GUIDELINES FOR THE IMPLEMENTATION OF BICYCLE LANES ON SRI LANKAN HIGHWAYS

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ABSTRACT

Bicycle lanes have become an integral part of the highway networks of many countries including Sri Lanka. They are encouraged as a pollution free, economic and healthy mode of transport throughout the world. So it is high time that a proper guideline for the same is introduced taking into account the local conditions of this country. Bicycle lanes are so far introduced to the road projects of Sri Lanka on ad hoc basis without consideration of the proper guidelines such as continuation of bicycle lanes on the road network, intersection treatment, avoidance of abrupt termination etc. Sri Lanka being a developing country with more or less a feudal framework of thinking, there is a social stigma towards the bicycling as a poor man's vehicle. In such a context, how should a design engineer in cooperate this green technology into our local highway projects so the common man can be immensely benefitted and our cities will be left with some fresh air to breath in the coming days of the future? This research was aimed at addressing these issues and finally coming up with a proper guideline to implement bicycle lanes in the future road projects carried out by Road Development Authority.

Key words: Bicycle lanes, Bicycle lane design, Non motorized transport

1. INTRODUCTION

1.1   General Background

Bicycle lanes are introduced to Sri Lanka as an integral part of the highway network. In an environment where the world is fast moving to the greener technologies, this introduction will offer many benefits to a country that is trying to emerge as a middle income economy in South Asia. In such a context stripping out the cons and associating the pros of this concept becomes an inevitable endeavor faced by the highway designers in the future. In Sri Lanka, bicycle lanes are so far introduced to the highways on ad hoc basis. The actual performance of such bicycle lanes is in question.

1.2   Objectives

Objectives of this research are as follows.

- Have the bicycle lanes/paths implemented been successful in the recent projects?
- What is the public opinion of the bicycle lanes?
- What could be the reasons for failures if any?
- Recommendations for the implementation for bicycle facilities in the future projects.

1.3   Scope of the Study

This study is restricted to the study of common objectives and design concepts of bicycle lanes and attempts to make recommendations on the implementation of bicycle lanes in the future road projects carried out by Road Development Authority.

2. LITERATURE REVIEW

2.1   Necessity of Bicycle Facilities

Bicycle facilities toady have become an inevitable part in highway design. In addition to the promotion of non motorized transport to save energy, it serves as a low cost alternative for the ever increasing travel demand. Michael Replogle [1991:1] says NMVs offer low cost private transport, emit no pollution, use renewable energy, emphasize use of labor rather than capital for mobility, and are well suited for short trips in most cities regardless of income, offering an alternative to motorized transport for many short trips. Thus, they are appropriate elements in strategies dealing with poverty alleviation, air pollution, management of traffic problems and motorization, and the social and economic dimensions of structural adjustment. NMVs have a most important role to play as a complementary mode to public transportation.

While most of the Sri Lankans are not so poor to afford the subsidized public transport costs, cycling is dominant in many areas outside Colombo. Bicycle population is dominant especially in North Central, North and East provinces. But no separate bicycle facilities are provided in these remote areas. This is explained by Michael Raplogle stating: In many low income Asian cities where NMVs predominate, there has been little need to create a separate cycle network because large numbers of NMVs define their own legitimacy to right-of-way. However, as motorization increases, or as traffic congestion worsens, it becomes increasingly important to develop modal separation in high traffic flow corridors. This is particularly vital in mixed traffic cities where NMV use is declining due to competition from growing motorized traffic.

2.2   Types of Bicycle Facilities

Bicycle facilities are incorporated into the traditional highway design in various magnitudes. They can be bicycle lanes running in the both sides of a highway, which are demarcated by lane marking, or separate bicycle paths. Four types of bicycle facilities are given in the Highway Design Manual [2006:1000-2] categorizes the bicycle facilities into four major groups.

2.2.1 Shared Roadway (No Bikeway Designation)

In some instances, entire street systems may be fully adequate for safe and efficient bicycle travel and signing and pavement marking for bicycle use may be unnecessary. In other cases, prior to designation as a bikeway, routes may need improvements for bicycle travel. Many rural highways are used by touring bicyclists for intercity and recreational travel. It might be inappropriate to designate the highways as bikeways because of the limited use and the lack of continuity with other bike routes. However, the

development and maintenance of 1.2 m paved roadway shoulders with a standard 100 mm edge line can significantly improve the safety and convenience for bicyclists and motorists along such routes.

2.2.2 Class I Bikeway (Bike Path)

Generally, bike paths should be used to serve corridors not served by streets and highways or where wide right of way exists, permitting such facilities to be constructed away from the influence of parallel streets. Bike paths should offer opportunities not provided by the road system. They can either provide a recreational opportunity, or in some instances, can serve as direct high-speed commute routes if cross flow by motor vehicles and pedestrian conflicts can be minimized. The most common applications are along rivers, ocean fronts, canals, utility right of way, abandoned railroad right of way, within college campuses, or within and between parks. There may also be situations where such facilities can be provided as part of planned developments. Another common application of Class I facilities is to close gaps to bicycle travel caused by construction of freeways or because of the existence of natural barriers (rivers, mountains, etc.).

2.2.3 Class II Bikeway (Bike Lane)

Bike lanes are established along streets in corridors where there is significant bicycle demand, and where there are distinct needs that can be served by them. The purpose should be to improve conditions for bicyclists in the corridors. Bike lanes are intended to delineate the right of way assigned to bicyclists and motorists and to provide for more predictable movements by constructing bike lanes is to better accommodate bicyclists through corridors where insufficient room exists for safe bicycling on existing streets. This can be accomplished by reducing the number of lanes, reducing lane width, or prohibiting parking on given streets in order to delineate bike lanes. In addition, other things can be done on bike lane streets to improve the situation for bicyclists, that might not be possible on all streets (e.g., improvements to the surface, augmented sweeping programs, special signal facilities, etc.). Generally, pavement markings alone will not measurably enhance bicycling.
If bicycle travel is to be controlled by delineation, special efforts should be made to assure that high levels of service are provided with these lanes.

2.2.4 Class III Bikeway (Bike Route).

 Bike routes are shared facilities which serve either to:
(a) Provide continuity to other bicycle facilities (usually Class II bikeways); or
(b) Designate preferred routes through high demand corridors.

As with bike lanes, designation of bike routes should indicate to bicyclists that there are particular advantages to using these routes as compared with alternative routes. This means that responsible agencies have taken actions to assure that these routes are suitable as shared routes and will be maintained in a manner consistent with the needs of bicyclists. Normally, bike routes are shared with motor vehicles.

The use of sidewalks as Class III bikeways is strongly discouraged.
It is emphasized that the designation of bikeways as Class I, II and III should not be construed as a hierarchy of bikeways; that one is better than the other. Each class of bikeway has its appropriate application.

In selecting the proper facility, an overriding concern is to assure that the proposed facility will not encourage or require bicyclists or motorists to operate in a manner that is inconsistent with the rules of the road.

An important consideration in selecting the type of facility is continuity. Alternating segments of Class I and Class II (or Class III) bikeways along a route are generally incompatible, as street crossings by bicyclists are required when the route changes character. Also, wrong-way bicycle travel will occur on the street beyond the ends of bike paths because of the inconvenience of having to cross the street.

In this research, only the Bike Lanes are considered for the analysis as it is the one introduced to Sri Lankan highways for the time being.

2.3 Pros of Bicycle Facilities

Winnipeng City [3] defines cons of bicycle lanes as follows. Bike lanes help define road space, decrease the stress level of bicyclists riding in traffic, encourage bicyclists to ride in the correct direction of travel, and signal motorists that cyclists have a right to the road. Bike lanes help to better organize the flow of traffic and reduce the chance that motorists will stray into cyclists' path of travel. Bicyclists have stated their preference for marked on-street bicycle lanes in numerous surveys. In addition, several real-time studies (where cyclists of varying abilities and backgrounds ride and assess actual routes and street conditions) have found that cyclists are more comfortable and assess a street as having a better level of service for them where there are marked bike lanes present.

In summary, bike lanes do the following:
- support and encourage bicycling as a means of transportation;
- help define road space;
- promote a more orderly flow of traffic;
- encourage bicyclists to ride in the correct direction, with the flow of traffic;
- give bicyclists a clear place to be so they are not tempted to ride on the sidewalk;
- remind motorists to look for cyclists when turning or opening car doors;
- signal motorists that cyclists have a right to the road;
- reduce the chance that motorists will stray into cyclists' path of travel;
- make it less likely that passing motorists swerve toward opposing traffic;
- decrease the stress level of bicyclists riding in traffic.

2.4 Width of Bicycle Lanes

Road Development Authority recently incorporated Bicycle Lanes and Bicycle Paths into their design strategy. The general bicycle lane width maintained by Road Development Authority is 1.5m for bicycle lanes.

Toronto draft bicycle design guidelines [4] recommends following widths for bicycle lanes.

Where curbs are present, the bicycle lane width, the distance from the face of the curb to the centre of the lane line, should be between 1.5 metres and 2.0 metres. On paved shoulders without curbs, the bicycle lane width, the distance from the edge of the pavement to the centre of the lane line, should be between 1.2 metres and 1.7 metres. A wide bicycle lane (1.8 to 2.0 metres where curbs are present; 1.5 to 1.7 metres without curbs) is recommended under one or more of the following conditions:
- where lateral obstructions, such as utility poles, are within 300 mm of the edge of curb;
- where the bike lane is on a bridge or underpass;
- where the posted speed limit is 60 km/h or greater;
- where the adjacent traffic lane is 3.6 m or greater;
- where the bike lane is between two traffic lanes;

- for all contra-flow bicycle lanes.

Where on-street parking is permitted, the preferred combined width of the parking zone and bicycle lane is 4.2 metres. The minimum combined width is 3.8 metres.

2.5   Intersection Treatment

Bicycle lanes should be a component of a network of bicycle lanes that maintains the integrity of the system. Toronto Draft Bicycle Lane Design Guidelines [4] proposes following lane marking in non signalized intersections.

The bike lane striping is discontinued across the leg of the intersecting street. If the approach with the bike lane features a stop line and crosswalks, the bike lane continues all the way to the stop line with, in most cases, the final 15 metres demarcated by a broken white line. The two exceptions are:

- where a nearside bus stop is present, the broken line begins 20 metres from the stop line; and,
- where right turns are not permitted, the solid line continues all the way to the stop line.

The solid lane line should resume immediately downstream of the farside crosswalk. The diamond and bicycle logo pavement marking should be placed within the first 15 meters of the lane.
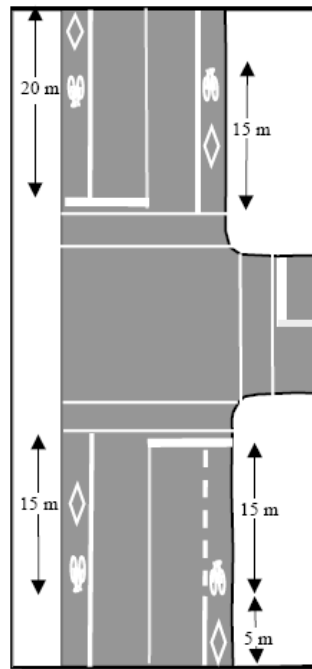

Figure 1 : Typical dimensions for an intersection treatment (non-signalized - four ways)

2.6   Crashing with Car Door Opening

On street parking is either allowed or illegally enjoyed in many of the urban highways in Sri Lanka. In places where the on street parking is allowed, the bicyclist is at risk the crashing with suddenly swung open doors of the cars. Maryland SHA Bicycle and Pedestrian Design Guidelines [5] describe this situation as follows.

In locations where bike lanes are adjacent to on-street parking, consideration should be given to the possibility that bicyclists may crash into car doors that are suddenly swung open. This type of crash is typically more likely in locations with higher parking turnover, such as main streets, streets near

restaurants and retail, etc. This is not typically a concern on residential streets. Bicyclists encountering an opened door must either stop short of the door, swerve into an adjacent travel lane or risk riding into the open door or being struck by the opening door. This act is commonly referred to as "dooring" by bicyclists. Bicyclists have been injured and killed due to dooring events.

To mitigate or reduce the possibility of a dooring event a number of communities have experimented with various pavement markings, regulatory signs, and or warning signs to prevent dooring incidents. The following mitigation measures have been analyzed in locations with high parking turnover, and 7 or 8 foot parking lanes adjacent to bicycle lanes; or locations with a history of dooring accidents or complaints of dooring "close calls." SHA may consider using these measures on urban streets with frequent on-street parking turnover, on an experimental basis.

2.6.1   Dooring Warning Sign

This sign can be located adjacent to existing parking regulation signs to increase theirvisibility to motorists. An example of a dooring warning sign is shown in below Figure 2.

Figure 2: A typical door warning sign

2.6.2   Modified Bicycle Lane Marking

Based upon a study performed in San Francisco, CA, marking the door zone with extension lines as shown in Figure 2.3 may encourage bicyclists to ride towards the left side of the bicycle lane outside of the door zone. Engineering judgment should be utilized to determine the frequency of placement of the door zone extension lines. Consideration may also be given to utilizing a smaller bicycle lane symbol and arrow which would be placed on the extreme left side of bicycle lane.
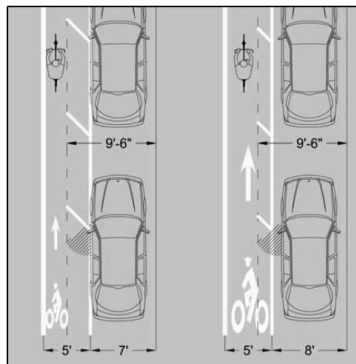

Figure 3: Modified bicycle lane marking with door zone

3. EXPERIMENTAL DETAILS

3.1 Method of Data Collection

Data were collected by the opinion surveys conducted in town areas where a bicycle lane would be beneficial. Questionnaire forms were prepared as this regard.

3.2 Groups for Opinion Surveys

Following 4 groups were selected to collect data.

- General public - Any conclusion for the integration of a new facility to a highway should incooperate the public opinion. Therefore the views of general public were extracted in an opinion survey. This survey was conducted in Malabe Town.
- School Children- School children are a potential group that can use bicycles. So an opinion survey was conducted at Boys' Model School, Malabe.
- University Students   - University Students are another potential group that can use bicycles. So an opinion survey was conducted at Sri Lanka Institute of Information Technology by among the second year engineering students.
- Bicyclists   - These are the people who really use bicycles for their day to day activities. Their contribution to this study cannot be overlooked at any rate. So an opinion survey was conducted with them in Malabe-Kaduwela Road.

4. DISCUSSION

4.1   Failure of the Bicycle as a Transport Mode in Sri Lanka

Long ago, one may be familiar with the bicyclists who had the dominance of our national road network. This is not the case with the recent development. This notion can be justified with the survey data collected in this research. No wonder none of the persons questioned in the category of general public responded affirmatively for their bicycle usage. While the data spectrum collected would not represent the total picture of the country's transport profile, it may be argued that the data collected were from Malabe where moderate income earning people reside. So it may be suggested that the bicycle is no more the common man's vehicle in this country, at least in the highly urbanized west. This is further consolidated with the fact that according to the survey, none of the school children use bicycle as a transport mode. In SLIIT none use the bicycle. This is a clear indication that supports the previous argument that bicycle is not used as a common transport mode among the moderate income group of this country.

In University of Moratuwa, mere 6% and in University of Colombo mere 10% of the students questioned used the bicycle as a transport mode to travel to the university. The indication given in both universities is tangible to note that the share of the bicycle as a transport mode is very low compared to other transport modes such as public transport which was used by 72% of the general public and 60% of the school children. This clearly shows that despite various strategies used by road agencies to promote the bicycle usage, the bicycle has failed as a transport

4.2   Reasons for the Failure of the Bicycle

An astounding reality that was revealed from this research was the fact that while the bicycle usage was that much low among various groups, the bicycle possession was substantial, accounting to 83% among general public, 69% among school children, 44% among SLIIT, 38% among University of Moratuwa students and 32% among University of Colombo students. The question emerges here as to why the

bicycle usage is such low while a fair number of people owned the bicycle. It may be argued that there should be a problem in our road system.

The failure of the bicycle as a common transport mode can be affiliated to various factors such as poor road condition, no facilities for the bicyclists, long distances, no safe parking, sweating and social stigma to name a few. Sweating was the major problem for school children and SLIIT students accounting to 62% and 40% respectively, while the two universities considered had their fair share. This is noted as a crucial factor in this research as Sri Lanka being a tropical country should focus its attention on these issues before investing heaps of money for the implementation of bicycle lanes. Social stigma played the least influential factor among educated masses i.e. SLIIT and the both universities while it was high among the school children where class differences as a shadow of the colonial past still haunted. It was further noted that many were reluctant to use the bicycle as a transport mode due to the long distance that they had to cycle. This was 38% among school children, 49% among SLIIT students, 29% among University of Moratuwa students and 25% among University of Colombo students. Parking was a major issue for the school children among whom 46% admitted that as a problem. This is true as the school in question did not have a safe parking place for the bicycles. This problem was not significant among students of SLIIT and both Universities where safe parking places actually existed.

4.3   Potential of a Bicycle Population

It may be argued with caution that there is a potential bicycle population in this country who really considered bicycling is convenient even in the current road network. That was 42% among bicyclists, 50% among school children and 34% among SLIIT students, while University of Moratuwa and University of Colombo held it to be 41% and 42%. The reasons for this notion could be many, among which short distance, traffic congestion, lack of doorstep transport, economy, lack of sufficient public transport and physical exercise were assessed. Short distance was the major factor for selecting the bicycle among almost all the groups. This gives a clear indication that people are ready to use the bicycle for short distances under improved road condition. Economy and physical exercise were other two major factors. A very important finding here was that bicycle was used as there was no public transport for the door step. It may be argued here that this stresses the need of improving byroads along with the national road network so the bicycles can be used effectively by those who are under privileged to have doorstep transport.

4.4   Ups and Downs for the Bicyclists in the Current Road System

Now it may be suggested that there is a potential bicycle population who would use the bicycle provided their expectations are met in the road network. A major factor those who were questioned mentioned for the convenience of the bicyclists was the separate bicycle lane. This was as high as 94% among school children. The next important point was the wide roads, which was admitted by 65% of the bicyclists and 72% of school children. May be the wide roads could reduce the negative effects of motorized traffic to the bicycles. Built up shoulders and good road surfaces did not have that much weight compared to the other factors.

The problems that prevented this potential bicycle population from actually taking a bicycle and riding on the road were numerous. Heavy congestion and poor driver discipline were the major factors according to the survey. Bicyclists' affirmative response was as high as 79% for heavy congestion while the SLIIT students' affirmative response was as high as 89% for safety. Lack of an exclusive bicycle lane apart from the road and lack of priority while considerable, did not have that of weight compared to the other factors.

4.5   New Proposals to Encourage Bicycles

Now the problem is shortened to the fact that while the presence of bicycles in our road network is minimal, there is a potential bicycle user population who do not actually takes a bicycle and rides owing to the various problems of the current road network. This research may not be able to address all of them, such as traffic congestion which requires major strategic planning and policy decisions to mitigate the effects. Four options were put forward for the assessment i.e. Exclusive bicycle lane, Separate bicycle lane, Raised bicycle lane and green shelter. Exclusive bicycle lane was preferred by many, accounting to 46% of school children, 50% of SLIIT students, 46% of University of Moratuwa students and 49% of University of Colombo students. Raised bicycle lane was the second best choice accounting to 21% of school children, 42% of SLIIT students, 37% of University of Moratuwa students and 36% of University of Colombo students. Separate bicycle lane was the least preferred. Green shelter had its fair share of preference accounting to 35% of school children, 26% of SLIIT students, 32% of University of Moratuwa students and 24% of University of Colombo students.

4.6   Lane Width

From the literature review, following lane widths may be suggested.
- Where curbs are present, the bicycle lane width, the distance from the face of the curb to the centre of the lane line, should be between 1.5 metres and 2.0 metres.
- On paved shoulders without curbs, the bicycle lane width, the distance from the edge of the pavement to the centre of the lane line, should be between 1.2 metres and 1.7 metres.
- A wide bicycle lane (1.8 to 2.0 metres where curbs are present; 1.5 to 1.7 metres without curbs) is recommended under one or more of the following conditions:
    - where lateral obstructions, such as utility poles, are within 300 mm of the edge of curb;
    - where the bike lane is on a bridge or underpass;
    - where the posted speed limit is 60 km/h or greater;
    - where the adjacent traffic lane is 3.6 m or greater;
    - where the bike lane is between two traffic lanes;
    - -for all contra-flow bicycle lanes.

4.7   Intersection Treatment

It was observed in our intersections the ad hoc bicycle lanes vanish due to the space constraints, without being a part of an integrated bicycle lane network. So it is suggested that a proper intersection treatment system such as that of Toronto or Chicago as given in the literature review be adopted. In this research, it is proposed to adapt to a lane marking system as shown below.
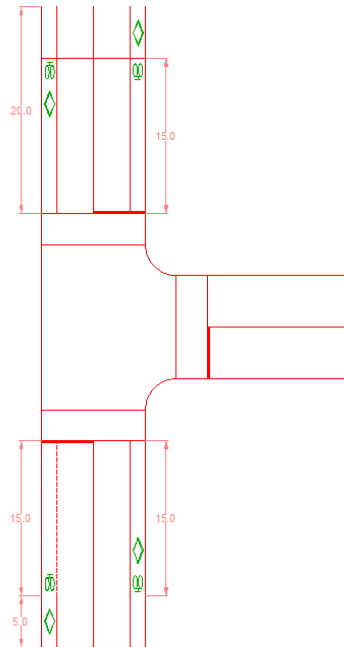
Figure 4: Lane Marking Suitable for a 3 way Intersection

This basic system can be improved to include 4 way intersections, roundabouts, signalized intersections etc. as the need arises.

4.8   Dooring Warning System

It is suggested that the warning symbol and the modified lane marking given in the literature review be adopted where the parking is allowed with the bicycle lane.

4.9   Necessity of Bicycle Parking Places

Majority of the school children accounting to be 46% admitted their inability to use the bicycle due to the fact there is no safe parking in the school. So the bicycle parking is a major issue in this country where proper bicycle parking facilities are not provided. Therefore, Alexandria government's bicycle parking technique is proposed.

4.10   By road Improvements

15% of the school children, 20% of the SLIIT students, 21% of the University of Moratuwa students and 4% of the University of Colombo students wanted to bicycle as they did not have the doorstep transport. So this is a clear indication that people use the bicycle to come to the main road hence the by roads should also be improved to cyclable condition along with the major road improvements.

4.11   Measures to Increase Bicycling Share

The suggestions of the people who were surveyed were assessed to increase the bicycling share of the transport system and highest demand was the concession on prices. This needs further investigation by means of a separate research.

The second highly demanded requirement was to provide more facilities for the bicyclists such as continuation of the bicycle lane etc. Parking shed had their fair share of demand while that for the giving priority for bicyclists was comparatively high. Bicycle registration system had the least demand of all.

5. CONCLUSION & RECOMMENDATIONS

It was explained in the discussion that there is still a fair demand for the bicycle but the common people are reluctant to use this economical transport mode due to various problems. Following recommendations can be made with regard to the literature review and data analysis.

- Where curbs are present, the bicycle lane width, the distance from the face of the curb to the centre of the lane line, should be between 1.5 metres and 2.0 metres.
- On paved shoulders without curbs, the bicycle lane width, the distance from the edge of the pavement to the centre of the lane line, should be between 1.2 metres and 1.7 metres.
- A wide bicycle lane (1.8 to 2.0 metres where curbs are present; 1.5 to 1.7 metres without curbs) is recommended under one or more of the following conditions:
    o where lateral obstructions, such as utility poles, are within 300 mm of the edge of curb;
    o where the bike lane is on a bridge or underpass;
    o where the posted speed limit is 60 km/h or greater;
    o where the adjacent traffic lane is 3.6 m or greater;
    o where the bike lane is between two traffic lanes;
    o -for all contra-flow bicycle lanes.
- Intersection treatment should be carried out as per the standards used in developed countries as given in this research.
- Dooring warning system should be implemented appropriately where parking is allowed with bicycle lanes.
- Proper bicycle parking places should be provided where a potential bicycle population is expected such as schools and universities.
- By road improvements should be carried out along with the main road improvements to facilitate the bicyclists use the road.
- Raised bicycle lanes, separated from the motorized way should be provided wherever possible.
- Green shelter should be provided for the bicycle lanes so the sweating would be minimized.
- Since the convenient bicycling distance varies, it is proposed that at least 4km bicycle lane should be provided surrounding the institutions like universities where a potential bicycle usage is anticipated, in case the whole road is not provided with a bicycle lane.

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