Research on Beijing’s Public Transportation Commuting Transit Network

Beijing Municipal Committee of Communications

Beijing Transportation Research Center

World Bank

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Outline

I. Background of Beijing PT Development

II. Problems & Challenges in PT Development

III. Proposals & Goals

IV. A Tentative Plan for BCTN

V. A Tentative Plan for BCTN Model Corridor

VI. Working Review and Plan for Next Stage
I. Background on Beijing PT Development

Facts & Figures

- Population: In recent 5 years, the population has grown by half a million every year, and till 2007, the total population stood at 16.33 million;

- Economy: GDP per capita has reached 58,204 yuan, 10% higher than that of 2006.

- Motor vehicles: 1,000 new motor vehicles are being purchased every day, and the total number of motor vehicles is 3.5 million.
I. Background on Beijing PT Development

Current situation of Public Transportation (PT) development

- Investment on PT development kept rising
  - Beijing’s investment on traffic infrastructure during the past ten years had kept rising, and PT investment has seen a rapid development. In 2007, municipal investment on track communication reach 13.2 billion yuan, 56% higher than the same period last year. The portion of investment on PT infrastructure accounted for 43.6% of the total investment on communication construction.

- Public Transportation is the major means for commuters
  - In 2007, 34.5% of residents chose PT when going out, almost the same as those who chose cars.

How did passengers travel
I. Background on Beijing PT Development

- Notable achievements were made on priority of PT development
  - By the end of 2008, there are 8 track communication lines, and the total length is 200 km, in which 86 km is newly built;
  - Ground PT was optimized. By the end of 2008, there were 644 bus lines, 19,395 vehicles, 4 PT junctions, 24 center stations, and 377 origin stations and terminals.
  - 3 BRT lines with great capacity, and the total length is 50 km.
  - From 2003 to 2008, 14,891 new environmentally-friendly vehicles were purchased and 430 PT lines were adjusted.
In 2008, the total ridership was 6.549 billion travels, in which 4.644 billion travels were carried by bus, 9.9% up compared to the same period of last year; 1.215 billion travels were by metro, 85.5% up compared to the same period of last year; and 0.69 billion by taxies, 7.6% up compared to the same period of last year.

PT ridership increases
Development Trend

1. As the urbanization develops so fast, the population and traffic demand surged

2. Cars increase rapidly, which is beyond the capacity of the limited urban resources and communication infrastructure;
I. Background on Beijing PT Development

3. The variety of citizens’ travel demand requires fast development of Public Transportation (PT);
   A lot of changes occurred in residents' travel volume, travel distance and space & time. Citizens’ various travel demand requires the establishment of a multi-layer service system.
Beijing’s priority of PT development policy is obviously effective, but the gap between the policy and urban development and social expectation is still huge:

- **Slow and time-consuming**: currently, the average distance of PT travel is 9.5 kilometers at an average speed of 14 kilometers per hour, which takes 66 minutes to travel at the rush hours; while the average distance of car travel is 14 kilometers at an average speed of 22 kilometers per hour, which takes 39 minutes at the peak hours.

- **Inconvenient to transfer**: now the average distance between two PT transfer stops is 355 meters, taking commuters 6 minutes on foot, which is farther than original design (*Code on Urban road traffic planning and designing* sets the maximum transfer distance at 200 meters)

- **Unpunctual and unreliable**: the punctual rate of PT is only 50%
A survey shows that 80% of the passengers' complaint is related to the problems mentioned above. These problems have greatly affected the running efficiency of the public transport, and reduced the attraction of the PT. The major causes of the problems are:

- **Networks' optimization and adjustment are not completed**: the three-level PT networks system is not perfect, especially for the express lines; there are many overlapped PT lines in the central areas, while PT networks haven’t reached some areas in the outskirts of Beijing.

- **PT transfer system is not perfect**: there are inadequate transfer stops.

- **PT road priority is not enough in busy areas**: there’s no breakthrough in the heavy-traffic areas, and the overall PT running speed has not been elevated.
Outlines:

- Targetting on the peak-hour commuting & traveling
- Aiming at increasing the ratio of PT for commuting & traveling
- Focusing on increasing bus speed and improving transfer conditions
- Also paying attention to the city’s development in a long run, and emphasizing solving the problems in a short run
- Building the public transportation commuting transit network on the base of metro and BRT system.
- Building an express Public Transportation Network (known as BCTN), which integrates bus, subway, and BRT that covers both the urban and the rural areas.
- Attracting commuters who drive cars to take public transportation, in order to increase the traffic efficiency.
III. Proposals & goals

Working objectives:

- **Improving travel conditions of BCTN**
  - Networks: covering key travel directions for commuters, and setting up Bus Commuting Transit Lines along major busy corridors.
  - Speed: 40 % up compared to conventional bus, reaching above 20 km/hr
  - Conjunction and transfer: cut distance & reduce time for transfer; efforts will be made to limit the transfer time within 10 min.
  - Punctuality: goes up to 90 % from 50 – 60 % for conventional bus

Generally, form a 1-hr commuting circle in the urban areas
III. Proposals & goals

Basic orientation:

- **Service target:** passengers commuting and traveling for work and school
- **Areas to be covered:** central areas of the city and expressways that links the urban and rural areas.
- **Component:** rail, BRT and ground express lines
- **Commuting period:** 6:00 - 9:30am & 4:30 – 7:00pm
III. Proposals & goals

The design for the BCTN

- Vehicles: 18 meters articulated buses in urban areas, and single buses in the suburbs.
- Logo system: well-marked logo should be seen on the platform and the buses, and the buses should be painted with bright colors that can be distinguished from conventional buses.
- Departure interval: 1-3 minutes
- Speed: 20 km/hr
- Road conditions: set continuous physically or traffic-marking separated special lanes for the Public Transportation only; buses to the suburbs will run on the express ways.
- Daily transportation capacity: 50-80 thousand travels.
An analysis on the BCTN plan based on the following four aspects:

1. The PT passengers actual routes and the ideal routes demand
2. PT travel OD distribution
3. Major places of PT passenger flow
4. Roads and bus lane network
A selection of passenger corridors that the actual two-way PT passenger flow surpasses 10,000 travels/hr at the peak hours.
A selection of passenger corridors that two-way PT passenger flow surpasses 10,000 travels/hr at the peak hours under the ideal passenger flow distribution.
IV. A Tentative Plan for BCTN

Layout of current PT corridors with huge passenger flow
IV. A Tentative Plan for BCTN

Layout of current PT corridors with huge passenger flow
IV. A Tentative Plan for BCTN

3. link big stations with huge PT passenger flow

This picture bases on the 2006 PT stop boarding and alighting data, not include Bafangda and 9-begin lines.
IV. A Tentative Plan for BCTN

4. Combine Closely with the PT Special Lane’s networks

Plan for Beijing PT Special lanes

Legend
Current PT Special Lanes
Proposed PT Special Lanes

Proposed length: 460 km
Finished length: 258.3 km
IV. A Tentative Plan for BCTN

- 9 Horizontal Lines
- 9 Vertical Lines
- 3 Rings
- 8 Radiation Lines
Combine the planned Track Transportation networks, exclude the roads that have and are going to build track transportation lines:

Roads that have built track transportation lines: Chang’an Street, road section from Chongwenmen to Songjianshuang, 2nd Ring Road, road section from Bagou to Jingcheng Express Way, Airport Express line, East 3rd Ring Road, etc. Roads that is going to build track transportation lines: Ping’an Street, Liangguang Road, Road section from Xizhimen to Zhongguancun
8 primarily selected BRT corridors

- Wangjing
- Shunyi, Pingguo
- Huairou, Miyun
- Tiantongyuan, Beiyuan
- Huilongguan, Changping, Tongyuan, Beiyuan, airou, Miyun
- Shunyi, Pingguo
- Tianqiao
- Chaoyang Road
- South Axis Road
- Xiangshan
- Shijingshan
- Fushi Road
- Jingshi Express Way
- Jingkai Express Way
- Fushi Road
- Shijingshan
- Mentougou
- Fangshan
- Daxing
- Songjiazhuang
- Demaozhuang
- Yizhuang
- Fatou
- Tongzhou
A further selection from the 8 primarily selected BRT corridors.
5 recently-built BRT corridors
According to the traffic congestion index of the recently-built roads, we choose corridors that are badly suffered from traffic jams: Chaoyang Road and Jingkai Express Way

<table>
<thead>
<tr>
<th>Roads</th>
<th>Traffic Congestion Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anli Road</td>
<td>7.1</td>
</tr>
<tr>
<td>Chaoyang Road</td>
<td>7.3</td>
</tr>
<tr>
<td>Jingkai Express Way</td>
<td>8.1</td>
</tr>
<tr>
<td>Jingshi Express Way</td>
<td>4.4</td>
</tr>
<tr>
<td>Jingshun Road</td>
<td>6.2</td>
</tr>
</tbody>
</table>
After analyzing the existing BRT, road conditions, traffic conditions, and PT commuters volume, finally we tentatively choose Chaoyang Road as a model line.

<table>
<thead>
<tr>
<th>Road</th>
<th>PT and car section passenger flow at peak hours (10,000 travels/hr)</th>
<th>PT section passenger flow (10,000 travels/hr)</th>
<th>Sharing ratio of PT (%)</th>
<th>Traffic congestion index</th>
<th>Road condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chaoyang Road</td>
<td>1.2~1.8</td>
<td>0.8~1.1</td>
<td>53~61</td>
<td>7.3</td>
<td>The existing BRT2 is not effective, and the PT special lane is in good condition</td>
</tr>
<tr>
<td>Jingkai Express Way</td>
<td>0.7~1.3</td>
<td>0.3~0.5</td>
<td>40~60</td>
<td>8.1</td>
<td>PT special line needed in the Express way</td>
</tr>
</tbody>
</table>
### Suggestions on construction schedule

According to the analysis above, we suggest the construction schedule as below:

**Recent construction: 5 lines**

<table>
<thead>
<tr>
<th>No.</th>
<th>Road</th>
<th>Completed/being built</th>
<th>建设时序</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chaoyang Road</td>
<td></td>
<td>An Example Project</td>
</tr>
<tr>
<td>2</td>
<td>Fushi Road</td>
<td></td>
<td>Under construction</td>
</tr>
<tr>
<td>3</td>
<td>Jingkai Express Way</td>
<td></td>
<td>near future</td>
</tr>
<tr>
<td>4</td>
<td>Anli Road</td>
<td>BRT3</td>
<td>near future</td>
</tr>
<tr>
<td>5</td>
<td>Badaling-the Old Summer Palace East Road(shangdi-Zhongguancun)</td>
<td>Need to build a main Road</td>
<td>near future</td>
</tr>
</tbody>
</table>

| 6   | Jingshun Road                             |                                                  | future           |
| 7   | Jingshi Express Way                       |                                                  | future           |
| 8   | Badaling Main line                        |                                                  | future           |
| 9   | Road section from Xizhimen to Xiangshan   | Partly Planned M4                                | future           |
| 10  | Ping’an Street                            | Partly Planned S1                                | future           |
| 11  | Chaoyang North Road                       |                                                  | future           |
| 12  | Road section from Fengbei Bridge to Fatou |                                                  | future           |
| 13  | Road section from Jianguomen to mentougou | Partly existing M2                              | future           |
| 14  | Jingcheng Express Way                     |                                                  | future           |
| 15  | Jingjintao Express Way                    |                                                  | future           |
| 16  | Road section from Huilongguan to the Old Summer Palace East | | future           |
| 17  | Xueyuan Road                              |                                                  | future           |
| 18  | Xidan-Gongyi Bridge                       |                                                  | future           |
| 19  | Road section from Huilongguan to Suzhou Bridge |                                              | future           |

**Future construction: 16 lines**

<table>
<thead>
<tr>
<th>No.</th>
<th>Road</th>
<th>Completed/being built</th>
<th>建设时序</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Fangzhuang East Road</td>
<td></td>
<td>future</td>
</tr>
</tbody>
</table>
Suggestions on construction schedule

Legend
- Near future construction
- Future construction
- Existing and planned track
- Existing and planned BRT

Near future construction:
- S1
- BRT1
- BRT3

Future construction:
- Airport
- Fatou
- Tiantongyuan
- Shangdi
- Huairou
- Miyun
- Shunyi
- Pinggu
- Shijingshan
- Daxing
- Demaozhuan
- Yizhuang

Existing and planned track:
- Shangdi
- Huairou
- Miyun
- Shunyi
- Pinggu
- Shijingshan
- Daxing
- Demaozhuan
- Yizhuang

Existing and planned BRT:
- Fangshan
- Songjiazhuang
A Tentative Plan for BCTN Model corridor

- An analysis of the current situation of the corridor
- The major problems of the corridor
- Tentative solution
The Current PT Situation of Chaoyang Road

Current condition of BRT2

- **OD:** Yangzha-Chaoyangmen
- **Lengthen:** 16 km
- **Stops:** 21, among which 18 are in use now
- **Daily passenger volume:** 45,000 travels
There are 25 crossing roads with traffic lights, 9 traffic lights for pedestrian and 3 crosswalks without traffic lights from Chaoyangmen to Yangzhahuandao. There is a traffic light every 450 meters.
PT condition of Chaoyang Road

PT stops and lines along Chaoyang Road
1. The PT special lane hasn’t showed its advantages. BRT2 speed is as slow as the conventional buses, with its speed at 15-16 km/hr at peak hours and 18-20 km/hr at level hours.

We compared the running time between BRT2 and its overlapped line (conventional Bus No. 846) at morning peak hours, level hours and evening peak hours. The compared road section is from Chaoyangmen to Yangzhahuandao (some 15 km). The comparison shows that BRT2 is more time-saving than conventional buses, but the advantages are not obvious, especially at the level and evening peak hours.

<table>
<thead>
<tr>
<th></th>
<th>Morning peak hours</th>
<th>Level hours</th>
<th>Evening peak hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRT2</td>
<td>59’ 45”</td>
<td>48’ 43”</td>
<td>55’ 16”</td>
</tr>
<tr>
<td>Bus No. 846</td>
<td>76’ 44”</td>
<td>56’ 44”</td>
<td>60’ 25”</td>
</tr>
</tbody>
</table>
BRT2 running time structure at morning peak hours

- Driving time: 1%
- Time spending at stops: 17%
- Time waiting for traffic lights: 21%
- Delay caused by traffic congestion: 54%
- Delay caused by other factors: 7%

Bus No.846 running time structure at morning peak hours

- Time spending at stops: 6%
- Time waiting for traffic lights: 23%
- Delay caused by traffic congestion: 18%
- Delay caused by other factors: 3%

BRT2 outbound running time structure at evening peak hours

- Driving time: 34%
- Time spending at stops: 2%
- Time waiting for traffic lights: 30%
- Delay caused by traffic congestion: 10%
- Delay caused by other factors: 0%

Bus No.846 outbound running time structure at evening peak hours

- Driving time: 55%
- Time spending at stops: 34%
- Time waiting for traffic lights: 9%
- Delay caused by traffic congestion: 1%
- Delay caused by other factors: 1%
Analysis on Travel time structure—take morning peak hours as an example

- BRT2 is roughly the same as conventional buses in travel time structure,
- Waiting time of the traffic lights is long, accounting for 21% and 23% of the total running time.
- One of the major causes that delays the buses is traffic congestion, accounting for 17% and 18% respectively.
- Time spending at stops is short, accounting for 7% and 6% respectively.
Major Problems

Major causes that affect BRT’s speed

- Distance between traffic lights is short (450 meters), and there’s no PT priority traffic signal, and the special lane’s advantages cannot be seen.

- There is no PT special lane at the entrance of the main road at the crossings below the bridges in peak-hour traffic congested areas such as Ciyunsi and Hujialou.

- The PT special lane is occupied by cars, which affects the PT speed.

- The road construction between the 4th and 5th ring roads makes the special lane discontinuous.
2. PT commuting demand is high along the line, and BRT2 hasn’t covered OD.

There is large commuting demand in Tongzhou North area:

1. Large area communities have been built around Wuyi Garden.

2. After a survey of Wuyi Garden, Jieyansuo, and Wuzi University stops, the inbound passengers volume of the three stops exceeds 10,000 travels, among which 70% cross Yangzha.
Preliminary plan for Chaoyang Road PT lines’ adjustment

Optimization goals:

- Enlarge service scale and passenger flow the PT system serves
- Optimize the PT lines
- Quicken the running speed
- Improve service quality
Enlarge service scale and passenger flow the PT system serves

- Extend BRT2 to Tongzhou’s Wuyi Garden, and cover major passenger flow areas in Tongzhou. The lengthen of the extended section is 26 km.
Enlarge service scale and passenger flow the PT system serves

- After BRT2’s extension to Wuyi Garden, such paralleled long-distance lines as Bus No. 342, 382, 488, 846, 855 should add fast buses which only stop at selected big stops, as BRT2’s supporting lines’ system, so that a BCTN system can be built on Chaoyang Road.
Preliminary plan for Chaoyang Road PT lines’ adjustment

Quicken the running speed

- The fast buses should stop at major passenger flow collector-distributor points such as Tongzhoubeiguan, Yangzha, Gaojing, Hongmiaolukou, Hujialou and Chaoyangmen.
- The fast buses should enter BRT2’s special lane to share same platforms for transfer.
- Analyze the passengers of Bus No.855 and 846, who get on in the east of Yangzha and get off in the west of Yangzha, and make reference to the setting of stops for the fast buses in the east of Yangzha.
Bus 855: Statistics on which stops passengers getting on in the east of Yangzha will get off

Bus 846: Statistics on which stops passengers getting on in the east of Yangzha will get off
Preliminary plan for Chaoyang Road PT lines’ adjustment

Quicken the running speed

- Take further PT priority measures
  - Extend the BRT special lane to the crossing under Ciyunsi and Hujialou Bridges.
  - At crossings with traffic lights, BRT priority control plan or green wave coordination control should be implemented.
  - Pedestrian traffic lights close to the BRT stops should be under coordinated control with the stops.
- Strengthen supervision of the PT special lane and avoid cars’ entrance to the lane to slow down the PT running speed.
Preliminary plan for Chaoyang Road PT lines’ adjustment

Improve service quality

- Establish BCTN system along Chaoyang Road based on BRT2
- Differentiate the buses of express lines and conventional lines, to make the express lines easier to be identified
- Different express lines share same transfer stations to improve the transfer system
- Add a forecast of arrival buses for the express lines
Expectations:

- Build a Chaoyang Road’s BCTN system with BRT2 supported by several other express lines.
- Form a BCTN corridor between Tongzhou district and the city center by the links between BRT2, subway Line 1, Batong Line and subway’s Loop Line & Line 10.
Preliminary plan for Chaoyang Road PT lines’ adjustment

Expectations:

- Passenger flow of the BCTN is estimated to increase to 100 thousand travels per day
- The speed of the fast buses in the corridor will be increased to over 20 km/hr
THANKS!