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Spatial configuration of Erbil Citadel: It's potentials for adaptive re-use

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Abstract

Erbil Citadel joined the UNESCO world heritage list in June 2014, and is one of the world's oldest continuously inhabited human settlements. From the first decades of the 20th century, it has witnessed continuous deterioration due to large number of influencing factors which have left it deteriorated and obsolete. In order to conserve and enhance this unique historic Citadel, a revitalization project was initiated. The "Conservation and Rehabilitation Master Plan" was proposed as a major decision making tool for the High Commission for Erbil Citadel Revitalization (HCECR). The Master Plan adopts adaptive re-use as the core strategy for a culturally-driven revitalization.

This research focuses on the issue of new uses allocation as a significant part of the adaptive reuse strategy. It is intended to approach the new uses allocation for Erbil Citadel in terms of a recognized influencing element: the Citadel spatial configuration. The main question is to what extent and how the properties of spatial configuration (syntactical properties) could be considered and invested in the allocation of new uses for Erbil Citadel. Answering this question, which is the main research objective, adds spatial configuration as another influencing factor and provides a more stable ground for assessing and developing the initial draft of the land use plan for new uses allocation to achieve an optimized and more appropriate re-use. It is expected to provide the indicators necessary to deal with a range of new uses competing for the Citadel buildings, most of which are traditional houses of similar typology.

The research method consists of: (1) introducing a theoretical background for the concept of adaptive re-use and the arguments concerned with the spatial configuration as related to the concept of adaptive re-use. (2) Analyzing the spatial configuration of Erbil Citadel by measuring its syntactical properties (Integration and Choice) to specify its potentials. (3) Analyzing the allocation of new uses in the initial land use draft for Erbil Citadel by classifying them according to their seeking for natural movement, a proposed variable which links the spatial configuration and the allocation of new uses. (4) Carrying on an analysis of association between the syntactical properties of the axial lines measured in (2) and the types of the new uses overlooking them classified in (3) to specify the extent those properties are considered in the initial draft. (5) An iterated analysis of association between the measured integration and choice, and the type of new uses re-allocated in a modified plan, proposed by this research, to specify how the syntactical properties are invested for more appropriate re-use. In conclusion, the degree of association between the syntactical properties and the new uses allocation are increased, to a considerable extent, in an intentional re-allocation process. This is achieved by

investing those properties as criteria to evaluate the initial plans of new uses first, and then they can be used as guidelines to direct the re-allocation process to achieve a more appropriate adaptive re-use.

Keywords

Erbil Citadel, adaptive re-use, new uses allocation, spatial configuration, syntactical properties.

1. Introduction

Erbil Citadel is one of the world's oldest continuously inhabited urban sites with unbroken occupation dating back about 6000 years and through centuries it was considered as a notable station on the ancient "Royal Road". The Citadel takes up an area of 10.2 hectares on an artificial elliptical-shaped earthen mound of about 32 meters height above the city level, therefore it becomes an iconic landmark and is regarded as the Crown of Erbil, the capital of Kurdistan Region/Iraq. The Citadel town which consists of traditional courtyard houses and few public buildings which are reached through a labyrinth of narrow alleyways is surrounded with contiguous houses that generate its fortified look perimeter wall. (Figures 1&2).



Figure 1: Erbil Citadel, Arial View

2. Revitalization of Erbil Citadel: Procedures of the revitalization process

Erbil Citadel has witnessed continuous deterioration from the beginning of the 20th century as the lack of services, the narrow insanitary alleyways, inaccessibility to cars, and the increased impression of being old-fashioned and inconvenient have triggered wealthy prominent families to depart the Citadel in favor of the lower city, leaving the abandoned houses to be occupied by the refugees and squatters. In 2006 Kurdistan Region Government decided to depopulate the Citadel so that it could be conserved and revitalized. In 2007, Erbil Citadel Revitalization project was started by the High Commission for Erbil Citadel Revitalization (HCECR) in collaboration with UNESCO.



Figure 2: Erbil Citadel, Panoramic View

Extensive series of studies and surveys were carried out to inform the “Conservation and Rehabilitation Master Plan”. Three main groups of missions have been addressed: the first includes the physical preservation procedures that are related to preserving and promoting the architectural, physical and structural quality of the Citadel buildings and constructions along with improving environmental and hygienic conditions. The second includes the procedures that are related to the concept of adaptive re-use as the adopted strategy for dealing with the preserved buildings and the third group includes the management and operational procedures to ensure effective implementation. (HCECR, 2009; 2010; 2012).

2.1. Adaptive reuse as a strategy for revitalization

Reviewing the Conservation and Rehabilitation Master Plan, two main important comments come out. First, the revitalization of Erbil Citadel is to be approached through the concept of adaptive reuse as the core strategy for a culturally-driven revitalization (HCECR 2012). Second, Adaptive reuse of Erbil Citadel has concentrated largely on the issue of the allocation of new uses for each individual building and the Citadel. It is stated that, to guide the determination of the new use for each building, four criteria must be followed according to which the new use ought to be compatible with: the spirit of the original use; the character and value of the building; the technical/ practical appropriateness of the building in terms of space available, adaptability, location and the access to vehicles; and finally, the socio-economic context and the sustainability of its management framework. For the Citadel as a whole, it is stated that, the new uses allocation is inspired by the Citadel historical district division as Saray District was devoted to a predominant cultural-related use, Takya District was devoted to a predominant touristic-related use, Takya District center was devoted to a predominant office- and archeological-related use and Topkhana District was devoted to a predominant residential-related use (HCECR 2012, p127) (Figure 3).

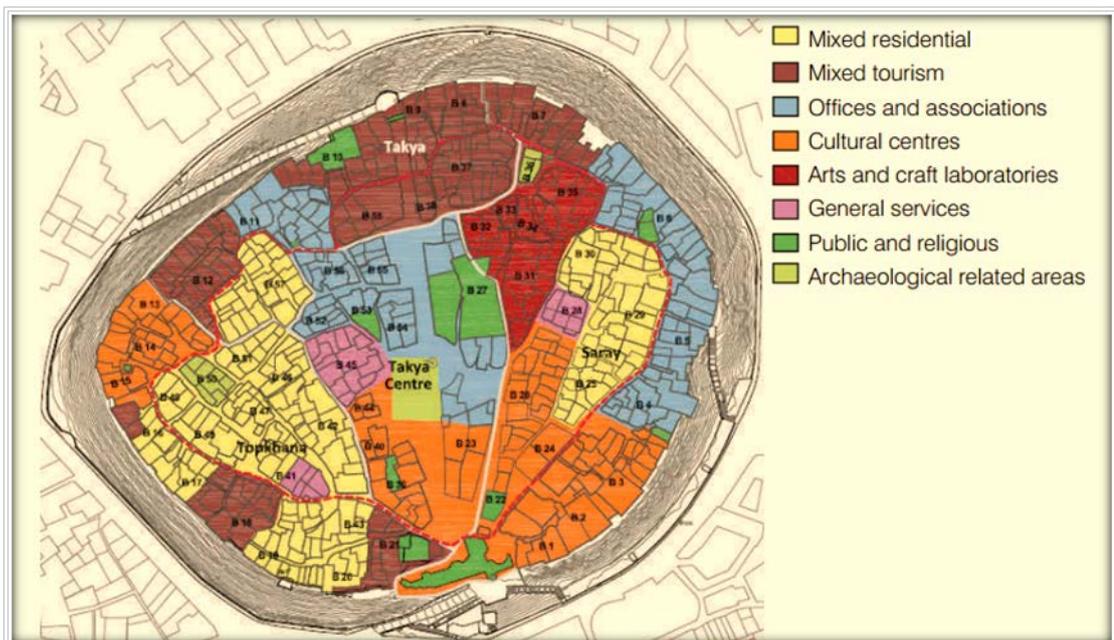


Figure 3: Erbil Citadel: Land Use Plan, Initial Proposal

3. Research problem, objective and method

The current research addresses the problem of new uses allocation for Erbil Citadel as a whole in terms of one principal influencing factor: the citadel's spatial configuration. The aim is to add one more influencing factor along with other technical and practical factors which have been already considered in the allocation of prevailing new uses in an initial Draft of the land use Plan (HCECR 2012). The new prevailing uses for the Citadel are intended to be determined by space related criterion rather than taking the inspiration from the Citadel historical district division, which is a geographical/ organizational criterion. Moreover, recommending that the allocation of the light commercial use to the small buildings located in prominent positions or in the vicinity of important visitor facilities (HCECR 2012), indicates that the initial draft addresses urban space local properties rather than the global ones. The research principal objective is to specify the extent and how the properties of spatial configuration (syntactical properties) are considered and invested in the allocation of new uses for Erbil Citadel. The significance of this objective comes out from at least two points: the first one concerns the hierarchy of the decisions related to the allocation of new uses within the whole decision process of adaptive reuse. Erbil Citadel is considered as a unique case as it is concerned with a historical empty city to be revitalized as a whole, and to be effective, adaptive reuse needs to be structured to insure that the decisions related to the bigger urban scale become a referential framework for the decisions related to the scale of the individual buildings. The second point is that the methodology to be introduced is intended to be an evaluative tool that provides a more stable ground to develop the initial draft through an effective feedback process.

3.1. *The Concept of adaptive reuse: definition, scope & benefits*

Adaptive reuse is neither a new phenomenon nor is it limited to architecture as it has been applied to almost all types of man-made artifacts across history. Adaptive reuse emerged as a response against three main types of obsolescence come over built entities, namely: physical, functional and economical (Eyuca, 2010). The literature of adaptive reuse introduced many definitions which cover its different aspects (Clark, 2013; Wilkes, 1998; Brooker and Stone, 2004). In its essence, the concept of adaptive re-use is defined as: "The process of using again a built entity which has a capacity or an ability to change to suit different situations". Adaptively re-used built entities vary in their scale, historical, traditional, architectural values. The process of adaptive re-use has been applied to individual buildings, sites, precincts and urban settlements. Adaptively re-used built entities include traditional buildings, old towns, modern and contemporary built forms. Those entities range between being of high and low architectural value. Adaptive re-use includes varied scope of physical and functional intervention. Physical interventions range from making significant modifications in the physical elements of the built environment to little or even without any physical modification. The physical elements include the structural system, partitions, the relationships between spaces etc. On the level of function, the scope ranges between inserting uses which are totally new and retaining the original uses without making any functional change. Finally, adaptive re-use has environmental, social, economic, functional, cultural, aesthetic, psychological and archeological advantages and benefits goals (Clark, 2013; Li, 2005; Brooker and Stone, 2004). As for Erbil Citadel, its adaptive re-use is an example of a process applied on an urban scale historical form with unique traditional, aesthetic and architectural values. Erbil Citadel as a whole is the main focus of the current research.

3.2. *Optimization in adaptive re-use*

The literature of adaptive reuse includes many references to the issue of optimization in the decisions of adaptive re-use, particularly, regarding allocating specific new uses for buildings. Two concepts have been introduced; compatible reuse and most appropriate reuse. They contribute to the sustainable development of historic areas (Yildirim and Turan, 2012). Compatible re-use, recommended in Burra Charter, is a re-use that respects the cultural significance of a place (Australia ICOMOS, 2000), whereas the most appropriate use is the reuse that will be economically sustainable (Pearson and Sullivan, 1999). In spite of being considered as alternative approaches toward adaptive reuse, they are, for this research, two integrative concepts. It appears, that compatibility is the

objective when the decisions are related to the building per se, whereas appropriateness addresses issues extended to include the buildings' settings. Therefore, it is argued that the new uses allocation for Erbil Citadel, concerns determining the most appropriate re-use for buildings which are mostly traditional houses. It is aimed to provide the indicators necessary to deal with the problem of there being a range of competing new uses for buildings of similar typology.

3.3. Spatial configuration and the allocation of new uses for Erbil Citadel

This section intends to link the allocation of new uses for Erbil Citadel with the concept of spatial configuration by reviewing the arguments of the relationship between the spatial configuration and adaptive reuse in general and the distribution of land uses in particular.

3.3.1. Spatial Configuration as Related to Adaptive Reuse

Spatial configuration is a significant issue for the adaptive reuse of Erbil Citadel. The literature of adaptive reuse includes explicit and implicit statements on the significance of the spatial configuration in any project. For example, in their contribution as design educators, (Eyuce and Eyuce, 2010) have argued that as adaptive reuse is the utilization of an existing building for a new set of functional requirements; two issues are to be considered: the first is concerned with the new space configuration of the adapted building, the second is related with the clues dictated by the existing configuration. Dealing with these main issues which are strongly focused on the morphological properties of the original building, constitutes the most important phase of all adaptive re-use processes. Also, as a guide for adaptive re-use projects, (Robert et al, 1998) argued for considering the spatial layout of the existing structure and the spatial layout for the proposed new use. When a new use complements the existing spatial layout, the result is more efficient and economical.

3.3.2. Spatial Configuration and Land Use Patterns

The relationship between the spatial configuration and land use patterns have been largely addressed by the literature of space syntax. It is argued that the configuration of urban space plays a key role in shaping and reshaping the land-use pattern. It influences another social phenomenon i.e., movement which is considered as the 'strong force' that holds the whole urban system. In Hillier (1993), a hypothetical model of the nature and direction of relationships between configuration, movement and attractions was introduced. Configuration may influence both movement and the location of attractors and the influence direction is from the first to each of the latter two which are influencing each other. The term 'movement' corresponds to the concept of natural movement proposed to denote the proportion of movement determined by the urban grid itself. It is the most pervasive type of movement without which most spaces will be empty for most of the time, although it is not always the largest portion of movement in urban spaces (Hillier 1993, pp31-32). In Hillier (1996b), it is argued that natural movement affects land use pattern by attracting movement-seeking uses such as retail to locations with high natural movement, and sending non-movement seeking uses such as residences to locations with low natural movement. The attracted uses then attracted more movement to the high movement locations and this in turn attracted further uses creating a spiral of multiplier effect which would result in a dense mixed uses pattern set against a background of more homogeneous mainly residential areas. Many subsequent researches were conducted in different geographical and cultural contexts to test and support these hypotheses with different degrees of corroboration. (Al Ghatam, 2012; Kubat et al., 2012; Ortiz-Chao, 2008; Min et al, 2007).

4. Research methodology

The relationship between the syntactical properties (integration and choice) and movement (pedestrian & vehicular) and thus the land uses, the hypothesis, largely corroborated in the literature of space syntax, is adopted by the current research as the initial base assumption to establish a methodology to assess and develop the initial proposal of new uses allocation for Erbil Citadel. The most appropriate proposal is expected to attain a high association between the measures of integration and choice of the urban axes and the new uses overlooking them. The degree of association is adopted as an indicator of considering and investing the syntactical properties for the allocation of new uses for Erbil Citadel in the land use Plan initial draft and a developed proposal prepared by the current research.

4.1. Analysis of Erbil Citadel spatial configuration: Technique of syntactical analysis

Erbil Citadel plan which represents its alley ways network is drawn as a geometrically closed polygon layout in DWG format, imported to Depth Map in a DXF format, then all-line-axial-map is automatically generated. This map is, then, reduced to a fewest-line-map which covers the spatial system with as few lines as possible to let any part of the system to be seen from a line and at the same time ensure the depth between all pairs of lines is minimized. The minimal version of the fewest-line map is selected rather than the subset version as it gives the more natural image that approximates what was done by syntax researchers. Finally, an analysis is run to calculate the values of syntactic properties.

4.2. Measurement of Syntactical Properties

Two syntactical properties are measured; the first is integration which refers to how many other lines are up to n steps away from each line (Hillier et al., 1987). In a more recent definition, it measures the distance from each spatial element to all others in a system (up to a certain radius and given a definition of distance), and so corresponds to mathematical closeness. According to this measure, the spaces of any spatial systems can be ranked from the most integrated (red axial lines) to the most segregated one (blue axial lines) (Klarqvist, 1993). The second is the measure of choice which refers to how likely it is to be passed through all shortest routes from all spaces to all other spaces in the system (Hillier et al., 1987). It is, according to recent explanation, the degree to which each element lays on path between elements (Hillier, 2005). Also, it measures the movement that passes through each spatial element on shortest trips between all pairs of spatial elements in a system (up to a certain radius and given a definition of distance), and so corresponds to mathematical betweenness. The literature of space syntax states that integration represents the *to-movement* potential of a space, and choice the *through-movement* potential, and points out also that the two measures correspond to two basic elements in any trip: selecting a destination from an origin (integration), and choosing the spaces to pass through between origin and destination (choice). Accordingly, these two syntactical properties can then define the type of land use that would fit best in this space (Charalambous and Mavridou, 2012).

5. The results of syntactical analysis

Despite their different nature, the geometric and syntactic properties are related to each other. As for the geometric properties of the axial lines of Erbil Citadel, there are two issues to observe. The automatic analysis has shown that the fewest number of the longest axial lines which cover Citadel urban space is 149 lines. These lines are varied in their length as the longest line (321m) represents the longest portion of the axis that penetrate the urban space between the two gates whereas the shortest axial line is about (7.3m). The total length of the Citadel axial line is about (7410m) with an average length of about 50m. Only 3 of the longest axial lines count 10% of the total length of the Citadel axial lines, whereas the number of the shortest axial lines which correspond to 10% of the total length is 46 axial lines. This dispersion and asymmetry in the pattern of lines length is reflected in the high values of the standard deviation (42.625) and the skewness (2.783). Regarding the types

of intersections in terms of axial lines continuation after the intersection points, two types are picked out. There is few number of the intersections in which the axial lines continue after the intersection point with. This type includes, largely, the lines connected to the longest axial line in the Citadel, whereas the intersections characterized by axial lines which are stopped by the others dominate the remaining parts of the Citadel. As for the syntactic properties of the Citadel connected with its bigger urban context, the analysis shows that the axial line leading to the northern gate is more integrated than that leading to the southern gate. For the Citadel itself, the average of Citadel Global Integration is 1.188 with min= 0.711 and max= 2.111 and a standard deviation of 0.280. The axial lines of the highest integration (10%=15 lines) appear in the four highest deciles with (1 line) in the highest decile, whereas the lines of the lowest integration (10%= 15 lines) appear in the first lowest integration decile (Table 1).

It is worth note that the edge effect which usually occurs as the routes lie along the axial map periphery become segregated as a function of the size of the selected boundary of analysis (Hillier, 1997; Penn et al., 1998), is not expected to appear due to the autonomous nature of Erbil Citadel as it is highly elevated from the city below and the closed boundary with only two main gates and a third secondary one. The Citadel is considered as a three entrances building. However, the results of syntactic analysis of the Citadel per se and the Citadel with its bigger context show that the results are approximately similar (<1%) (Figure 4).

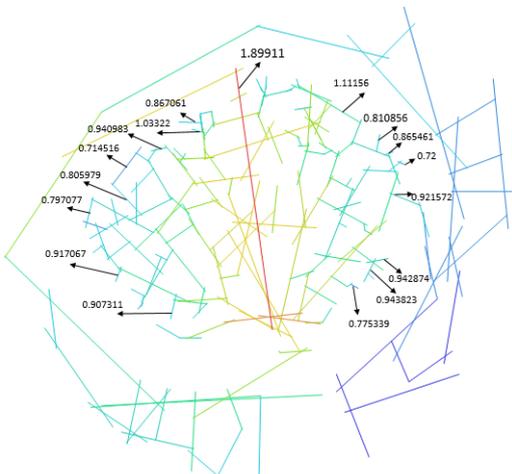


Figure 4a: Erbil Citadel with its surroundings: global integration

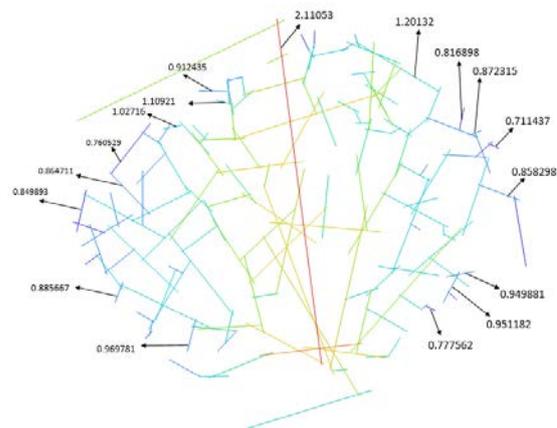


Figure 4b: Erbil Citadel: global integration

Erbil Citadel has an integration core (10%=15 of the highest integration axial lines). This core is of dominant fully connected linear hub started with a slightly exaggerated beginning from the southern principal gate up to the northern gate passing through the center. The integration core is clustered along the Citadel diameter without clear clues of the spokes and rim portions of the deformed wheel and the low integration axial lines are spread out on both sides of the integration core. The integration core consists of one series of axial lines of which the longest one is the most integrated, and is intersected with a group of passing through axial lines which slightly penetrate the spatial system. These lines of the second rank level of the highest integration represent the interface between the integration core and the adjacent spatial system of the low integration lines towards the most segregated axial lines of the dead end alleyways along the citadel's periphery. The linear integration core is characterized with 3 discernable dense clusters of high integration axial lines intersections; one of them is at the southern main gate, the second is at the citadel's center and the third is at the middle distance between the citadel center and the northern gate. (Figures 5, 6a & 6b).

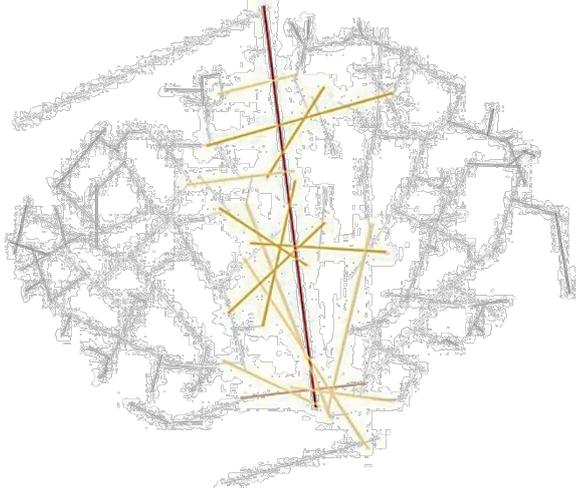


Figure 5: Erbil Citadel, Integration Core

Syntactical Property	Average	Maximum	Minimum	SD
Connectivity	4.067	15	1	2.548
Integration (HH) r=n	1.188	2.111	0.711	0.280
Integration (HH) r=3	1.763	3.154	0.333	0.521
Choice (norm) r=n	0.057	0.702	0	0.093
Choice (norm) r=3	0.062	0.282	0	0.062

Table 1: Erbil Citadel, Results of Syntactical Properties

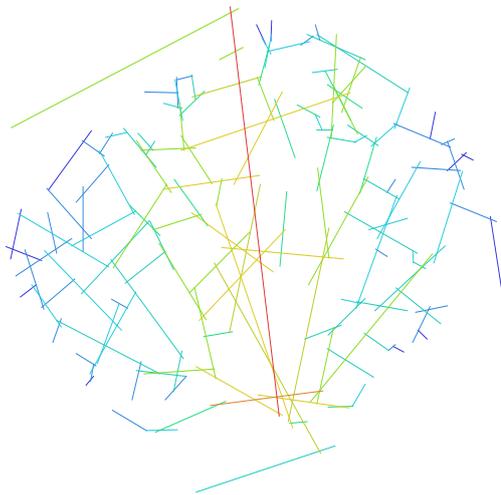


Figure 6a: Erbil Citadel, Global Integration r=n

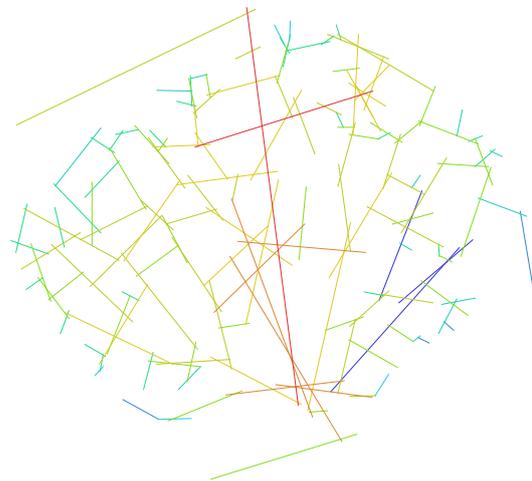


Figure 6b: Erbil Citadel, Local Integration r=3

As for local integration r=3, the results shows that the axial lines acquired higher integration values. The average local integration is 1.763 with min=3.154 and min=0.333 and SD=0.521.

The average of global choice (norm) =0.057 with a minimum value=0 and max. =0.702 and SD=0.093. Also the analysis results show a degree of global choice as 113 axial lines have been clustered within the lowest decile, whereas, the highest decile of choice contains only one axial line which represents the central line. There is only one line of the subsequent high degree of choice which intersects the central axial line of the highest choice in the midpoint between the Citadel center and the northern gate, this line penetrates the urban fabric on both sides of the central axial line. The two lines of the subsequent choice are located within the sixth decile from the highest choice intersects the central axial line near the main southern gate and penetrates, deeply, the urban fabric on right side. There are two more connected lines of high choice intersect the central axial line and penetrate the urban fabric on the left side of the main southern gate. On the other hand, the analysis results show a different pattern for the distribution of local choice $r=3$ as the axial lines of the highest choice appear in deep parts of the urban system on the right and left of the principal central axis along with the line which intersects perpendicularly near the principal central axis which is itself with moderate degree of choice (Figures 7a and 7b).

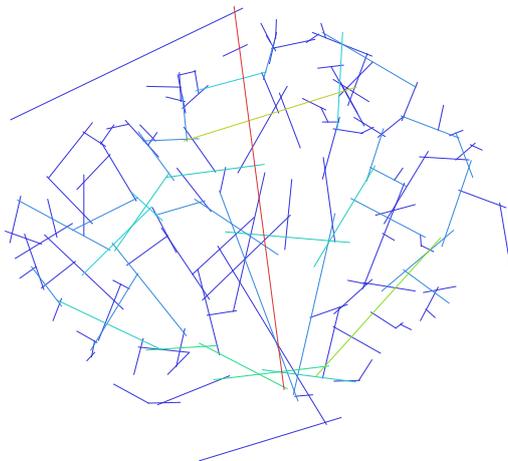


Figure 7b: Erbil Citadel, Global Choice $r=n$

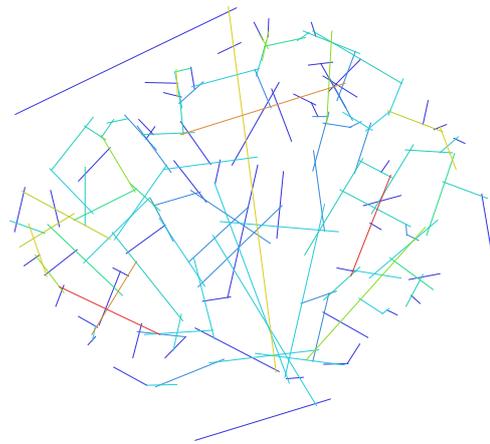


Figure 7a: Erbil Citadel, Local Choice $r=3$

6. New uses allocation for Erbil Citadel

Various new uses are usually designated to the adaptively re-used traditional buildings. This variety reflects adaptive re-use objectives related largely to sustainability, which means the continuous utilization of the built heritage in a more rational way, adapting present needs and lengthening the life of the asset (Norma and Cervantes, 2007; Pederson, 2002). New uses of the adaptively re-used built entities are unlimited theoretically; however, certain types of them are being focused on. These new uses are related to cultural tourism, lodging and commerce activities (Tiesdell, 1996). For Erbil Citadel, a range of viable functions have been proposed of certain categories: Culture- and Leisure-Related uses, tourism-related accommodations, offices related to cultural activities and residential-related uses (HCECR, 2012) (Figure 8a).

7. Density of movement sought as criterion for new uses classification

In order to assess the association between properties of spatial configuration (syntactical properties) and the types of new uses, proposed in the initial draft, it is essential to classify the allocated new uses according to a criterion directly related to those properties. The classification criterion/ variable proposed is based on space syntax theory on cities. New uses are to be classified in terms of the density of movement sought to three categories: uses which seeks high density of movement or high movement seeking uses in space syntax terminology, uses which seeks low density of movement or non/low movement seeking uses and uses which are expected in be in the middle of the two extremes of the scale. It is admitted that this classification is somewhat general and needs elaboration to be more sensitive to pick up the differences in the nature of each new use.

7.1. Initial draft: Allocated new uses classified

The new uses of the initial draft have been classified in terms of the density of movement sought by them. As the criterion of classification is a nominal scale variable, therefore, cultural, leisure and tourism-related uses are designated to the first category with the label (3); residential-related uses are designated to the second category with the label (1), whereas offices, social services are designated to third category with the label (2).

7.2. Analysis of association

An analysis of association is carried on using SPSS 20 software between the syntactical properties of the axial lines and the type of the already classified new uses of the initial draft. The analysis matrix includes the data for each of the (588) buildings of the Citadel with the corresponding syntactical properties (integration and choice) of the axial line and type of the new use overlooking them (Table 2).

7.3. Developed draft: new uses re-allocated

In order to specify how the syntactical properties are invested in the new uses allocation for Erbil Citadel, the current research initiates a development of the initial draft by re-allocating its new uses. Based on the measured syntactical properties, an intentional re-allocation process directed by the objective of attaining a high degree of congruence or association is carried on. This is achieved by assigning the new uses of the high movement seeking type to the buildings overlooking the axial lines of high values of integration and choice and vice versa. The final developed draft of new uses re-allocation is the result of four modified and overlapped drafts, each one of them is proposed according to each syntactical property (integration $r=n$, integration $r=3$, choice $r=n$ and local choice $r=3$). The axial map adopted in this stage considers the most recent modifications resulted by the Circuit Route which is aimed at facilitating the movement of visitors and guide them towards specific areas the site together with providing information and facilities at specific locations. These would help in the valorization of the site and in providing rest areas that would enhance the visitors' experience. Moreover, paths will help to bring back to the visitor the sense of the place and the historical urban fabric (Figures 8b & 9).

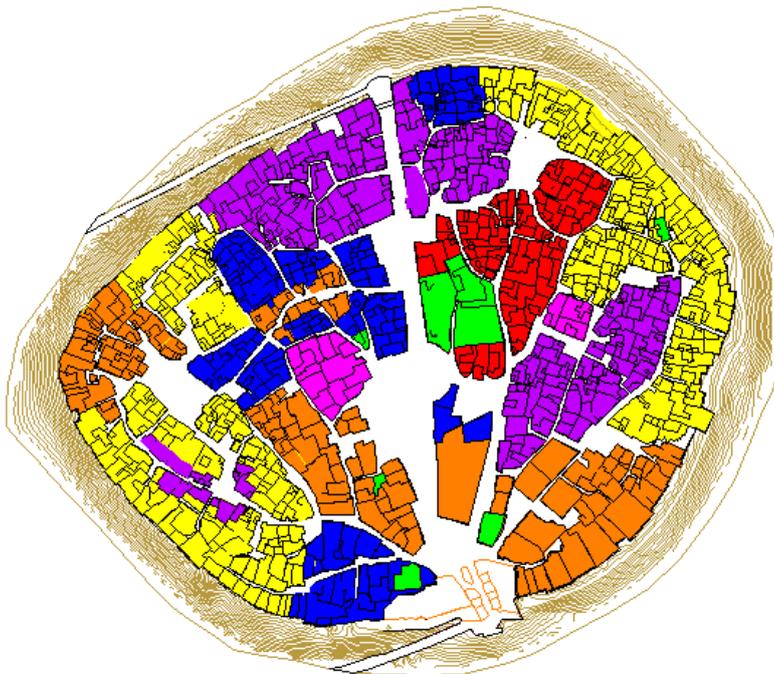


Figure 8a: Initial draft, new uses allocation

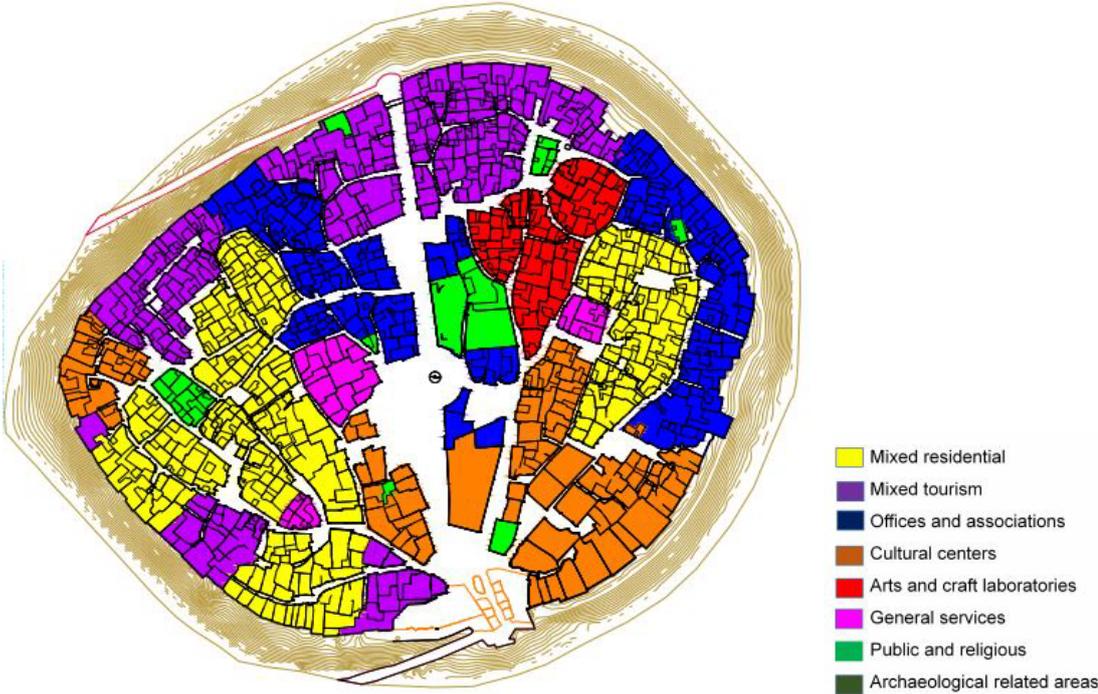


Figure 8b: Developed draft, new uses re-allocated

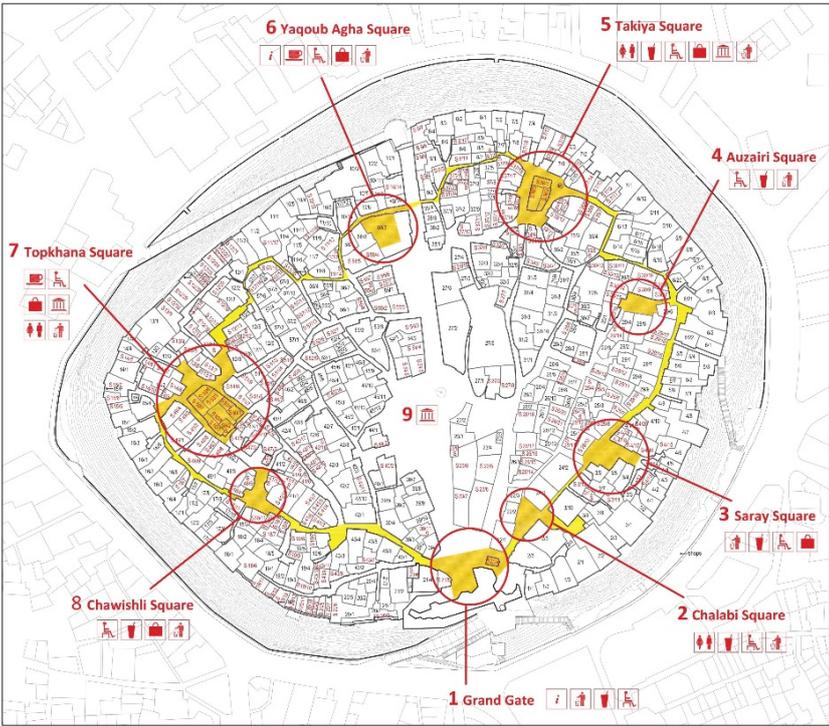


Figure 9: Erbil Citadel, Circuit Route

7.4. Iterated analysis of association

A second analysis of association is carried on between the syntactical properties of the axial lines and the type of the classified new uses re-allocated in the developed draft. Finally, a comparative analysis between the initial draft and the developed draft, prepared by the current research is made, to define the effect of the re-allocation process (Table 2).

Type of New Uses \ Syntactical Property	Global Integration $r=n$	Local Integration $r=3$	Global Choice $(norm) r=n$	Local Choice $(norm) r=3$
Initial Draft	0.167	0.098	0.082	- 0.102
Developed Draft	0.503	0.408	0.271	0.028

Table 2: Degree of Association

8. Conclusions and recommendations

The spatial configuration of Erbil Citadel has been analyzed and its syntactical properties (integration and choice) defined. The new uses of the initial draft have been classified according to the density of movement sought. Then the degree of association between the syntactical properties and type of allocated new uses of the initial draft has been analyzed as indicator of the extent to which the syntactical properties are considered. The degree of association between the syntactical properties of Erbil Citadel with the recent addition of the circuit route and the types of new uses re-allocated in a developed draft, proposed by the current research, is also measured and then a comparative analysis performed.

From the geometric analysis of Erbil Citadel axial map it is concluded that:

- Two distinct patterns of axial lines, in terms of their length, are picked up. There are a large number of short axial lines covering the Citadel on the global scale. These patterns present a geometric characteristic by which the Islamic City is distinguished (Hillier, 2001).
- Two distinct patterns of axial lines intersections are picked up. There are a large number of intersections in which the axial lines do not continue uninterrupted after the point of intersection. This phenomenon appears in Erbil Citadel on the global level and it also presents a geometric characteristic by which the Islamic City is distinguished. Also, there are fewer intersections of axial lines which continue uninterrupted. This type of intersections appears clearly in the parts of the Citadel which surround the central axis.
- These two distinct patterns of axial lines lengths and of intersection types imply that there are two geometric logics by which Erbil Citadel was formally organized across time. It is believed that these patterns are the consequences of the straight street that penetrated the traditional organic urban fabric of Erbil Citadel in the middle of the 20th century.
- Syntactically, the results of analysis show the clear influence of the break-through street on the spatial configuration of Erbil Citadel. This addition has caused a significant increase in the values of global and local integration, changed the shape of the core of integration in the Citadel, changed the pattern of integration core distribution, and re-distributed the values of global and local choice. However, defining the precise amount of change requires a separate comparative syntactical analysis for the Citadel before and after the addition.
- The analysis shows different patterns of syntactical properties of Erbil Citadel as an Islamic City. As Islamic Cities, the comparison of Hamedan (Hillier, 2001) and Erbil Citadel reveal that the average global integration and connectivity of Erbil Citadel is twice that of Hamedan while the local integration for both cities is approximately the same.

The effects of the Circuit Route to be implemented in Erbil Citadel are generally found to be positive from the syntactical point of view. The results reveal the following conclusions:

- The average global and local integration are both increased. This is expected to benefit the adaptive re-use of the Citadel. It makes it more globally and locally accessible.
- There is no-increase in the global choice as the averages of this measure in the initial draft and the developed proposal are the same. By contrast, there is a decrease in the average local choice. This situation is to be reviewed to pick up the possible solutions.

Assessment of the association between the syntactical properties of Erbil Citadel and the new uses allocation in the initial draft shows reveals the following:

- Weak association exists between the global integration, local integration and global choice and the type of new uses allocated. The direction of association is positive.
- Weak association exists between local choice and the type of new uses allocated but the direction of association is negative. This means that the new uses allocation isn't supported by this syntactic property.

Assessment of the association between the syntactical properties and the new uses re-allocated in the developed draft proposed by this research reveals the following:

- There is an increased degree of association between the measure of global integration, local integration and global choice, and the type of new uses re-allocated. The amount of increase is about 3-4 times. Also, the direction of association is positive.
- The results show weak associations between the measures of local choice and the type of new uses re-allocated. However, it is important to note that the direction of association for the developed draft is reversed, as compared to the initial draft.
- In order to re-allocate the new uses in the developed plan, the percentages of the new uses in the initial draft are fixed to carry out the analysis. However, in order to increase the degree of association the percentages of the new uses are to be revised.
- The results of syntactical analysis show that investing the syntactical properties in the new uses re-allocation is to be treated on two levels. When the task is related to re-allocating the new uses on the global level, the properties of global integration and global choice are to be invested in assigning predominant new uses to specific parts of the urban fabric of Erbil Citadel. When the task is related to re-allocating new uses on the local level, the properties of local integration and local choice are to be used to assign the new uses within specific part of the urban fabric; thus, the possibility of achieving mixed new uses.
- Finally, the degree of association between spatial configuration in term of its syntactical properties and the new uses allocation can be increased, to a considerable extent in an intentional re-allocation process. This is achieved by investing those properties as criteria to evaluate the initial plans of new uses on the one hand, and the other hand they can be used as guidelines to direct the re-allocation process to achieve a more appropriate adaptive re-use. Therefore, it is recommended to specify the syntactical properties of urban settlements and Erbil Citadel specifically as an important part of the stages of analysis, synthesis and evaluation within the process of planning and design for adaptive re-use.

References

- Al Ghatam, W. (2012), Cultural Movement Patterns and Social Implications in Space of Villages Absorbed by Cities in Bahrain. In: Greene, M. Reyes, J. and Castro, A. (eds.), *Proceedings of the Eighth International Space Syntax Symposium*, Santiago de Chile: PUC, 8210.
- Australia ICOMOS. (2000). The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance 1999, Burwood: Australia ICOMOS Incorporated.
- Brooker, G. & Stone, S. (2004). Re-reading: Interior Architecture and the Design Principles of Remodeling Existing Buildings, RIBA Publishing.
- Charlambous, N., Mavrido. (2012). Space Syntax: Spatial Integration, Accessibility and Angular Segment Analysis by Metric Distance (ASAMed). In Hull, A. Silva, C. & Bertolini, L. (eds.) *Accessibility Instruments for Planning Practice*. COST Office.
- Clark, J. (2013). Adaptive Reuse of Industrial Heritage: Opportunities & Challenges. Melbourne: Heritage Council of Victoria.
- Eyuçe & Eyuçe. (2010). Design Education for Adaptive Reuse. *International Journal of Architectural Research*, Vol.4, Issues 2-3, pp421-423.
- Kubat, A., Rab, S., Guney, Y., Ozer, O., Kaya, S. (2012). Application of Space Syntax in Developing. A regeneration Framework for Sharjah's Heritage Area. In Greene, M., Reyes, J. and Castro, A. (eds.), *Proceedings of the Eighth International Space Syntax Symposium*, Santiago de Chile: PUC, 8040.
- Hillier, B. and Hanson, J. (1984). *The Social Logic of Space*, Cambridge: Cambridge University Press.
- Hillier, B. (2001). A Theory of the City as Object. In Peponis, J., Wineman, J. and Bafna, S. (eds.), *Proceedings of the Third International Space Syntax Symposium*, Atlanta, U.S.A: Georgia Institute of Technology, 02.
- Hillier, B., Penn, A. and Hanson, J. and Grajewski, T. and Xu, J. (1993). Natural Movement: or, Configuration and Attraction in Urban Pedestrian Movement. *Environment and Planning B*, 20 (1), pp. 29-66.
- Li, X. (2005). *Adaptive Reuse in Beijing's Traditional Neighborhoods*, Dissertation, Brandenburg University of Technology: Cottbus.
- Min, K., Moon, J., & Kim, Y. (2007). The Effect of Spatial Configuration on Land Use and Land Value in Seoul. In: *Proceedings of the Sixth Space Syntax Symposium*, In: Kubat, A.S., Ertekin, O., Guney, Y.I.&Eyubolo, E., (eds). Istanbul: ITU Faculty of Architecture 080.
- Ortiz-Chao, C. (2008). Land Use Patterns and Access in Mexico City. *Proceedings of ACSP-AESOP Fourth Joint Congress*, Chicago, Illinois.
- Robert, A., Young, PE., Michael, M., Woods, A., Monsos, M., and Julie, W., RA, (1998). Reference Guide to Army Adaptive Reuse Projects. U.S. :Center for Architectural Studies, University of Utah and Army Construction Engineering Research Laboratories.
- The Royal Australian Institute of Architects, (2004). *Adaptive Reuse: Preserving our past, building our future*. Canberra: Department of the Environment and Heritage.
- Wilkes, J. (ed), (1998). *Encyclopedia of Architecture, Design, Engineering & Construction*. New York: John Wiley & Sons
- Yıldırım, M. and Turan, G. (2012), Sustainable development in historic areas: Adaptive re-use challenges in Traditional houses. Sanliurfa: Habitat International, journal homepage: www.elsevier.com/locate/habitatint36 Habitat International 36, pp 493_503, Turkey.