

APPLICATION OF GIS WITH TYPOLOGY IN URBAN REGENERATION PROCESS

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ABSTRACT. *Addressing urban regeneration in a compact urban environment is a complex task which requires a set of systematic guidelines with efficient visual tool. Literature review was carried out to establish a type model structure suitable for the urban condition of the study subject. Observation and data collection process were carried out to allocate environmental information and build facade features. Geographic information system (GIS) was used to efficiently manage database and map out the building environmental features to serve as a visual reference tool. Together with existing building regulations and urban design policies set out by the government, control guidelines could be formulated according to building regulation and the ultimate urban development vision of the local community. Results of the study can serve as a sufficient reference tool to assist design decision making in the urban regeneration process.*

Keywords: Typology, Design guidelines, Urban regeneration, Geographic information system (GIS)

1. Introduction.

1.1. Background and motivation. Development of urban environment was growing fast in Taiwan. With the enormous energy consumed inherently in the construction of buildings, significant pressure for a shift of consciousness in the construction industry is evident. A sudden increase in the topic of urban regeneration has emerged in an attempt to facilitate the sustainable management of the existing built environment and to maximize the efficient usage of existing urban resources. Addressing urban regeneration in an old town district of a compact urban city is a complex task, which involves consideration of many interconnected issues building activities, maintaining cultural identity, enhancing social diversity, sustaining economic viability, and creating community development and participation. Santos et al. applied building typology identification to supporting risk mitigation for the old city centre of Seixal in Portugal [1]. Tsou et al. investigated the effect of urban regeneration progress on thermal behaviour of the built environment [2]. In Rich's study, GIS tool has been used to guide urban revitalization process [3]. Tsai and Huang have applied the concept of type control in the urban regeneration process [4]. Consequently, the subject of urban regeneration and sustainable development with regard to the existing building fabric requires a systematic data management structure and effective reference tools.

Contemporary planning theory evolves towards planning through communication and debate [5]. The changes in real urban environment are preceded by creation of the coherent vision of what is planned [6]. Public participation has been recognized as a desirable element of the planning process, but traditional consultation and communication methods have not always been very efficient in representing it to the local community. Visual communication is a well-established method in attempts to overcome this barrier, particularly

tools based on the GIS database [7]. However, relatively little research has been done to investigate how this visual tool could be used in processing environmental building features and developing references for public participation. This research incorporated GIS software to create, manage, analyze and visualize environmental building data for the decision making process in urban regeneration.

1.2. Research objective. This study attempts to establish a type model framework for urban regeneration or sustainable urban development projects with regard to existing building environment. Literature reviews and documentation analysis were first carried out to establish the basic construct type model and principles for the study district. GIS tool was incorporated to efficiently manage the building environmental database and to map out the existing type feature conditions to serve as a visual reference decision making tool during the urban regeneration process.

1.3. Research subject. This research selected the old town district of Hsinchu City to be the study subject. The old town district of Hsinchu City is the location of city's earliest urban settlement; up till today, it still hosts most of the daily activities of the local people with the most important local religious temple located at the centre of the district. The area has a mixture of historical and modern buildings with diversity of building functions. Within the city itself, this district retains the greatest amount of traditional city fabric and historical architectural texture which is designated by the city government as the major tourist attraction area. However, with the existing staggered buildings, narrow and dark streets, a major urban regeneration process is inevitable to efficiently reshape the urban image.

2. Method. The research framework of the study was primarily set up with the concept of typology targeting the design guidelines addressing the regeneration district within an urban area. Through literature reviews, the theory of type control was understood and the method of operation and the systematic structure of the implementation process were set out. Systematic classification was carried out to formulate four main types of the building environmental feature to describe the architectural features within the urban environment. Type model structure for the building environmental feature is listed in Table 1. Observation and data collection processes were carried out to allocate types of building environmental feature of the study district. The collected data was inputted into GIS software with the map overlay function to systematically represent the existing building condition of the study urban environment.

TABLE 1. Type model structure for the building environmental feature

Main Type	Sub-Type	Sub-Type Feature	Main Type	Sub-Type	Sub-Type Feature
1. Envelope & Volume	1.1. Basic Elements	Style	2. Building Height & Skyline	2.1. Building Height	
		Shape		2.2. Orientation	
		2.3. Landmark			
	1.2. Geometry Vocabulary	Building Base	3. Setback & Building Line	3.1. Length Ratio	
		Rooftop		3.2. Area Ratio	
		Elevation	4. Exterior Attachment	4.1. Advertisement	Size
		Color			Color
	Material	Location			
	1.3. Composition Style	Opening Ratio			Style
		Function		4.2. Canopy	
		Configuration		4.3. Additional Equipment	

2.1. Typology. According to the Oxford Advanced Learners Dictionary of Current English, the word “typology” is explained as to distinguish between different types of type system [8]. On linguistics, biology is concerned, Croft [9] pointed out that “typology” can be roughly considered as synonym of taxonomy and classification. It is a study that classifying phenomenon into various types. In the field of architectural discourse, in terms of typology, it is defined as a way of understanding and thinking. In the eighteenth century, building typology is recognized as the method of a continuous and uniform system for the classification process for architectural building. According to M. Bandini [10], the concept of typology can be summarized as three aspects: the first one to be the method of city reading which emphasizes the integrated nature of the city and explore the morphology of city with the building types; the second aspect is concerned with the cultural perspective represented by G. Argan which addresses urban typology as a method consists of various city architectural styles; the third aspect, directed by Quatremere de Quincy and represented by O. M. Ungers and others, defines typology as the production tool and production theory of architecture.

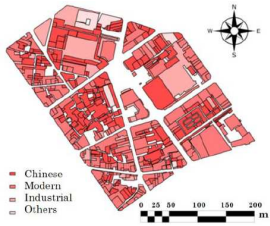
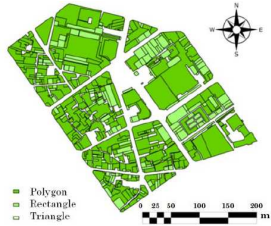

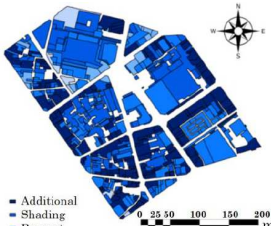
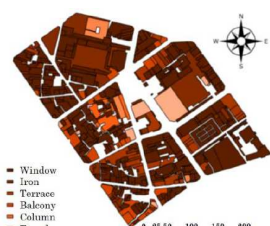
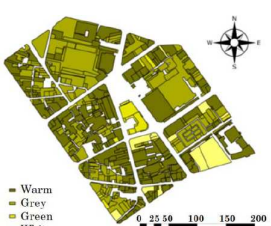
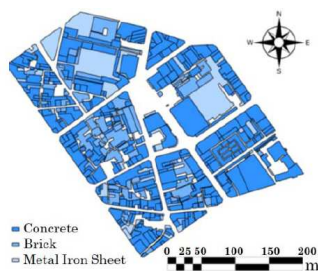
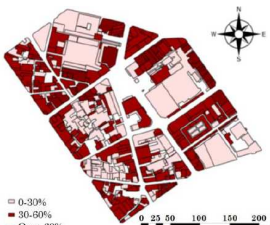
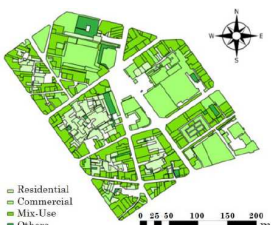

Since one type only requires one property, typology can be used in a variety of variables under various circumstances. In typology, a special order can be derived based on the research purpose and the research phenomena, and this order is able to set limitation on the methods of data interpretation. In terms of research, typology is an important concept; Johnson and Christensen [11] defined this concept as a classification system that splits something into a number of different types or kinds. Grix [12] refers to the concept as dividing the study objects into many types, where the attributes of each of the type are mutually exclusive to each other but together as an exhaustive system. Through a packet classification process it is to describe empirical phenomena. Without much explanation, it can be used as the preliminary research work in theory establishment, developing limited relationship between various phenomena in contribution to the demonstration and exploration of specific theory.

2.2. Application of GIS data input. The research employed the theory of typology to layout type model structure for the urban regeneration process. GIS software was used to construct the urban environmental database illustrating the existing condition of the study district. Different colours were used to represent different “sub-types” or “sub-type features” of the data information. The map overlay function was used to display different “feature types” underneath each “sub-type feature” which was represented by various levels of shades of the selected colour. This “level of shade” and map overlay method can later be used in representing different hierarchy levels, control strengths or characteristic types in setting out the control type design guidelines.

3. Results. The existing urban environmental features of the study district were input into GIS according to the developed type structure as shown in Table 1. The third main type, “Setback & Building Line” of the building feature was omitted in the data collection and data input process since the existing building environmental condition of the study district does not have such feature. Same as the “Exterior Attachment” type in regards to three sub-type features of the “Advertisement” sub-type and the “Additional Equipment” sub-type.

3.1. Main type 1: Envelope & volume. There are three sub-types under this type category. The first sub-type is the “Basic Elements” type which has two sub-type features as “Style” and “Shape”. In the “Style” sub-type feature, four shades of red represent *Chinese*, *Modern*, *Industrial* and *Other* building style mapped out from dark to light accordingly. The dark green in the “Shape” feature represents the basic element of the building’s envelope and volume is *Polygon* shape. The middle shade of green represents

TABLE 2. GIS mapping of the “Envelope & Volume” main type

Main Type: 1. Envelope & Volume		
Sub-Type	Sub-Type Feature	
1.1. Basic Elements	 <p>Style</p>	 <p>Shape</p>
	 <p>Building Base</p>	 <p>Rooftop</p>
1.2. Geometry Vocabulary	 <p>Elevation</p>	 <p>Colour</p>
	 <p>Material</p>	
	 <p>Opening Ratio</p>	 <p>Function</p>
1.3. Composition Style	 <p>Configuration</p>	

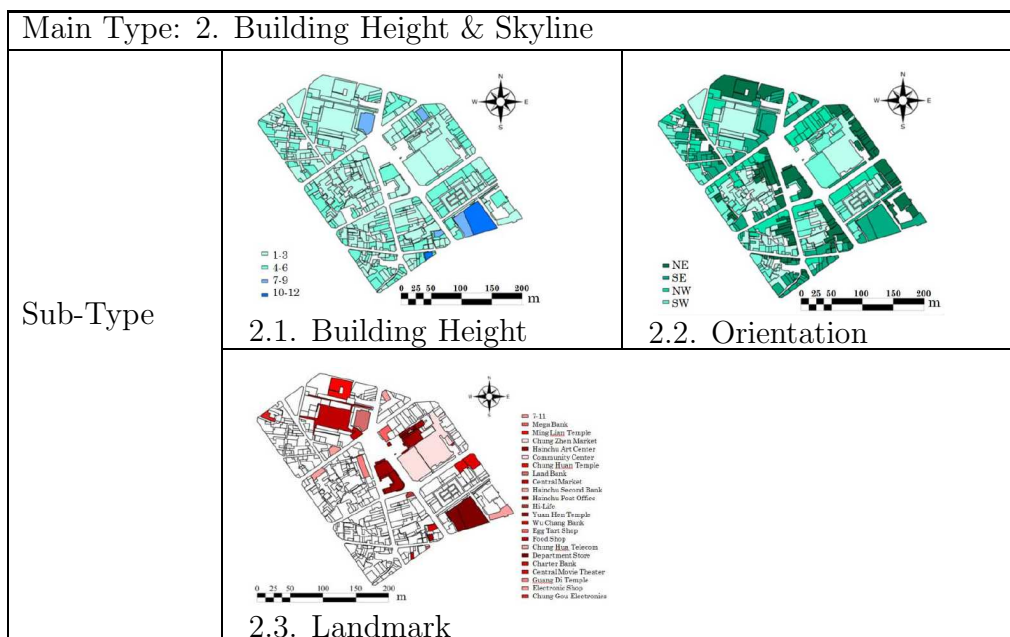
Rectangle shape and the Triangle shape is represented by the lightest shade of green, as shown in Table 2.

The second sub-type under the main type of “Envelope & Volume” is the “Geometry Vocabulary” sub-type, which has five sub-type features as “Building Base”, “Rooftop”, “Elevation”, “Colour” and “Material”. In the “Building Base” sub-type feature, four shades of brown represent *Residential*, *Commercial*, *Street Vendor* and *Office* function of use for the first floor of the building from dark to light accordingly. In the “Rooftop” sub-type feature, three shades of blue represent *Additional Construction*, *Roof Shading* and *Parapet Wall* of the existing building condition from dark to light accordingly. The “Elevation” sub-type feature is further classified into seven feature types as *Window*, *Corrugated Iron*, *Flower Terrace*, *Balcony*, *Decorative Column*, *Temple* and *Others* from dark brown to light brown accordingly. The feature of “Colour”, in response to the study district’s local identity as *Warm Colour Tone*, *Grey Shade*, *Green* and *White* colour type is listed and represented by green colour in the GIS mapping from dark to light accordingly. The last sub-type feature in the “Geometry Vocabulary” sub-type is “Material”, where three shades of blue represent *Concrete*, *Brick* and *Metal Iron Sheet* building material from dark to light accordingly, as shown in Table 2.

The last sub-type under the main type of “Envelope & Volume” is the “Composition Style” type which has three sub-type features as “Opening Ratio”, “Function” and “Configuration”. In the “Opening Ratio” sub-type feature, three shades of red represent *Over 60%*, *30-60%* and *0-30%* façade opening ratio of the existing building condition from dark to light accordingly. Four shades of green were used to represent *Residential*, *Commercial*, *Mix-Use* and *Others* building function from light to dark. In the “Configuration” sub-type feature, four shades of purple represent *Single*, *Street-Side*, *Semi-Detached* and *Single-Storey* building composition from dark to light accordingly.

3.2. Main type 2: Building height & skyline. The second main type of the building environment feature is “Building Height and Skyline” which has three sub-types as “Building Height”, “Orientation” and “Landmark” with no sub-type feature, as shown in Table 3. In the “Building Height” sub-type, four shades of green-blue were used to represent *10-12*, *7-9*, *4-6* and *1-3* floor height of the existing buildings in the study district from dark to light accordingly. Four shades of green in the “Orientation” sub-type

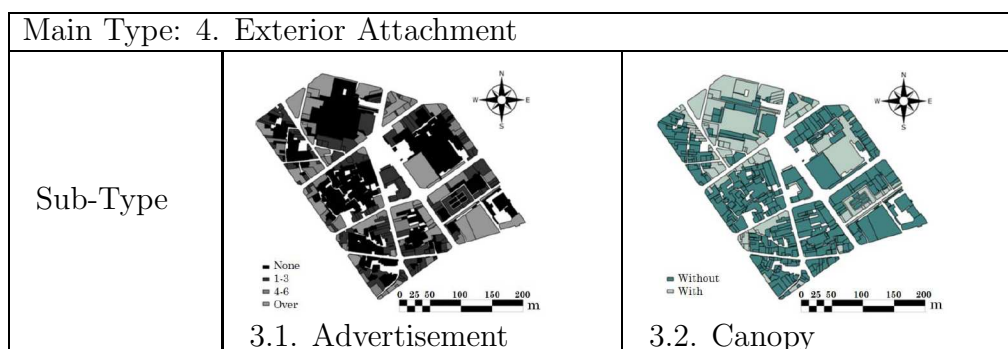
TABLE 3. GIS mapping of the “Building Height & Skyline” main type



represent *North-East*, *South-East*, *North-West* and *South-West* orientation of building's front elevation from dark to light accordingly. In regards to the "Landmark" sub-type, twenty-three different shades of red were used to represent different existing landmarks within the study district.

3.3. Main type 4: Exterior attachment. The last main type of the building environment feature is "Exterior Attachment", which has two sub-types as "Advertisement" and "Canopy" with no sub-type feature, as shown in Table 4. In the "Advertisement" sub-type, four shades of black were used to represent *None*, *1-3*, *4-6*, and *6 or Over* numbers of advertisement board on the building façade from dark to light accordingly. Two shades of green were used in the "Canopy" sub-type to represent either the building is equipped *With* (light green) or *Without* canopy (dark green).

TABLE 4. GIS mapping of the "Exterior Attachment" main type



4. Conclusions. The study established a systematic type model structure describing the building environmental feature with the concept of typology which can be integrated in the future research with city's urban development plan and existing local building regulations to formulate design guidelines for the specific community. The visual reference tool developed in this study could serve as a future reference for Hsinchu City government as design guidelines for specific regional planning policy to maintain the characteristic of local building style in the process of urban regeneration. In addition, the urban environmental analysis of this study could serve as a reference for future researches in the field of environmental management when dealing with both historical and modern urban district.

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