Change in Urban Form: Approaches for Assessment and Analysis in the Temple Cities of India

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Abstract— The paper attempts to explore the methods for quantitative assessment of change in urban form, specific to the context of Temple cities of India. The various theoretical approaches to studying urban form were reviewed for suitability to quantitative assessment and cognitive- aspect analysis approach was found suitable. Critical review of empirical research papers along this perspective was done and aspects and indicators relevant to the context of Temple cities of India were identified. The measurable indicators of change in urban form have been identified from existing literature at three scales – city, area and street level. At the city/area level, indicators have been identified for six aspects of urban form - urban expansion, population density, uniformity in population density and distribution, land utilization, mixing of land uses and accessibility of transport infrastructure. At the street level, the indicators were identified for four aspects of urban form – density, function, height and perception. The aspects and indicators are listed in a comprehensive matrix; for aid in quantitative assessment of change in urban form. The matrix proposed in the paper could help future empirical studies on change in urban form in Temple cities of India.

Keywords — Urban form, Quantitative analysis, Temple cities, Typological analysis, Temporal change

1 Introduction

Urban form is the construction of the city over time [1] and it changes in order to adapt to changing socio-economic conditions [2]. Urban form in all cities undergoes change, but certain cities witness rapid change. Historic urban areas most often witness rapid change due to the pressures of tourism-induced urban growth [3]. Most often such unplanned development generates chaos [4]. Research studies on quantifying the change in urban form are relevant in this context as the findings could help address the urban issues arising due to the change. It is further stated that "various studies reinstate the need for development of consistent relationships between urban form studies and urban planning policies" [5]. Hence it is necessary to initiate more research on change in urban form for translation of findings to future urban planning policies. A major constraint in initiating such studies could be a lack of a systematic approach to quantify the change. Studies have addressed various fragmented dimensions of change in urban form like - urban sprawl at a metropolitan level [6], [7], [8]; relationship between form and quality of life at a sub-metropolitan level [9] and imageability at a community level [10]. However, methods for quantitative assessment of change at a city and area level and not restraining to a single aspect of urban form need to be explored.

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This paper attempts to address this gap in literature by identifying aspects and its indicators of change in urban form. The study involved exhaustive review of the theoretical approaches and relevant research studies, to arrive at a set of aspects and measurable indicators. The aspects and indicators are listed in a comprehensive matrix; for aid in quantitative assessment of change in urban form. The matrix and methodology proposed in the paper could help future empirical studies on change in urban form in Temple cities of India.

2 Urban form

2.1 Definitions

Urban form has been defined along different perspectives since 1960s. One of the earliest attempts was by Rose. A., through her book in which she defines urban form as "the arrangement of large functional units of a city, defined by the spatial patterning of land uses and levels of residential density" [11]. This definition focuses on the spatial pattern as well as distribution of functions. Another definition stemming from sociological perspective is the one suggested by Castell in his book published in 1983. According to him, "urban forms are produced by the interactions between space and society, the relationship between human consciousness, matter, energy and information" [12]. A more recent attempt focusing on the temporal change defines it as "the morphological attributes of a city at all scales" [13]. Studies focusing on the historical evolution of cities, defines the study of urban form as "analysis of a city's evolution from its formative years through subsequent transformations, identifying and dissecting its various components" [14],[15],[16]. It can be seen from these definitions that the focus varies broadly across three major realms - history,

society and built form and its temporal variation. Segregated views along one of these perspectives have its limitations, as the form of the city is an aggregate of all these and is perceived as a whole. At this juncture, it is worthwhile to note the definition put forth by Aldo Rossi, as he attempts a relative holistic definition.

Aldo Rossi in his book, 'The Architecture of the city' defines urban form as "the construction of the city over time including aesthetic intention and creation of better surroundings for life" [1]. His idea of 'architecture of the city' as "the city is a gigantic complex piece of architecture growing over time as well as urban artifacts characterized by their own history and form" integrates history, built form and its temporal variation; and the emphasis on creation of better surroundings for life, brings in the societal aspects as well. He explains two levels of analysis for the study of urban form – morphology and typology, the former being the description of the form of an urban artifact and the latter as the structuring principles located in the transformation and adaptations of forms of habitation [1]. Rossi's definition was hence adopted for the study and the case study involved analysis of morphology and typology with consideration to history, society and built form and its temporal variation.

2.2 Theoretical approaches to studying urban form

The various theoretical approaches to studying urban form were reviewed for the suitability to the research study. As per a paper published in 2005, theoretical approaches could be mapped in a Cartesian grid with distinction made between broad typologies [17]. This was adapted and used for the study in listing the theoretical approaches to studying urban form. The different approaches to study of urban form studied were classified as whether they are cognitive or normative. Cognitive approaches are those that tend to explain the existing urban form whereas normative as those which prescribe a good city form. The approaches were further classified as those that include analysis of aspects or segregated elements of form and those which include process analysis where form is considered as a product of interrelated processes. The mapping aided a systematic understanding of the approaches in terms of suitability for the research study.

The cognitive-aspect analysis involving theoretical views on understanding the urban form by analyzing segregated aspects at different scales was found to offer a sound theoretical base for quantitatively measuring temporal change in urban form. The ideas integrating history, society, built form and its temporal variation, help in the understanding of the morphological evolution and analysis of change in aspects at a city/area scale. Along this theoretical perspective, the works of MRG Conzen in 1950-60s can be considered one of the pioneer works in study of urban form. The description by Whitehand, 2001 of Conzen's concepts, detailed the concepts with examples of current research grounded on the same. Conzen's concepts include the tripartite division of the townscape into town plan, building fabric and land utilization; the three scales at which the urban form of a city can be studied. He also puts forth the concept of 'morphological region', a region with similarity in built form which can be identified at different scales [18]. This approach is often referred to as the Anglo German approach to morphology and it focused on the geographical and spatial aspects of urban form. The limitations of this approach, included form being treated as a static entity and the temporal dynamics neglected.

Another major contribution was that of Saverio Muratori in the same period, to the development of concepts in urban morphology and studying the transformation of urban form over years. Muratori pioneered what later became popular as the Italian school of urban morphology with the focus on temporal variation of urban form; which was depicted through the evolving urban form of Venice, across three time periods. He elaborates the concept of 'type', which is similar to the morphological regions of Conzen; but with the focus more on the temporal change. In 1979, Gianfranco Cannigia simplified and highlighted the operational aspects of Muratori's concepts of 'type'; and his studies were carried forward further by Gian Luigi Maffei [19]. Lovra states that the spatial correlation between buildings and temporal dimensions were considered in these studies [20]. The two levels of analysis – morphology and typology, suggested much later by Aldo Rossi [1] can be considered a systematic combination of the Conzen- Muratori approaches.

Parallel to these schools of urban morphology in Europe, in America, there evolved several approaches which focused more on the human perception of urban form and study of elements. Kevin Lynch who was an early proponent of mental mapping in urban form studies had his ideas rooted on the belief that perception of the urban space is fragmentary and the image of the city is a composite of distinct elements. Lynch's ideas focus on the perception of the physical form of the cities and how each person constructs his or her own image of the city. The collective grouping of all of these mental constructions would give what could be the image of the city. He details the five elements of city form as paths, edges, districts, nodes and landmarks [21].

Spreiregen later supported Lynch's ideas in his book; and elaborated the aspects of urban form as urban shape, pattern, grain, size, density and texture, which he stated as the primary aspects of solid form- the building masses of the city [22]. His contribution to the study of urban form included various concepts like shape, urban pattern, grain and texture. The possible shapes of cities were explained by him, with radio centric being suggested as the most frequently found shape. Pattern is explained as the basic layout of blocks and streets and its geometry. Grain is detailed as the degree of fineness and coarseness of the urban fabric; such that when there are small buildings in small plots with streets promoting cross use

it can be termed as a fine grain and vice versa. The concept of a fine grain being 'desirable' was also suggested by Jacobs earlier in 1961 where she suggested that short size of blocks promoting greater cross-use in a neighborhood is needed for ensuring diversity in cities and hence a good urban form [23]. Texture was explained as a term used to explain the mixture or uniformness of built form aspects; such that even if a region has fine grain, it can be uneven texture and vice versa. Spreiregen further suggest the use of sketch maps for street level study of urban form. He defines it as those "produced by the "man on the street" to discern the urban features and forms prominent in the public's eyes" [22].

Aldo Rossi as discussed earlier defined urban form as "the construction of the city over time including aesthetic intention and creation of better surroundings for life"[1]. Besides explaining the two levels of analysis – morphology and typology, he also introduces the idea of 'type' which is a permanent and complex logical principle that is prior to but constitutes form and explains it as "the persistence and change evident in the physical fabric of the city as an artifact in time"[1].

Hillier and Hanson in their book 'The Social Logic of Space' suggests a new configurational theory of space as an important aspect of social life [24]. With space syntax analyses, spatial configuration could be described or analyzed as a set of lines that represent uninterrupted movement and visibility [25]. These linear representations or 'axial maps' showing spatial configurations was related with the distribution of movement patterns and has been widely used in empirical studies of city form since then [24]. More recently, Karl Kropf concludes on the 11 aspects of urban form as -site/environment; built form; social and economic context/local culture; Function/ use/ activity; control; intention/ design; construction; perception; natural - sunlight, wind, water; human - the movement of goods, information, energy, waste; and change/ development [26]. In the same year, Dempsey lists the five elements of urban form as – land use, density, housing, layout and transportation infrastructure [27].

Lynch's ideas of the perception of urban space being fragmentary, forms the basis for the segregated aspect analysis approach is taken for further study. Conzen's idea of studying the city at three scales and Muratori's studies on temporal change broadly guides the formulation of the aspects and indicators. As suggested by Rossi, the study should involve morphological and typological, analysis –morphological analysis at a city and area scale and typological analysis involving the study of temporal change in the built form aspects at a street level. Spreiregen's 'sketch maps' form a useful tool for detailed street level study of perceived urban form. Further the concepts of size, density, grain and texture aid can be analyzed to document existing conditions in streets. However, the space syntax studies which fall under this theoretical viewpoint, have limitations in studies involving city/area scale analysis as "axial lines are not a good representation in comparison with natural streets at the city scale" [28] and hence not considered further. Also, the aspects of Kropf and Dempsey though focusing on segregated aspects of form, does not encapsulate the concept of temporal change in urban form. In order to arrive at a list of measurable aspects and indicators, stemming from this theoretical perspective, empirical research papers with aspects relevant to the context were critically reviewed.

3 Context: Temple cities of India

Urban form in all cities undergoes change, but historic urban areas are one of the most affected cities. This is because most often they form cultural tourism attractions and face the pressures of tourism induced urban development [3], [29-30]. Across the world, many historic urban settlements show a planning order that distinctly marks a religious center as the genius loci of urban pattern [31]. In India, "with temples strewn all over the nation" [32], a large number of historic settlements had evolved with a temple as the focal point of urban growth. It is stated in multiple studies that there could be undesirable changes in the urban form of these Temple cities [33-40]. It is hence relevant to study the change in urban form in a Temple city of India and quantitatively assess it at a city/area scale.

From the vast pool of aspects and indicators of urban form that can be assessed at a city/ area and street level, those relevant to the context of Temple cities of India were hence identified. Besides contextual significance, the scope of the selection of aspects and indicators was delimited by constraints of data availability as well.

4 Change in Urban form: Aspects and Indicators

The details of the aspects and indicators selected from existing literature are provided in the matrix presented below.

Table 1- Aspects and indicators of change in urban form

Aspect	Indicator for quantifying temporal change	Brief details of the indicator	Source
City/ area level			
Urban expansion	Compactness ratio	The total urban area divided by the area of minimum circumscribed circle containing the urban area periphery	[41-42]

Uniformity in population density and distribution	Lorenz curve and Gini coefficient for uniformity in population distribution	Lorenz curve represents the cumulative percentage of population in a district against cumulative percentage of population of that district in the city; Gini coefficient is the area enclosed by the Lorenz curve and 45^0 line	[43-48]
	Spatial distribution of population density	The zone wise distribution of population density	
Land utilization for buildings	Land absorption rate	Total built up area of a zone divided by population	[49-52]
	Grid wise distribution of building footprint density	Percentage of building footprint within in each grid	[46], [53-54]
Mixing of land uses	Mixed Land use Index	Percentage of residential to other use, variation from 50% (optimal)	[48], [50]
Accessibility of transportation infrastructure	Change in road network density	Paved road area per capita	[41], [50]
	Change in access of bus stops	Percentage of households that fall in 400m circle of bus stops	[44]
Street level			
Density	Change in presence of buildings along street segment	Number of buildings along the street ; Built front ratio = percentage of street edge lined by buildings	[55-56]
Diversity	Building use changes/ density of use changes in the street	Number of use changes in the street segment/ length of street segment	[57]
	Built form conversions and modifications	Number of building modifications along the street segment/ length of street segment	
Height	Building height changes visible along streets	Change in front height = average height of buildings along street segment (percentage)	[51], [55-56]

5 Discussions

The matrix proposed in the paper could help future empirical studies on change in urban form in Temple cities of India. The process involved rigorous and systematic review of literature done to arrive at the list of methods. This process can be adapted and used for research studies in order to arrive at indicators of urban processes. The aspects and indicators formulated are useful for further empirical studies involving analysis of urban form and its changes at a city/area level. The aspects are also useful in exploratory analysis of urban form in cities. However, since urban form is also dependent on many social and cultural aspects, the results if not supplemented with a morphological evolution of the city as well as inputs from an exploratory study, may not give a clear understanding of the specific context. The study of these aspects and indicators would help quantify the temporal change and give a fairly holistic picture of change in urban form at a city, area and street level.

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Declaration of conflict of interest

The authors declare that only the authors have contributed academically to the contents of the paper.

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