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PLACEMENT OF RAILWAY STATIONS IN URBAN SETTINGS AND THE IMPACT OF LOCATION ON PERFORMANCE OF THE STATION

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Abstract

This research focused on the impact of the city has on the functioning of an urban railway station. Methodology for this study has derived from Node / Place categorization for railway stations introduced by Bertolini, and it has modified to suit the local context. Ten consecutive railway stations along Keleni Valley Line have been selected as case studies after careful consideration. Direct observation, mapping and informal interviews become the main data collection method. Two main performative parameters for railway stations can be derived through incorporating the passenger volume as criteria indicative of a successful achievement. Accordingly the station ability to function as an efficient transport node is considered as a performative parameter and it has been calculated by multiplying the values of 'node index' and number of passenger volume. The second performative parameter is the station's ability in generating diverse urban place. It has been calculated by multiplying the values of 'place diversity index' and the number of passenger volume. From the selected case studies, Nugegoda railway station preformed as the best in both categories followed by Maharagama railway station. Pangiriwaththa station performed as the weakest as a transport node. Considering the perfomative parameter in generating diverse urban place, Udahamulla railway station ranked the last.

Keywords: *City, Railway station, Performance index*

1. Introduction – this is an essential section of the paper

Railway is one of the major transport systems in Sri Lanka and existing railway stations remained in the core of the city's functionality. This research focused on the impact of the city has on the functioning of an urban railway station. All over the world railway stations display a strong co-relationship with the city; the way it functions and also how it has created a public place. Most of the transport nodes in Sir Lanka function only as transit spaces and little social interaction take place in these spaces. It is also recognized that most of transport oriented spaces have no proper linkage with the city and with the surroundings.

Strategic planning authorities of successive governments have identified railway as a sustainable, green and economical mass transportation mode in Sri Lanka. Proposals to extend existing railway network to Katharagama, Palmadulla and Dambulla are already included in the National structure plan for 2030. A study of existing railway stations is timely and will be beneficial for the future establishment of railway stations along the proposed railway lines. It is important to establish the functionality of a railway station to the location and its co-relationship with the city. Spatial and visual forms of public spaces are often discussed in literature, but research on functional performance of railway transport nodes in creating diverse urban public space according to the location is minimal, especially in the local context.

This study attempts to establish the connection between the performance of the railway to the commuters and the placement of station building in the urban context. The research also hopes to contribute to an urban designing solution for station area spatial arrangement and also to an urban planning solution to location of public transport interchanges. It would also be very useful if this study derives a clear classification of railway stations, according to the location and it will be beneficial for the further development of the cities.

1.1 METHOD OF STUDY

The methodology for this study has been influenced from Node / Place categorization for railway stations introduced by 'Spatial development pattern and Public transport' by Bertolini, L. (1999), and has further modified to suit the local context. The percentage of mix-modal passenger transit is considered in this study as the "node index" for the analysis of the performance of the railway station as a transportation interchange. Randomly selected sample of 50 passengers from each station have been

interviewed to identify the mode of arrival and departure to and from the railway station.

The percentage of non pedestrian commuter transit has been developed into “node index” represented as*;*

[NQ] α [PT1 + PT 2 + PT3] x 100/2 ; where [PT1] indicates the number of passenger transit to buses, [PT2] indicates the number of passenger transit to privete vehicals and [PT3] indicates the number of passenger transit via three wheeler taxis.

In the analysis of the railway station’s performance as generating a diverse urban public place, ‘Place index’ introduced by Bertolini has replaced by combination of “location index” and “place diversity index” to suite the Sri Lankan setting. “Location index” is derived from the distance to the nearest urban center from the station which is measured through the aid of Google Maps. “Location index” represented as; **[LQ] α [(1000/ (D)],** where (D) indicates the distance to the nearest urban center from the station.

“Place diversity index” indicates the placement of railway station within diverse urban context of different functions and building-use. Survey data and statistics obtained from Urban Development Authority and local authorities together with primary information collected onsite used to compile the building use maps. “Place Diversity index” represented as; **[PQ] α [(N non res B) x (NT)];**Where (N non res B) represented the number of nonresidential buildings in the selected area and [NT] represented the number of different activity types. For this index the selection of the study area is limited to 250m radius from the railway station.

The study proposed to analyse the passenger volume against these three different indexes to review the success of the placement of the railway station. Two main performative parameters for railway stations can be derived through incorporating the passenger volume as criteria indicative of a successful achievement. Accordingly the station ability to function as an efficient transport node is considered as a performative parameter and has been calculated by multiplying the values of ‘node index’ and number of passenger volume. The second performative parameter is the station’s ability in generating diverse urban place and has been calculated by multiplying the values of ‘place diversity index’ and the number of passenger volume.

1.2 SELECTION OF THE CASE STUDIES

Colombo Fort railway station functions as the main railway hub in Sri Lanka. Three main railway lines, Central Main Railway Line, Coastal Railway Line and Kelani Valley Railway Line radiate from Colombo. Coastal Railway Line was laid parallel to the south western coast and the formation of urban space always limited to the inland direction thus reduced the impact on the city. Hence coastal line was not considered for this study. Central Main Railway Line generates the highest user volume and the main railway stations located in similarly complex urban centers. Kelani Valley line is a single track railway which runs through relatively a compact urban setting and also limited in the commuter volume generation. Considering these facts ten consecutive railway stations along Kelani Valley Railway Line have been selected as case studies.

The Kelani Valley Line was originally built during 1900 – 1902. This line started from Colombo and terminated at Yatiyanthota via Avissawella. By 1912 it was branched off at Avissawella and extended up to Opanayaka. The railway line originally built as a narrow gauge line to serve the rubber plantations in the area. The line between Avissawella and Yatiyanthota was removed in 1942 and the section from Homagama to Opanayaka abandoned in 1973. The services were restarted up to Avissawella in 1978 and in 1992, a project was started to convert the line to broad gauge and completed up to Avissawella (58 km) in 1996. The selected stations are from Cotta Road to Kottawa represented mix of urban and sub-urban settings with varied passenger volumes.

2. Heading Level 1- Format of a typical page and final proceeding book

Heading Level 1 in main text will be in bold 11pt. The page of the final proceeding book measures 170 mm wide by 240 mm high. The text including figures fit into a rectangle of 120 mm by 197 mm. The inside and outside margins of final book are both 25 mm; the top and bottom margins are both 21.5 mm. However, this document is set for A4 paper of which margins are respectively 50 mm and 45 mm.

Left indent when starting a paragraph except the first paragraph of all sections, sub sections etc. There are no footers.

3. Heading Level 1- General paper formatting issues

It is recommended to have at least one paragraph of text underneath each heading. The maximum number of pages should be 12 including images and

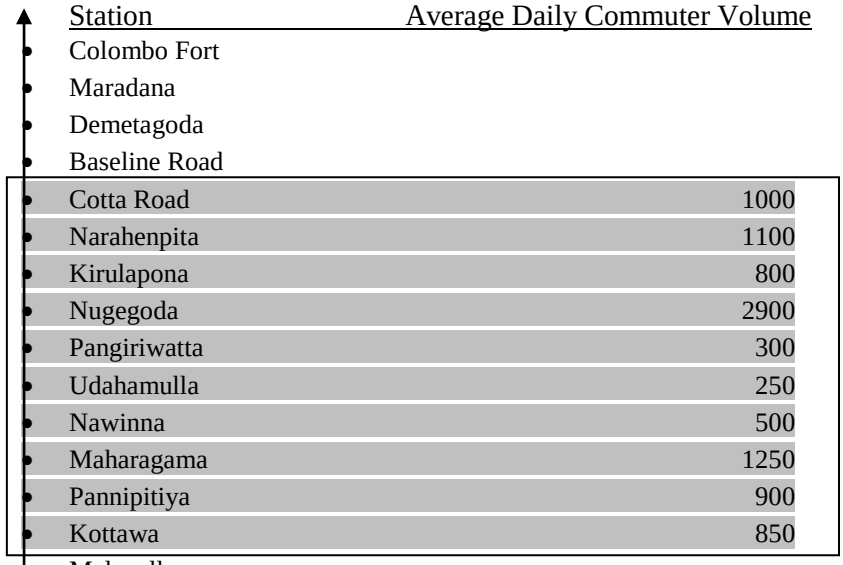


Fig. 01: Selected Stations along Kelani Valley Railway Line for case study

1.3 SCOPE AND LIMITATION OF THE STUDY

Facilities provided for commuters, proximity to the final destination cost of travel and efficiency of the network are some of the major factors which are not within the scope of this study but encourage public to use the railway transportation.

Catchment area size, quality of space-attractiveness of existing train stations, improvement of connectivity with the other functions, the road network and neighborhoods around the station and legibility of railway stations could have been within the scope was ignored for simplification of the study further.

2.0 Case studies

2.1 CASE STUDY ONE: *KOTTAWA RAILWAY STATION*

Fig. 02 Station Platform

Fig. 03: View from the bridge

Kottawa railway station is located in a residential neighborhood in isolation, approx. 500m away from the town center. The station does not have a clear visual connection with the main road or the town center. Most of the users are the residents in the neighborhood. The station is also functionally isolated within the surrounding.

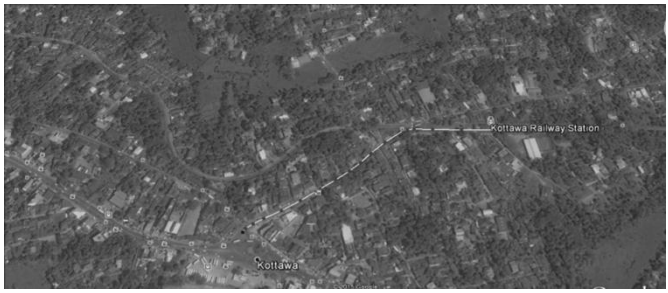


Fig. 04: Distance between Kottawa station and the city.

Source: Google earth

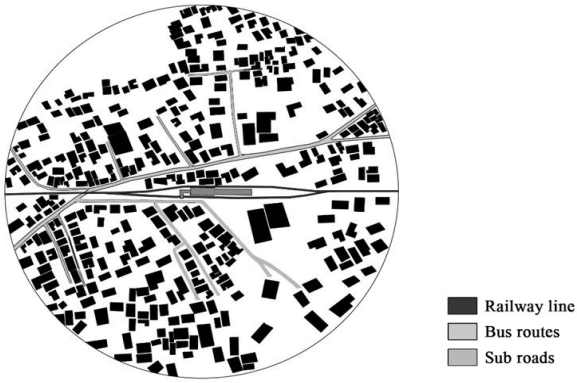
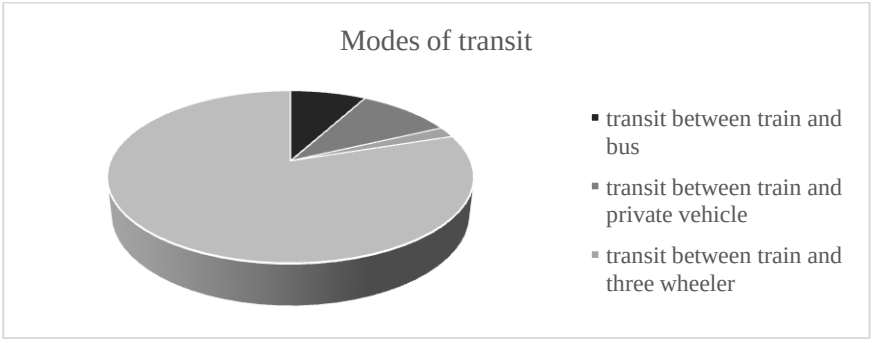


Fig. 05: Kottawa station and the surrounding neighborhood.

There is no direct access from the bus to the railway station and other sub roads leading towards the railway station come from residential areas.

- Daily passenger volume of the station – 850



NODE INDEX

[NQ] α [PT1 + PT 2 + PT3] x 100/2

[NQ Kottawa] α [(4/50) + (5/50) + (1/50)] x 100/2

[NQ Kottawa] α [20]

Fig.06: Modes of transit in Kottawa railway station

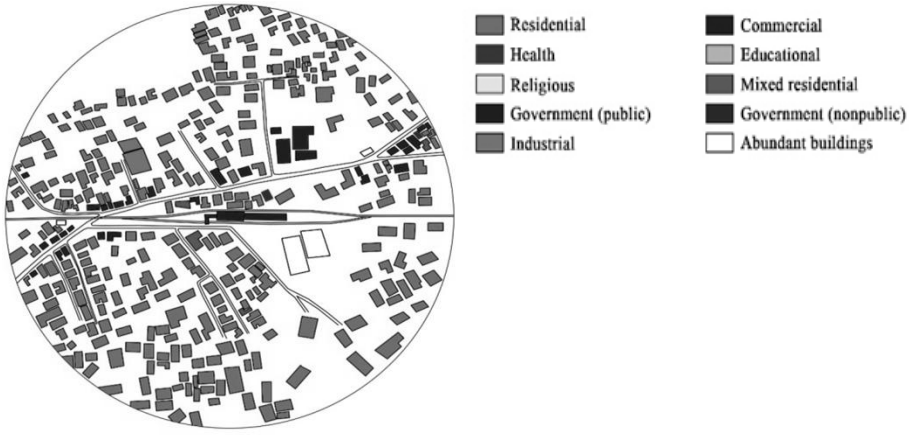


Fig. 07: Building use pattern within the 250m radius area of Kottawa railway station

Within the study area most of the buildings are residential and they have a small amount of commercial building and the surrounding functions did not affect to the functions of the railway station.

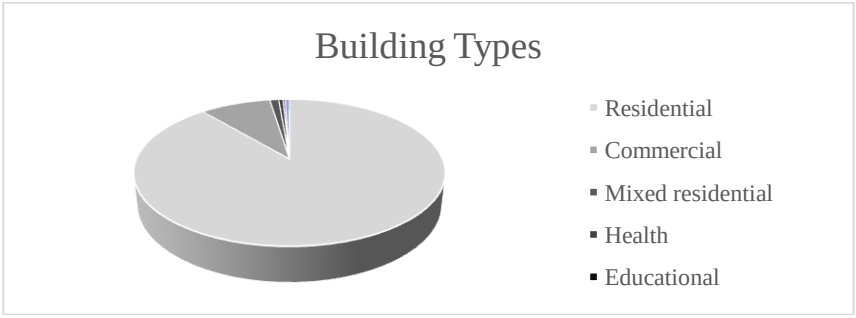


Fig. 08: Building use variation in Kottawa railway station area

PLACE DIVERSITY INDEX;

[PQ] α [(N non res B) x (NT)]
[PQ Kottawa] α [41 x 6]
[PQ Kottawa] α [246]

LOCATION INDEX;

[LQ] α [(1000/ (D)]
[LQ Kottawa] α [1000 / 495] [LQ Kottawa] α [2.02]

Even the area has a mixed development; compared to the residential activity the other developments are insignificant. The surrounding functions are not focusing on the station related activities and the station is not highlighted as an important building in the context.

2.2 CASE STUDY TWO: *PANNIPITIYA RAILWAY STATION*

Daily passenger volume of the station - 900

Node Index	[NQ] α [PT1 + PT 2 + PT3] x 100/2
	[NQ Pannipitiya] α [(24/50) + (5/50) + (9/50)] x 100/2
	[NQ Pannipitiya] α [76]
Place Diversity Index	[PQ] α [(N non res B) x (NT)]
	[PQ Pannipitiya] α [120 x 6]
	[PQ Pannipitiya] α [720]
Location Index	[LQ] α [(1000/ (D)]
	[LQ Pannipitiya] α [1000 / 585]
	[LQ Pannipitiya] α [1.71]

2.3 CASE STUDY THREE: *MAHARAGAMA RAILWAY STATION*

Daily passenger volume of the station - 1250

Node Index	[NQ Maharagama]	α	[(34/50) + (7/50) + (3/50)] x 100/2
	[NQ Maharagama]	α	[88]
Place Diversity Index	[PQ Maharagama]	α	[340 x 7]
	[PQ Maharagama]	α	[2380]
Location Index	[LQ Maharagama]	α	[1000 / 150]
	[LQ Maharagama]	α	[6.66]

2.4 CASE STUDY FOUR: *NAWINNA RAILWAY STATION*

Daily passenger volume of the station - 500

Node Index	[NQ Nawinna]	α	[(20/50) + (10/50) + (4/50)] x 100/2
	[NQ Nawinna]	α	[68]
Place Diversity Index	[PQ Nawinna]	α	[108 x 7]
	[PQ Nawinna]	α	[756]
Location Index	[LQ Nawinna]	α	[1000 / 350]
	[LQ Nawinna]	α	[2.85]

2.5 CASE STUDY FIVE: *UDAHAMULLA RAILWAY STATION*

Daily passenger volume of the station - 250

Node Index	[NQ Udahamulla]	α	[(12/50) + (6/50) + (9/50)] x 100/2
	[NQ Udahamulla]	α	[54]
Place Diversity Index	[PQ Udahamulla]	α	[25 x 6]
	[PQ Udahamulla]	α	[150]
Location Index	[LQ Udahamulla]	α	[1000 / 1175]
	[LQ Udahamulla]	α	[0.85]

2.6 CASE STUDY SIX: *PANGIRIWATHTHA RAILWAY STATION*

Daily passenger volume of the station - 300

Node Index	[NQ Pangiriwaththa]	α	[(4/50) + (6/50) + (2/50)] x 100/2
	[NQ Pangiriwaththa]	α	[24]
Place Diversity Index	[PQ Pangiriwaththa]	α	[90 x 6]
	[PQ Pangiriwaththa]	α	[540]
Location Index	[LQ Pangiriwaththa]	α	[1000 / 260]
	[LQ Pangiriwaththa]	α	[3.85]

2.7 CASE STUDY SEVEN: *NUGEGODA RAILWAY STATION*

Daily passenger volume of the station - 2900

Node Index	[NQ Nugegoda]	α	[(23/50) + (8/50) + (5/50)] x 100/2
	[NQ Nugegoda]	α	[72]
Place Diversity Index	[PQ Nugegoda]	α	[245 x 7]
	[PQ Nugegoda]	α	[1715]
Location Index	[LQ Nugegoda]	α	[1000 / 200]
	[LQ Nugegoda]	α	[5]

2.8 CASE STUDY EIGHT: *KIRULAPONA RAILWAY STATION*

Daily passenger volume of the station - 800

Node Index	[NQ Kirulapana]	α	[(3/50) + (10/50) + (14/50)] x 100/2
	[NQ Kirulapana]	α	[54]
Place Diversity Index	[PQ Kirulapana]	α	[68 x 6]
	[PQ Kirulapana]	α	[408]
Location Index	[LQ Kirulapana]	α	[1000 / 1540]
	[LQ Kirulapana]	α	[0.65]

2.9 CASE STUDY NINE: *NARAHENPITA RAILWAY STATION*

Daily passenger volume of the station - 1100

Node Index	[NQ Narahenpita]	α	[(15/50) + (12/50) + (5/50)] x 100/2
	[NQ Narahenpita]	α	[64]
Place Diversity Index	[PQ Narahenpita]	α	[191 x 8]
	[PQ Narahenpita]	α	[1528]
Location Index	[LQ Narahenpita]	α	[1000 / 590]
	[LQ Narahenpita]	α	[1.69]

2.10 CASE STUDY TEN: *COTTA ROAD RAILWAY STATION*

Daily passenger volume of the station - 1000

Node Index	[NQ Cotta Road]	α	[(24/50) + (8/50) + (6/50)] x 100/2
	[NQ Cotta Road]	α	[76]
Place Diversity Index	[PQ Cotta Road]	α	[98 x 8]
	[PQ Cotta Road]	α	[784]
Location Index	[LQ Cotta Road]	α	[1000 / 500]
	[LQ Cotta Road]	α	[2]

3.0 Observations

The selected railway-stations can be classify into, main three groups according to the location and distance to the town center or main commercial hub. Railway in an urban center (eg.Maharagama, Nugegoda) performs differently to a station in the periphery (eg. Narahenpita, Cotta Road, Pannipitiya, Pangiriwaththa, Kottawa, Navinna) or a station in suburban neighborhoods or countryside (eg.Udahamulla, Kirulapana). Table 1 discloses a summary of index values and passenger number for the selected case studies.

Table 1 – Performance of Railway station according to Node, Location and Place Diversity indexes

Railway Station	**Passenger Volume**	**Node index**	**Location index**	**Place Diversity index**
Kottawa	850	20	2.02	246
Pannipitiya	900	76	1.71	720
Maharagama	1250	88	6.66	2380
Navinna	500	68	2.85	756
Udahamulla	250	54	0.85	150
Pangiriwatta	300	24	3.85	540
Nugegoda	2900	72	5.00	1715
Kirullapona	800	54	0.65	408
Narahenpita	1100	64	1.69	1528
Cotta Road	1000	76	2.00	784

Two main performative parameters for railway stations can be derived through incorporating the passenger volume as criteria indicative of a successful achievement. Accordingly the station ability to be function as an efficient transport node is considered as one performative parameter and it has been calculated by multiplying the values of node index and number of passenger volume. The second performative parameter is the station's ability in generating diverse urban place. This has been calculated by multiplying the values of place diversity index and the number of passenger volume.

Table 2 – Performance criteria calculation for the selected railway stations

Railway Station	**Passenger Volume (V)**	**Node index (NI)**	**(V)x(NI) /1000**	**Passenger Volume (V)**	**Place Diversity index (PI)**	**(V)x(PI) /1000**
Kottawa	850	20	17	850	246	209
Pannipitiya	900	76	68	900	720	648
Maharagama	1250	88	110	1250	2380	2,975
Navinna	500	68	34	500	756	378

Udahamulla	250	54	13	250	150	37
Pangiriwatta	300	24	7	300	540	162
Nugegoda	2900	72	208	2900	1715	4,973
Kirullapona	800	54	43	800	408	326
Narahenpita	1100	64	70	1100	1528	1,680
Cotta Road	1000	76	76	1000	784	784

From the selected case studies as indicated in the table 3, Nugegoda railway station preformed as the best in both categories followed by Maharagama railway station. Pangiriwaththa station performed as the weakest as a transport node followed by Udahamulla railway station. Of the perfomative parameter ranking in generating diverse urban place, Udahamulla railway station ranked last behind Pangiriwaththa station.

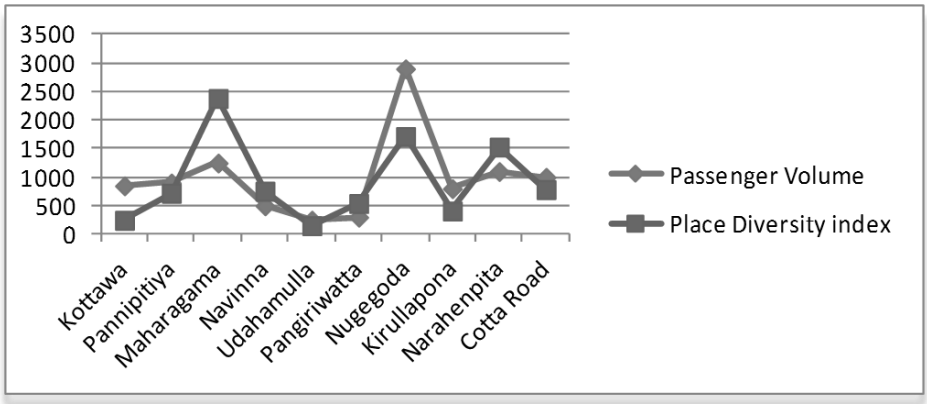
Table 3 – Ranking of selected railway stations according to the performance criteria

	Performance of the railway station as a transport node		**Performance of the railway station in generating diverse urban place**
1	Nugegoda	1	Nugegoda
2	Maharagama	2	Maharagama
3	Cotta Road	3	Narahenpita
4	Narahenpita	4	Cotta Road
5	Pannipitiya	5	Pannipitiya
6	Kirulapana	6	Nawinna
7	Nawinna	7	Kirulapana
8	Kottawa	8	Kottawa
9	Udahamulla	9	Pangiriwaththa
10	Pangiriwaththa	10	Udahamulla

Another important finding is that all three indexes are positively responded to passenger volumes throughout the selected study area which can be observed in charts 01, 02 and 03. As indicated in chart 03, passenger volume is highest in the stations located in the town centers and lowest at the

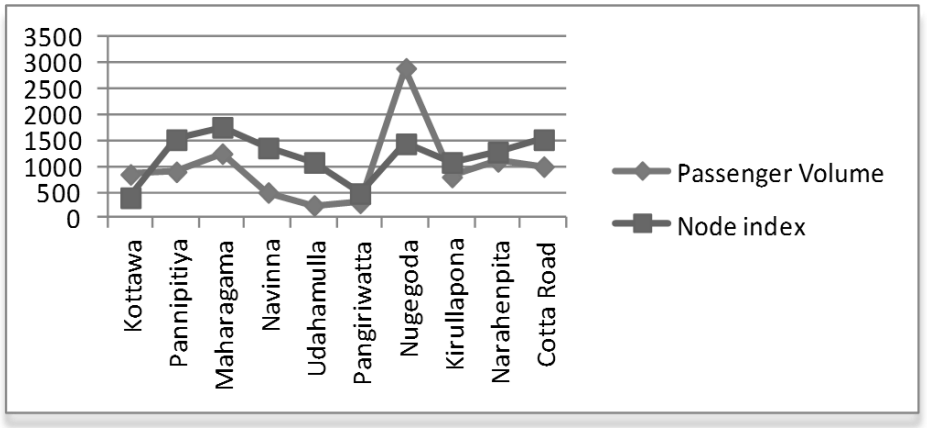
sub-urban areas. Since the railway stations were formation catalyst for these urban centers, it can safely assumed that the variety of urban activities, uses and functions concentrated in the surrounding area, caused the place diversity pattern indicated on chart 01.

Chart 01: Passenger Volume vs Place Diversity index



This study also demonstrated that when stations are well connected with the other modes of transit the passenger volume increases as indicated in chart 02.

Chart 02: Passenger Volume vs Node index



It should be also noted that Kirulapana station has ranked high as a transportation node due to the high demand from commuters to the neighboring Open University premises in Nawala, even though it is located reasonable distance away from the town center.

Chart 03: Passenger Volume vs Location Index

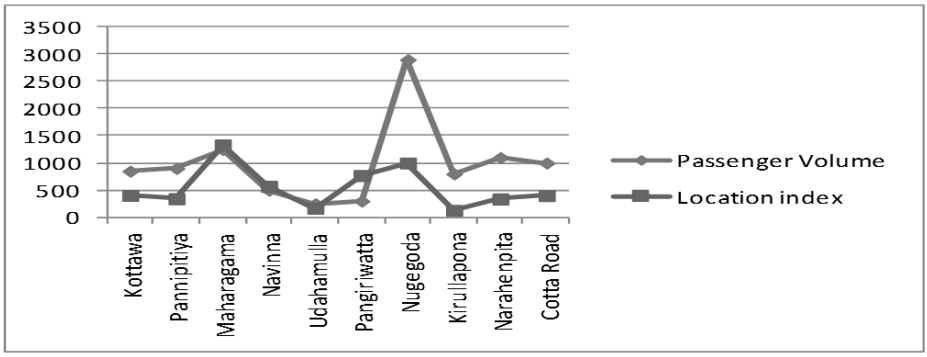
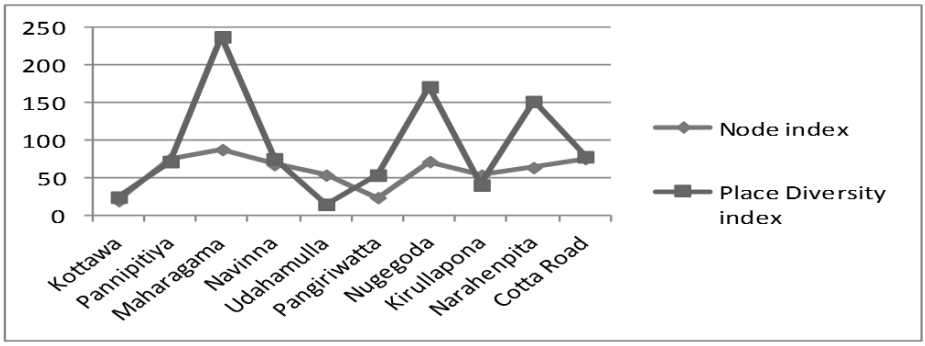


Chart 04: Place Diversity Index vs Node Index



4.0 Conclusion

A railway station placed in an urban center performs differently to a station in the periphery or a station in suburban neighborhoods or countryside. There are many factors to consider when establishing of new railway station or redeveloping of an existing railway station.

When the railway station is located in the city center it has a significant potential to develop as proper "Transport Nodes" and "Diverse Urban Public Places". When the distance between the railway station and the city increases, it shows the remoteness from the development.

When the cities become smaller the location of the station has a high potential to be, in the periphery of the city. Even though if a station is proposed for the periphery of a city, it should be locate in a place, which has high pedestrian accessibility and also has access through the other modes of transportations. The location should provide incentives and stimulus to the commuters to be at the station, so there should have diversified activities within the immediate surroundings.

Four potentials strategies to mitigate, the frequent inadequacies identified during the research, recommended below, which can be applied during design task for establishing of new railway stations or redevelopment of existing stations.

- Transform the station itself into multimodal hubs including bus station, taxi ranks and car parks. (This strategy focuses on increasing the performative parameter based on the 'Node index' value.)

- To reduce the barrier effect and enhance the visual relationship with the city center. (This strategy focuses on minimizing the effect by 'location index' by increasing the visual proximity.)

- Transform the station itself into multifunctional place including shopping and recreational activities. (This strategy focuses on increasing the performative parameter based on the 'Place diversity index' value.)

- Involve of wider area other than the station itself in the development activities. (This strategy focuses on increasing the performative parameter based on the 'Place diversity index' value.)

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