

APPLICATION OF 'GREEN CONCEPT' TO SEGREGATE PEDESTRIAN AND VEHICULAR LAYERS TO REDUCE URBAN TRAFFIC CONGESTION

A Case of Commercial-Pedestrian Underpass Network in Kandy, Sri Lanka

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Abstract: This paper presents the direct and indirect benefits of the feasibility studies carried out for a proposed commercial-pedestrian underpass network in Kandy CBD. Field observations and condition assessment process together with layout design of the underpass have been done by linking economic, social, and commercial centres. Services such as ventilation, water and sanitary, lighting, and security were designed following the green concepts. Natural ventilation, novel lighting techniques such as LED was introduced. Safety alarms and emergency exits were designed and well placed within the system. Further, greenery curtain concept and solar powered street lighting system were introduced to the city.

Keywords: commercial-pedestrian underpass network, green concept, conceptual design

1. Introduction

Kandy, the hill capital of Sri Lanka, is a compacted historical city where vertical expansions are restricted. City has an aggregated population density of 540 persons per sq.km. Besides, Kandy serves as a commercial hub for over two million people residing in adjacent areas. Though sufficient pedestrian walking facilities (e.g., sidewalks and crosswalks) are provided, many of them are occupied by street vendors, leaving hardly any space for pedestrians to walk along the sidewalks. Thus, pedestrians tend to walk on the road creating many vehicle-pedestrian conflicts creating life threats and disturbing the smooth traffic flow. Emission of carbonic gases and wasting of useful human-hours create massive environmental and economic impacts

The central business district (CBD) of the city is seeking of well integrated city planning for its road network (both vehicle and pedestrian) to overcome such barrier to stay still as one of the worlds greatest historical and prestige city. However, the increasing trend of traffic congestion in the commercial area of the city is hard to mitigate with ordinary solutions (with traffic circles and traffic lighting system) as most of the pedestrian walkways have been disturb by street vendors (Fig. 1) resulting pedestrians in the vehicular layer to cause traffic problems and accidents (Fig. 2). Further to this, the pollution caused by the emission of gases from vehicles in the traffic jam, loss of lives due to accidents and time wastages are hard to convert into financial terms. The economy of the country is also negatively affected and businesses are the first to suffer when customers find it is difficult to reach to CBD.



Figure 1: Conflict due to street vendors.



Figure 2: pedestrian- vehicle interaction

The impact on the aesthetic appearance should also consider prior to implementation of any modification as it merge with the great history of the city as well as the country. Underpass network is the one of the recommended option to solve the problem associated with Kandy as it act as graded

subway for the pedestrians with safe use. Moreover, it also can be used as a commercial and recreational centre for peoples to enhance their quality of lives.

2. Methodology

During the comprehensive literature surveys, following key factors have been identified as important for the safe design of commercial pedestrian underpasses. Namely, pedestrian behaviour (Pedestrian Level of Service), identification of control points and the lay out (Public and commercial places), lighting and ventilation, designing of the entrances and methods use to attract pedestrian and their safety. In the implementation stage of the project each scenario was addressed and solutions were proposed [1].

First, the CBD area that needs to be address during the project was identified (as shown in Fig.03) considering commercial and public locations as well as pedestrian behaviour. It includes Kandy hospital, Good shed, central market, post office, Telecom building, railway station, existing underpass, Bank of Ceylon building, Commercial bank building, Peoples bank building, Kandy commercial city, Cargill's food city, Hatton national bank building together with some other public locations.

Secondly, condition assessment survey was conducted in between predefined nodal points to count the number pedestrians and their moving speed to estimate existing level of services (Fig.04). Other than the pedestrian counting, measurement of existing pedestrian walkway dimensions was taken and used to calculate the existing level of service. Moreover, pedestrians and street venders were interviewed on site and their feedback was recorded.

Thirdly, relevant government authorities were consulted and the details of existing service lines such as water supply, sewer, electrical and communication lines were collected for the feasibility studies.

As the next step, desk studies were carried out to select possible alternatives by considering both pedestrians' movement and technical feasibility .Then the best alternative was selected to cater for the intended purpose.

Finally, proposal was made on the lay out of the underpass to locate shops and other basic facilities and services (electricity, water and lighting) to serve the pedestrians and attract them in to the commercial pedestrian underpass. Parallel to those modifications greenery concept was introduced to Kandy city to preserve its' historical value.

3. Observations and results

First of all, existing pedestrian lane widths were measured and effective lane width was identified due to street venders. In most of the locations, the presences of street venders disturb the flow of pedestrian movement. Apart from that, poor quality pedestrians' disciplines were identified at certain locations and cause of action for such incidence was identified as lack of road signs and inadequacy pavement width. As a result, most of the people tend to use the rail road as a pedestrian path though it is illegal.

Other than that, pedestrian vehicle accidents are the worst that can be happened due to bad attitude of both pedestrians and drivers. Data was collected regarding resent accidents and used for calculations. Several street venders were interviewed during the site visits and feedback was taken on the existing under pass and the proposed alternative. Majority of venders showed positive respond towards the proposed commercial pedestrian underpass because they will get permanent places to do their business as they are now in temporary shops made with timber. They also conclude that, the disturbance due to bad weather conditions will be completely vanished with the proposed underpass. From the pedestrian point of view, many of them accepted the proposal in an informal manner just because they wanted to have greenery Kandy city for their future generation.

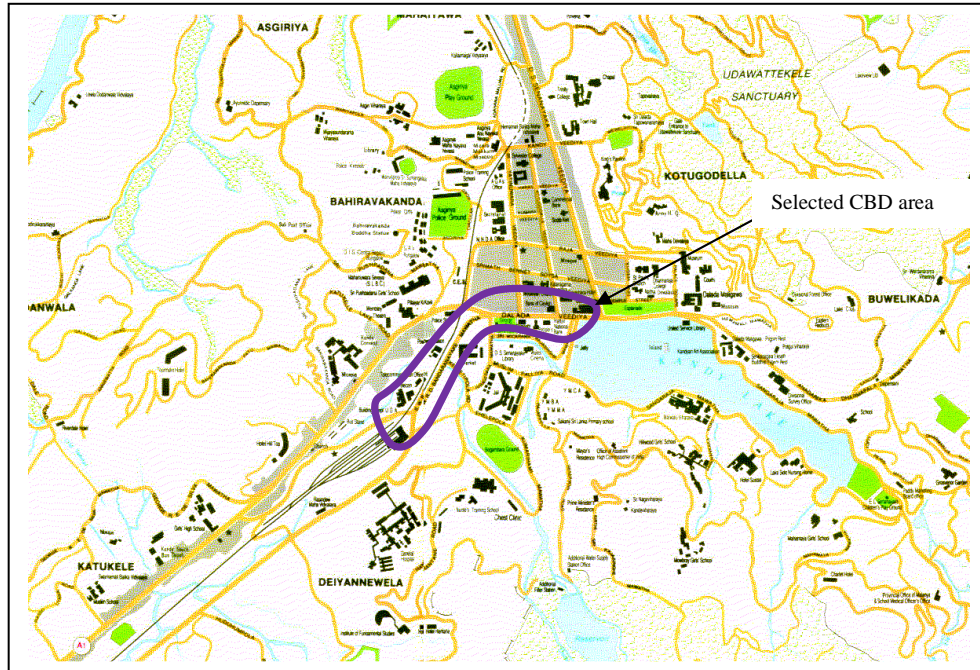


Figure 3: Kandy Central Business District

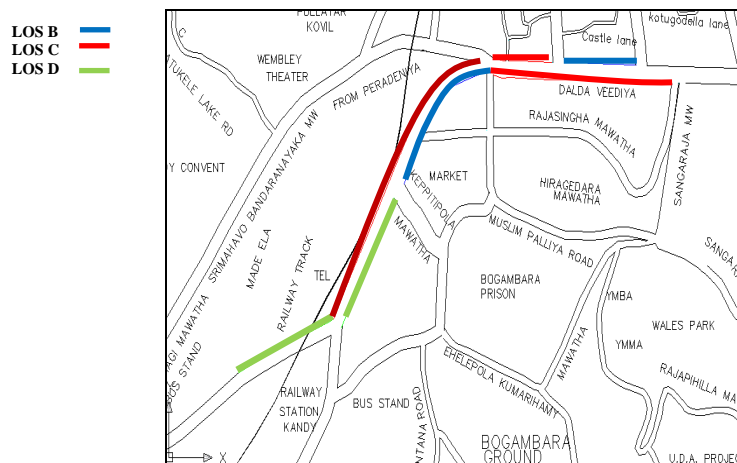


Figure 4: Existing Level of services

4. Conceptual design

During the conceptual design, priority was given to relocation of street vendors in a comfortable manner in order to do their business parallel to the greenery Kandy city concept. The direct and indirect benefits of the changes can be highlighted as follows [1, 2].

- Both pedestrian-vehicle accidents and conflicts are avoided
- Fuel consumption of vehicles is reduced
- Environmental pollution can be significantly controlled
- Time savings due to traffic can be improved
- Aesthetic appearance of the city can be improved

Selecting the locations and size of the entrances and exits, alignment of underpass were carried out by considering both space availability and existing service layout plans found during the condition survey. The dimensions of the underpass and other facilities including lighting, ventilation and

sanitary facilities were designed according to standard guide lines. Modern available technologies were introduced to the underpass towards sustainable design [7].

4.1 Dimension of the underpass

Pedestrian level of service was considered as the key design criteria in deciding the dimension of the underpass and its, shops and other facilities. Selections of the dimensions were performed according to standard guideline found during the literature survey. Conceptual design of the entrance was done and separate lane was provided for disabilities [10].

4.2 Lighting of the underpass

Natural lightning is almost impossible and it is proposed to have completely artificial lighting system with novel LED lighting. The intensity of the lighting was arranged as shown in the Fig.05. The intensity of lighting was maintained closer to the natural sunlight at the entrance and exit locations.

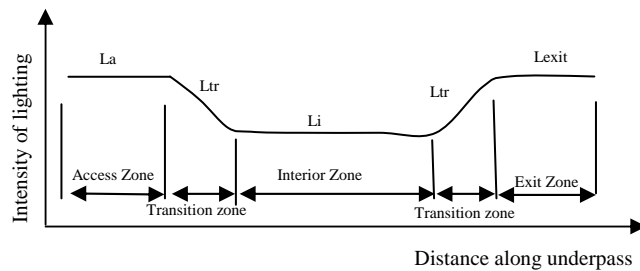


Figure 5: *variation of the intensity of lighting*



Figure 6: *Proposed LED lighting*

The LED lighting is a new energy saving product (Fig. 6) that utilizes high power LED's as a light source and it can be connected to direct power supply or can be powered with the optional power source. Other than that, there is no ultraviolet light, no infrared rays, no heat and no radiation products. As a result led tunnel lighting is a convenient "green" lighting source [6]. Moreover, emergency lighting systems with solar panels were proposed and reliability of lighting was guaranteed in a failure of supply from national grid.

4.3 Ventilation

It is proposed to have a natural ventilation system for the underpass except in between node 2 and 5 (See Annex "A") where there is no intermediate open area for free air flow. Calculation of the fan capacity was carried out and minimum air velocity through the underpass was considered as 1.25ms^{-1} and maximum 1.50ms^{-1} [5].

Table 01: *Calculation of fan capacity*

Air velocity /(ms^{-1})	Existing area with entrance and exits/ (m^2)	Required additional Inlet area/(m^2)	Total fan Capacity/(m^3/s)
1.25	22.30	13.80	28.32
1.50	22.30	16.50	33.88

4.4 Water supply and waste water system

Supply of water was planned to extract from public water supply located closely to the underpass system as identified during the survey. The soakage of waste water is not always possible and it is proposed to dispose it to the proposed sewer system by Kandy Municipal council (Annex “B”).

4.5 Safety within the underpass

The safety within the underpass was considered as a one of the key design criteria since it plays a vast role to attract pedestrians into the underpass. The design for safety was carried out to favour a range of peoples with different disabilities. Key areas were identified and addressed in the conceptual design [8, 9]. Namely, fire safety, safety at the entrance and exit, operating time for the underpass, lighting and ventilation within the underpass, emergency exists.

4.6 Kandy city surface

Greenery curtains were proposed for building structures within the selected CBD as shown in fig. 7. Further, street lighting system with solar panels was proposed and green Kandy city concept was established.



Figure 7: *Green curtain concept*



Figure 8: *Fences with greenery area*

5. Impact on environment

The initial environmental impact assessment was carried out and following areas were addressed during the project.

- Geomorphology
- Ecology and natural resources
- Socio economics
- Utility services

It could be concluded that the proposed project has positive yield towards the development of the city. However, the key issues that have to be addressed during the implementation of the project were identified during the IEA process. In particular, traffic caused by the construction of the underpass has to be addressed and close investigation of service ducts should be examined prior to the construction of the project. Other than that, effect of the project on the natural resources and bio diversity should be minimized. Finally, the effects on socio economic factors have to be addressed with careful inspection.

6. Conclusion

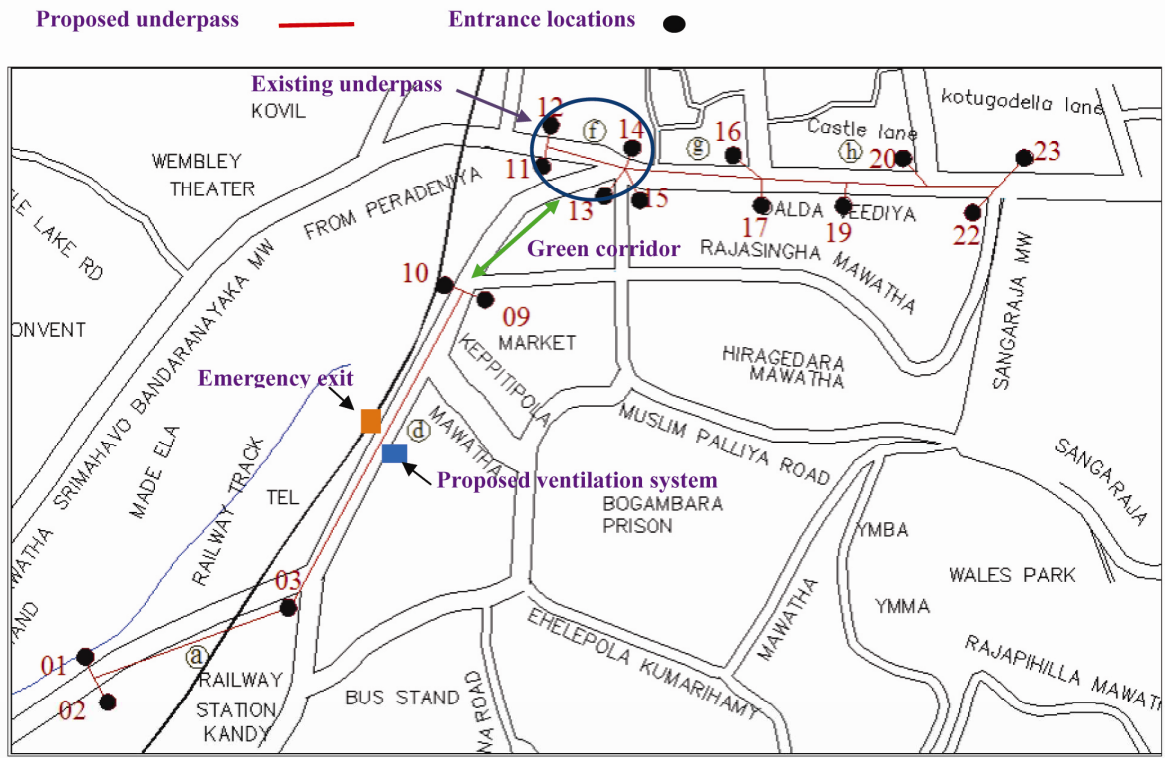
This paper summarises the direct and indirect benefits of a conceptual design of a proposed commercial pedestrian underpass system in the Kandy CBD. Factors such as, pedestrians' behaviour, technical and economical feasibility of proposed underpass was discussed with appropriate solutions. Relocation of street vendors in the either side of the sub-way road was given the priority and green garden was proposed to construct on that particular space. It can be concluded that the construction of underpass will directly reduces the vehicular- pedestrian conflicts. Other than that, smooth flow of vehicles can be achieved. This will yield to a low fuel consumption of vehicles. Apparently, wastage of time will be minimizing. Street vendors will get a well-projected zone for doing their businesses.

In conclusion, implementing the proposed commercial pedestrian underpass system, the dream of greenery Kandy city concept can be achieved and the same scenario can be implemented for other major cities in Sri Lanka.

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Appendix "A"



Layout of the proposed underpass

Appendix "B"

