EVOLUTION OF URBAN SPACE THROUGH INTERVENTIONS, APPROPRIATIONS AND ADAPTATIONS: A STUDY OF THE POST-HIGHWAY FLYOVER BUILT ENVIRONMENTS IN COLOMBO

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Abstract: The construction of flyovers is a commonly adopted measure to mitigate traffic congestion and improve vehicular movement in urban areas. While this intervention enhances traffic flow, its impacts extend beyond transportation, reshaping the city's spatial structure and the lives of its inhabitants. In turn, the adaptation processes of the inhabitants reshape the built environments leading to a process of spatial transformation. This study explores the process of human adaptation in transforming urban built environments through space appropriation in four highway flyovers, namely, Dehiwala, Nugegoda, Slave Island, and Kohuwala, in Sri Lanka. Positioned on Gibson's theory of Affordances and Lefebvre's Space Appropriation triadic, and using a mixed-method, the evolution of the built environments in those localities is analyzed and discussed as a transactional process between authoritative interventions and the inhabitants' space appropriations to adapt into new situations. The analysis is supported by visibility graph analysis and agent-based simulations. The findings reveal that these elevated infrastructures influence visual connectivity, integration, and movement patterns of the inhabitants. The ground observations also reveal that the inhabitants also adapt to new situations through a variety of responses, including both evading and appropriating the spaces formed by flyover structures to support their daily activities. Thus, the flyover constructions impact not only the traffic flows but also the overall built environments. This research contributes by making the architects, urban designers, engineers, and policymakers aware of the impact of infrastructure projects on shaping urban built environments through processes of decisions, interventions, and interactive behaviors of inhabitants.

Keywords: *Flyovers, Urban Built Environment, Adaptation, Space Appropriation, space syntax*

1. Introduction

The emergence of the "car age" culture during the 20th century marked a significant turning point in the physical transformation of cities. As the automobile industry expanded, urban form and infrastructure were systematically modified to accommodate rising vehicular traffic (Saouma, 2008). This transformation led to the emergence of a variety of road transport infrastructure, ranging from technologically sophisticated freeways, to more localized solutions such as signal light-based traffic control systems to elevated bypasses, commonly known as flyover bridges. Flyovers have been widely adopted to mitigate traffic congestion and to improve vehicular flows in urban areas.

Highway flyovers are generally recognized for their functional endeavor, facilitating uninterrupted vehicular flows by separating crossroad from mainstream traffic, but their influence extends well beyond that, impacting the behavior of the inhabitants, land uses, and the overall spatial structures of respective built environments. Much of the existing scholarship on flyover construction has focused on its functional implications, often evaluated through comparative analyses of pre- and post-construction traffic efficiency, changes in adjacent land use, economic impacts on commercial activities, and interventions designed to reactivate underutilized spaces beneath these structures. While these studies provide important insights, they often overlook the transformation of the overall built environments that follow such interventions. In this background, deviating from the conventional focus on the infrastructure and the traffic flows, this study focuses on the transformation of the built environments associated with the road flyovers. The introduction of elevated flyover structures not only alters the physical configuration of the city but also redefines how space is perceived, navigated, and used in everyday life. The study reveals how challenges and opportunities emerging from the sudden imposition of the flyovers were appropriated by the inhabitants to adapt into new situations, further transforming the built environment.

1.1. RESEARCH PROBLEM

Urban infrastructure has played a significant role in changing the form and function of cities. In rapidly evolving urban areas, highway flyovers have become a dominant strategy to alleviate increasing traffic congestion. Halprin (1966) critically noted that the planning of elevated roadways has historically disregarded urban design principles, leading to visual disruption, spatial fragmentation, and the breakdown of the vibrancy of urban activities.

The challenges are particularly obvious in the city of Colombo, where recent and ongoing flyover constructions are located within dense residential and commercial neighborhoods. This elevated infrastructure has transformed spatial settings, not only vehicle traffic flows, but also residents', vendors', and everyday users' lived experiences. In all situations, the flyovers in and around Colombo seem to have resulted in a mix of positive and negative impacts in terms of traffic flows,

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congestion, and commuter times. Despite the widespread discussions on the technical advantages of improving traffic flows, current planning practices and the broader urban planning and urban design discourse have paid limited attention to their impacts on social interactions, spatial practices, and adaptive responses of the inhabitants in the localities of the flyovers. It is often neglected that this road infrastructure causes a significant impact upon the overall built environment and its evolution.

1.2. RESEARCH OBJECTIVE

In the given background, the objective of this study is to develop a holistic understanding of the spatial transformations brought about by the flyovers. To achieve this, the study aims to:

- Examine the spatial and physical transformations in the built environment caused by flyover construction.
- Explore the experiences, perceptions, and challenges of inhabitants in areas affected by flyovers.
- Investigate the adaptive strategies and spatial practices developed by inhabitants in response to the new urban conditions created by flyovers.
- Interpret how these adaptation and appropriation processes contribute to the transformation of the overall urban environment and social dynamics.

2. Preceding Studies

A considerable number of studies have examined the impact of traffic flyovers in urban areas, both in local and international contexts. Anwari, Hoque, and Islam (2016), for instance, investigated the operational effectiveness of flyovers constructed to bridge railway crossings in Dhaka, Bangladesh. Their study analyzed traffic flow data, speed measurements, and safety assessments, concluding that the flyovers contributed to increased vehicle speeds. However, the researchers also noted that conflicts at grade crossings continued to occur. While their research addressed the social and environmental effects of flyovers on marginalized communities, it did not sufficiently explore how these communities adapt to and repurpose the newly transformed spaces. Rizkiya et al. (2024) examined the economic impact of the Surabaya Intersection flyover in Banda Aceh, Indonesia. Drawing on surveys and interviews with local business owners, they reported that businesses experienced a decline in income following the flyover's construction, despite initial expectations of economic benefits. This highlights the discrepancy between anticipated advantages and the actual outcomes experienced by local stakeholders. Studies have also paid special attention to the 'vulnerable' spaces created by flyovers. For instance, Saouma (2008) examined the potential of converting underutilized spaces beneath elevated highways in Bourj Hammoud, Beirut, into functional public areas. Using field observations and an interactive design strategy, his research emphasized the value of contextual design approaches in revitalizing these residual spaces for community use. Similarly, Abubakr, Elshater, and Fayoumi (2022) observed that the areas beneath flyovers hold the potential to evolve into vibrant public spaces. Their study, which employed qualitative methods such as semi-structured interviews and surveys, revealed that although these spaces are often perceived as neglected, they can be transformed into active urban areas. The research highlighted the role of landscape architecture in urban regeneration but also pointed out the limited community involvement in the design process.

In the Sri Lankan context, studies have primarily focused on functional and economic aspects of the flyovers. Yahampath, et.al. (2014), employing multiple methods, including field observations, interviews, accident data analysis, and before-and-after surveys, analyzed the Dehiwala road flyover, reported that the reduction of traffic congestion at a major intersection and improved road safety. While their findings confirmed that flyovers could enhance traffic flow, they also identified persistent safety issues linked to road geometry and uncontrolled vehicle stops. Similarly, Liyanage et al. (2018) evaluated the Rajagiriya flyover after its completion, using empirical traffic data, to find that traffic volumes increased, yet peak-hour congestion did not significantly improve. Although this study provided important insights into the conventional faulty understanding that flyovers could improve automobile traffic, it lacked a detailed analysis of social dynamics, user experiences, and the lived realities of people directly impacted by them. The literature review reveals that most of the existing studies have focused on traffic flows, safety, the design potential of under-flyover spaces, and economic outcomes. Relatively fewer studies have examined the social dynamics and spatial and behavioral changes that emerge from flyover construction and its transformation of the urban environment. Thus, revealing a knowledge gap on individuals and communities' adaptation processes to new situations resulting from flyovers.

3. The Approach and the framework of the study

In this work, we intend to study on the impact of flyover constructions on the evolution of built environments as a dialectic process between planning and design decisions and the responses of the impacted parties. For this purpose, the necessary conceptual and theoretical underpinning is drawn from the paradigms of environment-behaviour research. Gibson's (1979) theory of Affordances and Lefebvre's (1991) the Space production triadic provided the conceptual framework for the study. The theory of affordances emphasizes the adaptability of human behavior in response to environmental changes. While humans have the capacity to modify their environments to alter the affordances of the environment, the environment itself continues to place constraints on what is possible (p. 121). He further emphasized that, over the past few thousand years, humans could significantly transform the face of the earth, and this transformation did not result in the creation of a new, artificial environment distinct from the natural one, but rather represented the modification of the existing environment through human activity (Gibson, 1979, pp. 121-122). Lefebvre showed that these spaces emerge through cultural

expressions, artistic interventions, religious practices, and everyday activities, reflecting the ways individuals and communities appropriate and transform space. They also function as sites of resistance, challenging dominant spatial orders through nonverbal symbols, gestures, and cultural narratives that redefine urban landscapes.

3.1. EVOLVING PERSPECTIVES ON HUMAN-ENVIRONMENT RELATIONSHIPS

The earliest studies in this domain were based on the deterministic role of the environment played on human behavior. The environment was primarily conceptualized in its physical aspect, where spaces were perceived to have conditions influencing how people behaved and navigated urban areas (Moor, 1991; Dayaratne, 2002). Porteous (1977) suggested that 'environmental determinism' is a theory in which the environment is a causative factor in determining human behavior and leading it in one direction as opposed to another. Broady (1968) argues that this determinism operates as a one-way process, with the physical environment serving as the independent variable and human behavior as the dependent variable.

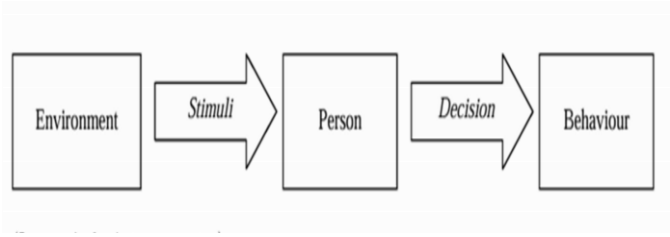


Figure 1: Deterministic View of the Person-Environment Relationship
(Source: Munasinghe, 2003)

However, the subsequent 'interactionist' perspective opposed environmental determinism and emphasized the role of individual variables in modifying and influencing the nature of environmental impacts (Munasinghe, 2003; Dayaratne, 2002). Lewin built on this idea that the relationship between behavior, personal traits, and environmental factors was dynamic and expressed it in the formula B = f (P.E). This change in theory resulted in a concentration on the study of personality traits and variations, and, more specifically, as prime components of people's responsiveness and reaction in the surrounding environment.

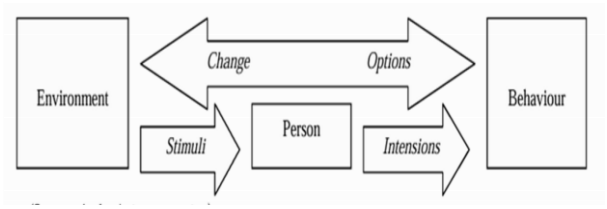


Figure 2: Interactionist View of the Reciprocal Person-Environment Relationship
(Source: Munasinghe, 2003)

This interactionist view emphasizes the reciprocal nature of human-environment interactions, where individuals actively engage with and shape their surroundings rather than passively responding to them (Werner & Altman, 2000). For instance, the construction of a flyover may initially disrupt the surrounding community. However, people respond to these changes by adjusting their movements and interactions within the built environment, ultimately reshaping its influence on their daily lives.

Building upon this foundation, the third 'transactionist' perspective emerged as an extension of the interactionist approach, further emphasizing the reciprocal and evolving relationship between individuals and their environments. It further leads to the suggestion that people do not merely adapt to their surroundings but actively reshape and redefine them to suit their needs. It is highlighted that "the influence of people on their environments may be much more than mere modifications of the impact of those surroundings; people may completely change the nature of their surroundings and the meanings they have" (Canter, 1985).

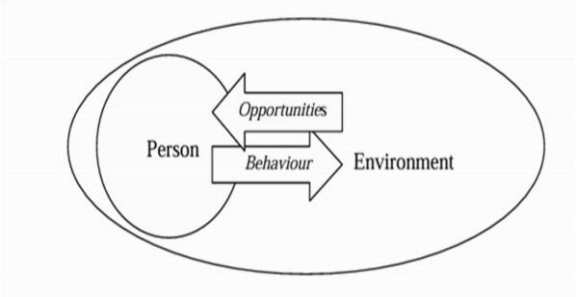


Figure 3: Transactionist view of the Person-Environment Relationship
(Source: Munasinghe, 2003)

3.2. CONTEMPORARY THEORIES ON INFRASTRUCTURE ADAPTATION

Several relevant theories were explored to build up a comprehensive theoretical foundation for this research. The Urban Resilience Theory is then introduced to explain how cities respond, resolve, and transform from these disturbances: economic, social, and environmental shocks. The Theory of Place and the Sense of Place (Tuan, 1977) also presents an important view of how individual's emotional attachment to places contributes to forming their identities, their behaviour and their dealings with the urban environment. The theory focuses on the social role of space as a resource by which identity is constituted: personal identity and collective identity, and offers a useful perspective for the understanding of how activities of change in urban landscapes, for example, projects of infrastructures, may affect community attachment and emotional balance. Moreover, the New Urbanism (Duany et al. 2000) offers a planning strategy that focuses on walkable, mixed-use communities and gives more priority to pedestrians over cars. It focuses on human designed based theory and human cohesion to foster urban sustainable environment. New Urbanism is a useful way to look at urban forms since it concentrates on human experience in urban spaces and develops urban forms that promote interaction and community-oriented living. From critical lens of Urban Informality (Roy, 2012 ; Yiftachel, 2009) the present study looks how marginalized communities adapt and transform the urban spaces, with specific reference to the infrastructural interventions.

3.3. THE THEORY OF AFFORDANCES AND ITS RELEVANCE TO HUMAN ADAPTATION

Gibson (1979) defines affordance as opportunities for action that the environment provides to an organism based on its physical properties and the organism's needs. Gibson further explains that the affordances of the environment are what it offers to the animal, either for beneficial or harmful purposes. These affordances are not merely properties of objects but are relational, shaped by the interaction between the organism and the environment. For example, differently laid out spaces afford different behaviours for various animals, and objects in the environment provide different affordances for manipulation, nourishment, and manufacture (Gibson, 1979, p. 120). The medium, substances, surfaces, objects, places, and even other animals possess affordances that either support or hinder an organism's needs and actions (Gibson, 1979, pp. 134–135). For example, flat, rigid surfaces afford support and equilibrium, allowing an organism to maintain posture and engage in behaviors such as locomotion or manipulation (Gibson, 1979, p. 119). This perspective suggests that what we perceive when interacting with objects is not their inherent qualities but rather the affordances, they offer us (Gibson, 1979, p. 126). Gibson's Environmental Affordance theory provides a sound conceptual framework to understand the opportunities provided by highway flyovers, which alter the built environments and affect inhabitants' choices towards adaptive behavior in the context of this research.

3.4. LEFEBVRE'S SPATIAL TRIAD AND THE APPROPRIATION OF URBAN SPACE

A spatial triad adapted from Lefebvre (1991) is another theoretical base to understanding the process of space production by flyovers and inhabitants. He defined a triadic interrelation of spatial practice (perceived space), representations of space (conceived space), and representational spaces (lived space). The city is constantly evolving as a result of planned impositions and inhabitants' responses.

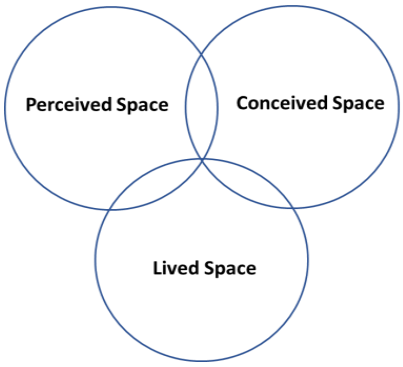


Figure 4: Lefebvre's spatial triad

Spatial practice (perceived space) is the process through which society actively produces, organizes, and appropriates space in everyday life. Rather than serving as a passive reflection of societal structures, spatial practice is a dynamic and ongoing process, continuously shaped by human activity, infrastructure, and spatial organization. Lefebvre argues that spatial practice exists in a dialectical relationship with society, where space both influences and is influenced by social interactions, economic systems, and political structures. Each society has its own distinct spatial arrangements, influencing how people navigate and experience their environment. Furthermore, individuals develop a level of competence and performance in engaging with these spatial norms, reinforcing social cohesion. This perspective highlights the reciprocal nature of space production, emphasizing that the built environment is not merely imposed but is negotiated and transformed through lived experience (Lefebvre, 1991, p. 38).

Representations of space is "conceived space," referring to the scientifically and technically constructed understanding behind the space formulated by planners, architects, engineers, and policymakers. As the dominant spatial framework within any society, it dictates how urban environments are planned, regulated, and organized, shaping the formal structure and intended function of space (Lefebvre, 1991, p. 38). The third element of Lefebvre's spatial triad is 'lived space', also

called representational space. It refers to how people perceive, assign meaning to, and engage with their environment, independently of their material characteristics or intended goal. The lived space is not a physical entity, but a space of meaning, memory, and interaction under the influence of individual and collective experience over time. Lefebvre asserts that such spaces can be formed through artistic interventions, religious practices, and everyday practices, as individuals and communities do well in transforming space. This Space Triad serves as a valuable analytical tool for illustrating the dialectic relationship between highway flyovers and the inhabitants of those settings, to reshape urban spaces and human practices.

3.5. RESEARCH QUESTIONS

In light of Gibson's Theory of Affordances and Lefebvre's Space Production triad, the following research questions are posed:

1. RQ 1: What were the spatial and functional characteristics of the selected junctions before the construction of flyovers?
2. RQ 2: What spatial transformations occurred as a result of flyover construction in relation to planners' conceived space?
3. RQ 3: How do changes in spatial configuration following flyover construction influence pedestrian movement and commercial activity patterns?
4. RQ 4: How do the post-flyover built environments afford new possibilities for use, and how do inhabitants, both consciously and unconsciously, internalize and appropriate these affordances in their everyday lives?
5. RQ 5: How does the current built environment reflect the co-creation of space between planning intentions and inhabitants' everyday practices?

3.6. STUDY LOCATIONS

The study covered four flyover settings in the Colombo metropolitan area, namely, Dehiwala, Nugegoda, Slave Island, and Kohuwala. Each of these locations has undergone significant spatial transformation during the post-flyover construction period. These locations are selected based on their strategic positioning within the transportation network in Colombo, the high levels of pedestrian and urban activity in these areas, and the diverse social and economic profiles that can be observed. This study incorporates both the most recently constructed flyover (Slave Island and Kohuwala) and the older flyovers (Dehiwala and Nugegoda), thereby providing a variety of situations to study.

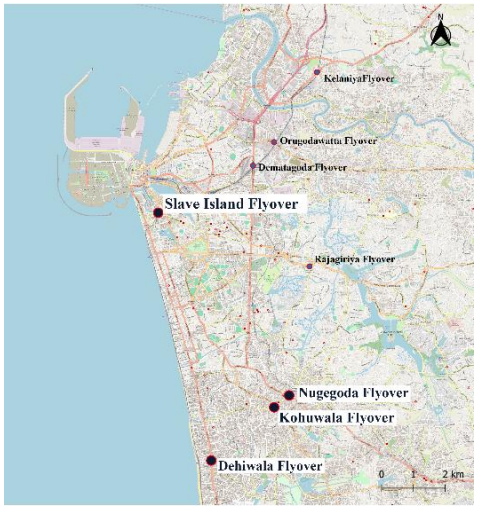


Figure 5: Location of Selected Flyovers in the Colombo Metropolitan Area

4. Methodology

4.1. METHOD OF STUDY

The research employs a mixed-method, combining both quantitative and qualitative techniques. The initial phase of the study involved direct, on-site observations of the flyover settings and their surrounding areas, focusing on pedestrian behaviors, public space usage, and the physical transformation of the surrounding built environment. In addition to field observations, open-ended interviews were conducted with a diverse group of participants, including local residents, daily commuters, and business owners whose routines and activities were affected by the construction of the flyovers. The interviews were conducted during both weekdays and weekends, in the morning and evening hours, to capture variations in daily activity patterns. At each selected location, between five and ten individuals were interviewed to obtain a broad understanding of the local perspectives and experiences. A visual assessment of the built environment over time was conducted using past and present photographs, supported by mapping pedestrian movement patterns and social interactions around the flyovers.

The study employed the Visibility Graph Analysis (VGA), a method grounded in graph theory, which is widely used to analyze spatial configurations (Jeong et al., 2014) and Agent-based Simulation. VGA is related to Space Syntax theory, which provided an analytical framework to address the configurational and structural aspects of urban space (Hillier, 1996; Hillier

& Hanson, 1984; Karimi, 2012). It has provided insights into how the arrangement of streets and buildings influences human behavior and social interactions (Hillier, 1985, 1996, 1999; Hillier & Hanson, 1984). Hillier (1996, p. 126) emphasizes that the spatial arrangement of an urban system is fundamental, as it shapes not only social relationships but also broader socioeconomic activities. To operationalize the space syntax analysis, the study used UCL Depthmap, a specialized software developed by Alasdair Turner at University College London. Depthmap enables the identification and evaluation of spatial configurations through syntactic analyses, including axial line analysis, convex space analysis, VGA and Agent-based Simulation (Hillier, 2004). Among these, VGA and Agent-based Simulation have been selected for the spatial analysis in this study. VGA allows a detailed examination of visual properties within the built environment, providing a quantifiable understanding of how space is perceived and used by its occupants (Ostwald, 2011). By integrating VGA with qualitative observations and interviews, the study aims to capture a holistic understanding of the flyover environment, encompassing both human behavior and spatial dynamics.

For the qualitative component, an 'across-case comparison' was conducted using a summary table to organize and synthesize findings from different case study locations.

5. Results and discussions

5.1. PRE-FLYOVER SPATIAL AND FUNCTIONAL CONDITIONS OF SELECTED JUNCTIONS

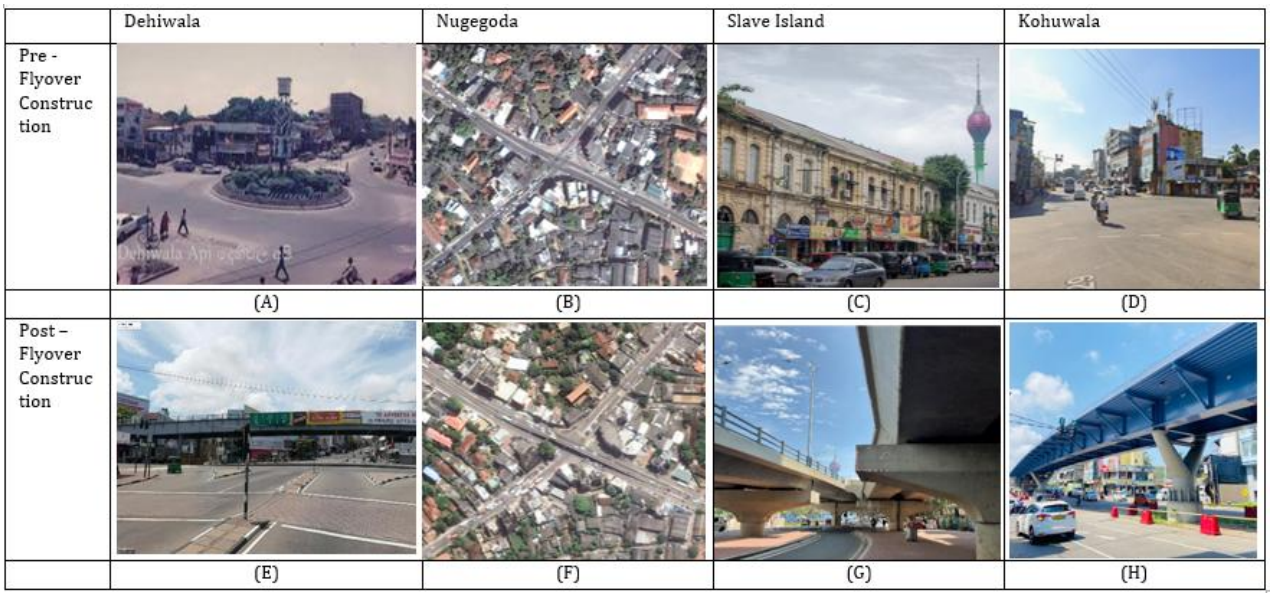


Figure 6: Spatial Transformation: Pre- and Post-Flyover Construction
(Source: field visit photographs and Google Images)

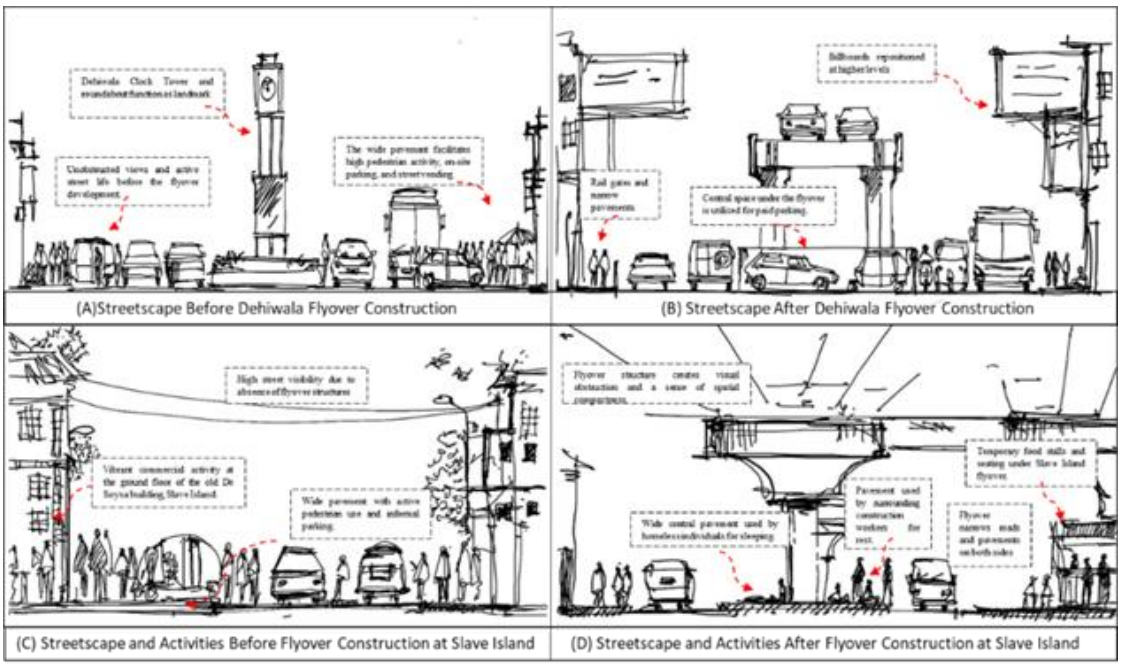


Figure 7: Impact of the Flyover on Built Environment and Social Dynamics

Before the construction of flyovers in the selected locations, each area had its own characteristics that contributed to its functionality and identity within the city. These areas were major junctions of the respective townships throughout. The area around the junction was a live and vibrant space. Before the construction of the Dehiwala flyover, there was a prominent clock tower at the center of the junction. Locals recognized this clock tower as a key landmark of the area in their place images (Fig. 6A and 7A). The business, such as fashion and garment outlets, retail shops, electric and electronic sales and restaurants of the intersections of the junction made it a busy commercial hub also supported by crowds, flashy colours, and neon lights at night.

Similarly, in the Slave Island area, where the flyover was built along Justice Akbar Mawatha, was once a bustling street with small-scale commercial activities (Fig. 6C and 7C). Before the construction of the flyover, the facade of the de Soyza building, the building abutting Justice Akbar Mawatha, provided the identity to the place, and its arcade along the street was active through nights with eateries, retail shops and local customer services. In the cases of the Nugegoda and Kohuwala, large, highly visible intersections were present at the junctions at the pre-flyover conditions, which were significant nodes of the place images in their users. But with time, traffic congestion at these junctions became a problem, and the relevant authorities decided to build flyovers to ease congestion and improve mobility across these urban areas.

5.2. CHANGES CAUSED BY THE FLYOVER: PLANNERS' CONCEIVED SPACE AND ITS SPATIAL TRANSFORMATION

The objective of the planners and engineers in all four cases was to reduce congestion and optimize traffic flow, and improve connectivity of these key strategic locations across the city. However, according to field observations and interviews with people, it was noted that in all four case locations, the construction of flyovers at major intersections has led to spatial compression, especially resulting from the narrowing of roads and sidewalks on both sides of the flyover. Pedestrians consistently reported increased congestion and unsafe conditions, especially as buses and heavy vehicles navigate these constrained spaces (Fig. 8D). In Nugegoda, business owners in the vicinity commonly reported that several commercial buildings were pushed back from their original frontage to accommodate the flyover, disrupting pedestrian access and street-level visibility. In Dehiwala and Nugegoda, residents and shopkeepers noted that spaces beneath the flyovers have become darker, less vibrant, and less inviting, particularly during afternoon and evening hours. The construction of the flyover led to the loss of convenient short-term parking facilities. Furthermore, the installation of pedestrian safety fences on either side discouraged quick vehicle stops and visits to nearby shops, resulting in a decline in footfall and overall business activity (Fig. 8H). In Kohuwala, some residents were required to shift their houses further back, reducing their connection to the street and altering traditional patterns of everyday interaction. In Slave Island, the change was drastic as the de Soyza building was totally demolished, erasing the vibrancy of the whole area. These changes show the authoritative conceived space (Representations of space) of the planners and engineers whose intension was to resolve traffic issues clearly reflecting the way that space is understood and constructed through professional lenses. As Lefebvre notes, this form of space is distinct from what is lived or perceived in everyday interactions. Accordingly, “Representations of space: conceptualized space” of scientists, planners, urbanists, technocratic subdividers and social engineers, identify “what is lived and what is perceived with what is conceived” (Lefebvre, 1991, p. 38). They focus on the technical aspects of flyover construction, guided by a traffic analysis and design to meet the needs of urban mobility, disregarding the inhabitants’ “perceived space”, which matters more in their day-to-day affairs.

Table 2: Cross-Case Analysis of Space Appropriation and Adaptation across Flyover Case Study Locations

Dimension	Dehiwala	Nugegoda	Slave Island	Kohuwala
Built Environment Change	Removal of the roundabout and clock tower, narrowed pavements, elevated billboards, and retail relocation due to the loss of on-site parking.	Commercial buildings pushed back, elevated billboards replacing pedestrian-level signage.	Demolition of De Soyza Building, creation of a wide central pedestrian pavement along Justice Akbar Mawatha.	Multiple commercial and residential structures were demolished, followed by the ongoing construction of new pedestrian infrastructure.
Daily Practices Change	Decline in vibrancy, both residents and members of the business community have reported that the space has become darker and less dynamic, particularly during the afternoon and evening hours.	Reduced walk-in customer traffic due to parking loss.	Displacement of businesses, decline in pedestrian activity after De Soyza Building’s removal.	Some Residents who lived near the main road had to shift their houses backward.
Pedestrian Movement	Moderate disruption; major crossing patterns remain unchanged; the placement of rail gates and flyover pillars creates visual obstructions and narrows walkways.	Pedestrians use informal routes, avoiding designated crossings.	Shift in pedestrian flow to central pavement beneath flyover.	Newly designated road crossings beneath the flyover are longer and less convenient, longer travel time, especially during peak hours.
Business Behavior	Decline in customer flow, particularly for retail shops; relocation due to onsite parking constraints.	Some businesses were required to relocate their shops to the rear of the original frontage to accommodate the construction of the flyover.	Reduced customer flow after loss of on-site parking; key commercial buildings demolished.	Decreased customer visits; lack of quick parking options discourages shoppers.
Adaptations and space appropriation	The space beneath the flyover used for paid parking, pavement	Paid parking and mobile vending, especially juice	Informal seating areas and vending stalls; homeless	Flyover space repurposed as waiting area for school

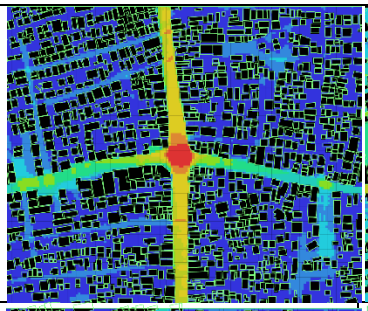
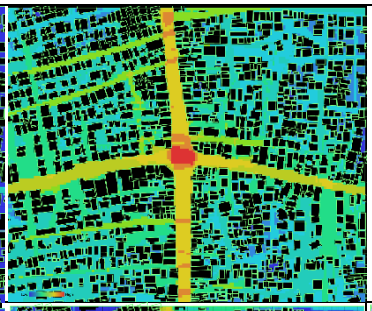
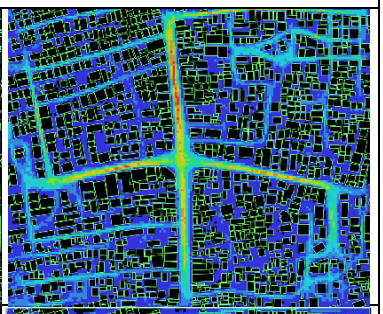
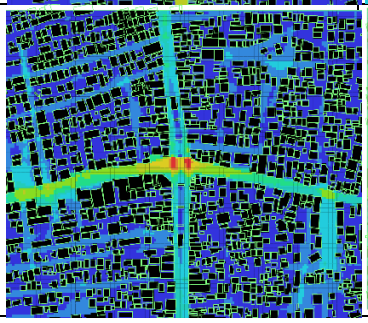
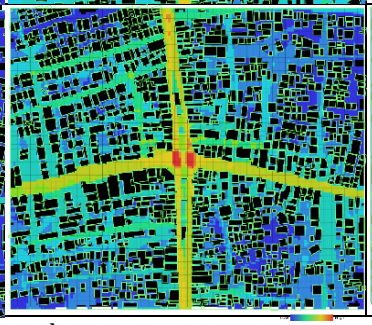
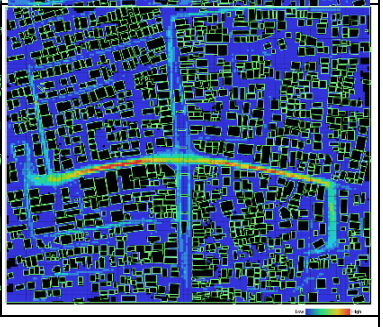
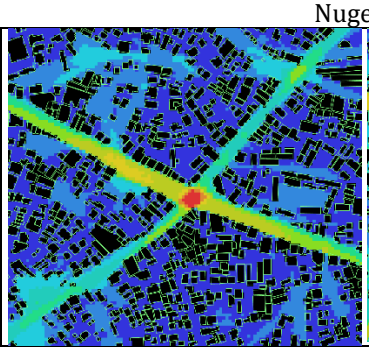
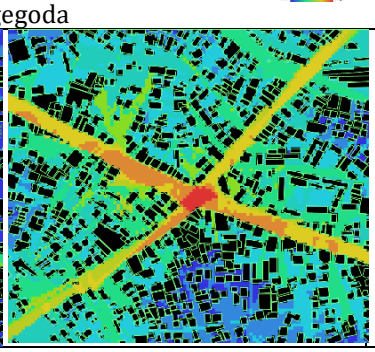
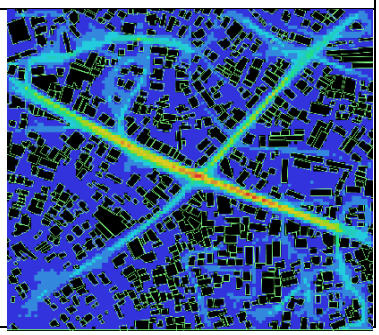
	vendors continue to operate near crossings to engage foot traffic.	stalls and food trucks during peak hours.	individuals use space for shelter.	vans, motorcyclists seek shelter during rain.
New changes in respective Built Environments	A pattern has been observed where commercial activities along Galle Road have shifted to Hill Street and Station Road.	Near the flyover areas, commercial activities and movement have shifted towards S. De. S. Jayasighe Mawatha.	Flyovers create comfortable, shady areas with wide pavements underneath, offering shelter from the sun and enhancing pedestrian comfort.	The business community and residents gradually adjust to the presence of flyovers.

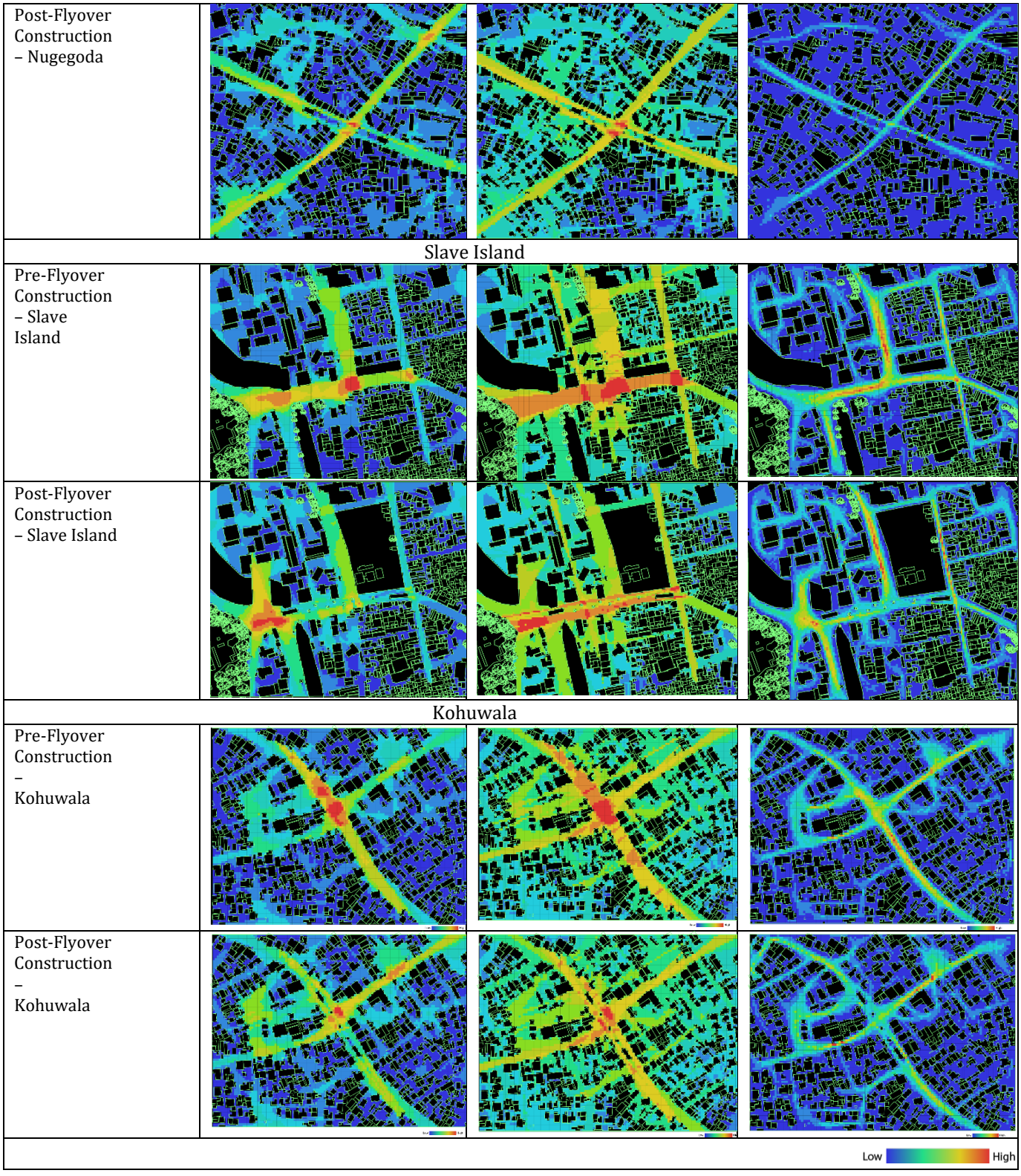
Through the cross-case analysis of all flyover locations (Table 2), the varying impacts of flyover structures on pedestrian movement patterns, business activities, and broader urban functions could be noted. In the next step, the focus was particularly drawn to the broader localities of the flyover settings. To examine this, visibility graph analysis (connectivity, integration) and agent-based analysis were used in all four locations.

5.3. INFLUENCE OF POST-FLYOVER SPATIAL CONFIGURATION CHANGES ON PEDESTRIAN MOVEMENT AND COMMERCIAL ACTIVITY

This study examined the spatial configuration changes resulting from flyover construction. In the pre-flyover period, the selected locations displayed distinct spatial configuration patterns, with each area having clear sightlines, high visual connectivity, and strong spatial integration along the main road corridors. The introduction of flyover structures, with piers and abutments positioned in the middle of the road, significantly altered these configurations. The analysis focuses on how these changes affected the indices of connectivity, integration, and agent movement. Table 1 presents a comparative analysis, illustrating the differences in the analytical spectra. The pre-flyover situation demonstrated a distinct spectrum, whereas the post-flyover condition did not exhibit such characteristics. In the case of Dehiwala, high visual connectivity, clear sightlines, and strong spatial integration were observed at the junction before the flyover. The agent-based analysis also recorded a high concentration of agents' movement along Galle Road, which functioned as a wide corridor supporting vibrant commercial and social activities.

Table 1: Comparative Visibility Graph Analysis (connectivity, Integration) and agent base analysis of Pre- and Post-Flyover Construction

Location	Connectivity	Integration	Agent base analysis
Dehiwala			
Pre-Flyover Construction – Dehiwala			
Post-Flyover Construction – Dehiwala			
Nugegoda			
Pre-Flyover Construction – Nugegoda			



Similarly, in Nugegoda, Kohuwala, and Slave Island, high connectivity, integration, and agent counts were observed along the roads where flyovers are now located. According to the theory of natural movement, also referred to as the natural movement economic process, the configuration of the street network directly shapes pedestrian flow and influences the distribution of commercial activities. Streets with higher spatial integration tend to attract greater pedestrian movement, thereby enhancing their economic value and commercial attractiveness (Hillier, 1996; Hillier, Penn, Hanson, Grajewski, & Xu, 1993).

In the post-flyover situation, connectivity, integration, and agent movement patterns were disrupted by the introduction of concrete pillars and heavy ramps (Table 1). These elements blocked clear sightlines, visual connectivity, pedestrian movement, and forced pedestrians toward less obstructed routes with clearer visibility.

By comparing the results of the Visibility Graph Analysis and agent-based movement simulations with on-site field observations and interviews with local residents, a strong relationship between changes in spatial configuration and

pedestrian behavior is evident. For instance, after the construction of the flyovers, the available space on either side of the structures became narrower. As a result, the frontage space of existing shops was significantly reduced compared to the pre-flyover situation. The business community reported that this change negatively affected customer foot traffic. Before the flyovers, people could easily stop their vehicles in front of shops to visit, but the reduced space now limits on-site parking, preventing customers from stopping. Delivery Lorries for the shops also lack sufficient space to park. Since most of these shops operate on a rental basis, the decline in customer visits has led to reduced income, adversely affecting the surrounding business community and prompting many to relocate to peripheral areas. The intersections are being occupied by small- scale utility businesses such as key cutters, toddlers, small-scale retail shops in all four locations. This change enables us to understand a mutual inter-relations between the activity types and the inhabitants' movement patterns. Changes in inhabitants' movements compel activities to change their locations, while, in turn, the attraction of such activities reinforces the movement patterns of the inhabitants. Collectively, the findings indicate the implications of flyover constructions on activity patterns and land use changes in their respective vicinities.

5.4. AFFORDANCES AND ADAPTATIONS: EXPLORING NEW OPPORTUNITIES AND USER RESPONSES IN THE POST-FLYOVER LANDSCAPE

These four flyovers have also provided new opportunities for human interaction with space. The inhabitants internalized and made them change their visibility through adjustments such as elevating their billboards so they could be seen from the flyovers, by strategically positioning to catch attention of those who drive high (Fig. 8C). This transformation in advertising techniques illustrates the adaptive use of space, appropriating the newly offered opportunities.

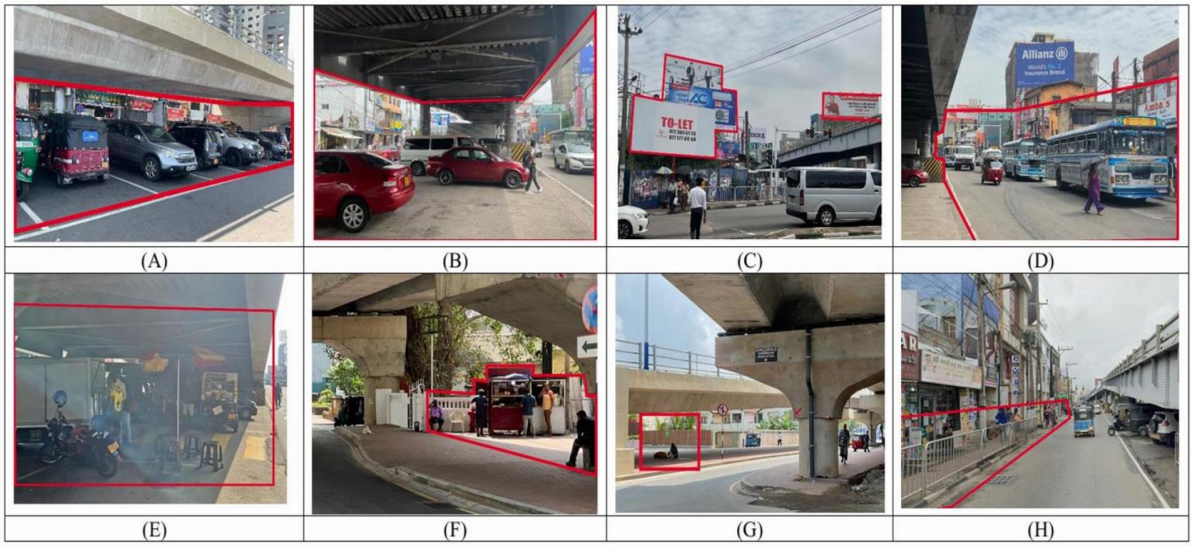


Figure 8: Space Utilization at Flyover Locations

Across all four case study locations, a notable affordance that emerged was the appropriation of spaces beneath the flyovers for vehicle parking (Fig. 8A and B). These areas, distinguished by their flat and shaded surfaces, have been repurposed for both formal paid parking, addressing the essential needs of nearby businesses and commuters. Interviews with residents and business owners in Dehiwala and Nugegoda highlighted that these towns, though bustling, struggle with a significant shortage of parking spaces. This scarcity of parking presented an opportunity for the local business community to resolve their long-lasting issue. Yet, these spaces are mostly avoided by many pedestrians for their perceived dark and contained nature. However, in both Nugegoda and Slave Island, areas beneath the flyovers have been appropriated for temporary vending stalls, food trucks, and makeshift seating. These spaces now serve as informal gathering points where people engage in social interactions, converse, and partake in food and tea in a relaxed environment. This transformation demonstrates that the spaces, though originally not intended for social use or ignored by professional interventions, are being repurposed for social use, reflecting the adaptive and flexible nature of the built environments and their users (Fig. 8E and F).Particularly in Slave Island, central pavements beneath the flyover have transformed into makeshift resting spots for homeless individuals and construction workers in the area (Fig. 7D and 8G), showing the resilience of communities in responding to changing urban environments. These adaptations align with Gibson's (1979) observation that "different layouts afford different behaviors for different animals, and different mechanical encounters" (pp. 119–120), demonstrating how changes in the built environment can directly shape human behavior and responses.

5.5. THE CURRENT SITUATION OF BUILT ENVIRONMENT: CO-CREATION OF SPACE BEYOND THE FLYOVER

In the post-flyover period, significant changes occurred in the broader study area, transforming both the physical infrastructure and the urban fabric. The space around flyovers became more compact, with elevated billboards, narrower pedestrian paths, and large structural pillars. These changes reflect the interaction between urban planners' designs and how inhabitants adapted. The inhabitants, including business owners, pedestrians, and residents, modified their daily routines to fit the new spatial setting. People moved beyond the intended function of the infrastructure, taking informal paths despite formal pedestrian crossings. The areas beneath the flyovers were re-appropriated for informal activities like

vending and social gatherings, creating new social spaces in some cases and dark corners in others. This highlights the dynamic relationship between perceived, conceived, and lived spaces in urban development, emphasizing that both planners and the inhabitants play equal roles hand-in-hand in shaping built environments.

6. Conclusion and recommendation

This study investigated four flyover settings in Colombo and compared the impacts on built environments, urban inhabitants, and their responses using both qualitative and quantitative methods. This analysis is framed through the theoretical lenses of Gibson's Theory of Affordances and Lefebvre's Space production triad, which help to understand the transactional dialectics between the built environment and human behavior and the adaptive process resulting from that. The findings reveal that the current state of the city's built environment reflects not only the intentions of planners but also the active role of city dwellers in adapting to and reshaping urban spaces. Results from the visibility graph analysis indicate that flyover pillar structures significantly reduce area connectivity and integration. This structural interference significantly affects urban socio-economic activity and city dynamics. Furthermore, the agent-based simulation demonstrated significant shifts in movement patterns following the flyover's construction. Together, these findings underscore the complex and collaborative nature of urban transformation. The significance of this study lies in its development of a theoretical framework that explains how city dwellers accommodate and reshape the outcomes of relatively large-scale infrastructure. The process of space transformation and human adaptation discussed in this research is not limited to flyovers but can be applied to other types of urban interventions.

However, the study has a few obvious limitations. First, it could not be extended to capture overall land use changes in the wider localities surrounding the flyover constructions, mainly due to limited data availability. Even though observable, such changes may also be influenced by factors beyond the flyovers themselves, requiring a more complex dataset obtained through controlled observation. The second limitation is that the findings are from four settings in Colombo, whose socio-cultural and functional settings may have differences to those of other cities in Sri Lanka or elsewhere. Third, in this research, the visibility graph analysis and agent-based simulation also present certain limitations. VGA is restricted by its two-dimensional approach, which does not fully capture the three-dimensional qualities of urban environments that influence wayfinding and spatial experience. Similarly, the agent-based simulation incorporated only a limited set of factors to model changes in pedestrian movement caused by flyover structures. As a result, while these analyses provide valuable insights, they may not fully represent the complexity of real-world urban dynamics.

However, the findings of this study are significant for urban planning, as they reveal the co-creation process of urban spaces by planners and inhabitants. The experienced urban spaces are not solely constructed through planned and designed interventions, rather they result from transactional processes between the interveners and the intervened; impositions and adaptations; affordances and appropriations. This understanding challenges the conventional planning and urban design thinking process and practices, which mostly understand the evolution of urban environments as one-way processes, and are thus amenable to planning and design decisions. Thus, the institutionalized practices in shaping urban spaces are usually authoritative and guided by unidirectional 'deterministic' envisioning. This study contributes to a potential shift in such conventional practices underpinned by unidirectional understanding.

Building on this contribution, future research should extend the scope to include other forms of infrastructural interventions introduced by planners and city authorities. This would allow for a better understanding and foresight regarding the impact of different physical interventions on human behaviour and the use of urban space. Further investigation is also recommended into the long-term land use changes and socio-economic impacts of flyover construction on urban communities. Moreover, the application of more advanced space syntax simulations, particularly in three-dimensional space, would provide deeper insights into how human behavior evolves in response to infrastructure and spatial dynamics in rapidly changing urban environments.

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