Traffic Engineering Solutions for Non-motorized Transport
– Bicycle in Shijiazhuang, China

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Table of Contents

Abbreviations 1
Abstract 2
Acknowledgement 2
I. Background 3
II. Summary of Main Issues of NMT in Shijiazhuang 4
III. Some Recommended Traffic Engineering Improvements for NMT 7
IV. Implemented Some of the Traffic Engineering Measures 16
V. Recommendations for Improvement of NMT 19

References and SJZ Studies

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Abbreviations

ADB: Asian Development Bank
MV: Motorized vehicle
NMT: Non-motorized transport
PT: Public Transport
SJZ: Shijiazhuang, the capital of Hebei Province, China
SMEDI: Shanghai Municipal Engineering Design Institute
SUTPO: Shijiazhuang Urban Transport Project Office
TDM: Transport Demand Management
WB: World Bank
Abstract

Non-Motorized Transport (NMT) -- pedestrian and bicycle -- has often been neglected in many developing countries, despite its economic significance to the poor and its importance to livable cities. Reasons for the neglect include the misconceptions that walking and bicycling are not “modern” and are associated with poverty, and the mistaken belief that bicycling uses an inordinate amount of road space compared to bus-based public transport.

Poor traffic engineering and roadway design have also contributed to the often poor performance of NMT compared to motorized modes. The objectives of this Paper are to (i) provide a brief overview of the issues identified in NMT and other studies in Shijiazhuang (SJZ), China; (ii) demonstrate how good traffic engineering and roadway design can not only benefit the pedestrians and bicyclists, but will also make transport safer and better performing for everyone; and (iii) recommend how NMT modes could be better treated in urban transport policy and investment planning, roadway design and traffic engineering and management in Asian cities.

Parts I and II of the Paper summarize the NMT issues based on the results of a variety of surveys and studies (see Reference and Studies), including a 1,000+ person survey of NMV users’ travel behavior and attitudes. Part III describes a number of NMT-friendly traffic engineering concepts. Part IV applies these traffic engineering for NMT concepts to Ping’an Street, a major arterial road in SJZ. Finally, Part V summarizes recommendations for improving NMT performance in developing cities.

Acknowledgements

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1. Background

1. China has been known as the "Kingdom of Bicycles." However, people's views about bicycles have been paradoxical and have changed over time. Before the policy of "opening" in late 70s, people had no other choice but to use bicycles and walking as primary modes. Moreover, workers were assigned to housing near their jobs and bicycling and walking were ideal at the resulting short to medium trip lengths. After the economic reform opening, bicycling began to be perceived as a symbol of poor and under development. As the number of private vehicles increased dramatically, many professionals and lay people believed that bicycles were a cause of congestion and wanted to remove or reduce their use and take road space dedicated to them in favor of general traffic. However, walking and bicycling are now recognized as "green" transport and as symbols livable cities and one of the most sustainable transport modes.

2. The provincial capital of Hebei Province, Shijiazhuang, is an ideal for bicycle use. It has a population of about 3 million population and a land area of approximately 455 km² both within the urban core, making it nearly as dense, over-all, as the City of New York's five boroughs. It has a relatively mild annual average temperature 13.3 Celsius (°C) and is on a flat plain with few hills–in short, favorable geographic conditions for walking and bicycling.

3. More than half (54 per cent Tsinghua NMT Study) of SJZ people still use bicycle as a major means for travel, one of the highest bicycle mode shares remaining in China. This high bicycle mode share could be because as an industrial city, incomes are relatively low compared to the wealthier coastal cities and the majority of SHZ's workers still live in close proximity to their jobs. Figures 1 and 2 show SJZ bicycle travel shares by occupation and by purpose.

![Figure 1. Bicycle Travel Share for Different Occupations](image-url)

Source: Tsinghua SJZ NMT Study, 2007
Through the Tsinghua study showed that bicycle use has remained more stable than in other Chinese cities, it is not without its issues.

II. Summary of Main Issues of NMT in SJZ

4. Bicycle users surveyed by Tsinghua believed that bicycling is not safe. (see Figure 3). Bicycle and pedestrian space have also been reduced and NMT networks are increasingly unconnected as formerly dedicated space is given to general traffic.

5. The study by Tsinghua identified the major causes of declining NMT performance and safety as related to strategic policy and finance, land use and transport planning, conflicts among transport modes mixed on general traffic roadways and inadequate roadway design, traffic engineering/management and enforcement.

6. NMT Policy and Finance. Figures 1 and 2 above show that more than 80 per cent of people travel by bicycle and pedestrian (NMT) in SJZ; however, there were no policy and development guidelines formulated by governments at any level specifically directed to those modes. Development of dedicated NMT facilities has not been a priority over other transport modes and little if any funds specifically invested in them.

7. Land Use and Transport Planning. Many of today’s NMT problems stem from land use
and transport decisions that were made a long time ago. These influenced the shape of current city development and solving them has proven to be very difficult and costly.

a. SJZ urban road network is cut by two rail lines which cross the inner city. Both minor residential streets and secondary arterial roads around the city are cut by the railway with no grade crossings. This forces both MV and NMV travel that crosses the railway lines to use the few bridges and tunnels on the main arterial roads. The railway dissection of the city leads to serious congestion in general traffic and NMV lanes and disorder at intersections during peak hours. This is a particularly vexing problem for NMT travel which is forced into conflicts with other traffic at the few crossing points.

b. According to the latest urban planning, the city has proposed to extend urban development axis and perfect the city functions at either sides of the railway, the flow of NMV traffic which crosses the railway is decreasing; compared with 1998, declined by 19 percent (Tsinghua, Op. Cit.). Meanwhile, the NMV flow from south to north increased by 7 percent (Tsinghua, Op. Cit.) in the same time frame.

c. An unbalanced road network structure formed the current roads network in Shijiazhuang. In the first Ring (City Center Business District), most NMV traffic flow is loaded onto four main roads. This is because of limited secondary roads, poor connectivity between existing secondary roads, many roads coming to an abrupt end, plus many narrow alleys, and a lack of guideposts and direction systems.

d. There are no NMV planning and development directions in the urban master planning in SJZ. Local government did not give much importance to NMV traffic. Also, a shortage of financial support causes a lack of NMV traffic investment in relevant traffic design and in traffic management agencies. Agencies lack relevant statistical data on NMV, and thus have no means to administer special planning for NMV.

8. **Conflicts among motorized and NMT traffic.** Mixed traffic among bicycles/ pedestrian has a negative impact on the traffic flow of the city and has been a major cause of road accidents, particularly the following:

a. Vehicles and bicycles between intersections: Motor vehicles directly threaten the safety of cyclists in most road sections since physical separations between lanes used for bicycles and those for general motorized vehicles are not normally provided. Making this situation particularly difficult is that cyclists frequently do not obey traffic laws and may turn at any time and in any place.
b. Bicycles, pedestrians, and motor vehicles at bus stops. Buses routinely have stops in bicycle lanes for boarding and alighting. This forces the flow of bicycles out into the motorized vehicle lane. This creates traffic disorder and turbulence, posing danger to the cyclists, motorists, and often bus passengers accessing/aggressing stops.

c. Bicycles, pedestrians, and vehicles at intersections. The struggle for space-time resources at intersections increases conflicts during "green times." For example, right-turning motor vehicles must pass through both straight running bicyclists and pedestrians. This increases the insecurity and uncertainty of drivers and cyclists, decreases the total person throughput of the intersection as well as creating significant safety issues. This is not helped by signal designs which already feature cycle times which are far too long and incorporate far too many phases in lieu of banning certain movements (e.g., left, right turns for motor vehicles).
9. Traffic Management and Enforcement

a. Main roads in SJZ are designed with median barriers, but traffic safety signs, guide posts and markings are relatively ineffective due to limited numbers and poor quality. This is especially the case with respect to NMV channeling, guide-flow signs, markings and guideposts. Pedestrian crosswalk signage, marking and other facilities at road mid points and intersections are also inadequate.

b. According to the Tsinghua survey of SJZ Traffic Management Development Planning, the number of pedestrian safety islands on very wide major arterial roads are limited, especially in view of the high NMV road crossing demand.

c. Signal programming usually does not adequately reflect temporal changes in NMV traffic volumes and their peaking characteristics. Queues in NMV lanes are not cleared quickly enough and waiting time for pedestrians to cross the road is also inefficient, deteriorating the situation where there are large mixed MV and NMV traffic flows through intersections.

d. Motor vehicle parking has increasingly occupied NMT space of NMT. There is not enough bicycle parking and what is provided is not properly managed.
e. NMV users and pedestrians lack education in traffic safety and laws. Pedestrians and bicycle users in SJZ are generally indifferent to traffic safety rules and simply do not obey traffic regulations. Crossing roads randomly along super blocks and at intersections when pedestrian indications are red, disturbs traffic order and obviously creates great accident risks. This not only threatens the safety of NMV traffic users, but also affects the safety and performance of motorized vehicle users. The Tsinghua Study Team observed pedestrians and cyclists disobeying traffic rules everywhere at all times. According to a survey of traffic police (Tsinghua Op. Cit.), the biggest management problem in Shijiazhuang is that NMV users and pedestrians do not obey traffic regulations.

III. Some Traffic Engineering Approaches for Improving NMT and Motorized Traffic Performance, Especially Safety

10. Different Characteristics of Mixed Transport Modes at Signalized Intersection. In China and many Asian countries, transport movement is a mixture of different transport modes instead of a single mode, and the operational characteristics of different traffic modes are very distinct from each other. On the basis of traffic movements, Table 1 concludes the mixed traffic feature. Comparatively, the different traffic modes in operation share obvious differences at the signal intersection.
### Table 1. Characteristics of Signalized Intersections

<table>
<thead>
<tr>
<th>Category of the traffic flow</th>
<th>Traffic Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pedestrian flow</strong></td>
<td>Beginning of green time: Little reaction loss; PEd.'s move into intersections en masse</td>
</tr>
<tr>
<td><strong>Bicycle flows</strong></td>
<td>Reaction time is almost zero; Bicyclists move into the intersections en masse, turning left entering un—marked, undifferentiated vehicle lanes creating conflicts</td>
</tr>
<tr>
<td><strong>Vehicle flow</strong></td>
<td>Reaction time is from 2 seconds to over 10 seconds; Few vehicles able to move out in a consistent manner</td>
</tr>
</tbody>
</table>

Source: Tongji University, Pang'an Road Rehabilitation Design, 2007

#### 11. Optimized design of bicycle space in mid-block road sections.
According to the Tongji study, Op.Cit.), bicycle volumes are much higher at peak hours than at non-peaks; therefore, space available for bicycles may be different for peak and non-peak periods. For example, high flows of bicycles can occupy one or more motor vehicle lanes during high flow traffic periods, while they revert to use of a single lane during the rest of the day.

In the period of low flow when there are fewer bicycles, vehicles have enough space with a single dedicated bicycle lane, enlarging intersection capacity, reducing delay for all intersection users.

**Figure 7. Adjustment of Space Dedicated to Bicycles as a Function of Time of Day and Bicycle Volume**

12. **Bicycle space and Bus Stops.** The corresponding design between bicycle and bus traffic should pay more attention to managing this relationship at the bus station. The Study proposes, in conclusion, a different clearance method according to the various transects that follow.

Figure 8 illustrates the normal roadway design at bus stops in Shijiazunag (and all of China). This design concept creates traffic turbulence for bicyclists and pedestrians which, in turn, affects passenger boarding and alighting times and safety; By “pushing” bicyclists into general traffic lanes, it is especially threatening to the safety of the bicycle traffic.

![Figure 8. Normal Bus Bay Design](image)

**Figure 8. Normal Bus Bay Design**


**Improved Bus Stop Design.** A revised design (Figure 9) is proposed that uses part of the pedestrian area to allow bicycles to safely move around bus stops. Through the compression of the pedestrian area, the newly combined bicycle lane deflects bicycle traffic into the inner-side of the stationary buses, thus meeting the demands of the buses and avoiding a conflict for moving vehicles of all types. This new design approach avoids unnecessary conflicts between bicycles and vehicles and further promotes safety and efficiency, special care must be exercised to retain sufficient space for pedestrians.

![Figure 9. Revised Bus Bay Design](image)

**Figure 9. Revised Bus Bay Design**


13. **Space optimized design for bicycles in intersections.** Since vehicles and bicycles cover a relatively large space in a huge intersection without defined channels for various movements, the interference among different modal flows is serious. Turning general traffic threatens the safety of cyclist making all movements, while bicycles disturb the movement of all general vehicle traffic flows and cause delays at the same time.

Therefore, the purposes of the optimized design of the bicycle space in the intersection are to (i) mitigate the inter-influence between motorized vehicles and bicycles; (ii) decrease delays; and (iii) promote safety for all.

This can be achieved by keeping motor vehicles on the outside of intersections, by
making bicycles and pedestrians share the same space for passing through intersections, or by implementing turning left in two phases, one for NMT and one for motor vehicles. However, by doing so, the separation between bicycle and pedestrian has to be very clear and visible and care has to be exercise to keep cycle lengths within tolerable limits (e.g., 150 seconds).

14. **Bicycle Waiting.** The design and operation process is focused on the front area of the bicycle lane in intersections, where it will be possible to set up a left-turn bicycle waiting area.

During green time, bicycles and vehicles wait in the opposite left-turn waiting area until the other green light is switched on. The design and the operation process sample are illustrated in Figure 10.

**Figure 10. Accomodating Large Volumes of Bicycles at Busy Intersections**

![Figure 10. Accomodating Large Volumes of Bicycles at Busy Intersections](image)


**Size for bicycle waiting space.** Bicycles crossing intersections and motor vehicle's turning left often share the same green time. During period of high bicycle flow, the traditional intersection design cannot meet the demand requiring a significant amount bicycle waiting space. Conflicts among bicycles, and motor vehicles turning left also causes turbulence and congestion.

An improved curb design needs to address two functions (removing bicyclist/motor vehicle conflicts and providing sufficient bicycle storage space) to ensure smooth intersection crossing. There are two ways to dispose of the curb: change the curb from A to D (as in Figure 11) to a gentle slope, with a proper anti-slip surface; and shorten the distance between A and D.
Since the space of the pedestrian area can be used for bicycle waiting, the flexible second method is advisable.

The situation of mixed waiting of both bicycles and pedestrians at intersections and at low flow is illustrated in Figure 12.

**Figure 12. Situation of mixed bicycles and pedestrian waiting without curb disposal**

A. The bicycle volume is low  
B. The bicycle volume is high


From what has already been discussed, it is known that the size of the bicycle waiting area should depend on the flow, differing between the high flow period and the rest of the day.

15. **Time-optimized method.** Traffic signal programming is one of the most effective ways to address traffic problems. Traffic signal programming should reflect the mix of NMT and motorized traffic, by movement through intersections by time of day. Constraints include storage or queuing space as well as the need to keep cycle lengths below a certain amount (e.g., 150 seconds, maximum) to avoid negative impacts on high volume public transport operations.

IV. **Implementing NMT-Friendly Traffic Engineering Measures on Pang'an Street: A Case Study**

The following discussion illustrates how some of the traffic engineering approaches described were used in the reconstruction of Ping'an street, a north-south trunk arterial road. They were
used to reconstruct the section between Zhongshan East Road and Zhengdong Road in the central district of Shijiazhuang City where enormous flows of pedestrians, bicycles and motor vehicle join together.

16. Analysis of Current Situation

**All-Mode Traffic Volumes:** The following traffic volume data is derived from surveys done on typical working days at the Ping’an Street-Zhongshan East Road Intersection, the most important in the entire city.

**Table 2. Traffic volumes in single peak hour**

<table>
<thead>
<tr>
<th>Entrance</th>
<th>Mode</th>
<th>Small vehicles</th>
<th>Large vehicles</th>
<th>Standard vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>East entrance</td>
<td>Turn left</td>
<td>117</td>
<td>18</td>
<td>153</td>
</tr>
<tr>
<td></td>
<td>Go straight</td>
<td>1035</td>
<td>93</td>
<td>1221</td>
</tr>
<tr>
<td></td>
<td>Turn right</td>
<td>156</td>
<td>0</td>
<td>156</td>
</tr>
<tr>
<td>West entrance</td>
<td>Turn left</td>
<td>156</td>
<td>15</td>
<td>186</td>
</tr>
<tr>
<td></td>
<td>Go straight</td>
<td>1065</td>
<td>120</td>
<td>1305</td>
</tr>
<tr>
<td></td>
<td>Turn right</td>
<td>156</td>
<td>42</td>
<td>240</td>
</tr>
<tr>
<td>North entrance</td>
<td>Turn left</td>
<td>159</td>
<td>9</td>
<td>177</td>
</tr>
<tr>
<td></td>
<td>Go straight</td>
<td>588</td>
<td>51</td>
<td>690</td>
</tr>
<tr>
<td></td>
<td>Turn right</td>
<td>525</td>
<td>24</td>
<td>573</td>
</tr>
<tr>
<td>South entrance</td>
<td>Turn left</td>
<td>189</td>
<td>9</td>
<td>207</td>
</tr>
<tr>
<td></td>
<td>Go straight</td>
<td>489</td>
<td>27</td>
<td>543</td>
</tr>
<tr>
<td></td>
<td>Turn right</td>
<td>153</td>
<td>0</td>
<td>153</td>
</tr>
<tr>
<td><strong>Σ</strong></td>
<td></td>
<td>4788</td>
<td>408</td>
<td>5604</td>
</tr>
</tbody>
</table>

Source: Tongji, Op.Cit.. Note: the unit in the table above are pcu/h or passenger car vehicle unit equivalents.

The previous channelization and signal design for this important intersection could not meet the transport demand any more. The queues for all modes at the intersection are excessively long. There is a serious conflict between pedestrians, bicycles and motor vehicles turning right. Weaving is serious, traffic capacity is low and there is also a safety risk. Tables 3 and 4 illustrate the tremendous flow of buses through the intersection as each route has a minimum frequency of 4 per hour during peak periods, with some routes have 10-15 buses per hour.

**Table 3. Bus Routes on Ping’an Street**

<table>
<thead>
<tr>
<th>Intersection approach</th>
<th>Turn left</th>
<th>Go straight</th>
<th>Turn right</th>
</tr>
</thead>
<tbody>
<tr>
<td>North entrance</td>
<td>12, 29</td>
<td>7</td>
<td>31, 43</td>
</tr>
<tr>
<td>South entrance</td>
<td>16</td>
<td>7</td>
<td>/</td>
</tr>
<tr>
<td>East entrance</td>
<td>106</td>
<td>1, 5, 6, 30, 34</td>
<td>/</td>
</tr>
<tr>
<td>West entrance</td>
<td>31</td>
<td>1, 5, 6, 30, 34, 106</td>
<td>16, 45, 55</td>
</tr>
</tbody>
</table>

Table 4. Location of bus stops and bus routes

<table>
<thead>
<tr>
<th>Bus stop location</th>
<th>Bus route</th>
</tr>
</thead>
<tbody>
<tr>
<td>North entrance</td>
<td>31, 43</td>
</tr>
<tr>
<td>North exit</td>
<td>7, 12, 29</td>
</tr>
<tr>
<td>South exit</td>
<td>7, 16, 45, 55, 106</td>
</tr>
<tr>
<td>East exit</td>
<td>1, 5, 6, 12, 29, 30, 34, 106</td>
</tr>
<tr>
<td>West exit</td>
<td>1, 5, 6, 16, 30, 34</td>
</tr>
</tbody>
</table>


Table 5 Traffic volumes at peak hour

<table>
<thead>
<tr>
<th></th>
<th>Bicycle</th>
<th>Pedestrian</th>
</tr>
</thead>
<tbody>
<tr>
<td>East entrance</td>
<td>3637</td>
<td>260</td>
</tr>
<tr>
<td>South entrance</td>
<td>5166</td>
<td>721</td>
</tr>
<tr>
<td>West entrance</td>
<td>4593</td>
<td>370</td>
</tr>
<tr>
<td>North entrance</td>
<td>2445</td>
<td>325</td>
</tr>
<tr>
<td><strong>Σ</strong></td>
<td><strong>15841</strong></td>
<td><strong>1676</strong></td>
</tr>
<tr>
<td>Composition ratio</td>
<td>99% of bicycles and 1% of tricycles</td>
<td></td>
</tr>
</tbody>
</table>


These tables indicate that there is heavy non-motor traffic as well as bus and general traffic flows through the intersection. A significant volume of bicycles move against the traffic flows assigned a green phase, and many pedestrians and bicycles run red lights during left-turn phases. To guarantee the safety of slow traffic and the normal operation of motor vehicle traffic flows, such a situation must be considered during design.

17. **Design Concepts; Expansion of entry and exit approaches.** Intersection space is reconfigured to take advantage of the existing road resources at the intersection and avoid building demolition. Improving the canalization of the connecting points of the motor vehicle lanes through the internal area of the intersection to make the driving routes clearer and improving the order of the motor traffic flows.

Use of dividers and other facilities to define the space for pedestrians, bicycles and motor vehicles ensures that different kinds of traffic can pass through the intersection in a safe, orderly and smooth manner.

**Develop integrated design for pedestrians and bicycles.** Bicycles are forced to cross the road by turning left twice (with storage space assigned accordingly) to reduce the conflict between the motor vehicles and non-motor vehicles. This guarantees the safety of bicyclists and improves the operation efficiency at the intersection for all users without causing the undue delay for public transport that inordinately long cycle times would cause.

18. **Corner barricade design.** At least one vehicle turning right should be able to wait in this area. Low bushes should be planted in dividers. If it is not possible to set up such a
green separation, a fence can be used.

**Figure 13. Example of corner barricade facilities**


19. **Design of slow traffic system.** Within the scope of intersection, the level of bicycle lanes should be elevated physically to bring it at the same level as the pedestrian walkway in order to maximize use of space and improve safety.

**Figure 14. Integration of slow traffic at the intersection**


20. **Road crossing for slow traffic.** Pedestrian and bicycle crossings should be clearly marked for all the directions of the intersection. Pedestrian road-crossing safety islands with sufficient protected pedestrian storage space should be set up in the middle of the road to make road-crossing safer. Non-barrier designs should be applied at both ends of the pedestrian crossing.

To avoid conflict between NMT and motor vehicles, improve the safety of NMT during road crossing, and adapt to the motor vehicle control design, the traffic space of NMT and road crossing ways should be adjusted: NMT should not be allowed to enter the internal area of the intersection, and they should travel at the periphery area. Bicycles and pedestrians should cross roads in the same way. The bicycles turning left should turn left twice to cross the road. See the graphics below.
The following factors should be considered when the pedestrian/bicycle crossing at the intersection is designed. Since there is a heavy bicycle flow in Shijiazhuang, bicycles should be given special consideration when designing the intersection. Proper width of bicycle crossing should be identified. A standing zone should be set up in the middle of the road. As for wide road, if it is difficult to cross the road at the late period of the green light, the pedestrians could stand within the pedestrian protection zone (safety island) to wait for the next green light phase. The safety of pedestrians would be improved in this way.

No-barrier facility (mild slope) design should be applied at both ends of the pedestrian crossing to make it more convenient for pedestrians/bicycles to cross the road. Twice road-crossing model should be adopted for bicycles turning left to minimize conflict with motor vehicles, ensure safety for road-crossing, and improve the overall operation efficiency of the intersection.

21. **Design of signals.** To improve the efficiency by function integration, different signal heads lights should be installed on the same mast as much as possible. Both high and low traffic signal heads shall be set up at large-scale intersections. As for the setup location of pedestrian/bicycle signal lights, to improve the safety of road crossing, the signals should be located in the same direction with the conflicting motor flow from people’s perspective as much as possible.
V. Recommendations for NMT Improvement

22. **Policy Formulation and Funding Allocation to Promote NMV.** Asian cities should formulate a clear policy and conduct an entire strategic development to promote development of NMT. The purpose of the policy, in combination with the land use and transport strategic plan would be to formally state the importance of NMV modes and enunciate strategies for its improvement. Such a policy also requires strong financial support for the appropriate facilities and equipment (e.g., dedicated lanes, physical channelization and separations, safety islands, ITS applications, signage and markings, etc. The main objective of NMV transport development and finance is to pursue the maximum social and environmental benefits, and these should be reflected in the multiple factor economic analyses done to set priorities and allocate public transport investment funds.

23. **Inclusion of NMT into Urban Land Use and Urban Transport Planning.** NMT planning should be fully and explicitly incorporated into urban land use and transport planning, reflecting the identification of current and long term local needs. For Asian cities, the ultimate uses of cycling and pedestrian planning should be the identification of a special dedicated network for cyclists and pedestrians that will significantly improve NMV performance and safety, thus making cities more livable, especially for vulnerable populations like women and children who are overly dependent on these modes. The plan should explicitly address the location of new routes, critical intersections, extensions of existing routes, markings and signage and necessary ITS and signal applications.

24. **Incorporation of NMT modes into all road designs.** The NMV traffic problem is an important characteristic of cities in China and in Asia that differ from those in more
advanced countries. Traffic engineering approaches specifically directed to NMT modes has not been used very often and theoretical research for conducting planning and management for NMV transport has not been conducted in Asia. Cities should try to analyze their own NMT issues first, and share information on what works and what doesn’t with experienced experts so others can gain experience and knowledge. Some of the examples from Shijiazhuang shown in this Paper could be used as starting points for other cities to use to develop traffic engineering and roadway design approaches tailored to their specific NMT problems.

25. The traffic engineering design should take into consideration connections to the regional roadway and public transport networks, coordinating the balance between bicycles, pedestrians, public transport and private vehicles. Traffic engineering and roadway planning and design for NMT should not only consider major arterials, but should also take advantage of minor arterials and residential streets in order to achieve a balanced distribution of the bicycle volumes, reduce travel indirection and decrease the traffic pressure on the arterial roads.

26. **Enhancement of Traffic Management Enforcement and Education.** According to the survey (Tsinghua, Op. Cit.), citizens in Shijiazhuang were found to be indifferent to traffic regulations and safety. At intersections and between them, bicyclists and pedestrians often ignore traffic rules and cross as they wish, thus creating both traffic turbulence and a safety hazard for all. As a result, all aspects of NMT traffic safety and regulation should be incorporated into formal education programs reaching all segments of urban populations, from children to senior citizens. These program should be carried out by traffic management agencies, the traffic police and non-governmental safety promotion organizations with both government and private sector (e.g., auto, trucking and insurance companies) financial support.

27. **Social and Institutional Issues.** NMT traffic is not just about traffic issues, but also about an intricate social and institutional problem that is often easily ignored by local authorities. Identifying and solving NMT traffic problems need extensive public participation and cooperation with community organizations. The improvement of NMV traffic requires not only strong commitment from municipal departments, but also collaboration with other government departments, civic associations and agencies. The traffic management, city planning, engineering design, civil administration and public service departments altogether have an important role to play. Development of a close relationship between the traffic research institution and school educational framework is also vital.

28. The Paper recommends establishing a harmonious mechanism between each department and correlative public participant pattern by organizing formal, periodic communications activities. This would address NMV traffic problems and organize various agencies and listen to the concerns of the public. It will effectively improve the environment of NMV traffic in cities, and set up more user-friendly urban traffic systems.
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