GOPP) (2006). 'GIS database for Greater Cairo Region'. Cairo: Ministry of Housing, Utilities and Urban Development.

Greene, M. (2002), '*From Informal Settlements to Sustainable Neighbourhoods: The role of spatial configuration in the urban system*', Doctoral thesis, University of London.

Greene, M. (2003), Housing and community consolidation in informal settlements: A case of movement economy. In: Hanson, J. (ed.), *Proceedings of the Fourth International Space Syntax Symposium*, London: University College London, pp. 38.1-38.24.

Herbert, John S., and Stevens, H. B. (1960) 'A Model of the Distribution of Residential Activity in Urban Areas', *Journal of Regional Science,* 2, p.21-36.

Herzog, J., de Meuron, P., Herz, M., Rahbaran, S. and Zhou, Y. (2009), Nasr City. ETH Studio Basel.

Hillier, B., Penn, A., Hanson, J., rajewski, T. and Xu, J. (1993), 'Natural Movement: or, configuration and attraction in urban pedestrian movement', *Environment and Planning B*, Vol. 20, p.29-66.

Hillier, B. (1996), *Space is the Machine*, Cambridge: Cambridge University Press.

Hillier, B., Greene, M. and Desyllas, J. (2000), 'Self-Generated Neighbourhoods: the role of urban form in the consolidation of informal settlements', *Urban Design International*, Vol.5 (2), pp.61-96.

Hillier, B. & Iida, S., 2005, "Network and psychological effects: a theory of urban movement". In: Cohn, A.G. and Mark, D. M., (eds.): 475-490. Springer-Verlag Berling Heidelberg.

Hillier, B. & Sahbaz, O., (2005), `High Resolution Analysis of Crime Patterns in Urban Street Networks: an initial statistical sketch from an ongoing study of a London borough'. In: van Nes, A. (ed.), *Proceedings of the Fifth International Space Syntax Symposium*, Delft: University of Technology, p.01-28.

Hillier, B., Yang, T., Turner, A., 2012, "Normalising least angle choice in Depthmap and how it opens up new perspectives on the global and local analysis of city space". In JOSS, 3(2)155-193.

Integrated Urbanism and Sustainable Design (IUSD), (2013), Integrated site analysis: the case of Ezzbet Al-Nasr. Integrated case study module. Ain Shams University & Stuttgart University.

JMP®, Version 6.0. SAS Institute Inc., Cary, NC, 1989-2007.

Lerman Y., Omer I. (2013), 'The Effects of Configurational and Functional Factors on the Spatial Distribution of Pedestrians', in: VANDENBROUCKE D., BUCHER B., CROMPVOETS J. (eds.), Geographic Information Science at the Heart of Europe, Springer, Berlin Heidelberg, pp. 383-398.

Lorenz, M. O. (1905), 'Methods of measuring the concentration of wealth', Publications of the *American Statistical Association*, Vol. 9 (New Series, No. 70) p.209-219.

Lowry, I. S. (1964), 'A Model of Metropolis, Rand Corporation, Santa Monica, California'. In: Putman, S. H. (ed.) (1979), Urban Residential Location Models, Studies in Applied Regional Science, Vol. 13, Berlin: Springer Science & Business Media, 3.4.

Mohamed, A., van Nes, A. and Salheen, M (2015) Beyond Informality: Traders as space experts in their own informal settlements, *proceedings of 10th Space Syntax Symposium*, University College London, pp. 135:1-20.

Narvaez, L., Penn, A., and Griffiths, S. (2014) The Spatial Dimensions of Trade: From the geography of uses to the architecture of local economies., A|Z *ITU Journal of Faculty of Architecture*, Istanbul. Vol. 11 (2), pp. 209-230.

Olatubara, C.O. (1996) 'Urban activity distribution – induced residential satisfaction model' Ife Psychology 1A

Porta, S., Strano, E., Iacoviello, V. and Messora, R. (2009) Street centrality and densities of retail and services in Bologna, Italy. Environment and Planning B: Planning and Design, 36, pp.450–465.

Shafiei, K. (2007), 'Internal Commercial Streets and The Consolidation of large Informal Neighbourhoods: the case of Zahedan, Iran'. In: Kubat, A. S., Ertekin, Ö., Güney,Y. I. and Eyübolou, E. (eds.), *Proceedings of Sixth International Space Syntax Symposium*, Istanbul: ITU Faculty of Architecture, pp. 087-1: 087-16.

Shafiei, K. (2013), '*The Fragmented Morphology of Spontaneous Settlements: The case study cities of Jeddah (Saudi Arabia) and Zahedan (Iran)*', Doctoral thesis, University of London.

Shehayeb, D. (2009) Advantages of living in informal areas. In: GTZ, Cairo's informal areas between urban challenges and hidden potentials: facts, voices, visions.

Sims, D., (2003), 'The Case of Cairo, Egypt'. In UN HABITAT, Understanding Slums: Case Studies for the Global Report on Human Settlements, UCL and dpu, p.1-24.

Tag-Eldeen, Z. (2003) 'Participatory Urban Upgrading - The Case of Ezbet Bekhit, Cairo'. The Built Environment Analysis Div, Department of Infrastructure, KTH.

Turner, A., (2004), Depthmap 4: A Researcher's Handbook, London: Bartlett School of Graduate Studies, University College London.

Turner, A. (2007), 'From axial to road-centre lines: a new representation for space syntax and a new model of route choice for transport network analysis', *Environment and Planning B: Planning and Design*, Vol.34 (3) p.539–555.

Ullman, E. L. (1956), 'The role of transportation and the bases for interaction'. In: W. L. Thomas, (ed.), Man's role in changing the face of the earth, Chicago: University of Chicago Press, 862-880.

UMP TU Berlin (2010), Improving informal areas in Greater Cairo: The cases of Ezzbet El Nasr & Dayer El Nahia, Berlin: TU-Berlin.

UNCHS (Habitat) (2003), The Challenge of Slums: Global Report on Human Settlements, London: Earthscan Publication Ltd.

van Koppen, B. & Cullis, J. (2007) Applying the Gini Coefficient to measure inequality of water use in the Olifants River water management area, South Africa, IWMI.

van Nes, A., 2005, 'The Burglar's Perception of His Own Neighbourhood'. In: A. van Nes (ed.), *Proceedings of the Fifth International Space Syntax Symposium*, Delft: University of Technology.

van Nes, A., and Lopez, M. (2013), 'Spatial-socio classification of deprived neighbourhoods in the Netherlands,' in: Young Ook Kim, Hoon Tae Park and Kyung Wook Seo (eds.), *Proceedings of 9th International Space Syntax. Symposium*, Sejong University Press, Seoul, Korea.

van Nes, A. and López, M. (2010), ``Macro and micro scale spatial variables and the distribution of residential burglaries and theft from cars: an investigation of space and crime in the Dutch cities of Alkmaar and Gouda', *Journal of Space Syntax*, Vol. 1(2) p.296-314.

Varoudis T., (2012), 'depthmapX Multi-Platform Spatial Network Analysis Software', Version 0.30 OpenSource, http://varoudis.github.io/depthmapX/

Weisstein, Eric W. (2010) Cumulative Frequency. Math World-A Wolfram Web Resource. Available at: http://mathworld.wolfram.com/CumulativeFrequency.html. (Accessed: 10 October, 2012)

Ye, Y. and van Nes, A. (2013), 'Measuring urban maturation processes in Dutch and Chinese new towns: Combining street network configuration with building density and degree of land use diversification through GIS, *Journal of Space Syntax*, Special Issue, Urban Challenges. Space and society in the contemporary urban world, Vol 4, No 1 p.18-37.