

ANALYZING THE COMBINED INFLUENCE OF ACCESSIBILITY AND CAPACITY OF ROADS ON URBAN DENSITY, LAND USE MIX AND VITALITY

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ABSTRACT - Research focuses on analyzing the factors behind the change of urban form and its relationships. The main four urban form elements are recognized as Road network, land use mix, density and vitality based on natural movement and Transport land use feedback theory. A Road network is a combination of accessibility and capacity of the road, which can be referred as topological and mobility characteristics. Planners have identified theories and relationships, but never captured the combined influence of topological and mobility parameters of the road networks. It is required to analyze and quantify the Combined Influence of Accessibility and Capacity of Roads on Land Use Mix, Urban Density, and Vitality to identify the behavior of the urban form. This research was conducted in Colombo, Kurunagala, and Mawanlla. Results reveal the combined influence of accessibility and Capacity of roads to change land use, density and vitality. MATLAB 3D graphs, SPSS regression correlation analysis have been used to model real ground data. Cities have been tested for Accessibility and Capacity of road parameters. The study has recognized that the influence of accessibility varies from 50% - to 60% and the influence of the Capacity of Roads varies from 30% – to 45%. The study can be used for local and urban planning and will be a guide for preparing future plans and regulations.

Keywords: Accessibility, Capacity of Roads, Urban Density, Land use Mix and Vitality.

1. INTRODUCTION

“Urban form is changing temporally, but it is more important to find some logic to explain the factors behind this change and relationships to manage better city order” (Bandara & Munasinghe, 2007). “Urban form is the spatial characteristics that is created by built-up areas, including the shape, size, density, and configuration of settlements (Batty, 2007; Pinto & Antues, 2007; Ye, Yeh, Zhuanga, Nes, & Liu, 2016; Ye & Nes, 2014). Road network is an essential component that interacts with urban form elements (Chaudhuri and Clarke, 2015) and an integral part of any human settlement, facilitating the movement of people, goods, and information. Urban street network has two components as topological properties and geometric / mobility properties (Hillier 2001/2).

There are studies which investigate the relationship between Topological Accessibility on land use, density and vitality. Another set of studies investigate on Capacities of roads / geometric properties on land use density and vitality. However, none or very limited studies have attempted to investigate the combined influence of topological accessibility and capacity of roads. In addition, these studies have been identified as isolated relationships in topological accessibility and land use, topological accessibility and density, topological accessibility and vitality, but accessibility influence on land use, density, and vitality combined impact has not been studied (Bafna 2003; Batty 2004; Webster 2010; Hillier et al. 2010). Although the influence of capacity of road infrastructure studied individually on land use, density and vitality separately, but not studied combined impact (Hillier & Iida 2005, Hillier (2010) and Porta et al. (2011). Some of the studies have identified the relationship between accessibility and vehicular movement, as well as accessibility and pedestrian movement. Another set of studies had identified the relationship between the capacity of roads and vehicular movements and pedestrian movements individually (Smith et al. 2015).

Though there were previous studies on individual influence of accessibility and capacity of roads on vehicular and pedestrian movement, the combined influence of accessibility and capacity of roads has not been investigated. According to the above-identified research gaps and limitations, this proposed study will investigate and conceptualize the combined influence of accessibility and capacities of road infrastructure on land use mix, urban density, and vitality.

Objective

To explore the combined influence of accessibility and capacity of road infrastructure (Roads and sidewalks / walking paths) on land use mix, urban density and vitality

2. METHOD

A series of urban planning literature explains the measuring approaches for accessibility, capacity of road infrastructure, land use mix, urban density and vitality. The area in Colombo was divided into 389 sample segments, Kurunagala was divided into 235 sample segments and the Mawanalla was divided into 102 sample segments by completing a database for each city.

Parameter	Measure	Source
Accessibility (Freeman, 1978)	Closeness Centrality (Global and Local integration)	Prepared by author
Capacity of road (Alejandra, 2004)	Road Widths and Walking path widths	UDA Data Base and Prepared by Author
Land use mix (NES, Pont, & Mashhoodi, 2012)	Mix use index / entropy index	UDA Data bases Kurunegala transport plan, Mawanalla bus terminal project
Urban Density (Bahadure & Kotharkar, 2015)	Space matrix (FAR, Building Height, Plot Coverage)	UDA Data base, Kurunegala transport plan data, Mawanalla bus terminal project
Vitality (Yue & Zhu, 2019)	Traffic Volume and Pedestrian Volume	JICA, Kurunegala transport plan data, Mawanalla bus terminal project

3. RESULTS AND ANALYSIS

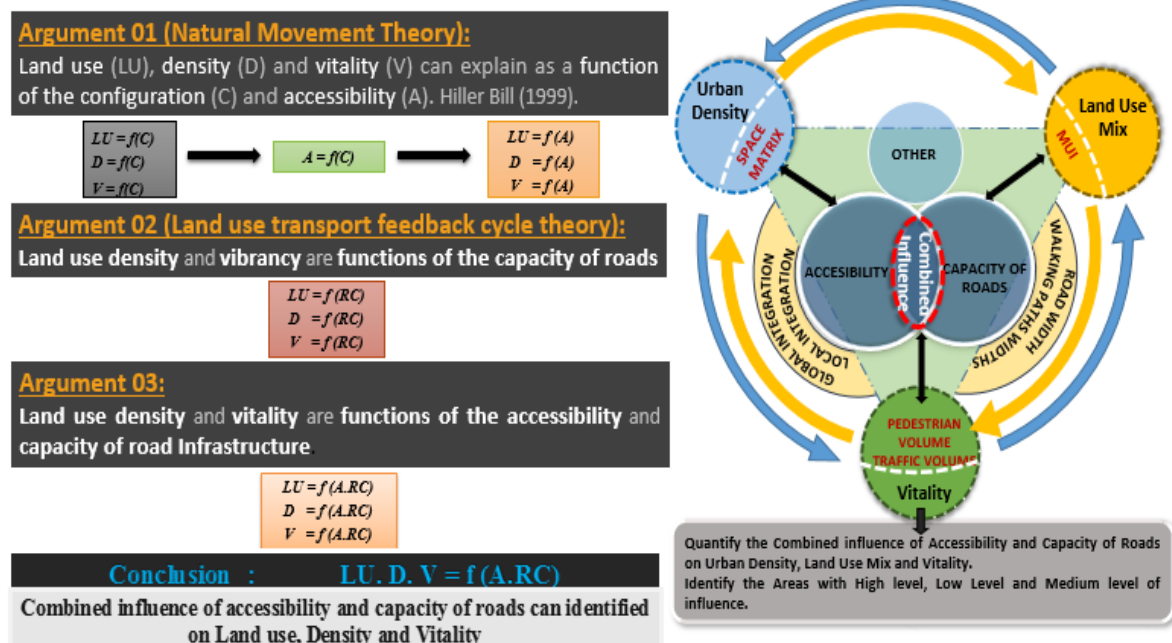


Figure 1. Arguments and Conceptual Framework

Accessibility and Capacity of Road parameters work as a guide of the land use mix, urban density, and vitality of the urban form. Change in a single unit of Road Network will increase accessibility and capacity of the roads, and will also influence the change in land use and density vitality at different degrees. Influence of accessibility is in the range of 50% to 60% in all cities and influence of Capacity of roads is in the range of 30% to 45%.

Summary of influence by Accessibility and Capacity of roads	Land Use Mix			Density			Traffic Volume / Pedestrian Volume		
	Colombo	Kurunagal ^a	Mawanalla	Colombo	Kurunagal ^a	Mawanalla	Colombo	Kurunagal ^a	Mawanalla
	Global Integration	41%	33%	34%	39%	41%	38%	38%	31%
Local Integration	16%	17%	21%	16%	14%	18%	20%	21%	24%
Accessibility	57%	50%	56%	55%	55%	57%	58%	52%	59%
Road Widths	32%	25%	27%	34%	35%	29%	30%	27%	27%
Walking P/Widths	11%	15%	17%	11%	9%	11%	10%	10%	10%
Capacity of roads	43%	40%	43%	45%	44%	40%	40%	38%	37%
Combined influence	100%	90%	99%	100%	99%	97%	98%	90%	96%

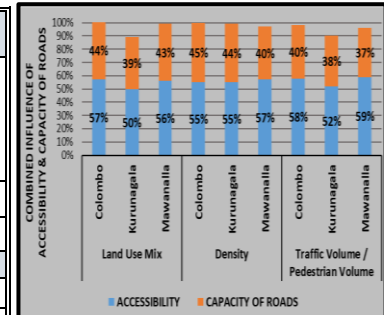


Figure 2. Summary of influence by accessibility and capacity of roads

Accessibility and Capacity of road parameters influence the city scale (vehicles) and local scale (pedestrian scale). To assess city scale influence, Global integration and Road Widths were used, and to assess local scale, local integration and walking path widths were used. There is high influence by vehicles within the range of 55% to 80% but the pedestrians influence varies from 25% to 40% on LU, Density and Vitality.

Summary of combined influence on pedestrian and vehicles	Land Use Mix			Density			Traffic Volume / Pedestrian Volume		
	Colombo	Kurunagala	Mawanalla	Colombo	Kurunagala	Mawanalla	Colombo	Kurunagala	Mawanalla
	Global Integration	41%	33%	34%	39%	41%	38%	38%	31%
Road Widths	32%	24%	27%	34%	35%	29%	30%	27%	27%
Vehicles	73%	58%	61%	73%	76%	67%	68%	59%	62%
Local Integration	16%	17%	21%	16%	14%	18%	20%	21%	24%
Walking P/Width	12%	15%	17%	11%	9%	11%	10%	10%	10%
Pedestrians	28%	32%	38%	27%	23%	30%	31%	31%	34%

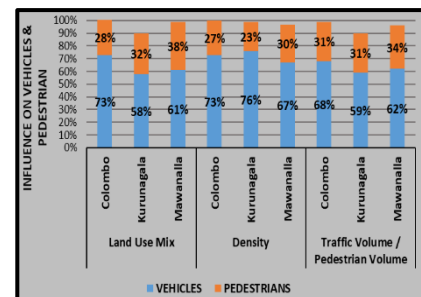


Figure 3. Summary on combined influence on pedestrian and vehicles

4. CONCLUSION AND RECOMMENDATION

As the Contributions to the knowledge and practice, this study has identified the combined influence of accessibility and capacity of roads **on land use mix, urban density, and vitality** and the combined influence of accessibility and capacity of roads **on Pedestrian and vehicular movement**. The study suggests that this combined influence approach might be useful when preparing zoning factors, zoning guidelines, land subdivision guidelines and building & planning regulations. This will also be decision making on local planning and urban land use planning, resilience city planning, and transport planning.

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