Nature Based Solutions for urban planning

Table of contents / *Sommario*

Nature Based Solutions for urban planning

Sommario

Understanding mass rapid transit system related urban development of existing core areas in a city: case study of Kolkata

Abhiroop Das, Sanjib Nag

Abstract

Mass Rapid Transit System (MRTS) has created a significant impact on urban development in the core areas of cities throughout the world, and has been running along the movement corridors, especially in and around these areas resulting in a deterioration of the overall urban environment. It has also become evident that, in these core areas of the cities, mostly in the developing countries, like Kolkata, these developments have been largely uncontrolled, sporadic and piecemeal in nature, creating haphazard and chaotic spatial/ physical environment, primarily influenced by unregulated market forces.As a result, these core areas require immediate intervention to rectify the problems, as well

Fig. 1 – Uncontrolled & sporadic developments taking place near Metro Rail Station Areas
Source: Author, 2020

as to arrest any further deterioration of the spatial /physical environments. However, in cities like Kolkata, these interventions are based on conventional Urban Planning paradigm, and so far have failed to address the situation properly. Thus an investigation of the impact of MRTS on these core areas is required to understand these developments which are generally occurring in an intermittent manner, thereby formulating necessary recommendations from an urban design viewpoint. Accordingly, in this paper an attempt has been made to thoroughly understand the said impact, primarily from an Urban Design viewpoint in order to guide these developments in the desired direction.

Keywords:

Mass Rapid Transit System (MRTS), urban development, core Area, Kolkata

Comprendere lo sviluppo urbano correlato al sistema di trasporto rapido di massa delle aree centrali esistenti in una città: il caso studio di Calcutta

Il Mass Rapid Transit System (MRTS) ha creato un impatto significativo sullo sviluppo urbano nelle aree centrali delle città di tutto il mondo e ha corso lungo i corridoi di movimento, specialmente all'interno e intorno a queste aree, comportando un deterioramento dell'ambiente urbano complessivo. È anche diventato evidente che, in queste aree centrali delle città, soprattutto nei paesi in via di sviluppo, come Calcutta, questi sviluppi sono stati in gran parte incontrollati, sporadici e di natura frammentaria, creando un ambiente spaziale/fisico casuale e caotico, influenzato principalmente da forze di mercato. Di conseguenza, queste aree centrali richiedono un intervento immediato per correggere i problemi, nonché per arrestare qualsiasi ulteriore deterioramento degli ambienti spazio/fisici. Tuttavia, in città come Calcutta, questi interventi si basano sul paradigma di pianificazione urbana convenzionale e finora non sono riusciti ad affrontare adeguatamente la situazione. Pertanto, è necessaria un'indagine sull'impatto di MRTS su queste aree centrali per comprendere questi sviluppi che generalmente si verificano in modo intermittente, formulando così le raccomandazioni necessarie dal punto di vista della progettazione urbana. Di conseguenza, in questo lavoro si è cercato di comprendere a fondo tale impatto, principalmente da un punto di vista di Urban Design, al fine di guidare questi sviluppi nella direzione desiderata..

Parole Chiave:

Mass Rapid Transit System (MRTS), sviluppo urbano, Core Area, Kolkata

Understanding mass rapid transit system related urban development of existing core areas in a city: case study of Kolkata

Abhiroop Das, Sanjib Nag

1. Introduction

1.1 Background

Throughout the World, Mass Rapid transit system (MRTS), has been operating, along crucial and well developed movement corridors, mostly in and around the core areas of the developed cities, thereby creating significant impact on urban spatial/physical development and bringing significant increase in transport, trade and commerce.

It has also become apparent that, in these core areas of the cities, mostly in the developing countries, these developments have been largely anarchical, discontinuous and piecemeal in nature, creating haphazard and chaotic spatial environment, influenced by unstructured market forces.

Hence, intervention is necessary to rectify this lacuna and to apprehend further deterioration of this environment.

However, in cities like Kolkata, these investigations have been carried out by only few public institutions, that have only delineated the actual impact zones, without proper analysing the nature of the impact. Due to this fact, the strategies and recommendations that have been formulated are ad hoc in nature, or disarticulated renewals, based on formal planning epitome, which have failed to address the situation in a proper direction.

In this perspective, the said research work has been undertaken and an attempt has been made to thoroughly understand the said impact, primarily from an Urban design viewpoint in order to guide these developments in the desired direction.

Now, to make this attempt successful, the important aspects of the research work has been defined theoretically and their parameters and sub parameters has been identified.

As this research work focuses on the process of urban development in the core areas of the city of Kolkata due to the impact of MRTS, a detail study has been conducted on the same, based on specific parameters and sub parameters and relevant Urban Design strategies and recommendations has been formulated in order to identify issues, contributions and areas of future investigation.

In this context, the main objectives of this research work mainly deals with defining important aspects of research work and identifying related parameters and sub parameters. Studying in detail MRTS related Urban development of existing Core areas of Kolkata based on these parameters and sub parameters and formulating strategies and recommendations for selected study areas of Kolkata considering these parameters and sub parameters.

However, the impact of MRTS on Urban Development of existing Core areas, encompasses complex issues and composite variables. As a result, investigating the impact on Urban Developments of Core areas of cities in all related contexts, throughout the world, may vary and is beyond viability considering the significance of this research work.

Thus, the unaddressed issues and variables have been taken into consideration and the scope of this research work has been focussed on only the impact of only underground type of MRTS on Urban Developments of Core Areas including the spatial/ physical attributes of Urban Developments primarily from an Urban Design viewpoint.

Accordingly, in this paper an attempt has been made, to understand the said impact with more limpidity in a structured and sequential manner.

2. Discussion

2.1 Literature Study Throughout the World

Mass Rapid Transit System (MRTS) is one of the most popular modes of public transportation used to address transportation issues in cities around the world. As a result, a rapid structure of improved connectivity and mobility causes dynamic shifts in a city's overall urban growth trend.

Urban Development is the method of expansion of an area within a city or town, or having similar characteristics, is known as urban development. It has physical and spatial characteristics as well as natural, economic, social, cultural, and political manifestations.

Core Area of a city is essentially the middle portion of the city or metropolis, and has a high population density. Furthermore, it has a high concentration of spatial and physical growth.

Fig. 2 – Mass Rapid Transit System
Source: www.google.com, 2020

Kolkata is a north-south linear city with the Hooghly River on the west and wetlands on the east. It is India's largest metropolis in terms of size, despite being a colonial capital.

In the early 1990s, public transportation in Kolkata was severely restricted, prompting the introduction of the underground MRTS, also known as the Kolkata Metro Rail, which has been in operation since 1985.

According to the available literature studies, MRTS has a substantial effect on urban spatial and physical growth.

Many experiments and studies have been undertaken across the world, focusing on the key aspects of the literature studies mentioned earlier, to study urban planning due to the influence of MRTS in a holistic way, by several well-known urban designers and planners.

Fig. 3 – MRTS as principal mode of transportation
Source: www.google.com, 2020

Fig. 4 – Urban development
Source: www.google.com, 2020

Fig. 5 – Developed city
Source: www.google.com, 2020

Fig. 6 – Core Area
Source: www.google.com, 2020

Fig. 7 – Central part of a city
Source: www.google.com, 2020

It has already been accepted that, there is a symbiotic relationship between the transit systems and a particular form of urban development and the two support each other and need each other. (Black A., 1995).

In today's context, much of urban design involves fitting the transit systems to the existing spatial / physical environment of a city. (Lang J., 1994).

It has also been stated that MRTS produces a large number of passengers who can travel to different areas of a region, which has an impact on their movement patterns.

This, in particular, has an effect on pedestrians in terms of delivery and associated events. Again, from the perspective of Urban Design & Planning, in a built community, all types of operations have been identified as a dominant closed trait known as spaces, and all spaces are enclosed with the use of forms.

The volume of both motorized and non-motorized vehicular movements especially in urban cores, triggers more accessibility for public transportation to operate freely in and around the Metro station areas. (Malcolm Cachia., 2017).

It has been also found that, the Mass Rapid Transit Station influenced areas, have been defined as the conjugation of the census parcels, near the station areas and these areas have been accepted and widely used as the mean walking distance especially for the volume of pedestrian movements to reach the stations. (Landis., 1995, Papa E., 2007).

From the studies it can be ascertained that, there is a generic increase in land value and also overall change in the activity pattern in terms of change in land use pattern near the Metro station areas, especially in the central areas of cities, and the property value is considered to be higher in the core areas than in other areas. (Papa E., 2007).

Rail based urban transit system have the potential to increase drastically the land values /prices , located in the core areas, and efficiently shaping the urban structure of these areas.(Peitong Zhang et al., 2014).

Studies indicate that more density of urban forms around Metro Stations in the central areas, can somewhere give rise to linear as well as radial pattern of development with increased mobility, in terms of spatial characteristics. (Yang et al, 2012, Zhao., 2011).

There is a general increase in land value near the Metro Station Areas, especially in the core areas, in terms of intensity of spaces and also increase in the property values as compared to other urban areas. (Papa E., 2007).

The densification of the land use has started to emerge in terms of increase in building heights in the immediate vicinity of Metro Stations, mainly in the core area of developed cities, thereby drastically changing the skyline, due to the variation of the built forms. (Gupta S., 2016).

Through previous studies, it has been observed that MRTS plays a significant impact on the high rise high density urban forms as well as transformations in the urban fabric, thus changing the architectural image near the Metro Rail Station Areas. (Pan, Shen & Zhang., 2009 & Srinivasan S., 2010).

Accordingly, these studies have ultimately established the fact that, MRTS induced spatial / physical urban development can be articulated into 4 distinct parameters,

namely Movements, Activities, Spaces and Forms.

Again, with reference to the theoretical study as well as logical analysis, these 4 distinct parameters can be further subdivided into other sub parameters from an Urban Design view point, which can be established as follow:
• Movements in terms of Volume of public and private vehicles as well as Volume of pedestrians, in and around Metro Rail Station Areas.
• Activities in terms of Land use and Locations of residential, commercial and others such as institutional as well as recreational, in and around Metro Rail Station Areas.
• Spaces in terms of Land values and Patterns in and around Metro Rail Station Areas.
• Forms in terms of Skyline and High rise and density in and around Metro Rail Station Areas.

Fig. 8 – City Of Kolkata
Source: www.google.com, 2020

2.2 On Site Study

It has been already discussed earlier that, MRTS has created a significant impact on the urban fabric, especially in the core areas of the linear city of Kolkata, thereby bringing certain changes in the activity patterns and overall physical environment.

MRTS is now present in over 100 cities around the world, including Kolkata. In this city, the underground MRTS already runs along large and well-developed movement corridors in the north-south direction, with the majority of stations located on well-developed existing operation nodes.

In this regard, 4 different Metro Rail Station Areas have been selected for the onsite study, which are situated in the core areas of Kolkata. They areas follow:

Fig. 9 –Kolkata City
Source: www.google.com, 2020

- MG Metro Rail Station Area
- Central Metro Rail Station Area
- Maidan Metro Rail Station Area
- Rabindra Sadan Metro Rail Station Area

These selected stations mentioned above are situated in the underground part of the Kolkata Metro Rail and have been situated geometrically and functionally along the north-south movement corridors along the important activity nodes of the core area of the city of Kolkata.

In these selected Metro Rail Station Areas stated above, MRTS have been running for more than 34 years, and as a result, the changes in the overall urban development process, due to the impact of the MRTS are already evident.

In this perspective, in this research work, the said investigation has been carried out, through Urban Design based visual survey as well as physical survey, mainly concentrating on these basic parameters and sub parameters discussed earlier.

As this research is focussed on the impact of MRTS on the core areas of the city of Kolkata, the inner impact areas of all the 4 Metro Rail Station Areas have been considered

which are immediately in and around the main activity nodes, with high concentration of vehicular traffic along the major north- south and east- west movement corridors of the selected Metro Rail Station Areas mentioned earlier.

Accordingly, based on the datas that have been collected while conducting the survey of the selected Metro Rail Station Areas of Kolkata, the most important observations and the subsequent analysis are as follows:

In terms of Movement,

• A large Volume of public and private vehicles have been generated especially during the peak hours and also in the off peak hours which are approximately 14420 nos. per hour & 7160 nos. per hour mainly along the north –south direction and also some along the feeder vehicular movement routes.

• The feeder vehicular movements have also taken place along the important corridors running perpendicular to MRTS alignment which also created a linkage to the neighbouring residential as well as commercial areas.

• The Volume of pedestrian movements during the peak hours & off peak hours have been found to be approximately 11400 nos. per hour & 5780 nos. per hour with the formation of smaller loops in some areas where well defined activity nodes are located.

In terms of Activities,

• In terms of Land use, it has been found that the commercial activities have increased significantly in the context of overall land use. The commercial activities ranges up to 75% of which especially the informal shops holds good as compared to the formal shops, followed by residential activities up to 15% and other activities by 10%. respectively.

• The commercial activities in the form of high order retails have come up and are situated along the main arterial road, which are close to the station areas, whereas the lower order retails have also developed long the connecting feeder corridors, away from the station points.

• In terms of Locations, as found in the survey, there are approximately 50 nos. both Multiple ownership and Single ownership that have come up along with 120 nos. of shops, mostly informal in nature, situated along the spine in linear formation,

Fig. 8 – The Kolkata Metro Rail network
Source: www.google.com, 2020

followed by 7 nos. of institutional buildings following a linear pattern along the road, near Metro Rail Station Area.

In terms of Spaces,

• The existing urban structure has changed drastically, due to the sporadic and chaotic real estate activities in and around the station points.

• There has been drastic change in the overall land value of residential, commercial as well as other activities. The Land Value has been found to be around 17,000 per sqft.for residential, followed by commercial that is around 23,800 per sqft. and others around 15,800 per sq. ft.

• There have been characteristic transformations in terms of Patterns on either side of the Metro Rail alignment. The commercial as well as residential activities have been found to be mostly Linear pattern by almost 70% and Radial pattern by 30%.
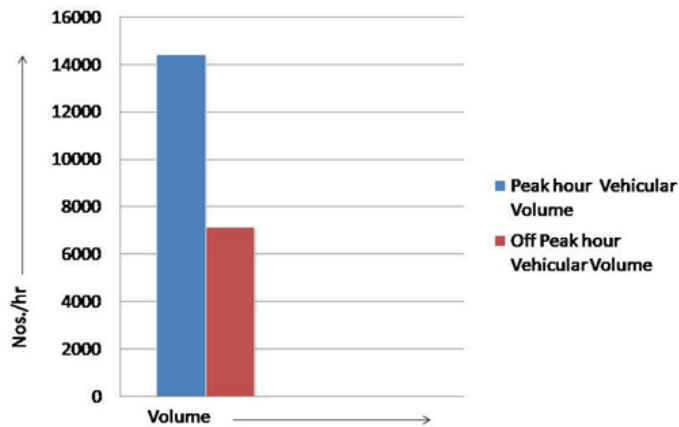
In terms of Forms,

Fig. 9 – Volume of Vehicular Movement
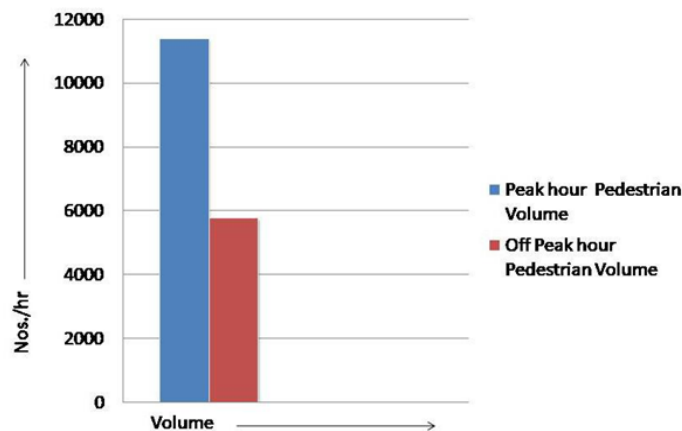*Source:Author, 2020*

Fig. 10 – Volume of Pedestrian Movement
Source:Author, 2020

- The transformation of the height of the buildings along the arterial road, are significant in and around the station areas.

- The new buildings that have come up, have drastically transformed the existing skyline. The building height has been found to be 18m average for residential buildings, 3m for commercial buildings & 12m for institutional buildings respectively, resulting in a higher concentration of chaotic development of built forms.

- The overall space form relationship, which was predominantly low rise high density condition, has changed into high rise high density, thereby adulterating the overall image of the areas. The high rise high density built forms have increased by 65% as compared to other low rise built forms.

As discussed earlier, based on these observations and analysis of the 4 Metro Rail Station Areas, situated in the core area of the city of Kolkata, it has been found that, all these station areas shows significant increase in commercial activities as compared to residential and other activities.

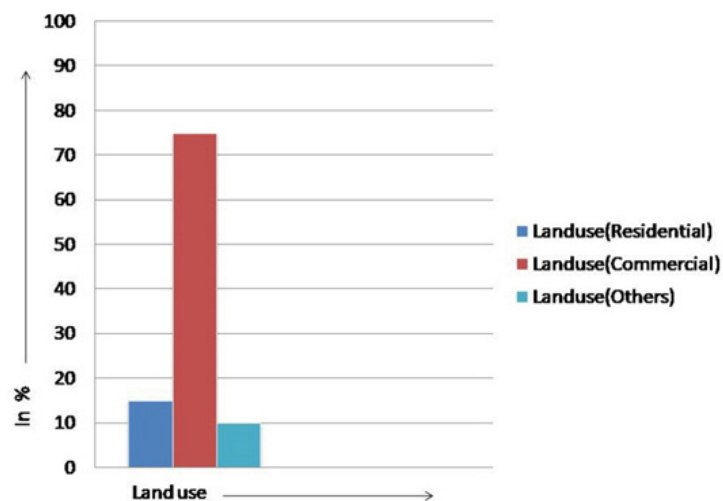Further, in this particular research work, Multiple Linear Regression Model using

Fig. 11 – Land use of Residential, Commercial & Others
Source:Author, 2020
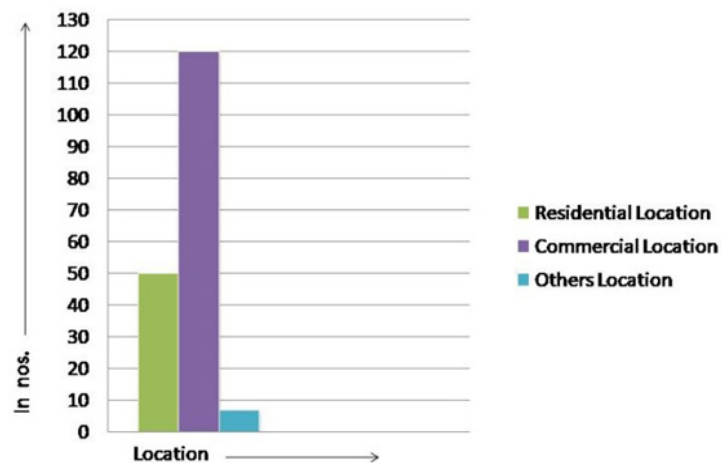

Fig. 12 – Location of Residential, Commercial & Others
Source:Author, 2020

the MATLAB programming, has been found relevant and thus has been considered to
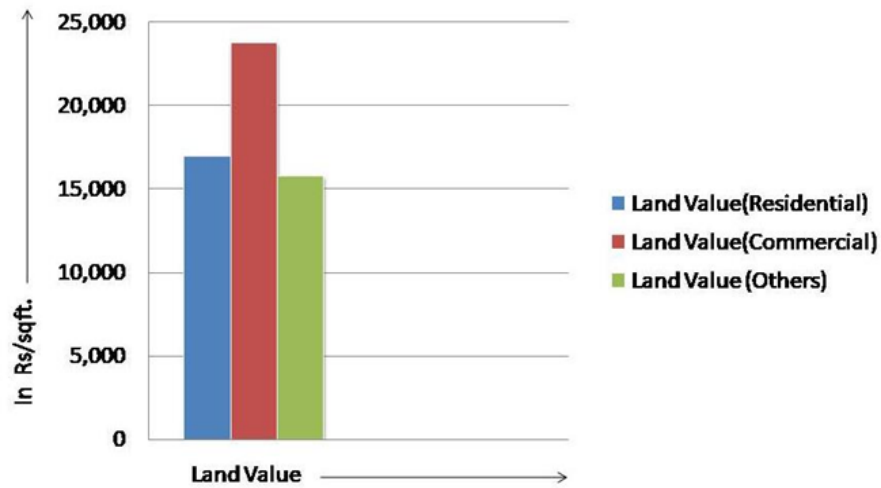

Fig. 12 – Land Value of Residential, Commercial & Others
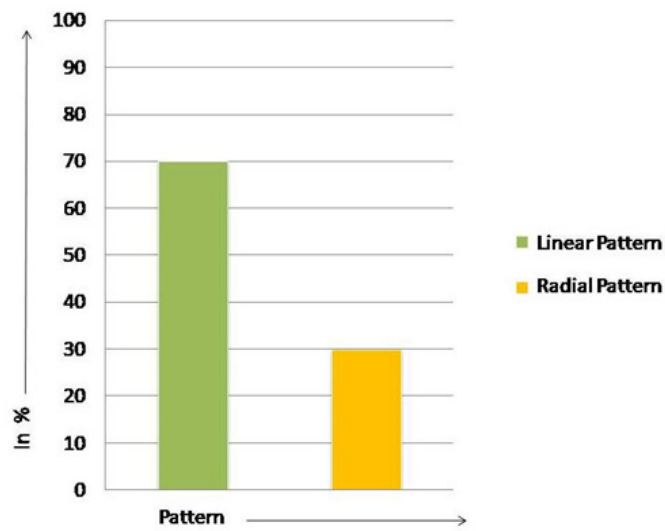*Source:Author, 2020*

Fig. 13 – Linear & Radial Pattern
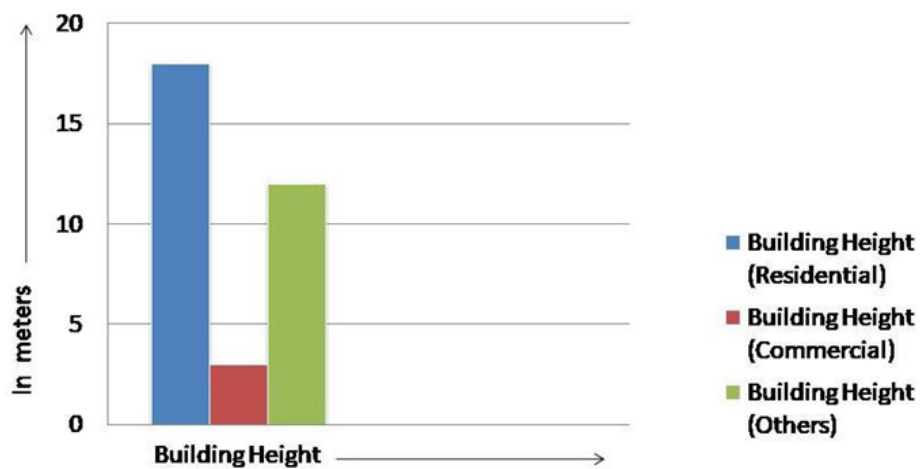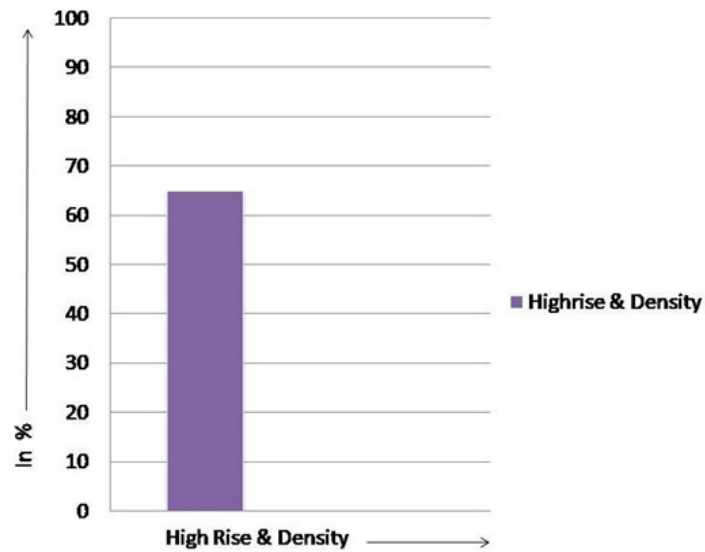*Source:Author, 2020*

Fig. 14 – Building Height of Residential, Commercial & Others
Source:Author, 2020

Fig. 15 – High Rise & Density
Source:Author, 2020

validate the observations based on the data collected from the survey.

Accordingly, the generic model equation has been derived as follow:
$y = a_0 + a_1 * A + a_2 * B$,

where y is the distribution of area around Metro Rail Stations.
a_0 be the y intercept.

A & B are the independent variables
a_1 & a_2 are regression coefficients associated with independent variables A & B respectively.

The 2 independent variables namely Land use and Location have been considered to be the impactful variables for this particular research work, to conduct the statistical analysis.

y is the distribution of area around Metro Rail Stations and it contains 4 datasets consisting of Residential, Commercial, Institutional as well as Recreational activities.
Now, based on the Observations related to Activities of 4 Metro Rail Station Areas, the sum total & average values for Land use and also for Location of main arterial roads situated in the north south as well as east west direction has been considered & subsequently their percentage has been evaluated.

Again, based on the evaluation, the Commercial activities have been found to be 70.51%, whereas the Residential has been 24.04% and other Activities are 5.45 % respectively.
Now, the Multiple Linear Regression has been applied, to predict the dependent variable (Y). Further, the program has been run, over the relevant datasets, using

MATLAB programing which is as follow:

```
clc
close all
clear all
A=[17.5;72.5;10;0];
B=[24.04;70.51;5.45;0];
y=[20.76;71.51;7.73;0]
scatter3(A,B,y, 'filled')
hold on
n=length(A);
o=ones(n,1);
x=[o A B]
b=regress(y,x)
A=0:10:100;
B=0:10:100;
y=b(1)+b(2)*A+b(3)*B
plot3(A,B,y)
```

The following Results s follows:

```
x =   1.0000  17.5000   24.0400
      1.0000  72.5000   70.5100
      1.0000  10.0000    5.4500
      1.0000   0         0
```

where x is the matrix of order 4X3 of 4 observations of 2 explanatory variables

```
b =   -0.0010
      0.5014
      0.4986
```

where b is the regression coefficient

```
y =   20.7605
      71.5098
       7.7308
      -0.0010
```

Thus, the distribution area around Metro Rail Station Area (y) for Residential is 20.76 %, for Commercial is 71.50 % , for Institutional & Recreational is7.73 % respectively.
The linear regression equation is: y = -0.0010 + 0.5014*A + 0.4986*B

Again, to understand the impact of MRTS on urban developments in a broader scale, a

further study and a comparative analysis has been conducted in a generalized manner, framing the development growth pattern of the cities where MRTS is yet to come with respect to MRTS of Kolkata.

In the mega cities of the Third World countries like Delhi, Mumbai, Chennai & Kolkata, MRTS has already been running along the important corridors in these cities, especially in the core areas, and has been already considered as one of the principal mode of public transportation system.

Now, in the eastern zone of India, like the city of Kolkata, similar type of important cities like Bhubaneswar as well as Patna has also developed. In these 2 particular cities, there is absence of MRTS, till date.

In this regard, a study has been conducted to analyse the growth pattern of the specific core areas of Bhubaneswar & Patna, with respect to the core areas of Kolkata, based on the parameters and sub parameters discussed earlier.

From the onsite / primary source of information of MG Road, Central, Maidan &

Rabindra Sadan Metro Rail Station Areas and from the offsite studies / secondary source of information of the core areas of Bhubaneswar as well as of Patna, it has been found that, there has been a comparative rise in the average growth pattern in terms of Movement, Activities, Spaces as well as Forms in Metro Rail Station Areas situated in the core areas of Kolkata as compared to core areas of Bhubaneswar as well in Patna.

It has been found that, the Metro Rail Station Areas situated in the core areas of Kolkata shows an overall rise in average growth pattern in terms of both vehicular & pedestrian Movement by 44% approximately, as compared to the core areas of Bhubaneswar.as well in Patna.

Similarly, in terms of Activities, the Land use of the residential as well as commercial activities of the Metro Rail Station Areas situated in the core areas of Kolkata ranges up to 85% & 90% whereas in the core areas of Bhubaneswar.as well as in Patna, these activities have been found to be 60% & 55% respectively.

In terms of Spaces, the Land value of the Metro Rail Station Areas situated in the core areas of Kolkata, show rise in average growth pattern in terms by 28% approximately, as compared to the core areas of Bhubaneswar as well in Patna.

In terms of Forms, the High Rise & Density of Metro Rail Station Areas situated in the core areas of Kolkata, are about 60% and 65% as compared to core areas of Bhubaneswar as well as in Patna which are 30% & 25% respectively.

2.3 Strategies & Recommendations

Again based on the observations and analysis, the most important recommendations are as follows:

•There should be adequate traffic management facilities thereby facilitating proper functioning of vehicular movements as well as their connecting loops, in terms of huge volume of public and private vehicles, which creates a linkage to the nearby magnets and generators, as well as the landmarks near the Metro Rail Station Areas.
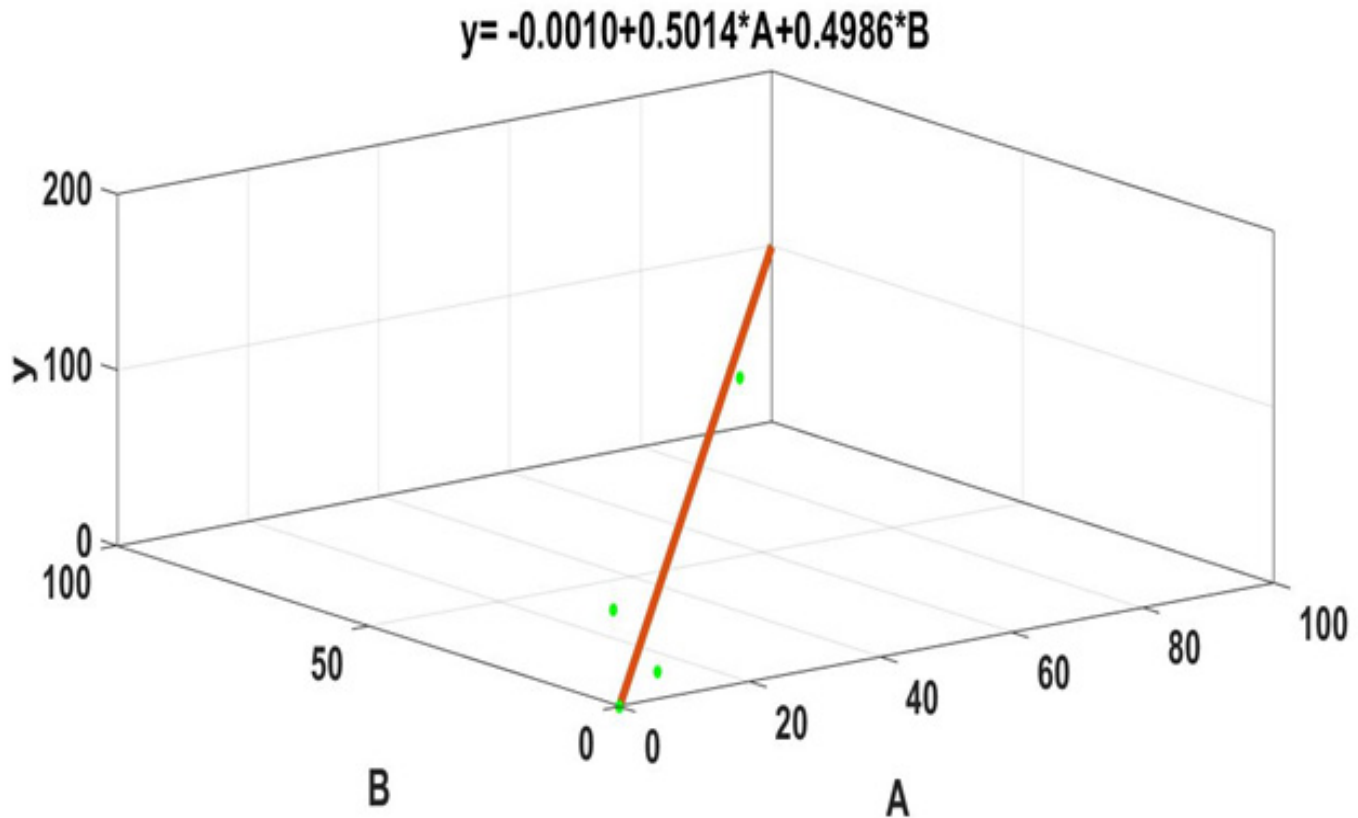
Fig. 16 – Graphical representation of the Linear Regression Model for Metro Rail Station Areas situated in the Core Areas Of Kolkata Source:Author, 2020

• There must be adequate traffic management facilities in the existing pedestrian loops to secure movements of the large volume of pedestrians which also creates a connection to the nearby magnets and generators, as well as the landmarks near the Metro Rail Station Areas.

• There should be adequate traffic management facilities, to segregate vehicular as well as pedestrian movements, especially in and around the Metro Rail Station Areas.

• The homogeneous activities in terms of land use (residential, commercial, institutional & recreational) should be recommended in such a way that it respects the character of the specific zones.

• The commercial activities, especially the informal as well as the formal shops which are situated in a chaotic manner, on either side of the Metro Rail alignment, should be located properly, along with upcoming developments of residential buildings, such that it integrates with the new developments, in and around the Metro Rail Station Areas.

• The residential developments should be wisely located in and around the Metro Rail Station Areas with the upcoming new developments.

• The multipurpose public spaces should be developed and well defined, especially in the zones dominated by the commercial activities, thereby catering the need for other activities.

•   There should be a proper mechanism of controlling the intensity of spaces in terms of rise in the land values, by incorporating certain development control regulations, in and around the Metro Rail Station Areas.

•   Proper mechanism should be followed to control the skyline of the overall urban form thereby controlling the sporadic and chaotic high rise structures that came up along the movement loops near Metro Rail Station Areas.

•   Proper mechanism should be implemented to control the overall character of the architectural image especially highlighting the high rise and density of the urban form, thereby maintaining the open space- built form relationship of the new developments that are coming up, along the movement loops near the Metro Rail Station Areas.

3. Conclusion

In this perspective, as stated earlier, based on 3 main research objectives, the contributions of the thesis are as follows:

•   Theoretically defining, studying and properly understanding MRTS, Urban developments and Core areas.

•   Identifying related parameters and sub parameters, to make a detail analytical study of the impact of MRTS on the core areas of the cities.

•   Applying the important parameters and sub parameters to conduct on site studies of the selected core areas of the city of Kolkata and accordingly making a detail analysis of these study areas.

•   Formulating Strategies and Recommendations for selected study areas thereby identifying major issues and areas of future investigations.

Thus, holistically, based on the introduction, this discussion and this conclusion of the research work, considering the 4 Metro Rail Station Areas situated in the core areas of Kolkata, as case study, it is evident that, MRTS creates a significant impact on the overall urban development process of these areas.

This particular research exercise has been conducted considering interventions in such Metro Rail Station Areas whose process of urban spatial / physical development due to the impact of MRTS has already being piece meal and chaotic in nature which can be further continued to conduct similar interventions on newly developed urban areas where MRTS corridors are yet to be proposed and thereby evolving specific urban development guidelines for those new corridors.

However, in order to understand the said impact with more clarity, further research work has to be carried upon on this particular subject matter thereby focussing on the new urban challenges in terms of increase in population, the transport system, the

congestion as well as the pollution especially in the central part of the city of Kolkata so that, in future, this would help to plan necessary interventions in these areas, thereby designing alternative proposals, in order to guide these developments in the desired direction.

REFERENCES

- Black A., 1995, Urban Mass Transportation Planning, Mc Graw-Hill
- International editions, Singapore
- Cachia M., Conference paper on Sustainable Urban Mobility,
-                  3rd CSUM, Greece, pp- 433-441, May 2016.
- Central Business District, http://en.wikipedia.org/wiki, 2019.
- Cervero R., Built Environment & Mode Choice towards a Normative Framework, Transportation Research, Part D: Transport & Environment,7(4), pp-265-284, 2002.
- Gupta S., 2016, A Study on Urban Mobility of India..
- Kolkata, http: //en.wipedia.org/wiki, 2019.
- Kolkata Improvement Trust, 1982, Report on Urban Renewal.
- Kolkata Metropolitan Development Authority, 1982, Report on Strategy for Immediate Development Freeze around MRTS Stations.
- Landis J., 1995, Rail Transit Investments, Real Estate values & Land use change:
- A Comparative Analysis of Five California Rail Transit Systems.
- Mofidi, 2007, Report on Sustainability & Energy, University of Tehran.
- Pan H, Shen Q & Zhang M., Influence of Urban form on travel behaviour in Four Neighbourhoods of Shanghai. Urban Studies 46(2), pp-275-294, 2009
- Papa E., 2007, Report on Urban Transformations & Rail station System:
- Case Study of Naples
- Peitong Z., Assessment of the Impacts of Urban Rail Transit on Metropolitan Regions using System Dynamics Model, China. Transportation Research Procedia 4,
- pp-521-534, 2014.
- Rapid Transit, http: //en.wikipedeia.org/wiki, 2019.
- Report on Exploring New Forms Of Inclusive Urban Governance, 2016, Transit Oriented Development & Sustainable Urban Planning.
- Report on Indian Economic Policy Reform, Review, 2004.
- Report On National Urban Transport Policy, 2014, New Delhi,
- Ministry Of Urban Development.
- Sausanis 2011, Report on World's Vehicle & Population & the control growth pattern.
- Singh 2005, Regional Conference on Mass Rapid Transport System for Urban areas – Opportunities & Challenges.
- Srinivasan S., Linking Travel Behaviour & Location in Chengdu, China, Transportation Research Record: Journal of the Transportation Research Board, 2193, pp-85-95, 2010.
- The Times of India, Kolkata Metro, 2010, Report on Metro & Indian Railways.
- Urban Planning, http: //en.wikipedeia.org/wiki, 2019.
- World Bank Urban Transport Strategy Review, 2002, Report on Cities on the move.
- www.google.com
- Yang et al., 2010, The Role of Economic Clusters in Improving Urban Planning Support, China.
- Zhao X et al., 2009, Seasonal and Diurnal Variations in Urban & Rural Environments in Beijing, China.

Abhiroop Das
Faculty, Department of Architecture, Om Dayal College of Architecture, Uluberia
abhirooparch76@gmail.com

Das is B.Arch (2006), Utkal Univ., Rourkela, M.Arch (2011), Jadavpur Univ., Kolkata. and Ph.D. (2020) submitted. Above 4 years of Industrial Experience and above 9 years of Teaching Experience. Present Assistant Professor, Dept. of Arch., Om Dayal College Of Arch., Uluberia

Sanjib Nag
Supervisor, Professor & Former Head, Department of Architecture, Jadavpur University, Kolkata.

Above 10 years of Industrial Experience and above 21 years of Teaching Experience. Former Head and present Professor, Dept. of Arch., Jadavpur Univ., Kolkata. Specialization in methodological parametric study and application in UD and related Urban Dev.