EVIDENCE-BASED SPATIAL INTERVENTION FOR REGENERATION OF INFORMAL SETTLEMENTS:
the case of jeddah central unplanned areas

Kayvan Karimi
Space Syntax Ltd.

Abdulgader Amir
College of Environmental Design, King Fahd University

Kaveh Shafiei
Space Syntax Ltd.

Noah Raford
Space Syntax Ltd.

Esenghiul Abdul
Space Syntax Ltd.

Ji Zhang
Space Syntax Ltd.

Magda Mavridou
The Bartlett School of Graduate Studies, UCL

Abstract

This paper presents a new approach to the improvement of informal settlements through limited physical interventions. The main argument in this research is that the benefits of the transformation of urban fabric should be evaluated by a deeper level of interaction between spatial configuration and socio-economic dynamics. The theoretical foundation of this claim is driven from previous research that indicate the significant role of spatial configuration in the gradual self-improvement of informal settlements. A direct implication of such findings is that limited physical interventions as a design method can be used to facilitate the self-improvement of informal settlements by increasing their spatial integration to the whole of the city. Furthermore, the transformation of strategically located unplanned areas can also create a positive impact on the urban areas that surround them.

The case of Jeddah Central Unplanned Areas poses the challenge where a highly self-grown urban fabric is struggling with overcrowding, degrading built environment, social malaise and poverty. This research demonstrates that the major problem of these areas rises from the fragmentation of their internal spatial structure, on the one hand, and lack of city-wide or district-wide connectivity, on the other hand. The spatial analysis reveals two very different spatial systems, the planned and unplanned areas, in a conflicting situation. The upgrading strategy suggested by this research is to redesign the urban fabric of the unplanned settlements through their realignment and connecting their fragmented spatial core to the city-wide spatial grid. What makes this solution different from the conventional approaches in that it sees the benefit of spatial improvement in a mutual relation with the whole of the city. In order to base the design on more layers of evidence, a multi-criterion GIS method has been developed which takes into account different spatial factors and a set of socio-economic data. A product of applying such a method is the development of a ‘transformability index’; a composite baseline guide for decision making and assisting the process of design. The overall process includes consequent stages of design and analysis to fulfill the objectives set at the beginning. The study concludes with a clear strategy for limited spatial intervention, which will enhance the Central Unplanned Areas significantly and will contribute to the development of Central Jeddah.

Introduction and Problem Definition

The city of Jeddah sits strategically at the intersection of key routes to the Holy Cities of Makkah and Madinah, on the Red Sea coast of...
Saudi Arabia. With a current population of approximately 3 million, Jeddah is the second largest city in Saudi Arabia. It has historically and still continues to function as the gateway to two important religious cities as destinations in the Muslim world and as an important commercial hub for the entire Red Sea region.

In the 1960s and 1970s, car driven growth along the Makkah Raos and Madinah Road corridors outstripped radial growth around the centre (Figure 1). The rapid development of the city was facilitated by large scale motorway infrastructure to the north and east of the Historic Core. This development favoured long distance car travel as the main mode of transport, resulting in a network of highly accessible vehicular routes and neighbourhoods juxtaposed against the dense, walkable core of the Historic Centre. Major ring roads were also introduced during this period that pierced the increasingly dense unplanned areas to the east and south of the historic core. As these settlements grew denser and more impoverished, they began to act as a barrier to growth and investment, which only increased the incentive to develop to the north and east.

Despite a concentration of major commercial centres in some areas of the Historic Core, most of the established commercial activities did not penetrate into the unplanned areas. This whole process resulted in a subsequent shift in land uses, and a conflict of scales, with rapidly developing neighbourhoods sprawling beyond the Historic Core. At the same time, The Historic core had to serve a central role for a larger system that made it rather crowded, noisier and polluted. Moreover, its physical fabric had to deal with demands for modern functions and chronic dilapidation. These ever-increasing problems in the historic centre led to the departure of the more affluent residents who left the centre for more fashionable zones that became accessible through the car based growth of the street network. Meanwhile, and afterwards, during the 1980s oil boom, the subsequent influx of rural and foreign migrants started to put pressure on the housing market in the cities of Saudi Arabia, especially Jeddah. This triggered a much faster growth of the informal settlements without any planning control over them.

For the migrants and urban poor, central unplanned areas have become the most affordable locations to live in, with foot access to facilities, services and jobs. The maintenance of urban infrastructure, however, has remained very poor in these areas while subsequent subdivision of the residences over time has led to a high population density. This can be explained through classic models of low-income housing preferences that suggest the only way the urban poor can...
pay the high rent prices of accessible central lands is through overcrowding (UNCHS 2003). Moreover, looking closely at the distribution of land uses within the unplanned areas and all over the city suggests that the local properties of the street network play a major role in all activities and especially in the commercial uses. This localized spatial pattern in conjunction with the smaller size of urban blocks and more fragmentation in the street network are in contrast with the characteristics of the city at a global scale, which is characterised mostly by a regular urban grid with larger urban blocks, reflecting the influence of vehicular transport and higher mobility of the better-off citizens.

The sharp morphological difference between the formal and informal fabrics of Jeddah can be best shown by comparing the measures of angular segment choice (Hillier and Iida 2005) for local and global radii. By doing so, a very polarized pattern emerges: unplanned areas come out as areas with high measures of local choice while the city-wide super-grid underlined by higher values of global choice run outside these areas (Figure 2). It is also noticeable that these areas develop a very distinct local structure, but this structure does not fit into any spatial structure in the surrounding areas. In other words, these unplanned areas form their own local structure, but this local network is not associated with the overall urban grid. This phenomenon explains a great deal about the socio-economic conditions of these areas.

Poor accessibility of the unplanned settlements to the infrastructure and service network has been reported before in other cities of developing countries (Balbo, 1993). Space Syntax research has shown that spatial configuration plays a major role in the formation consolidation process of informal settlements (Hillier et al., 2000). It is apparent in Jeddah that the spatial discontinuity between the local and the global scale of urban grid impedes their socio-economic improvement in the long term, especially through decreasing their share of the global ‘movement economy’.

The impact of the current conditions of the central unplanned areas falls not only on these areas themselves but also on the whole city centre of Jeddah. A collar of densely populated, inaccessible areas has practically cut off the Historic Core from the rest of the city and created a major obstacle in the development of a larger, more functional city centre in Jeddah. While the Historic Core of Jeddah is a bright piece of the urban heritage of the whole of the Arabian Peninsula 1, and has every potential to play an important role in the formation of a larger city centre, it suffers from many problems which
have forced major urban activities to move out of it. This situation has left the historic core with an undesirable physical and social fabric. The very poor condition of the central unplanned areas in Jeddah has also resulted in some very radical slum clearance suggestions, promoted by private developers and local authorities, which seek a total demolition and redevelopment of these areas. The situation in these areas is perceived as being so bad that such extreme measures are now being seriously considered. Consequently, the improvement of the unplanned areas of Jeddah has become one of the most important issues for the local and regional authorities.

The improvement strategy that this paper proposes is building on the strategic challenges and opportunities that were concluded from the detailed analysis of these areas within the context of the whole of Jeddah. A major idea in this approach is to reconnect the isolated and fragmented core of the unplanned areas to the city-wide street grid while preserving their local physical and spatial structures as much as possible. On one hand, preserving the integrity of the local structure of an unplanned settlement requires a detailed analysis of urban and socio-economic data of its maintainable buildings (such as land use and building quality). On the other hand, finding the best way to connect its core to the global grid requires a fine-scale syntactic analysis.

The main question here is how these different criteria can be brought into a single framework to inform the design decision? The answer, as this paper suggests, is a multi-layered analysis to prioritize and translate different spatial and non-spatial data into design aiding information. As part of the process to find the answer, the two methods of 'Segment Route Filtering' and 'Transformability Index' have been produced to simplify the complexities of the analysis. These methods will be discussed later on in this paper.

This paper reports the results of an urban improvement project done by Space Syntax Limited as part of a wider Strategic Planning Framework study commissioned by the Municipality of Jeddah. This paper does not extend its scope to non-central unplanned areas, nor does it suggest any detailed procedure to implement its plans at the grass-root level. The latter point needs collaboration with local communities, negotiation with them and capacity building (now in the process by other agents and local authorities).

**Theoretical Context**

Since the total demolition of informal settlements has proven to be economically and socially inappropriate, the governments of developing countries have begun to search for alternative solutions. Also, because of the problems caused by the morphological formation and unclear illegal status (Dwyer, 1975; Balbo, 1993), finding a viable solution for informal settlements has become an important issue for city authorities. Although unplanned areas are built illegally in the beginning and have limited access to the urban infrastructure and services, they can gradually improve to become legally recognized and less undesirable places to live in. This process of socio-economic and physical improvement of low-income settlements is referred to as ‘consolidation’ (Pacione, 1996). As a result, governments of the developing countries have started to adopt enabling approaches, generally referred to as ‘upgrading’, which aim to empower the urban poor to improve their social and economical conditions (UNCHS, 2003). The problem facing authorities and academics in this regard has been to recognise the factors that facilitate the consolidation of informal settlements and to inform the upgrading programs.
Some researchers suggest that security of tenure or the provision of urban services and infrastructure, are the most effective factors facilitating the consolidation process (for example see Pacione, 1996). As a result, slum upgrading strategies usually adopt techniques such as legalization of tenure or provision of urban services and infrastructure. However, less has been said about the role of physical and locality issues. For example, what is the effect of the location of an informal settlement on its consolidation and consequently on the appropriate strategies for its upgrading? From a broader perspective, the recent report by UNCHS (2003, p.84) suggests that the spatial and physical attributes of an informal settlement can assist the adoption of more effective strategies when trying to improve the condition of these areas. For example, centrally located settlements might benefit more from tenure legalization while peripheral ones might require access to infrastructure and services (UNCHS, 2003).

Physical and spatial issues have not gained enough attention until recently. One reason for this lack of attention, as suggested by Mukhija (2001) is that most research and policies assume that the informal settlements do not benefit from any physical interventions. On the contrary, he argues that at least in his case, Bombay, this did not hold true since the residents were in favour of physical intervention and redevelopment of their dwellings. The main reason, as he explains, was that the residents could predict the added value to their properties when regularising the layout of their settlements made it possible to extend the urban services and infrastructure into them.

The consequent question is ‘what are the implications of such limited physical interventions in an informal settlement?’ Unfortunately there are not many references regarding this issue. An exception is Potter and Lloyds’s (1998) work; with regards to the rationalization of the physical layout and street alignment they suggest: “Such ‘reblocking’ inevitably involves the dislocation of existing structures; sometimes as many as 50 percent of homes have to be either moved on the site or relocated elsewhere. There are salient potential gender, age, community participation and other issues in this connection as well…” (Ibid., P. 155).

Space syntax research shows that the spatial configuration of cities and buildings can be associated with their social circumstances (Hillier and Hanson, 1984). Informal settlements, as an important component of cities in the developing world, are not an exception. The effect of spatial configuration on the formation of informal settlements and the spatial organization of social and economical activities has been the subject of some studies by space syntax before (for example Budiarto, 2003, Mora, 2003). Important research in this regard is the study of informal settlements in Santiago, Chile (Hillier et. al 2000; Greene, 2001), which shows that the way that informal settlements are embedded in their global context and the way these can benefit from the natural movement patterns in their host city, plays a major role in their improvement or decline in the long term. Moreover, space syntax theories and methods have a long history of informing designers to predict the socio-economic impact of their schemes (Hillier, 1996), which could be used as a basis to assess the effects of intervention-led improvement schemes.

Although it is known that limited physical intervention in informal areas is a valid improvement method in certain conditions, especially when the irregular layout of the street network impedes the spatial integration of these areas, to their wider urban context, there is a theoretical and methodological gap to support design decisions when such interventions are required. Originating from real life consultancy projects, this paper aims to fill this gap and provide a framework to...
inform the limited physical interventions by relating different layers of analysis and design, which could be used not only for the special case of the Central Unplanned Areas of Jeddah, but could inform the upgrading programs of other cities around the world.

**General Approach and Methodology**

The general approach in this study follows a process that includes four major elements:

- a detailed spatial analysis method to select, refine and design the route structure of the unplanned settlements
- supporting studies and analyses
- a review of the overarching guidelines and strategies
- design development

Figure 3 summarises the process and the relationship between the different elements of the study. The process begins with a series of spatial analyses and route design modifications that is informed by the important issues that relate the central unplanned settlement to the rest of the city. This part of the study will be discussed in detail in the Route Selection Strategy section. Route selection strategy is also informed by a composite index which brings together all the current available data, such as land use, building height, density, building conditions and so on, into one practical and mappable measure, called the ‘Transformability Index’.

This initial phase of analysis and modification is repeated over several rounds to generate an optimum route structure. A study of the appropriate road widths assists further in the final route design network, which is the base for the street and urban block design.

The spatial design is further continued by developing specific planning guidelines for land use, density, building height and other planning issues. These guidelines determine how the new spatial structure will
function. Furthermore, to demonstrate what the spatial solution will look like, the character of the major urban areas are designed and visualised and a sample of each public space type is designed in further detail. This process links design and analysis through a reiterative process that can be applied not only to the unplanned areas of Jeddah, but any other similar cases in other cities.

The further section of the paper explains the important elements of the process. This will introduce the way that each of these elements has contributed to the overall process and the innovations that have been created within each component of the overall methodology. The result is an ‘analysis-driven’, ‘evidence-based’ process for the improvement of the unplanned areas. Since the element of design is inevitably an important part of this process, it is apparent that this process cannot be a totally scientific process. However, this study has tried to develop a rigorous methodology that can inform and shape the design by continuous analytical input.

**Route Selection Strategy**

It was concluded from the spatial diagnosis that in nearly all of the cases the local cores of the Unplanned Areas are fragmented and isolated from the global grid. In other words, there seems to be a break in the hierarchy when moving from the global to the intermediary, and finally to the local scales of the urban network. This gap is clear from the analysis of the segment angular choice where the cores of informal settlements are highlighted as highly accessible at the local scale, but not at the global scale as illustrated in Figure 2. The suggested methodology, therefore, attempts to identify the inconsistent points of a network. The basic requirement is to define a criterion that selects street segments with high angular choice value in different metric radii (i.e. global, intermediary and local scales). The output will be used as a base for identifying the potential street network and its weak points, and solutions to fix them (e.g. road widening, intervention building removal or just improving the quality of the existing road).

A statistical method was utilized to filter the routes that have the highest values in angular choice at each level of metric radii (i.e. from local to global). In effect, five levels of analysis are used from the global to the local including the following radii: infinity and 10,000 meters (the global level), 5,000 meters (intermediate level), and 750 and 2,000 meters (the local level). The aim here is to use the extracted routes at each level of radii to get a clear picture of the inconsistencies of the street network. The question is what percentage of the street segments with higher choice value should be picked to inform the design stage. After experimenting with different thresholds it was concluded that the optimum threshold was 5% of the routes that have the highest values at each level. A measure of distance from the overall mean, expressed as multiplications of standard deviation (SD), was used to control the percentage of selected records. Assuming that 95% of records were below the 2.0 SD of the mean in a normal distribution, the remaining 5% of routes were selected at different levels of spatial angular choice. After the statistical filtering of routes, a first ‘raw’ spatial network with different levels of spatial choice is derived from the segment model. The ‘raw’ spatial network in this context refers to the route network established by the first round of filtering at all scales (Figure 4).

Based on this analysis, the proposed network of routes can be designed through different levels of physical intervention. The result of this design intervention can be subject to the same filtering methodology in order to test its validity. Based on the new results the design proposal can be refined and retested. The methodology can be
applied as many times as is necessary to reach the optimum result. This filtering method ultimately aims to ensure that the proposed street network scheme will target the segregated areas of the Unplanned Areas and result in a tangible improvement of the spatial and, therefore, socio-economic integration of these areas in the city.

The Transformability Index

Any decision concerning street widening should take into account the existing condition of the buildings along the street. In many cases, widening a street involves the removal of buildings which subsequently affects the life of the people living in those areas and the future of the city as a whole. As part of the network identification and design intervention methodology, the Transformability Index has been developed, taking into account any recommended removal. This index is a ranking system that gives the redevelopment potential for each building based on its existing conditions. Ranking the buildings based on this index can be used as a guideline for decisions related to street design and the degree of physical intervention in each one. The categories used for the Index were: building quality, building height, age of building, material, occupation and land use (Figure 5).

It should be mentioned that depending on the available data and the nature of a project, the formula and the weighting presented here could be further improved by additional data, such as land value and land ownership. After testing different models and ranking systems, it was found that the following empirical formula best reflects the conditions in Jeddah. The formula for the Transformability Index is:

Figure 4: Existing route structure (left) and the proposed ‘raw network’ (right)
TI = (2 x building quality) + building height + age of building + material of building + occupation + weighted land use

This empirical formula, as well as the weighting factors, could be further improved by additional socio-economic studies, as well as more data, such as land value and land ownership.

Building quality, age of building, material of building and occupation are described by a number that shows the ranking inside that particular category. The ranking according to land use was done according to the following criteria:

- religious buildings must be kept intact
- community facilities to be preserved where possible
- commercial uses to be preserved where possible
- low quality residential blocks to be redeveloped where possible.

And according to these criteria the weighting of the land use categories are as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Religious</td>
<td>0</td>
</tr>
<tr>
<td>Community facilities</td>
<td>0</td>
</tr>
<tr>
<td>Governmental</td>
<td>0</td>
</tr>
<tr>
<td>Educational</td>
<td>0.5</td>
</tr>
<tr>
<td>Commercial</td>
<td>1</td>
</tr>
<tr>
<td>Mixed use</td>
<td>1</td>
</tr>
<tr>
<td>Residential</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Although open spaces are highly re-developable in terms of the actual removal and building effort, the design guidelines for the development should include a ratio of open spaces to be replaced, reflecting their role in the urban and social network. An estimate of the building condition was derived by applying this formula to each building in the

Figure 5:
Transformability Index map as a guiding tool for designing the new urban grid. The selected routes for widening or re-aligning are compared against the Transformability of the areas and further decisions are made.
study area, and as a result buildings were prioritized for redevelopment.

**Route Design**

The physical interventions in the unplanned areas is not complete until the urban blocks are fixed, open space are designated and the width of the roads are determined. The width of the road in traditional town planning normally follows vehicular traffic. In this study the intention was to create 'streets' which could maximise the interaction between people and the city and improve the public realm. In order to have a more informed response to this design stage, a study of the streets and boulevards in Jeddah and all over the world was conducted to determine the most appropriate widths for different street types (Figure 6). This study looked at the profiles of the streets and the urban block surrounding them. The result was a helpful guide for designing streets in Jeddah.

![Figure 6: Study of the profile and surrounding urban blocks for a sample of international streets and boulevards. An important characteristics which was looked at in detail was the proportion of width of the boulevard to average junction distance](image)

Each of the routes selected through the route selection process belong to different metric networks (local, intermediate and global) and are categorized according to their corresponding network. The categorisation of routes is reflected in their morphological characteristics, such as width and height, and the land use development strategy for the surrounding areas. A two phase hierarchical grading approach was used, combining accessibility and width hierarchies. Based on the five metric networks that were chosen from the spatial analysis, four street type categories were introduced: Primary Boulevards/Streets, Secondary Boulevards/Streets, Locally important streets and Special Boulevards/Streets.

Primary Boulevards are roads with global importance in the city structure, connecting the Historic Core with the surrounding areas. These routes are prominent in the global and 10,000 meter network analysis. Primary Boulevards will be developed as an effective model for combining multiple forms of movement and activity. They tend to carry car traffic but pedestrian activity along them should be facilitated...
by the creation of a pedestrian friendly environment and the inclusion of main public transportation routes. They also have important retail and commercial uses.

Secondary Boulevards share similar characteristics to Primary Boulevards except that they are important within the district network, and not necessarily at the city-wide level. These boulevards are highlighted in the 5,000 meter network analysis and will carry lighter traffic volumes and more local commercial uses.

Locally important routes appear at the neighbourhood level, and figure in the 2,000 and 750 meter network analysis. These routes host local type retail. A low traffic flow is expected along these streets, but they are predominantly used as pedestrian and shared spaces.

Planning Guidelines
The concept of the land use proposal is to introduce the top-down interventions of the global economy along the key routes to let them trigger and encourage the bottom-up initiatives of the local economy along local streets. In this study it has been attempted to propose a different approach to planning by attributing different characteristics to different faces of urban blocks according to their spatial accessibility. This is fundamentally different from the prevalent ‘zoning’ approach and presents a more dynamic and flexible approach.

A phasing process of implementation allowing for a more sensitive process is also suggested here. First, major retail buildings and offices can be developed on global key routes, those of city wide importance, to maximise the prosperity of economic activities and create a sustainable city centre. This will attract higher pedestrian movement, create a competitive economy and, therefore, be beneficial to the development of the more local routes. At the opposite end of the spectrum are the residential buildings and local retail buildings that will be located inside the mega-blocks in an attempt to retain the local culture, which will also sustain a smooth transaction from public to private domains.

The methodology is based on the spatial accessibility analysis for the whole city. The spatial values are assigned to the faces of the blocks along each street. Each face of the block will be graded according to the spatial index indicating the degree of activity the uses should have. It is suggested that the more accessible, the more active the land use implemented should be (Figure 7). Based on existing land use patterns and the new spatial strategy proposed by Space Syntax Limited, a hierarchical land use system is set up and divided into five categories based on the percentage of non-residential land use in each category. Non-residential use includes commercial, mixed uses, community facilities etc.

The same principles could also be applied to building height, FAR (Floor Area Ratio), building densities and other planning guidelines. Again, the spatial accessibility of each face of the urban block determines its different planning attributes. Since all of these attributes follow the spatial structure, they produce a high degree of coherence and consistency. It means where there is higher spatial accessibility, and consequently more movement, there will be the land uses that are linked with high degrees of movement. Meanwhile, these locations have also higher height, densities and other attributes to complement their urban role.

It should be emphasised that this process only creates the planning foundations and has to be completed by a sensitive and detailed building code and regulatory system. This study concludes, however, that this approach is robust enough to offer a more realistic and
flexible urban planning guideline for the Central Unplanned Areas of Jeddah.

Conclusions

This study presents an approach to the upgrading of Jeddah Central Unplanned Areas. The approach is primarily based on a diagnostic analysis of the whole of city to determine the fundamental reasons behind the deprivation and decline of unplanned areas. This analysis identifies the main problem of these areas namely their inability to
relate to their wider context and the whole of the city. In the case of the Central Unplanned Areas, this inability causes problems not only for the Unplanned Areas themselves, but also affects the Historic Core and the larger city centre of Jeddah.

In order to resolve the problems of the Central Unplanned Areas, limited physical interventions through a careful process of analysis and design have been developed. The interventions aim to reinforce the internal structure of the Unplanned Areas while reconnecting them back to the whole of the city to provide the interface that is currently lacking (Figure 8). A route selection methodology based on filtering the routes through a wide range of local-global scales was introduced to generate a preferred raw route structure, which was further modified by design decisions influenced by the current socio-economic conditions. These conditions were brought to a multi-layered index, the Transformability Index, as a complementary tool for route design. A comprehensive study of street characteristics also helped the process determine the most appropriate widths and street profiles. This whole process was completed by a set of planning guidelines for land use, density, building height and so on, based on the spatial structure of the areas and degree of significance for different faces of the urban blocks.

This study demonstrates that the improvement of unplanned areas can be done in a more analytic and evidence-driven way. Being highly related to design issues, the developed method cannot (and should not) be a purely scientific method, as it offers a much more evidence-informed approach for large urban projects compared to many other traditional approaches. Although this methodology has been developed specifically for the Central Unplanned Areas of Jeddah, it holds important principles that could be applied to any other similar areas anywhere else.
References


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i. The Old City of Jeddah is currently through the process of being listed as one of UNESCO’s World Heritage Centres

ii. There are at least two major proposal for clearance of the University Unplanned Area and the Sabil area. The estimate for population of these areas in excess of 200,000 residents.

iii. For instance see the MIT’s webpage at: [http://web.mit.edu/urbanupgrading/upgrading/](http://web.mit.edu/urbanupgrading/upgrading/)