平成25年度研究調査プロジェクト（H2540）

インドにおける交通安全のための
コミュニティデザインに関する研究調査

報 告 書

平成26年3月

公益財団法人 国際交通安全学会
International Association of Traffic and Safety Sciences

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目　次

インドにおける交通安全のためのコミュニティデザインに関する研究調査

１．はじめに

１．１　プロジェクトの目的

本プロジェクトは，海外の研究組織とIATSSとの連携強化を目的とした「海外展開プロジェクト」の２年目として，昨年度のH2429プロジェクトに続き実施されたものである。交通死亡事故が急増しているインドの６つの都市（いずれも人口100～200万人規模）を対象に，より詳細な事故データを収集することに力点を置き，加えて以下の５つの項目にも着手した。

1)都市間の事故率の違いに関する原因分析
2)昼夜間での走行速度の差違に関する把握
3)道路・沿道空間における夜間照度の把握
4)交通死亡事故に関わるパーソナルリスクと社会的リスクの詳細分析
5)コミュニティデザインの実践に向けたコミュニティリーダー会議の立上げ

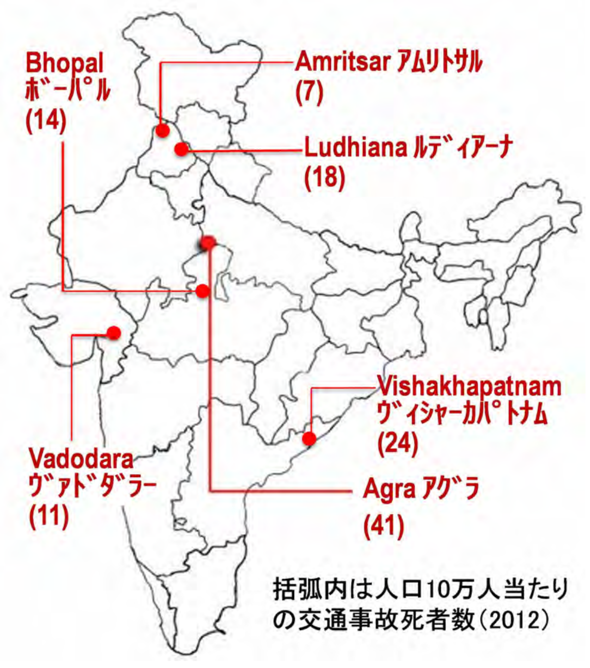


図-1　事故データの収集都市（H2429より継続）

１．２　プロジェクトの実施体制

本年度もH2429プロジェクトと同様に日印の共同研究体制の下で研究調査を実施した．日本側のメンバーは都市計画，交通工学，環境学，教育学および機械工学の専門家から構成され，インド側もそれに対応してインド工科大学デリー校（以下，IITD）の都市計画，交通工学および機械工学の専門家から構成されている．

なお，本年度は現地での詳細な事故データの収集を必要としたことから，IITD側のメンバーが中心となって調査を行うこととなった。日本側は車両の走行速度の計測や道路空間の照度計測に関する技術的な検討を行うとともに，11月26日～30日までデリーおよびアグラを訪問し，コミュニティデザインの実践に向けたコミュニティリーダー会議の準備を行った。

年度内に開催した研究打ち合わせおよびプロジェクト会議等は以下のとおりである。

① 7月 15-18日：ブラジル・リオデジャネイロ市でのWCTR 2013大会における研究打ち合わせ（土井，大口，Mohan, Tiwari）
② 9月 9-12日 ：台湾・台北市でのEASTS 2013大会における研究打ち合わせ（土井，Mohan, Tiwari）
③ 11月26日～30日：インド・デリー市でのプロジェクト会議（27日：土井，北村，梶田，佐々，Mohan, Tiwari，Mukherjee）およびアグラ視察（28日：土井，大口，梶田，佐々）
④ 3月1日：平成25年度IATSS内部報告会

２．現地調査の概要

２．１　都市間の事故率の違いに関する原因分析

交通事故率が相対的に低い都市としてルディアーナ，高い都市としてアグラを抽出し（図-1参照），以下の要因が事故率の差異に及ぼす影響を捉えた。

・周辺市街地の人口密度
・道路ネットワークおよび道路構造
・都市内の幹線道路および高速道路の比率
・事故の第一・第二当事者の構成
・事故多発地点における道路幅員および道路施設

２．２　昼夜間での走行速度の差違に関する把握

最も年間の交通事故死亡率が高いアグラを対象として，3つの道路における昼夜間の車種別の走行速度と交通量を以下の様に計測した。

・計測用のビデオカメラの設置
・ビデオデータに基づく自動二輪車，自動車，オートリクショー，バス，トラックの走行速度の平均値と分布の算出
・昼夜間での車種別走行速度の平均値および10パーセンタイル値，90パーセンタイル値の比較

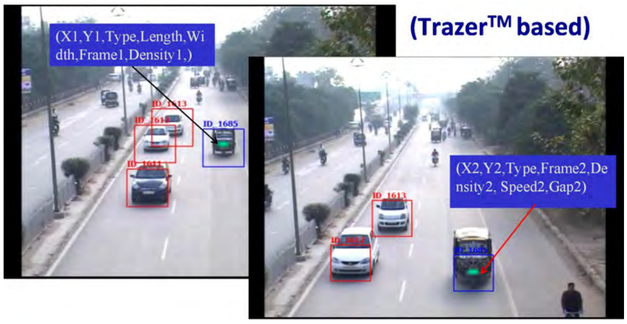


写真-1 昼間の走行速度の計測

写真-2 夜間の走行速度の計測

なお, 走行速度の計測にあたっては写真-1に示すTrazer™を活用したが，夜間の計測時には道路空間内が暗く車両を同定・追跡することが困難な状況もあったことから，照度の高い特定道路区間（写真-2）にビデオを設置し，2地点を通過する車両の画像データから走行速度を算定するという補完調査を行った。

２．３　道路・沿道空間における夜間照度の把握

上記の3つの道路の道路空間および沿道空間における照度の計測を行い（写真-3）, 基準値との比較を行った。併せて，街灯の設置・稼働状況の調査を行なった。

写真-3 道路・沿道空間での照度の計測風景

３．アグラにおける調査・分析の結果

３．１　交通事故多発地点の分析

アグラにおける交通事故の多発地点を図-2のようにプロットし，GIS分析により道路種別・構造・施設，昼夜間の交通量および周辺市街地の人口密度などとの関連を分析した。

分析の結果，国道2号線（NH2），11号線（NH11）およびマハトマガンジー道路（MG Road）が特に交通死亡事故の多い道路として抽出された。前二者は都市を貫く都市間高速道路であり，MG Roadは都市内の幹線道路である。

図-2 アグラにおける交通事故多発地点

なお, 昼夜間の交通量に関する3つの道路の特徴は以下のとおりである。

・NH2
　交通量は昼夜でほぼ同じ
　オートリクショーの減少
　自動車の割合が増加（ 19% から 31%へ）
・NH11
　交通量は昼夜でほぼ同じ
　オートリクショーの増加（ 6% から17%へ）
　自動車の割合は低下
・MG Road
　自動車の割合が増加（ 32%から49%へ）
　バイクの割合は減少（ 62%から40%へ）

３．２　昼夜間の走行速度の比較

3つの道路における昼間と夜間の車種別の走行速度の比較を示したものが表-1である。

NH2においては，オートリクショーや自動二輪車をはじめとして，車両の走行速度は昼間より夜間の方が低い傾向にある。NH11においては昼夜間での明確な速度の差違は見られない。他方，都市内の幹線道路であるMG Road においては，各車両とも夜間の走行速度の方が高い傾向が読み取れる。以上の走行速度の比較から，夜間の平均走行速度が相対的に高く，アグラの夜間の交通死亡事故の多さに対して影響を与えていると結論づけることは困難である。しかし，その一方で，NH2やMG Road においては，夜間における自動車交通量の増加が夜間の交通死亡事故の増加に寄与していることが疑われる。MG Roadにおいては，夜間に自動車の割合が17%増加（昼間：32%→夜間：49%），自動車の平均走行速度は7km/時以上も増加している。その多くは通過交通である。

表-1　昼夜間の走行速度の比較（道路・車種別）

Location	昼間速度 km/h (10%, Mean, 90%)				夜間速度 km/h (10%, Mean, 90%)			
NH2	TSR	14.5	26.4	38.3	TSR	13.7	21.6	29.5
	MTW	17.8	32.2	46.6	MTW	14.9	27.7	40.5
	Car	10.2	29.3	48.4	Car	11.0	26.9	42.9
	Truck	16.1	26.0	36.0	Truck	12.7	23.4	34.2
NH11	TSR	22.0	32.1	42.2	TSR	17.4	28.3	30.0
	MTW	19.3	32.7	46.2	MTW	19.6	33.0	34.7
	Car	20.3	29.4	38.5				
MG Road	TSR	5.5	12.0	18.4	TSR	7.5	15.7	23.8
	MTW	7.6	13.6	19.6	MTW	9.1	17.9	26.7
	Car	6.6	13.0	19.4	Car	11.5	20.5	29.5

TSR: オートリクショー，　MTW: 自動二輪車

３．３　夜間の照度と視認性の分析

図-3は対象道路における実際の照度と基準値，および街灯の設置状況を示している。

NH2やNH11においては，平均照度は10～12luxと基準値の30luxを大きく下回っている状況にあり，NH11においては街灯の設置間隔が50mと長く，街灯直下から7m離れると1luxにまで低下することが明らかにされた。

中心市街地を走るMG Roadにおいては，平均照度は20luxと基準値を上回っているものの，街灯の設置間隔が長く，街灯から離れた地点では照度が大きく低下していることが読み取れる。

上記の街灯の設置間隔に加えその稼働状況を見ると，多くの街灯が実際には機能していないか，盗難等により電球自体が存在していないという状況が散見された。

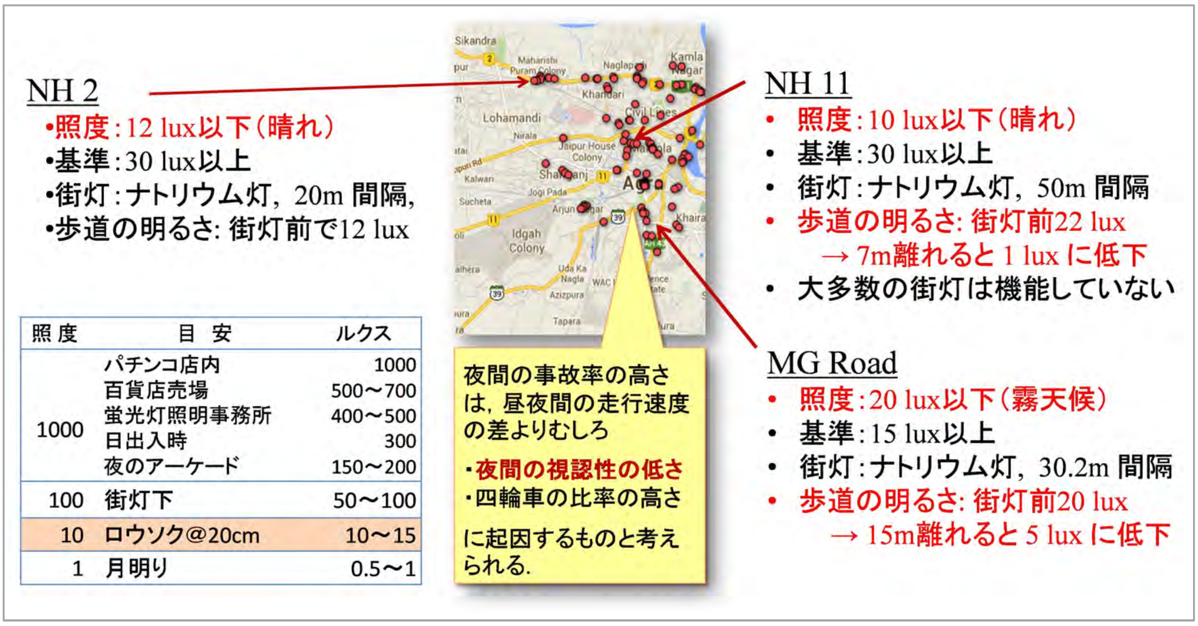


図-3　対象道路における照度と街灯の設置状況

写真-4 昼夜間での視認性の差違
（上図：昼間，下図：夜間）

道路・沿道空間における照度の不足は，写真-4に示すようにトラックや自動車の運転者から見た歩行者，自転車および自動二輪車等に対する視認性の著しい低さにつながっている。

４．　おわりに ― コミュニティデザインの実践に向けて ―

４．１　コミュニティデザインの位置づけ

本プロジェクトにおいては，インドにおける交通死亡事故の抑制のために，道路・車両デザイン，都市環境デザインおよびコミュニティデザインに跨る総合的な対策案を立案することを最終目標としている。

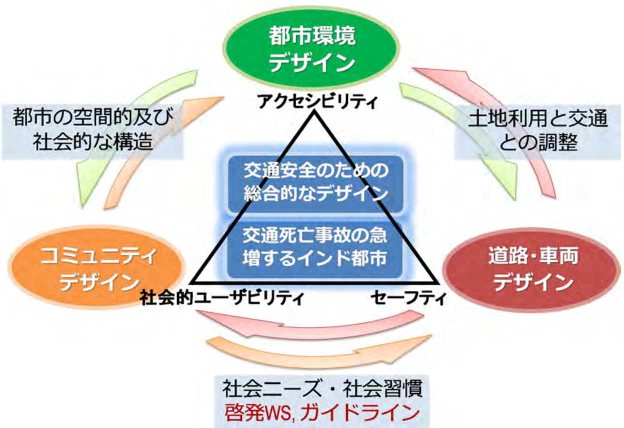


図-4　交通死亡事故の抑制のための総合的アプローチ

上図においては, 道路･車両デザインをセーフティに, 都市環境デザインをアクセシビリティ（接近可能性）に対応させており，コミュニティデザインを社会的ユーザビリティすなわち社会の多様な利用者にとっての使いやすさ（実用性）に対応させている。また，1)道路・車両デザインと都市環境デザインに跨る要素としての「土地利用と交通とのコーディネーション」，2)都市環境デザインとコミュニティデザインに跨る要素としての「都市の空間的および社会的構造」，そして3)コミュニティデザインと道路・車両デザインに跨る要素としての「社会ニーズや社会習慣」の重要性を示している。本プロジェクトの目標とするコミュニティデザインとは，「都市やコミュニティの社会的構造を踏まえた上で，多様な社会的ニーズや社会習慣に即した実用的なデザイン」を志向するものである。

４．２　コミュニティリーダー会議の準備

上記のコミュニティデザインの実践に向けて，本年度はアグラ市の中心的なステイクホルダーから成るコミュニティリーダー会議（以下，CLM）の準備を行った。ここで言うコミュニティリーダーとは, 以下の主体である。

・アグラ地区政務官，市長
・自治会代表
・行政（都市開発・高速道路・交通局)
・医療専門家（医師会やトラウマセンター）
・自販組合会長，バス協会代表
・NGOs
・メディア

これらのステイクホルダーとの対話を通じて，プロジェクトの知見を社会へ還元し，安全なコミュニティのための道路設計ガイドライン“Streets for Safe Communities”の提供，危険運転を抑制するための指導・取締，社会的リスクの高いバス交通の安全化等に関する提言を行うことが上記のCLMの目的である。

なお, インド国内では平成26年5月に国政選挙が予定されており，年度を跨いで政治および行政体制の大幅な変化が予想される。そこで，CLM開催を平成26年度の5月以降に実施することとし，H25年度はIITDを介してその立上げ準備を行った。

４．３　コミュニティのニーズ把握のための調査設計

CLMの開催に先立ちコミュニティ側のニーズ把握を目的として，交通の安全性に対する現状評価，交通事故の原因に対する現状認識，交通安全対策への要望，予算制約下での各種対策の優先順位などに対するアンケート調査票の作成を行った。この調査票の内容は，次頁のQuestionnaire for Stakeholders in the Communities (Draft) に記す通りである。なお，調査そのものはCLMと同様にH26年度の国政選挙後に実施することとした。

本年度の調査の結果，夜間に多発する交通死亡事故の主因が，1)道路・沿道空間の照度不足による視認性の低さと2)市街地を通過する自動車交通量の増加であることが明らかになった。来年度は，コミュニティ側のニーズを踏まえながら，本調査の知見を安全なコミュニティのため道路設計ガイドラインの作成へと結実させたい。

Questionnaire for Stakeholders in the Communities (Draft)

1. Sex: ___Male ___Female

2. Age: ____________

3. Current job status: ____

4. Educational background (Last educational level you finished):

   ___Primary education
   ___Lower secondary education (junior high school)
   ___Upper secondary education (high school)
   ___Higher education (college/university)
   ___Graduate level (Master's and Doctoral studies)

5. What kind of roles you have been playing in your community?
   (The term "your community" hereinafter refers to the community you are currently living. Therefore, "people in your community" means those neighbors living in the area where you reside and it includes not only people in the same socio-economic status as yours but also those people in different socio-economic statuses.)

   ____

6. How long have you lived in this area?

   ____

7. What mode of travel do people in your community most often use?

   ____

8. Do people in your community use local transit/public transport?

   _____Yes _____No

   => **<u>If Yes</u>,** public transport is used by:

   ____Everyone in the community
   ____More than half
   ____Half
   ____Less than half

9. If people in your community do not currently use public transport, what prevents you from using it?

   ____

   ____

10. Overall, how would you rate the following transport system in this area?

Condition of roads	___ Excellent	___Good	___Fair	___Poor
Traffic speed	___ Excellent	___Good	___Fair	___Poor
Traffic safety	___ Excellent	___Good	___Fair	___Poor
Footpaths/Pedestrian Crossings	___ Excellent	___Good	___Fair	___Poor
Traffic signal system	___ Excellent	___Good	___Fair	___Poor
Street furniture*	___ Excellent	___Good	___Fair	___Poor

*Street furniture includes traffic barriers, street lamps, traffic signs, bollards, and bus stops, etc,

11. If you had control over the transport budget, how would you rank the following in importance? (Please **put the number from 1** being most important **to 5** being least important.)

____Condition of roads
____Traffic speed
____Traffic safety
____ Footpaths/Pedestrian Crossings
____Traffic signal system
____Street furniture

12. How would you rate the situation of traffic accidents in this area?

____Very safe
____Safe
____Dangerous
____Very dangerous

13. In your understanding, what are the causes of traffic accidents (hit by a car) in this area? (Please choose the **maximum of two items** below.)

____High traffic speed
____Drinking and driving
____Poorly lighted roads and routes
____Bad road conditions
____Low skill of drivers
____Carelessness of drivers
____Carelessness of pedestrians/cyclists

14. Of the roads and routes that your community has, which is **used most often**?

____Paved road
____Dirt or unpaved road
____Paths
____Train (railway route)
____Other, what? ____

15. In your opinion, since 2009 (last 5 years) the roads and routes:

____Have improved
____Have gotten worse
____Stayed the same

16. What benefits would your community receive if the roads in this region were improved? (Please choose the **maximum of two items** below.)

____Easier access to markets
____Better opportunities to work
____Lower the prices of consumer goods
____Could have more doctors
____Could have more teachers
____Expansion of cultivated areas
____Other, what? ____

17. What are the **2 principal problems** with the service of public transport?

____Insufficient buses
____Buses in bad condition
____Public transport is bad
____The routes are far away
____Don't keep to the schedules
____Poor service at night
____Other, what? ____

18. For the improvement of traffic safety, how would you rank the following in importance? (Please **put the number from 1** being most important **to 5** being least important.)

____Vehicle design for driver and passenger protection
____Vehicle design for pedestrian protection
____Road design and street furniture
____Roadside land use and built environment
____Safety habits, culture and education

19. What persons or institutions are currently assisting or have assisted the local authority in your community in order to improve the transport systems and road conditions? (Please choose **all applicable items** below.)

____The government
____The police
____The politicians
____The religious groups
____The school/teachers
____NGOs
____People from the community
____Other, What? ____

20. Does your community organise awareness-raising activities for residents about the risks of traffic accidents?

____Yes ____No

=> **If Yes**, what persons or institutions organise such activities? (Please choose **all applicable items** below.)

____The government
____The police
____The politicians
____The religious groups
____The school/teachers
____NGOs
____People from the community
____Other, what? ____

★Finally, please describe your opinion on how community should be involved to enhance traffic safety in your area.

____
____
____

Thank you very much for your cooperation.

END

A STUDY ON COMMUNITY DESIGN FOR TRAFFIC SAFETY PART II

Submitted to

The International Association of Traffic and Safety Sciences (IATSS)

Dinesh Mohan

Geetam Tiwari

Sudipto Mukherjee

February 2014

Transportation Research and Injury Prevention Programme

Indian Institute of Technology Delhi

CONTENTS

A STUDY ON COMMUNITY DESIGN FOR TRAFFIC SAFETY – PART II

FINAL REPORT

OBJECTIVE

1. Detailed plotting of crashes for all six cities included in the work done in 2012-2013.
2. Understanding reasons for differences in high crash rates in one city with low crash rates in one city.
3. Research of the running speed changes of each vehicle type between day time and night time or hours in a day in one city.
4. Research of the luminance/darkness on the road and the road side in one city.
5. Detailed analysis dividing into day and night or into hours of a day of the personal risk and the social risk that were reported in the last year project for one city.
6. Organise a meeting with community leaders of one study city to discuss findings and possibilities for future action.

RESEARCH TEAM

Indian Institute of Technology Delhi

1. Professor Dinesh Mohan. Ph.D. in Bioengineering, University of Michigan, Ann Arbor, Michigan, USA.

2. Professor Geetam Tiwari. Ph. D. In Transportation Planning, University of Illinois, Chicago, Illinois, USA

3. Professor Sudipto Mukherjee. Ph.D. in Mechanical Engineering, Ohio State University, Columbus, Ohio, USA.

TIME PERIOD

1 JULY 2013 – 31 MARCH 2014

BACKGROUND

This project is continuation of the project H2540 funded by The International Association of Traffic and Safety Sciences (IATSS) at the Transportation Research and Injury Prevention Programme (TRIPP), Indian Institute of Technology Delhi (IITD) for the period 2012 – 2013. This is as a collaboration between IATSS and TRIPP at IITD with the objective of gaining an international understanding about road traffic crashes and methods of controlling the same in the future.

Current status

The findings of the work done in the period 2012-2-13 were submitted to IATSS in April 2013 and the work was approved as satisfactory by IATSS. An interim discussion on Phase II was held in Delhi in November 2013. The main findings of the first year project are given below.

City and roads

- The six cities studied vary considerably in the total number of fatalities per unit population and rates of fatalities per 100,000 vehicles. This is in spite of the fact that the population sizes are not very different.
- For the two cities where more detailed work has been done (Ludhiana and Vadodara), and for one city where locations of crashes were plotted for a one-year period, it appears that wide arterial roads, highways passing through the city and bypasses have high crash rates.
- The above observation suggests that all methods available for speed control (road design, traffic calming, and enforcement) need to be employed on arterial roads and highways crisscrossing the city. It would also be advisable to review the design criteria for provision of bypasses around the city for trough intercity traffic. It is possible that these highways need to be on elevated sections to reduce the possibility of interaction with local traffic.
- The high association of buses and trucks, and a surprisingly significant involvement of MTWs in VRU fatalities suggests that this is partly due to the fact that pedestrians and cyclists have to share the curbside lane with these vehicles in the absence of adequate sidewalks and bicycle lanes. This makes a clear case for the establishment of standards and laws that require all arterial roads to be outfitted with adequate pedestrian paths and bicycle lanes within a specified time frame.

- The detailed work in Vadodara and Ludhiana indicates that some fatalities do occur on non-arterial roads also. This implies that there would be a significant number of non-fatal crashes on these roads also. These can be reduced significantly with provision of appropriate traffic calming measures.
- The data indicate that there is an increase in the number of fatal crashes in the period 20:00-22:00 when traffic volumes are likely to be lower than those in the daytime. This suggests that there may be a need for improving visibility and lighting conditions on urban roads.

Vehicle design issues

- One of the very significant findings in this study is the discovery of the relatively high association of motorcycles in pedestrian and bicycle crashes. A detailed analysis needs to be done to ascertain whether vehicle design changes can reduce the probability of serious injury in these crashes.
- Personal risk of motorcycle riders is the highest compared to occupants of other vehicles. This could be reduced significantly by enforcement of helmet use and daytime running light laws. Since motorcycles far outnumber cars in Indian cities, it is necessary to focus on further improvements in motorcycle design (eg. braking systems, conspicuity, signaling systems).
- High association of buses and trucks with VRU crashes in all cities studied strengthens the argument for development of a pedestrian impact standard for these vehicles.
- TSRs are not safe enough either for their own occupants or the VRUs they impact. Crashworthiness standards including pedestrian impact standards specifically for these small and light vehicles need to be developed.

Community and enforcement issues

- The police departments need to focus on
  - Speed control, especially at night
  - Enforcement of helmet use laws
  - Control of drinking and driving
- Community involvement and pressure needed for
  - Rethinking urban road design issues so that wide high-speed roads do not go through cities

- Provision of facilities for pedestrians and bicyclists
- Introduction of traffic calming measures
- Improving design of para-transit vehicles.

Extension for the period 2013-2014

Discussions were held between team members from TRIPP IITD and IATSS on 10th February 2013 at IITD in Delhi, and then on 1 March 2013 at the IATSS office in Tokyo. Following these meetings it was agreed in principle the project should be extended for one more year to work on details of the crashes. TRIPP IITD submitted a proposal for the same in April 2013. Team members form IITD and IATSS discussed this in further detail in July 2013 in Rio de Janeiro and agreed upon a common set of objectives for the work to be done in 2013-2014.

ETHICS AND HUMAN SUBJECTS ISSUES

1. No human subjects are involved.

2. Names and addresses of all road traffic crash victims will be not be included in any of the data files maintained at TRIPP to maintain the confidentiality of the victims

WORK DONE

1. Detailed plotting of crashes for all six cities

Detailed plotting of all crashes has been completed for all the cities: Agra, Bhopal, of Ludhiana and Vadodara. In this phase we will do the same for Amritsar, Agra, Bhopal Ludhiana, Vadodara and Vishakhapatnam. Location information of crashes as recorded by the police report were used for plotting the same on detailed maps for each city with details of victim type and impacting vehicle included in the data. This work required searching the police recorded locations on Google maps and then locating them on GIS maps. This work was very labour intensive.

2. Understanding reasons for differences in high crash rates in one city with low crash rates in one city.

One low rate city (Ludhiana) and one high rate city (Agra) were selected for this comparison. The differences in these cities are being evaluated for the following variables:

a. Population density

b. Road structure

c. Proportion of arterial roads and national highways in the city
d. Differences in victim type and impacting vehicles
e. Road widths and facilities on high incidence roads in the city
f. Location of crashes in the two cities

3. Research of the running speed changes of each vehicle type between day time and night time or hours in a day in one city

a. Three locations were selected in Agra for study of speeds and traffic flow in the day and night with high rate of night-time crashes. The same procedure will be followed for Ludhiana in March 2014.
b. At each location a video camera was set up to record traffic flow and traffic flow recorded.
c. The video data obtained as been analysed to calculate speeds of every vehicle passing by: motorised two wheelers, cars, three-wheeled scooter taxis, buses and trucks. The number of vehicles included in the sample will be such that the mean speed of each group of vehicles stabilises within 5 per variance.
d. Comparisons have been made for different time periods and different types of vehicles for mean speeds, 10 percentile and 90 percentile speeds.

4. Research of the luminance/darkness on the road and the road side in one city.

Luminance measurements have been made at three locations in Agra. The same will be done in Ludhiana in March 2014.

5. Detailed analysis dividing into day and night or into hours of a day of the personal risk and the social risk that were reported in the last year project for one city.

This work will be completed after data for Agra are available.

Both cities will be used for this analysis and then the crashes distributed by time. Personal risk and social risk factors for different road users will be then estimated for different times of day.

6. Organise a meeting with community leaders of one study city to discuss findings and possibilities for future action.

This work will be done after all the analyses are complete.

DETAILS

A. Effect of built environment on road traffic fatalities

The following work has been completed for Agra:

- Assimilation of built environment data from GIS basemap, Google Maps and site visits/Google Street View
- Partitioning of traffic fatality and corresponding built environment data on basis of latitude/longitude so that we can develop a safety model through regression and determination of significant built environment parameters
- Partitioning the city of Agra into 30 regions based on latitude/longitude for analysis and extraction of Built Environment data in each region using ArcGIS 10.0 and Google Maps, extraction of total length of all roads using 'Calculate Geometry' function in ArcGIS 10.0, extraction of lengths of primary roads and highways using 'Distance Calculator' tool in Google Maps, extraction of number of intersections using 'Intersect' tool in ArcGIS 10.0.
- An onsite inventory of characteristics a sample of Roads in Agra has been done by a site visit to Agra. The following criteria were used:

- At least 20% of the total length of roads in each region was traversed for data collection

- All categories of roads (Highways, Primary Roads and Arterial Roads) were adequately represented in each region

- As far as possible, the following details have been collected for the roads in Agra, and the same will be done In Ludhiana in March 2014.

  - Number of lanes – average value taken for all surveyed roads in a region
  - Width of lanes - parameter was divided into three categories - Wide, Medium and Narrow
  - Median presence –parameter was assigned categories ranging from 1 (completely absent) to 5 (completely present)
  - Safety barrier presence - parameter was assigned categories ranging from 1 (completely absent) to 5 (completely present)
  - Average width of paved/unpaved shoulders –the parameter was divided into four categories: Wide, Medium, Narrow and No
  - Number of traffic lights per unit length (km) – by visual inspection

- Number of street lights per unit length (km) – The number was approximately estimated by extrapolating a small sample
- Moderate curves per unit length – Moderate curves were those where the roads bent by 20-30 degrees
- Sharp curves per unit length (km) – Sharp curves were those where the roads bent by an angle greater than 30 degrees
- Adequacy of road markings –collected qualitatively and categorized as adequate/inadequate
- Number of access points per unit length (km) – defined as a point where a street, road or highway connects the general street system, parameter was divided into three categories: Low, Medium, High
- Pavement Quality/Sidewalk provision - collected qualitatively in three categories: Good, Medium and Poor
- Population density of nearby area - parameter was divide into three categories - Low, Medium and High
- Land-use pattern of nearby area: This parameter was divided into four categories - Residential, Industrial, Mixed and None

Figure 1. Sample of roads in Agra

Details of data collected in Agra are given in Table below.

Table 1. Road profile data for Agra

Parameter	Min	Max	Average
Regions covered			27
Total readings			57
Lanes per direction	0.5	3	1.316
Width of Lanes	Narrow = 30	Wide = 6	Medium = 21
Median presence	1or 2 = 34	3 or 4 = 10	5 = 13
Safety barrier presence	1 or 2 = 55	3 or 4 = 1	5 = 1
Paved shoulder width	None = 35, Narrow = 10	Wide = 4	Medium = 8
Unpaved shoulder width	None = 22, Narrow = 16	Wide = 4	Medium = 15
Traffic lights per km	0	10	0.62
Street lights per km	0	100	60.4
Moderate curves per km	0	50	7.78
Sharp curves per km	0	50	2.92
Delineation	Inadequate = 42	Adequate = 15	
Access points per unit length	Low = 15	High = 22	Medium = 20
Pavement quality	Poor = 23	Good = 15	Medium = 19
Sidewalk provision	Poor = 39	Good = 7	Medium = 11
Population density	Low = 15	High = 20	Medium = 22
Land use	Residential = 20	Industrial = 7	Mixed = 27 None = 3

Further analysis of these data are only possible after data for the second city (Ludhiana) become available in March 2014. This work will include a regression analysis to determine significant built environment parameters and their relationship with traffic safety.

Factors influencing night time crash rates

Traffic flow data, speed profiles and luminescence data for roads in Agra have been collected. The same data for Ludhiana will be collected in March 2014.

Figure 2 shows the number of crashes per month in Agra. The number of crashes per month in January-February is not significantly lower than the other months of the year, and therefore, collecting data in February is not likely to influence our results.

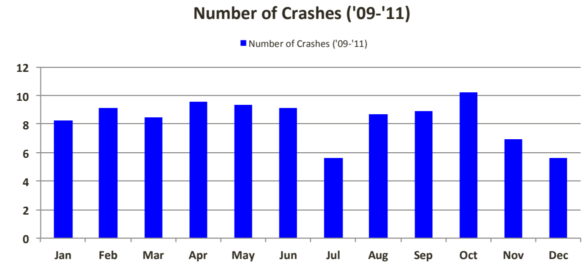


Figure 2. Number of crashes per month in Agra

Field observations

a. Traffic volume data collection by taking videos of traffic:

- Location 1: Janki Emporium (from 1st Floor of a building) on National Highway 2
- Location 2: Housing Complex (from 2nd Floor), National Highway 11
- Location 3: S N Medical College (from 1st Floor), MG Road

b. Luminescence Data Collection:

- Mid Block Sections: NH2, NH11, MG Road (NH 44)
- Intersection at NH11 to an arterial road

Figure 3 shows the set up for taking video recordings of traffic from an elevated location.


Figure 3. Video recording of traffic flow

Figure 4 shows the traffic images recorded at two locations in the day and night.

Figure 4. Examples of traffic shots at locations 1 and 3 in day and night.

Speed data

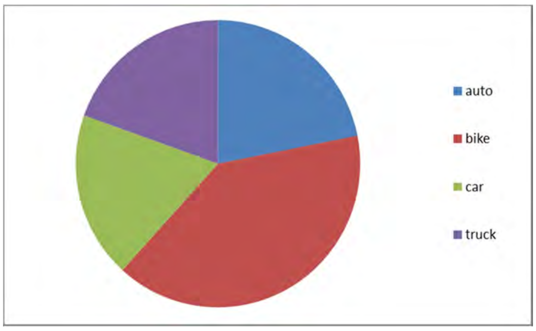
The data for speeds in the day and night are given in the Table 2 below

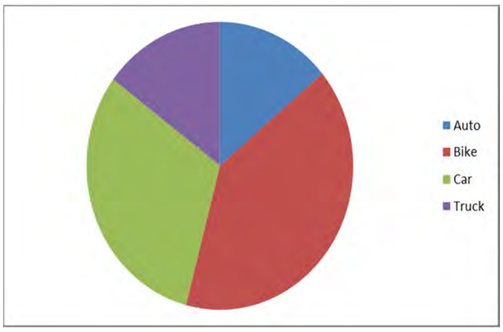
Table 2. Velocity profiles at 3 locations in Agra (TST- Three-wheeled scooter taxi, MTW-Motorised two-wheeler)

Location	Day velocities km/h (10%, Mean, 90%)		Night velocities km/h (10%, Mean, 90%)	
Location 1	TST MTW Car Truck	14.5, 26.4, 38.3 17.8, 32.2, 46.6 10.2, 29.3, 48.4 16.1, 26.0 36.0	TST MTW Car Truck	13.7, 21.6, 29.5 14.9, 27.7, 40.5 11.0, 26.9, 42.9 12.7, 23.4, 34.2
Location 2	TST MTW Car	22.0, 32.1, 42.2 19.3, 32.7, 46.2 20.3, 29.4, 38.5	TST MTW	17.4, 28.3, 30.0 19.6, 33.0, 34.7
Location 3	TST MTW Car	5.5, 12.0, 18.4 7.6, 13.6, 19.6 6.6, 13.0, 19.4	TST MTW Car	7.5, 15.7, 23.8 9.1, 17.9, 26.7 11.5,20.5,29.5

Location 1 observations

- The number of TSTs have decreased at night-time.
- The proportion of cars has increased at night time from 19% to 31%
- The proportion of 2-wheelers and trucks remains almost constant.
- In terms of vehicle speed on NH-2 an overall decrease is noted during night (approximately 10-12%).
- Overall traffic volume is almost the same

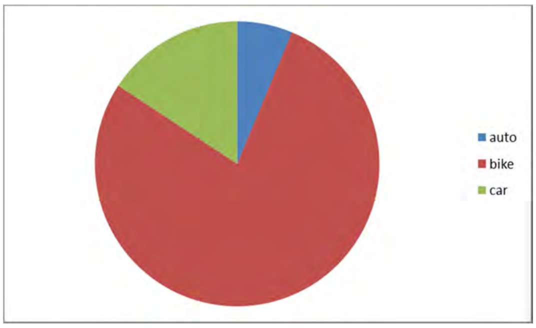


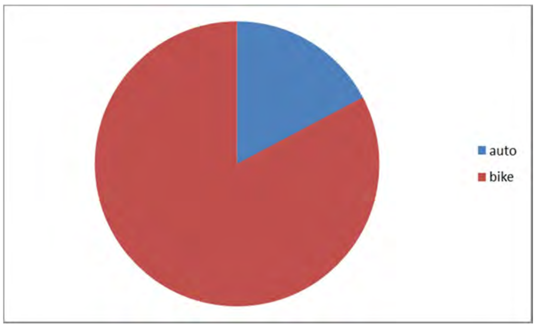


Day **Night**

Location 2 observations

- NH-11, has a very high portion of MTW traffic.
- During the night time, the proportion of cars in the location drops from 16% to almost zero.
- The proportion TSTs in the area increases at night from 6% to 17%
- No decrease is observed during the night-time, the traffic travels with almost similar 90% and mean limits.
- Overall traffic volume remains unchanged, but is lower than NH2.

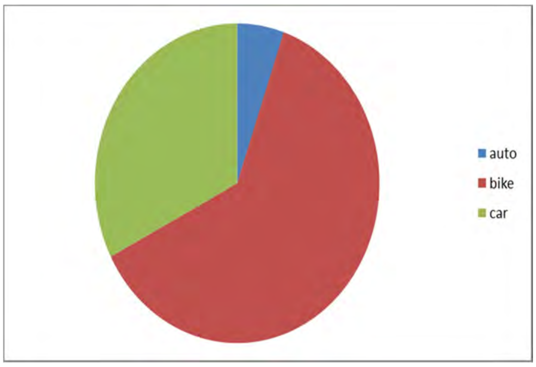


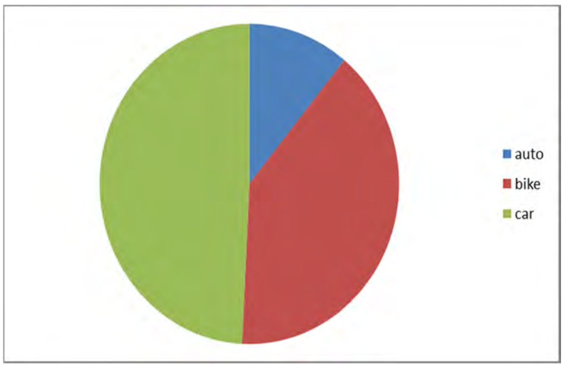


Day **Night**

Location 3 observations

- Proportion of cars in traffic has increased from 32% to 49%, with a decrease in number of "bikes", from 62% to 40%
- The number of TSTs has also increased.
- Higher speeds are observed all throughout the traffic for night time with greater variation in data.
- This can be explained by the good quality of road in the area and drastic drop in traffic from 54 to 16 vehicles per minute.





Day **Night**

The above data show that there are no significant speed differentials in day and night. However, there are differences in modal shares with a slightly higher proportion of four wheeled vehicles at night.

Luminescence data

Luminescence data was measured by assembling three light metres orthogonally and mounting them on a tripod (Figure 5).

Figure 5. Assembly of 3 light meters mounted on a tripod.

NH2 Observations

- Conditions: Highway, Clear weather, Mid-Block Section
- Type of Luminaire: Na Vapor Lamp, 20m spacing, (neighboring street light non-functional)
- No value in any direction greater than 12 lux compared to Road Class: A1, average recommended luminance is 30 lux.
- Overall Uniformity = 1 (but values 2/2) > 0.4
- Longitudinal Uniformity= 0.5 < 0.7
- Surround Footpath Values (direct): 12 lux
- Many extra posts exist, but lights on many non-functional

MG Road Observations

- Conditions: Highway, foggy weather, mid-block section
- Arrangement: Opposite
- Type of Luminaire: Na Vapor Lamp, 30.2m spacing, neighbouring street light non-functional
- No value in any direction greater than 20 lux, Road Class: A2, average luminance by code 15 lux.
- Overall Uniformity = 1 (but values 2/2) > 0.4 ok
- Longitudinal Uniformity= 1.0 > 0.7
- Surround Footpath Values (direct): 20 lux in front of post
- Surround value drops to 5 lux 15m from the post

NH 11 Observations

- Conditions: Highway, Clear weather, Mid-Block & Intersection
- Arrangement: Opposite
- Type of Luminaire: Na Vapor Lamp, 50m spacing, neighbouring street light non-functional
- No value in any direction greater than 10 lux, Road Class: A1, average luminance by code 30 lux
- Overall Uniformity = 0.25 < 0.4
- Longitudinal Uniformity= 0.5 < 0.7
- Surround Footpath Values (direct): 22 lux front of post
- Surround value drops to 1 lux 7m from the post
- A large number of lights non-functional leading to low U values.

Luminescence values suggest that lighting conditions on all roads are much lower than that recommended by national and international standards.

SUMMARY

1. The data presented above are results of work underway. Conclusions can only be drawn after work in the second city (Ludhiana) is completed.

2. The data from Agra suggests that the high rate of night-time crashes in Agra is probably not due to day and night speed differentials, but may be due to low visibility conditions at night and a higher proportion of four-wheeled vehicles. This could be particularly true when a vast majority of the victims are vulnerable road users. The probability of fatalities for pedestrians increases for about 10 percent at impacts of 30 km/h to over 70 per cent at 50 km/h.

3. Preliminary understanding regarding alcohol use is that there were a negligible number of persons arrested for driving under the influence of alcohol. However, there are a reasonably large number of alcohol shops and bars in Agra. After obtaining data from Ludhiana, we will approximate the average alcohol consumption per capita in the two cities.

4. The role of the built environment will be presented after regression models are run for both cities.

5. The luminescence data for Agra and Ludhiana will analysed in greater detail in the next report and compared with the best roads in Delhi and international recommendations in the final report.

非売品

H2540 プロジェクト
インドにおける交通安全のためのコミュニティデザインに関する研究調査
報 告 書

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