Strategies for Urban Residual Areas as a Planning Tool: Towards Achieving Sustainable Built Environment by Connecting Neighbourhoods

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Abstract. In large parts of the Gulf countries, neighbourhoods’ mono-functional structures with their low density and their lack of social functions, lively public spaces, public transportation and climate responsive design features have catered for an environmentally unfriendly development pattern. Borders between neighbourhoods are mostly socially repulsive as they usually host large residual and underutilized spaces such as oversized main roads and other infrastructure elements. Consequently, these residual areas constitute large breaks in the neighbourhoods’ building pattern and physical barriers for the inhabitants. Since we see a great potential in these residual areas, we have elaborated a planning tool which is generally applicable for sustainable development of transitional spaces between neighbourhoods. This study demonstrates different strategies on how these urban thresholds between neighbourhoods can be transformed into central active mixed-use public spaces that will be reachable for all residents by walking. Accordingly, they can promote for social interaction between different neighbourhoods and thus social sustainability. Within this paper, at first, the thresholds between different residential neighbourhoods’ structures are examined to better understand their qualities and deficits. Secondly, various sustainable development options for the threshold areas are demonstrated. An exemplary site in the Capital Area of Muscat, Oman serves as a case study. The third part consists of an evaluation of the elaborated proposals according to their ecological, social and economical efficiency in order to create adequate implementation strategies. Finally, we propose that the ecological solutions for residual areas as developed in this paper for the GCC region can be expanded to other hot-climate countries as a planning tool to achieve sustainable built environments by connecting different neighbourhoods.

1. Introduction
Ecological footprints and sustainability with all its aspects are preoccupying urban planners and designers nowadays. However, residential neighbourhoods in a large part of the Gulf countries have shown the other way round. In most cases, neighbourhoods are developing as separated entities with mono-functional structures which usually are of low density, lack social functions, lively public spaces and public transportation. Moreover, only few showed climate responsive design features.
1.1. Thresholds between neighbourhoods as a real problem that needs to be resolved
The separation between neighbourhoods creates residual areas or thresholds that are mostly socially repulsive as they don't provide neither economic nor social activities. They usually host infrastructure elements, oversized main roads and underutilized spaces that could host potential economic/social poles. These areas are usually of low density and free of public transportation. This is why there is a high ratio of car dependency. Furthermore, the lack of climate adaptation and public utilities plus the mono-functionality in these thresholds have established a sense of social repulsiveness. Consequently, these residual spaces constitute large breaks in both the urban fabric and the social structures, as well as physical barriers for the inhabitants.

1.2. Thresholds as urban tool connecting neighbourhoods and achieving social sustainability/resilience
The social part to ultimately achieve sustainability was mostly neglected in most of urban planning trends, especially in the middle east. However, this approach which received very little attention is a main key to achieve sustainability in general [1]. Social sustainability is about resilience and stability of different social groups, which form one population, and the way they practice their social lives in the urban space. The more these groups are blended and tied together through social practices, the more the community will be resilient. This is why decisions and urban policies which consist of producing connected/loose urban fabrics contribute largely in creating or not strong/weak social bonds in the community. In order to achieve sustainability of the built environment, the key is to aim for social cohesion as a common goal in the new growing communities [2]. On the one hand the thresholds, between neighbourhoods in the Capital Area of Muscat, can be of a great potential and the residual areas can be used as a planning tool to connect neighbourhoods instead of separating them. Thresholds can be the bonding nodes in the urban fabric. They may attract different population to come together and to exchange. These nodes can be considered to some extent as a reinforcement tool for the urban fabric and the social structure of the community, hence they will promote social resilience and cohesion in these neighbourhoods. On the other hand, these nodes can be planned in a way to offer new propositions for sustainability via using ecological building materials and renewable energy sources suitable for the environment. We believe that finally thresholds can be a key to minimize exclusion and to achieve social diversity and self sufficient resources.

2. Research Background and Challenges
Urban development of neighbourhoods in the Gulf area is currently faraway from ecological notions. Each neighbourhood represents an enclave by itself where inhabitants live and practice their urban space separately. The lack of social interaction between neighbourhoods is a threat to social/urban sustainability of the whole city. Consequently, the threshold areas between these enclaves, if left without a clear planning strategy, will be a threat to these neighbourhoods' sustainability in general. We believe that there is a great potential in these unplanned areas as they could be transformed from barriers to adhesive zones and they could explore new economic opportunities. These thresholds could become the key to social/urban sustainability in the neighbourhoods, as every neighbourhood will be a part of a bigger tissue which integrates all its cells together in a balanced way. This proposition will reinforce the social cohesion of the population as well as the community resilience.

It will be as if we imagine that each neighbourhood represents a cell from a bigger tissue and each cell functions on its own vs. cells that function in harmony all together in one unifying organism.

Social sustainability is a must in order to manage urban and economic sustainability. The re-management of thresholds – which are existing between the neighbourhoods in Muscat, Oman – could contribute to achieve this social sustainability.
3. Paper's Aim and Interests
The current mode of urbanization in the Gulf Countries, doesn't really take into consideration their ecological footprints. The problem is deeply aggravated by the existence of threshold spaces between different neighbourhoods. This study aims at highlighting planning strategies which could be used as a tool when it comes to the problem of residual spaces resulting from different neighbourhoods' implantation. These strategies take into consideration the existing urban fabric as an asset. They can be igniters to make the highest profit from the existing urban tissue via reducing the urban threshold inconveniences and maximizing the spatial liberty and their interactions. We believe that these strategies could be of a help to the gulf cities in shifting towards more climate resilient awareness and sustainable built environment development [3].

4. Neighbourhoods Today and Their Threshold Spaces
Urban policy in Oman promotes for the spread of detached mono-functional neighbourhoods. In fact every Omani individual is assigned at the age of 25 a piece of land on which she or he is supposed to build their own houses. The problem is not all the Omanis are ready to have their houses built at this age, which led to urban vacancies through neighbourhoods[4]. The fact that each individual is assigned a piece of land while he is not ready for the construction, plus the Gulf culture of having stand alone house even on small piece of land for intimacy reasons, cater for the creation of vacant areas between neighbourhoods. The microclimate of these residual spaces is especially harsh not only due to the high temperatures, but also because of unprotected sun and wind exposure. Furthermore, the hot climate makes it even harder to develop or to plant the resulted residual areas. Consequently, the neighbourhoods are disconnected from each other. All these factors are part of the reason for the current unsustainable development. This phenomenon was also nourished due to the socio-economic rapid growth of the gulf countries in general. Accordingly, the common residential building type is mostly the wide-spread single family house. The Capital area of Muscat plus the development of its suburbs, stretched for more than 100 km along the coastal plateau of Al Batina, is a living example of what a loose urban fabric looks like [5]. The loose urban fabric in Muscat, especially in the residual areas between neighbourhoods, has manifested the following symptoms within various levels:

4.1. Functional aspects
Most areas have mono-functional structures. The density of buildings and population is low. Buildings and public street spaces are completely exposed to the sun. Buildings, streets and the large amount of sealed surfaces contribute to urban overheating which causes the urban heat island effect. Buildings are arranged in an unsustainable way, many plots remain inbuilt. Climate responsive urban and architectural design strategies are missing.

4.2. Social aspects
The walkability within the neighbourhoods is very limited. Social functions are lacking. Lively public spaces are not existing. There is no public transport. Due to the lack of mobility, several population groups are socially excluded (e.g. elderly people, children, handicapped, low income expats). Social interaction is absent. Social repulsiveness has been established.
4.3. Threshold spaces
The borders between neighbourhoods consist of large residual and underutilized spaces, often as oversized main roads and other infrastructure. They constitute physical and mental barriers. Due to their large size they can be seen as breaks in the building pattern.

**Figure 2** Al Khoud, Capital Area of Muscat / Oman – typical example of a residential neighbourhood with large areas of unused street space (threshold and residual space indicated with red texture), GPS 23.604316, 58.164498 (Source: Map data © 2018 Google, Digital Globe).

5. Case Study Area in the Capital Area of Muscat Oman
The area of Al Mabeila as indicated in figure 4 served as an exemplary site for the case study analysis.

**Figure 3**. Satellite image of the case study area with diverse neighbourhoods and large unused spaces between them in Al Mabeila, Capital Area of Muscat, GPS 23.380301, 58.074790 (Source: Map data © 2018 Google, Digital Globe).
Figure 4. Satellite image of the case study area with indication of threshold and residual spaces.

6. Methods of Integrative Urban Development of Threshold Areas

We have developed a strategy of how the areas can be transformed into an integrative urban development with central active mixed-use built environments with lively public spaces which will be reachable for the residents of the adjacent neighbourhoods by walking. Thus the former threshold areas can promote for social interaction between different neighbourhoods and create social sustainability. Among others, key indicators for the success of the new urban areas are a re-densification of the neighbourhoods with a minimum of ca. 10,000 inhabitants/km² and public functions on the ground level of mixed-use buildings. Also the public exterior spaces are to be re-developed. The proposed urban green is to be irrigated with recycled wastewater from the households. Figures 5-8 are demonstrating this in regard to the individual interventions.

Figure 5. Diagrams of current situation (left) with separated neighbourhoods and unused / wasted residual threshold spaces and proposed transformation of the threshold areas into connecting areas.

Figure 6. Strategic concept plan with improvement proposals.
Figure 7. Design example from a student project supervised by one of the authors (Bachelor Thesis 2018, student: Hajir Al Alawi)

Figure 8. Design example (zoomed in) from a student project supervised by one of the authors (Bachelor Thesis 2018, student: Hajir Al Alawi)

7. Planning Tool

Urban nodes can be implemented at the residual spaces between different neighbourhoods. The following table 1 illustrates the individual enhancement interventions and also serves as a preliminary ‘proof of concept’ by indicating the expected type of benefit (social, ecological, economical) which also serve as key performance indicators.

| Goal | Intervention | Type of Benefit |
|------|--------------|-----------------|
| 1    | Breaking physical barriers (e.g. roads), thus increasing the area's walkability | Social | Ecological | Economical |
|      | Creating safe pedestrian crossings | √ | √ |
| Step | Description | Outcome | Notes |
|------|-------------|---------|-------|
| 2    | Create enhanced liveliness and social interaction within a neighbourhood and between different neighbourhoods, increased number of homes, more services | Increasing population and building density by adding new mixed-use buildings in a compact arrangement | ✓ ✓ ✓ |
| 3    | Creating urban nodes with services and public squares / plazas, all daily needs will thus be placed in walkable distance for all residents | ✓ ✓ ✓ |
| 4    | Better adaptation to climate, reduction of urban overheating (urban heat island), improved air quality, increased walkability | Implementation of local plants, creation of shaded pathways with trees (irrigated with recycled household water) | ✓ ✓ |
| 5    | Green roofs, green facades with the use of local plants (irrigated with recycled household water) | ✓ ✓ ✓ |
| 6    | Reduction of urban heat island by improving the solar reflectance of surfaces | For all sun exposed surfaces: use of materials with bright colours and smooth surfaces which have a high solar reflectance index (SRI). Use of pavement only when absolutely necessary, unsealed areas could be covered with green (irrigated with recycled household water) | ✓ ✓ |
| 7    | Better interconnections between the neighbourhoods for pedestrians and cyclists, mobility improvements, reduction of car use | Implementation of net of pedestrian and bicycle paths which connect the neighbourhoods and newly developed former residual areas | ✓ ✓ ✓ |
| 8    | New network of pedestrian and bicycle paths to connect with existing network of residential streets. Existing connections to be extended for pedestrians and bicyclists | ✓ ✓ |
| 9    | Sustainable and healthy food production, reduced dependency on food import, improved micro-climate | Urban agriculture | ✓ ✓ ✓ |
| 10   | Increase liveliness of neighbourhoods | Playground areas and outdoor activities | ✓ |
| 11   | Schools and kindergartens accessible by walking | New schools and kindergartens to be placed on former residual areas | ✓ ✓ ✓ |
| 12   | Less emissions, less dependency on fossil fuels | Renewable energy generation (e.g. with building integrated photovoltaic, shading devices with integrated photovoltaic, small wind turbines) | ✓ ✓ |
| 13   | Enhanced outdoor comfort, better microclimate | Wind corridors enable natural ventilation of the neighbourhoods | ✓ ✓ |
| 14   | Recreational green public spaces | ✓ ✓ |
| 15   | Mobility improvements | Public Transport Connections | ✓ ✓ |
| 16   | Providing public E-Bikes / E-Scooters | ✓ ✓ |
| 17   | Strengthened local economy, offering sustainable products | Local markets | ✓ ✓ ✓ |
8. Conclusion
Thresholds spaces between neighbourhoods aggravate the urban evolution and diminish the eco-friendly development of residential areas in the Gulf Countries in general. Muscat in Oman is a living example for this pattern. This current mode of urbanization increases ecological footprints and plays against the sustainability of the built environment with all its aspects. The paper suggest the introduction of a planning tool which will connect separated neighbourhoods while targeting a wide spectrum of the population. This will offer the inhabitants a safe, secured climatically adapted mixed-use public urban space which strengthens exchanges and interrelated social practices. New knitted social relation between different neighbourhoods will promote especially social sustainability. The latter will be a key to achieve sustainability on a larger level. More explicitly, on urban level, the suggested urban nodes can be inserted to connect and enhance the urban qualities of the loose urban fabric in the void areas between neighbourhoods. They will introduce new attractive social activities which were lacking before. Consequently, they will also present new economic potentials and opportunities, as each neighbourhood will be more anchored in the urban tissue while having a new specific sociological and economic role, the social cohesion and community resilience will be reinforced. On architecture level, new urban nodes will be an opportunity to architectural development with local eco-friendly construction materials in a contemporary trend in order to support the built environment sustainability [6]. Finally we believe that the analyses, research and application on Muscat as a case study, proved that connecting neighbourhoods – via implementing urban nodes in the existing thresholds between residential areas – can be used as a planning tool to lead suburban residential districts in the Gulf Countries towards sustainable built environment. Furthermore, many aspects of the tool are also valid for other hot-climate countries.

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