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Kunming BRT System Study

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Bus Rapid Transit System in Kunming

Research Director:

Lin Wei

Research Personnel:

Lin Wei
Senior engineer, Kunming Urban Traffic Research Institute

Wen Jie
Senior engineer, Kunming Urban Traffic Research Institute

Zhang Xudong
Senior engineer, Kunming Urban Traffic Research Institute

Ji Wenbo
Assistant engineer, Kunming Urban Traffic Research Institute

Gao Jie
Assistant engineer, Kunming Urban Traffic Research Institute

Sun Jingyi
Associate professor, Traffic School of Kunming University of Science and Technology

Zhao Sheng
Engineer, Kunming Tongxiang Computer Software Company

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PROGRESS REPORT

(I) GENERAL DESCRIPTION

In 1996, Kunming and Zurich launched an international technological cooperation on bus transit planning, putting forward the BRT priority policy. In April 1999, Kunming had its first modern bus lane, marking the earliest practice of BRT in China.

In November 2003, the Energy Foundation, in support of Kunming's study on BRT planning, provided Kunming with part of the research funds and much technical advice, aiming at helping the construction of city's BRT system, and promoting sustainable traffic development. Within a year, Kunming Urban Traffic Research Institute (KUTRI) completed four research projects--- Study on the Regulations on Kunming's Bus Lane Design, Study on Kunming's Urban BRT Network Planning, Study on Kunming's Urban Bus Ticket System, and Study on Kunming's Urban BRT Security System--- which have all passed the review and evaluation by experts. The major conclusions of these projects have been submitted to Kunming Municipal Government as KUTRI's formal technical proposals on the city's BRT development, and some of them have been adopted by the government and carried out by government departments. To date, these projects have resulted in the following:

1. In February 2004, the *Traffic Alleviation Blueprint for Major Urban Areas of Kunming* established the specific steps of the development of Kunming's BRT system, which have been included in the government work report.

2. In July 2004, in cooperation with Kunming City Bus Company, KUTRI worked out the inquiry manual on the city's present bus routes, and the map of the city's present bus network, in which the routes of each bus terminal are differentiated from those of other terminals using a distinctive color. The manual and map makes it much easier for the residents to recognize and locate the city's bus routes.

3. In August 2004, the city's "Feng Xing Cai Yun" bus route inquiry hotline (96312) was established.

4. In September 2004, the initial design of the city's fourth bus lane (2.6km) was completed in combination with the transformation and renovation of the Kunming-Wanding Highway, which is part of the chessboard-shaped bus lane network. The construction of this bus lane will be completed in the first half of 2005.

5. In October 2004, in the manufacture of new buses, the vehicle assembly plant of Kunming City Bus Company adopted some of the bus design ideas required by the BRT system, such as the employment of the environmental-friendly engine, roomy

body and doors, and lower chassis.

6. In November 2004, the international mayors' forum on urban sustainable energy development was held in Kunming, which has greatly promoted the development of BRT in Kunming and in other Chinese cities.

7. In December 2004, KUTRI made lots of publicity efforts of the main ideas put forward in the mayors' forum with the help of the media, and presented to the government its near-term countermeasures and technical proposals by submitting the *Working Plan on the Comprehensive Control of the Urban Traffic of Kunming City 2005*.

Generally speaking, through these projects, KUTRI has played an active role in guiding the government in terms of the city's traffic development. By publicizing the BRT ideas, and by providing the government with technical guidance and proposals, KUTRI has helped to strengthen the concept of the government and relevant departments as to BRT priority, and to promote the development of Kunming's BRT system.

(II) MAIN CONCLUSIONS AND PROPOSALS

1. Since establishing the BRT priority, Kunming built a number of bus lanes, which are number one in both technical standard and efficiency in China. Compared with the world-class BRT systems, however, Kunming's BRT system still has a long way to go in improving its carrying capacity and service level, to let the government and the public see the expected effects of public traffic priority.

2. The modern BRT is a comprehensive system. That means that the bus lane facilities are far from sufficient, and that all aspects of the BRT system, including the vehicles, bus route network, stations and terminals, bus ticket system and passenger service, must be developed according to the BRT standard and the city's conditions as well.

3. The modern BRT can reach the carrying capacity and service level of rail traffic, but its construction and operation costs are much lower than that of rail traffic, and it can be built and put into use in a short period of time. That makes it particularly suitable for economic strength-lacking cities in developing countries like Kunming.

4. Kunming's bus lane facilities need to be improved. Not only should the bus lanes' technical standard and design details be improved; it is most important to improve the closure conditions of the bus lanes by applying low and rigid partition walls to improve the efficiency and running stability of the buses. In addition, people should be able to use the bus lanes as the rescue paths in case of emergencies.

5. The city's bus lane network should be expanded in stages to make the total length of the bus lanes reach 63km. To achieve that, it is planned to build bus lanes in Xichang Road, Beijing Road, and the Extension of Eastern Renmin Road according to the BRT

standard, and then to build a high-standard bus lane from Juhua Flyover to the eastern part of the city via Guikun Road and Kunluo Road in combination with the development of city's eastern part.

6. The BRT system should employ a new electronic free-transfer ticket system, which would allow passengers to travel within the entire network aboard one bus with just one ticket payment at no additional cost if his/her two bus transfers are within one hour. This would enable the passenger to travel within the network rather than along the bus routes. The passenger should be able to spend less time getting on a bus, and the time of his stay at the bus stops should be shortened. Such changes of the passenger behavior will promote the reasonable arrangement of the bus lane network.

7. The bus route network should be optimized by dividing it into different levels. The first level should have the high carrying capacity and service level of the standard BRT system; the second should be made up of district bus trunk lines as a supplement to the first level; the third should be passenger-collecting sub-routes with a high percent of passenger coverage.

8. The carrying capacity and operating efficiency of the bus lanes should be improved by employing high-quality and ultra-long-body buses, and running them in busy trunk routes with closed-type bus lane. The carrying capacity of the bus lanes should reach 12,000~15,000 passengers/hour.

9. Buses should be given traffic signal priority at crossroads by making use of the signal control technology to make their running speed reach 20~25km/h, and improve their running stability and arrive-on-time rate.

10. To improve the service level and appeal of the buses, a human and informative bus passenger service system should be established to enable passengers, esp. foreign passengers, to get the bus transit information they want in an easy and convenient way.

11. The bus terminals should be designed and built as passenger traffic hubs, which would help form a reasonable transfer relationship between bus routes, between different means of public transit, and between bus transit and other means of traffic such as cars, bicycles and walking.

12. A good BRT security system aimed at ensuring BRT priority should be established to provide supports for the city's bus transit development. This system should include such elements as urban traffic policies, the integration of passenger transport markets, the application of new technologies, financial support and other preferential policies.

(III) WORKING PLAN FOR THE NEXT PHASE

The Study on BRT System in Kunming has established the technical framework and steps for the city to develop its bus lane system into a BRT system. The key emphasis in following work is to promote the implementation of these steps in stages, and to provide the responsible departments with sustainable technical supports in their implementation of specific projects. Closing existing bus lanes, putting into practice the new free-transfer ticket system, optimizing the bus route network and building new bus lanes will be the priorities of the following work.

I. STUDY ON THE REGULATIONS ON KUNMING'S BUS LANE DESIGN

Bus lane is an effective means of urban bus transit, and a necessary infrastructure of a BRT system. How to achieve BRT priority under China's particular urban traffic conditions is a question of practical significance faced by many Chinese cities. Based on the our experiences of designing Kunming's existing three bus lanes, we have drawn out the regulations on Kunming's bus design in an attempt to explore the urban bus transit development mode that meets China's situation and successful and pragmatic bus lane technologies, and to secure BRT priority and bring into full play the roles of bus lane in the city in the sense of hardware. The purpose of the regulations is to guide the improvement of Kunming's existing bus lanes, the building of the city's new bus lanes and the design of the city's BRT system. We hope that we can build these regulations into the ones with a high academic level and a certain authority by repeatedly practicing and improving them.

(I) GENERAL REGULATIONS

1. The purpose of bus lane planning and design is to research and determine the network, location, and route of urban bus lanes in consideration of all involved technical, economic and social factors under the guidance of the city's public transit planning;

2. Bus lane planning, designing and building must be based on the city's general planning and comprehensive traffic system planning, meet the city's size, trend of development and passenger traffic demand, and facilitate the harmonious development of the city's all means of traffic;

3. Two large-capacity one-way bus lanes may be built in newly developed urban areas and some other suitable areas;

4. Bus lane design should embody the policy of BRT priority in terms of road space use, traffic facilities arrangement, and traffic signal setting; and

5. Bus lane design should properly handle the relationship among the passengers, the

bus lanes and the environment in accordance with the requirements of traffic engineering;

(II) PLANNING AND DESIGN OF INTERSECTIONS

1. Types of intersections;
2. Location, type, structure and function of bus stops at intersections;
3. Design bus lanes at intersections, and the forms of and the Requirements on lane channeling at intersections;
4. Process of the planning and designing road grade intersections in combination with bus lane design;
5. Requirements on the length and section width of the entrance and exit channels of bus lanes at intersections, and the size of bus stops; and
6. Requirements on designing of non-motorized vehicle lane system and footpath system, traffic signs and markings and other traffic control facilities and their accessories.

(III) PLANNING AND DESIGN OF ROAD SECTIONS

1. Cross section distribution, and arrangement of bus lane in cross section;
2. Designing of motorized vehicle lane and non-motorized vehicle lane;
3. Isolating facilities (facilities ensuring BRT priority) of bus lane;
4. Road section signs and markings; and
5. Street-crossing facilities and signals.

(IV) PLANNING AND DESIGN OF BUS STOPS

1. General requirements;
2. Type of bus stops, and requirements on bus stop selection;
3. Regulations on the site and interval of bus stops;
4. Requirements on the structure, verticality and drainability of bus stops; and
5. Auxiliary facilities of bus stops

Big Chinese cities have some distinctive features, such as the high population density, the large bicycle traffic volume, the low road network density, and the lack in street width. These regulations are for the designing of bus lanes with Chinese characteristics by combining the successful experiences of international BRT with the characteristics of big Chinese cities.

II. STUDY ON KUNMING'S URBAN BRT NETWORK PLANNING

The study is focused on how to build a highly effective, economical and feasible BRT network in the city in combination with urban land utilization by building BRT channels in city's central areas, as well as the steps of building the network. The purpose of the study is to direct the optimization, adjustment and rearrangement of the city's bus routes in a certain period of time to come.

(I) CONCEPT AND PRACTICE OF BRT

In a particular area like a city, BRT can better meet the passenger transport demand than cars. In designing a BRT network, importance must be attached to the network's safety, speed, reliability and comfort. By comparing Kunming's experience in building BRT system with some other countries' experience in urban bus transit development, we find that the BRT system in Curitiba, Brazil can be used as a good reference for Kunming. Based on that, we have advanced the idea of building Kunming's BRT system in stages based on the city's existing bus lanes. This idea is made up of the following elements:

1. To integrate the bus route network and ticket system;
2. To expand, extend and transform the existing bus lane;
3. To combine BRT channel development with land utilization to establish the idea of BRT-oriented city development;
4. To optimize the BRT network and its operation and dispatch, improve the technical level of the bus vehicles, and build large-capacity, high-efficiency and easy-to-recognize bus channels, to prepare for the all-sided development of BRT;
5. To estimate and review the function and position of BRT in the city's future urban traffic system by making use of its flexibility and economical efficiency to combine its near-term benefits with its long-term benefits; and
6. To establish the precedence of BRT in the city's traffic system, and encourage the development of the city's bus transit and walking facilities and their operating mechanism.

(II) EVALUATION OF KUNMING'S URBAN BUS TRANSIT SYSTEM

1. Bus Transit Infrastructure

Presently, Kunming has three bus lanes, whose total length is 19.5km. They are the north-south bus lane in Beijing Road, and the east-west bus lanes in Renmin Road and Jinbi Road. The bus lanes are in the middle of the roads so that the rights of the bus lanes are well secured.

2. Bus Route Network

Now Kunming owns 93 bus routes, consisting of 64 routes in the urban area, 24 routes in the suburban area and 5 routes in the exurban area. Their total length has reached

2,191km, of which the length of urban routes is 664km; while their average length is 10.4km. The total length of the city's bus route network is 1,072km. The coverage of the network will be expanded with the city's urban expansion.

3. Bus Transit Operation

In the recent years, the annual mean growth rate of Kunming's bus passenger transport volume has been 11.5%, suggesting an optimistic trend of bus transit development. Under the existing policies, the profitability of the bus company considerably affects its own development as well as the development of the city's urban bus transit.

The existing bus route network has still been of a small scale. There are a large number of disconnected bus routes, as a result of the failure of achieving the relative equilibrium of the network by making full use of the existing transfer and route connecting facilities of the network. It is true that such a network can reduce passengers' bus transfer frequency to some extent, but it can hardly have all parts of the city smoothly connected by the bus routes so that it is actually a hindrance to the remarkable increase of bus passengers to some extent.

4. Main Conclusions and Review

Urban traffic policies and bus transit infrastructure produce great influence on bus transit development. The rapid expansion of Kunming leads to a considerable increase in the citizens' citywide travel distance, and their demand for motorized travel. Bus ticket system imposes an important influence on bus passengers' travel demand and behavioral characteristics, and thus on the distribution of bus transit network. In a certain period to come, a notable increase in the bus company's profitability is necessary, but in a long term, it is a must to improve the operating efficiency of the entire bus transit network.

(III) TREND AND VOLUME OF BUS PASSENGER FLOW

With Kunming's urban development, there have appeared some changes in the distribution of the city's urban functions. The population of the central urban area tends to move outwards, and the high-intensity land development has provided large numbers of employment opportunities. That results in the extension of the commuting distance and time of the citizens whose average daily travel distance has extended to about 5km now. The city has to face more and more tide-like commuters each day. The bus passenger follow is concentrated in the city's central area, as well as the northern, southeastern, western, and northwestern parts of the city.

As indicated by our analysis of the bus transit operation, the city's existing three bus lanes have shouldered a large proportion of the bus passenger transport in the city's central area, and they should be upgraded to a full-BRT system as soon as possible. It is estimated that without being modified considerably, the bus lanes can theoretically reach a peak-hour capacity of 15,000~22,000 persons per hour if the large-capacity (160~250

persons) bus vehicle is adopted, if the bus's running speed can reach a required level, and if the recycling period of the traffic signal at intersections is less than 150 seconds.

(IV) ARRANGEMENT OF THE TRUNK BUS ROUTE NETWORK

1. Objectives and Principles

The objectives of the near-term optimization of the network are:

(1) To upgrade the bus lane system in the central urban area, and promote the realization of BRT in the new urban areas;
(2) To improve the efficiency of bus transfer to reduce all passengers' total travel time to the lowest possible level;
(3) To have all levels of the bus routes well divided and connected to maximize the profits of the entire network and minimize the operating cost of the network;
(4) To expand the coverage of the network and reduce the "blink zone" of the network;
(5) To enable the profitability of the bus company to keep a proper level.

The following principles should be observed in the adjustment and optimization of the network:

(1) To improve the operating efficiency and capacity of the existing bus lanes according to BRT design concepts to form a high-standard BRT lane network;
(2) To promote the development of big-capacity modern BRT system in the city's newly developed areas;
(3) To facilitate bus transfer, and minimize the passengers' bus transfer frequency;
(4) To reduce the blink zone of the "basic road network" and maximize the coverage of the bus route network;
(5) To control the length of the bus routes to ensure the economic feasibility of the bus routes;
(6) To reasonably balance the relation between bus transit supply and demand, and in some particular areas, to make the demand meet the supply; and
(7) To adjust the bus routes step by step keeping pace with the ticket system reform with considering the passengers' familiarity with the existing routes.

2. Structure of Bus Route Network

The bus route network will have a structure with "chessboard radiation + rings". By "chessboard", it means the basic bus route network will be made up of the chessboard-shaped bus lanes for the BRT truck routes; by "radiation", it means the interconnected secondary bus routes of the chessboard-like bus lane network in the central urban areas will radiate towards all directions; by "rings", it means some routes will be designed to facilitate passengers' bus transfer, and to meet the passenger transport demand along the routes.

The bus route network will be divided into the following three levels according to the road conditions and passenger transport demand:

(1) Nonstop rapid routes: they will serve as the central urban BRT channels which are to mainly use the bus lanes, and transport the passengers in the urban center and the passengers transferred from other levels of routes. They will have the typical characteristics of BRT and large carrying capacity.
(2) District routes: they will be supplementary to the nonstop rapid routes. Some of them can pass by the BRT channels and run in parallel with the nonstop rapid routes. Their speed is expected to reach 15～20km/h;
(3) Passenger-collecting sub-routes: They will be connected with or intersected by the nonstop rapid routes or district routes, and their function is to collect and disperse passengers at passenger-flow-occurring points and in between the said two levels.

(V) BUS ROUTE NETWORK AND BRT NETWORK PLANNING

The bus route network in Kunming's urban area is made up of 58 routes whose total length and average length are respectively 551.6km and 9.5km. Of the 58 routes, there are 13 nonstop rapid routes whose total length is 137.7km, 19 district routes whose total length is 196.1km, and 26 passenger-collecting sub-routes whose total length is 217.8km. The urban bus route network contains 7 BRT routes running in bus lanes whose total length is 47km. In addition, on the trunk road from the main urban area to the new urban area is a 26km long BRT route, thus, Kunming will have a total of 73 km BRT routes.

Table 1 Planned BRT Routes in Kunming

Route No.	Length (km)	Average stop interval (m)	Route Flow	Stop
001	11.9	661	Yinhe Residential Quarter – Northern Bus Station – Yancao Road – Extension Beijing Road – Northern Railway Station – Beijing Road – Southern Railway Station	19
002	10.8	568	Minshan – Western Renmin Road – Middle of Renmin Road – Eastern Renmin Road – Tanhua Temple	20
003	8	500	Daguan Park – Daguan Road – Xiyuan Road – Xiba Road – Jinbi Road – Tuodong Road – Juhuacun - Eastern Bus Station	17
004	11.5	575	Huangtupo – Kunwan Road – Western Bus Station – Xichang Road – Mile Temple – Jinbi Road – Yunnan Provincial Stadium – Old Minhan Road – Guanshan	21
005	13	591	Huangtupo – Kunwan Road – Western Bus Station – Xichang Road – Old Haigeng Road – Xingke Road – Shili Changjie – Rixin Flyover – Kunming Airport	23

006	10.9	606	Juhuacun - Eastern Bus Station – Tuodong Road – Tangzixiang – Beijing Road – Extension of Beijing Road – Yancao Road – Northern Bus Station	19
007	9.9	550	Minshan – Western Renmin Road – Middle of Renmin Road – Jiaosanqiao – Beijing Road – Southern Railway Station	19
New town	26	About 800	Juhuacun – Chenggong New Town	30

(1) Bus Trunk Route Network Operation

Kunming's bus transit system should be able to provide citywide travel service for 25%~35% of the city's population, or 1.85~2.7 million citizens each day. To achieve this, the city's BRT routes must be improved in the following aspects:

- Bus vehicle: BRT system should be equipped with high-quality modern buses with wide doors, low chassis, and large carrying capacity (160~180 persons);
- Dispatch: BRT system should have a modern bus dispatch center employing GPS or other positioning system, which would ensure the operating stability and high efficiency of the BRT system;
- Bus ticket system: ticket system should realize "seamless" bus transfers, which would enable the passenger to make use of the entire network rather than a single bus route to get to the place he want to go with just one ticket;
- Traffic signal: buses should receive prior or shorted traffic signals at intersections. The recycling period of the traffic signal should be no more than 150 seconds in the short term. Green wave may be set up according to the speed of the buses.

(2) Bus Transfer Hub

The BRT system will have 5 bus stations, 5 bus transfer hubs and 6 bus transfer stations, which are in line with the city's general planning and bus network planning, as well as the city's short-term and long-term size and overall arrangement.

- Five bus stations---Huantupo Bus Station, North Bus Station, Juhuacun Bus Station, South Railway Station, and Minshan Bus Station, will have the functions of parking, maintaining and dispatching buses, and connecting different citywide bus routes, and connecting the bus transit system with other traffic systems.
- Five bus transfer hubs: North Railway Station, Liangjiahe Bus Station, Xiaoximen Bus Station, Panjiawan Bus Station, and East Bus Station, which are transformed from the existing bus stations, will have the function of connecting different levels of bus routes. The construction of the hubs will be combined with comprehensive land utilization.
- Six bus transfer stations: Xiaocaiyuan, Jiaosanqiao, Tangzixiang, Mile Temple, Panjiawan, and Kunbaida-Zhengyi Road Shopping Mall will serve as the meeting point of trunk bus routes, aiming to increase the availability of the buses and the flexibility of bus utilization.

(3) Steps of Building the BRT Network

- To improve the operating efficiency of the bus lanes;
- To make the 5 bus transfer hubs become the experimental units of bus transfer where the trunk bus routes and the three levels of bus routes can be transferred;
- To establish branches of the bus operating company under the new bus network;
- To extend and expand the bus lanes and BRT routes; and
- To attempt the combination of BRT with land utilization.

(VI) TECHNICAL PROPOSALS ON BRT IMPLEMENTATION

1. To establish the policy of BRT priority;
2. To establish traffic control measures in favor of BRT;
3. To work out the plan of combining land utilization with BRT development;
4. To integrate bus transit and other urban passenger transport systems; and
5. To develop the city's pedestrian street system.

III. KUNMING'S URBAN BUS TICKET SYSTEM

Bus ticket system is an important element of BRT. It has an important influence on the service level and operating efficiency of the BRT system and even of the entire bus transit system. It is composed of such basic elements as ticket rate, type of ticket, type of payment, and type of ticket checking.

(I) KUNMING'S CURRENT BUS TICKET SYSTEM

The coin-ticket system has been adopted in Kunming------the passenger is to pay one or two yuan for a ticket of an ordinary bus or a deluxe bus and put the money into the coin box near the front door of the bus after getting on the bus, and no exchange can be expected. In addition, large numbers of welfare Monthly ticket cards have been in circulation, causing an operating loss of some 27 million yuan each year.

The main problems of the coin-ticket system include:

1. It seriously hinders bus transfer, and causes the fact that with a ticket the passenger can only use one route rather than the entire bus network;
2. It directly leads to the complication, disorder and low efficient of bus route arrangement;
3. The bus route network is so complicated that it is not easy for the bus stations to effectively dispatch the buses, and for the passengers to learn and use the bus routes;
4. Because of such a ticket system, there are too many routes in the bus lanes, and plus their low efficiency, these routes often contributes to traffic jams;
5. The bus with big doors and large carrying capacity cannot use the coin-ticket system;

6. Passengers must prepare small changes before getting on the bus, which is troublesome to passengers;
7. The ticket-checking flow is of low efficiency, and can cause considerable loss of ticket money; and
8. It hinders the formation of the integrated multiple-means high-efficiency passenger transport market.

The coin-ticket system's influence on the various aspects of Kunming's bus transit system is quite underestimated. Some of the most prominent problems in the bus transit system are the disordered route arrangement, low service level and low passenger flow volume, are all closely and directly related to this ticket system. According to our analysis and evaluation, we believe that the ticket system is the biggest bottleneck to the city's bus transit development, and that it is necessary and urgent for the city to establish and apply a modern bus ticket system.

(II) TECHNICAL PRINCIPLES OF DESIGN THE NEW TICKET SYSTEM

1. Efficiency: the new ticket system should have a high-efficiency and convenient ticket-checking flow to enhance passengers' getting-on and getting-off speed, reduce the buses' detaining time at bus stops, and improve the operating efficiency of the buses.

2. Simplicity: the new ticket system should provide manual ticket service by providing easy-to-read tickets to facilitate the learning and use of the ticket by passengers.

3. Network: the new ticket system should reduce or eliminate the hindrance caused by the ticket expenditure to passengers in using the entire bus network rather than a single bus route to transform the large number of potential passengers into real customers of the bus network.

4. Social service: the new ticket system should bring into play the social roles of public transportation. The ticket should be affordable to the public, esp. the low and medium-income population, and welfare or discounted ticket should be available to the elderly, students and children. The government should offer some preferential policies and fiscal subsidies for the bus company to provide such social services.

5. Safety: the ticket money flow must be absolutely effective and safe to the bus company. It should be easy for passengers to correctly and effectively pay for the ticket, and their payment must be safe. Passengers should have the right to learn their ticket expenditure and account balance.

6. Economic balance: the ticket should be priced to a level that helps to achieve the balance between the bus company's service level and operating cost. The building, application and maintenance of the ticket system should be of low cost.

7. Compatibility: the new ticket system should be convenient for various consumers, types of payment, charging mechanisms, as well as the integration of and the transfer between different means of public transit, and between bus transit and other means of traffic.

8. Value increment: the factors that may cause increment of the value of the IC ticket card should be considered, such as the IC card's functions of data storage and other consumption and payment functions.

(III) TECHNOLOGIES FOR THE NEW TICKET SYSTEM

1. Development Strategy

Short-term Strategy: besides the existing coin-ticket system, electronic ticket will be introduced. The purpose of that is to increase the proportion of the passengers using electronic tickets. The method of charging by ride will still exist. Efforts will be made to reduce or eliminate the problems caused when passengers transfer bus routes.

Long and medium-term Strategy: electronic ticket will be made the mainstream bus ticket. The ticket price structure that meets the multiple needs of various groups of passengers will be developed. Integrated ticket system will be applicable to various public transit systems and various forms of public traffic. Highly-effective bus transfer and through traffic will be realized with the help of the new ticket system. The ticket will have multiple value-increment functions.

2. Short-term Bus Ticket-making Technologies

The non-contact ticket IC card system will be introduced, and coexist with the coin-ticket system for a certain period to come. It will finally replace the coin-ticket system and become the mainstream form of payment for bus ticket.

(1) Bus Price Structure

The method of charging by ride will be applied for a short term. No ticket fee will be charged by ticket zone or by ride distance. Passengers using IC ticket card will be entitled to enjoy some ticket discount, in order to increase the number of IC ticket card users. In principle, welfare Monthly ticket card will be available only to the elderly, children, primary school and middle school students, and other populations covered by relevant polices. The key target of the short-term bus ticket system reform is to realize free bus transfer.

Table 2 Proposed Ticket Rates in Kunming for A Short Term

Type of passenger		Type of bus	Ticket price	Note
Coin-ticket user		Common bus	1yuan/ride	
Coin-ticket user		Deluxe bus	2yuan/ride	
Common Ticket IC card user	Ride	Common bus	0.9yuan/ride	10% discount
		Deluxe bus	1.8yuan/ride	10% discount
	Transfer	Among the same type of bus From deluxe to common From common to deluxe	Free of charge Free of charge 0.9yuan/ride	All conditions for free transfer must be met
Personal Ticket IC card user	Students	Common bus	20yuan/month	Valid within the month
	The elderly	Common bus	20yuan/month	Valid within the month
	Other disadvantaged populations	Common bus	Subject to relevant policies	Valid within the month
Children		All types of bus	Free of charge	Children must have a height of lower than 1.3m, and be accompanied by adult (s)

(2) Type of Ticket

Coin ticket, common ticket IC card for common passengers, and personal ticket IC card for populations entitled to welfare ticket

(3) Charging and Ticket Checking Method

Coin ticket: the passenger is supposed to put the required money for ticket into the coin box near the front door of the bus after getting on the bus, and no exchange can be expected.

Ticket IC card: the card reader will identify the type of passenger and collect the information affecting ticket fee charging such as the passenger's course of travel; then the money stored in the card will be deducted according to the preset charging standards, and the deducted sum and account balance will be displayed.

Two alternatives to achieve free bus transfer:

Alternative 1: card readers installed by the front and rear doors of the bus will identify the getting-on time and getting-off time of the passenger, and if the card reader judges that the bus taken by the passenger now is not the bus last taken by him and the interval between the time when the passenger gets on the present bus and the time when he gets off the last bus is within 20 minutes, then no money will be deducted from his

account, and the reader will show that he has passed ticket checking.

Alternative 2: the passenger who has paid when he gets on a bus can transfer to another bus without paying additionally if the interval of his two rides are within one hour, so that the card reader by the rear door can be saved.

(4) Composition of the IC Card System

The IC card system for Kunming's bus transit system will be composed of four parts: information and control system, information transmission system, manufacture maintaining system, and customer service system.

3. Mid-Long Term Ticketing Technologies

Table 3 Proposals for Mid-Long term Bus Ticket Price Structure and Ticketing

SN	Target	Measure and Technical Solution
1	To increase the BRT system's attraction to bus passengers to expand the fixed bus passenger market	● To offer them a certain ticket discount after their bus consumption reach a certain level within a certain period; ● only for ticket IC card users (by programming the charging mechanism)
2	To encourage prepayment of ticket fee to reduce ticket operations and increase the profits of the bus company	● one whose single prepayment of ticket fee reach a certain level will be entitled to a certain ticket discount; ● He can buy ticket and charge his ticket fee account at a discounted rate.
3	To optimize the ticket price structure and balance the relation between the cost and the service level	● To establish bus ticket districts to serve the entire urban area of Kunming.
4	To encourage the use of bus by participants of large-scale activities to relieve the impacts of the car fleet of such a population on traffic.	● To combine the bus ticket with the ticket for the activity; ● To operate by making use of commercial or administrative actions according to the nature, scale and influence of the activity.
5	To cover the new forms of public transit and other traffic forms combined with bus transfer	● To carry out ticket integration, and reasonable settlement mechanism based on the principle of multi-win cooperation, and to realize automatic ticket money allocation; ● To reduce or remit the transfer expense of other traffic service providers and other forms of public transit
6	To encourage travel in non-peak hours to relieve traffic jam in peak hours	● To offer proper ticket discount for passenger who choose to travel by bus in non-peak hours which are determined according to the ratios of passenger flow to bus capacity in a day, to encourage travel in non-peak hours by passengers sensitive to ticket price; ● To realize this by optimizing the common ticket IC card and personal ticket IC card.
7	To attract and facilitate the use of bus by foreign tourists and	● To issue one-off short-term certificate-type ticket like daily ticket, a-few-days ticket and week ticket,

	persons on business trips to improve the image and taste of Kunming as a tourist city	which is determined by considering the required number of days, target areas, and forms of bus transit; ● To issue tourist's ticket IC cards at a range of prices; ● To provide convenient ticket IC card buying, charging and returning services; ● To provide some ticket discount or free bus transfer service for bearers of effective airline tickets and railway tickets.
8	To satisfy special and customized needs for bus ticket	● To provide specially priced tickets to meet special ticket needs; ● To introduce fashionable and individualized designs of ticket IC cards, such as watches and mobile phone ornaments.

The bus ticket IC card might be used for a wide range of purposes such as the charging of parking fee, car renting service fee, expressway/highway and bridge tolls, taxi rent, gasoline fee, public utility fee (such as gas, water, power and park fees), and shopping and entertainment expenses.

(IV) EXPECTED BENEFITS AND RISKS OF THE NEW TICKET SYSTEM

It is vitally important to enable all involved parties to receive the maximum possible profits and prevent the contradictions and risks that may occur. Below is a brief analysis of the expected benefits and risks of the new bus ticket system of Kunming:

1. Bus service provider

(1) Expected Benefits

It will improve the quality, image and attractiveness of the city's public transit system;
It will provide drive for the optimization of the city's bus route network;
It will help reduce the cost of the bus system and upgrade its capacity and service level;
It will help increase the number of bus passengers;
It will create new sources of income for the bus company;
It will promote the formation of high-standard BRT system as soon as possible;

(2) Risks

Revenue loss from bus transfers;
Additional efforts to cancel the monthly ticket for adult passengers;
Disputes in financial settlement may arise among involved parties;
The operation pattern of the new ticket system will affect the operator's profitability;
The new ticket system requires the support of a strong service network.

2. Government

(1) Expected Benefits

It will improve the city's traffic efficiency and environmental quality;
It will improve the quality and efficiency of the city's public passenger transport system;

It will help to realize the multiple-industry electronic payment.

(2) Risks

It takes considerable effort to coordinate and balance the relation between the social targets and the profits of the bus company;

It takes efforts to properly handle the relation between ticket integration and the benefits of particular units;

It takes effort to properly handle the relation between the different stages of the implementation of the new ticket system.

3. Public

(1) Expected Benefits

One can buy one ticket to travel within the entire network;

It will be less expensive and more convenient for passengers to use the buses;

Passengers can enjoy diversified and individualized services.

(2) Risks

Troubles may arise if the details of the new ticket system are not designed properly;

The benefits of adult bearer of the welfare monthly ticket will be lost;

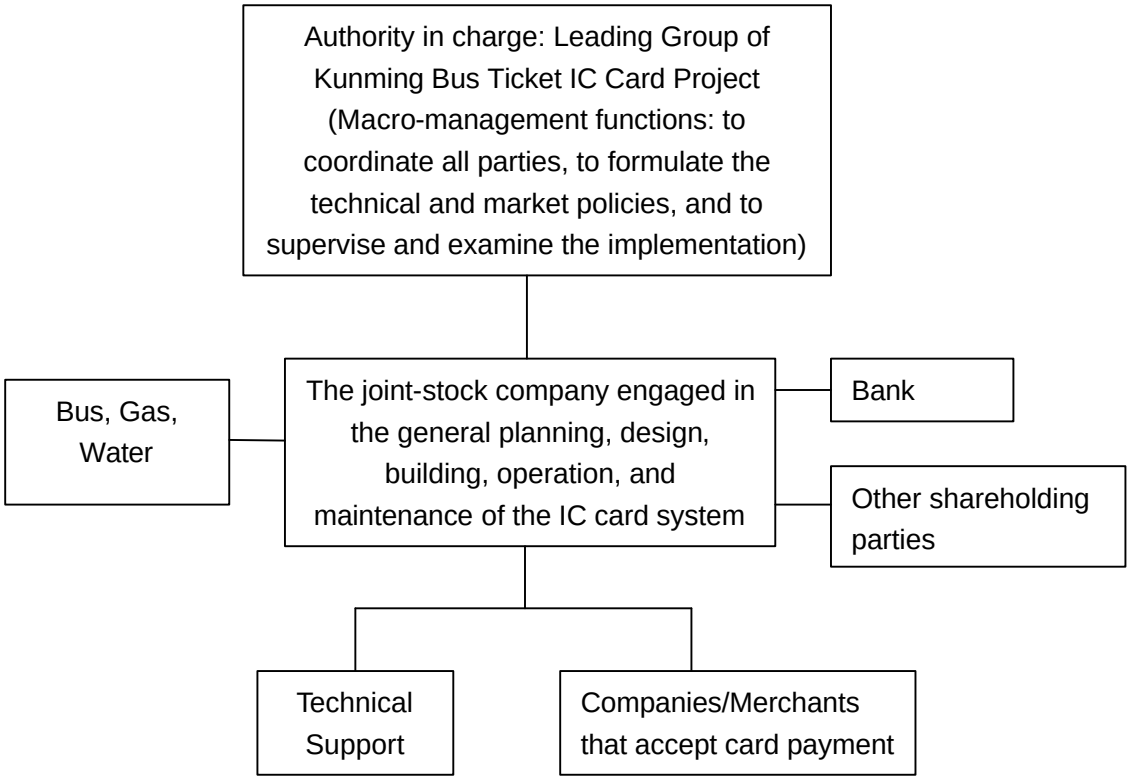
Inconvenience in using the ticket IC card may take place if the ticket services are not well designed.

(V) RECOMMENDATIONS FOR THE NEW TICKET SYSTEM

1. To establish the management mechanism for the IC card system, to ensure the realization of the overall technical framework of and functions of the IC card system in various stages, and to work out the relevant rules and regulations;

2. To carry out the IC card system in the bus transit system first, and then to extend it to other industries when all the required conditions are met;

3. To found a joint-stock company specialized in the IC card making under the guidance by the government by making use of commercial banks, and not to found a monopoly company through administrative means.



IV. STUDY ON KUNMING'S URBAN BRT SAFETY SYSTEM

Not only does the BRT priority mean the need to build bus lanes, it also means the need to make bus transit the priority in transportation development within the entire system. The purpose of the study on Kunming's urban BRT security system is to research the various policies, mechanisms, and managerial and technical factors related to BRT development apart from the basic technical framework of BRT, and to put forward the corresponding principles and proposals, to promote the healthy development of Kunming's BRT system.

(I) MAIN EXTERNAL FACTORS AFFECTING KUNMING'S BRT DEVELOPMENT

1. Kunming's urban traffic development has deviated from the policy of BRT priority. It is true that Kunming is the first Chinese city that practices BRT priority, but so far Kunming has not legally established the precedence of BRT in urban traffic development, of which the emphasis has still been placed on the development of the traffic facilities for cars

2. The citizens' awareness of advocating cars has hindered the city's bus transit development. On one hand, such awareness causes the orientation of motor vehicle

traffic to be seriously partial to car traffic so it is common for the car-possessing population to refuse to use bus transit service; on the other hand, the car-possessing population has more influence on the policy making as to the city's traffic development.

3. The advantages of bus transit are restricted by the city's current road arrangements. There are large numbers of secondary main roads and branch roads in the city, which are unsuitable for the development of bus transit facilities, thus causing the existence of many dead angles of the bus network. Even the bus lanes are lacking in room, and this, to some extent, also affects the efficiency of the bus lanes and hinders the formation of high-efficiency bus transfer stations.

4. The city's traditional bus transit system and its operation and management have some negative influence on the improvement of the bus service level. Under the traditional bus transit system, the bus company is both a monopoly enterprise and a public utility. It lacks vitality because it does not have to face competition. Additionally, it is not completely operated according to the law of market, and it can hardly receive any fiscal allowance. Furthermore, the low-efficiency manual dispatch mechanism has constituted a major hindrance to the improvement of the operating performance and service level of the bus transit system.

5. The management of the bus passenger transport market has been in disorder. Illegal transportation activities exists as well as a lack effective management of self-employed passenger transport service providers, esp. minibus operators who compete with public buses using cutthroat competition, and who have seriously disrupted the public transportation market.

6. There is a rapid growth in the number of private cars, which contributes a lot to the formation of traffic jams. The city's rapid motorization has caused the entire urban road network to face traffic congestion all the time, and become the direct cause of the decline in the operating speed and arrive-on-time rate of the buses. It is frequent that other types of vehicles occupy the bus lanes.

7. There is a certain lack of integration of bus transit with other forms of traffic. There is no traffic strategy, particularly traffic planning that integrates buses, cars, and bicycles. Such a lack has caused a certain loss of bus passengers, and it cannot effectively reduce the traffic load in the city's central urban area either.

8. The lack in technical innovation has hindered the improvement of the bus service level. The operating efficiency and service level of the buses have been not improved by making use of such mature technical factors as the modernized bus dispatch center, the passenger information service system, and the signal priority technology.

(II) FRAMEWORK OF THE BRT ASSURANCE SYSTEM

1. Funding: through policy and mechanism making, efforts should be made to enable the bus transit traffic development to be backed by sufficient and stable fund sources, which would be not only used in developing and maintaining modern standard bus transit facilities and bus vehicles, but also in improving the operating efficiency and service level of the bus transit facilities.

2. Speed: the key to assuring speed is to eliminate various delays and disruptions in operating the buses to improve the speed of both the BRT routes and ordinary bus routes. As for the BRT routes, it is necessary to first secure the buses' exclusive right to the bus lanes, and then to reduce as many delays at intersections as possible. This is the only way that the operating speed of the buses can be ensured.

3. Facilities: the infrastructure or hardware of the BRT system is mainly made up of the roads, and bus stations and stops. These facilities are mainly brought under control through city planning and administration. It is important to enable the facilities to have complete and reasonably arranged functions, and ample capacity and room.

4. Efficiency: There should be a healthy market competition mechanism for the bus transit system. The bus dispatch system should be optimized by building a modernized bus dispatch center, and applying new technical means to improve the operating efficiency of the bus transit network.

5. Ridership: incentive policies and guidelines should be established to encourage the citizens to use buses as much as possible and restrict their use of cars by cultivating their modern traffic awareness, to enhance the proportion of the citizens who travel by bus and optimize the structure of the citizens' traffic means.

6. Safety: the key of safety is to effectively reduce the occurrence of bus-related traffic accidents and public security hazards.

(III) CONTENTS AND PRINCIPLES OF THE BRT SECURITY SYSTEM

1. Policies on BRT Priority

- Legal strategies and policies on traffic development;
- Bus route network and facilities planning and implementation steps;
- BRT-oriented urban development and renovation planning;
- Sum and source of funds for the development of urban bus transit;
- Funds using plan that embodies BRT priority;
- Policies on financing and investment in bus transit;
- Pricing policies in favor of bus transit development and policies for making up the losses permitted by policy;
- Preferential taxation policies for the bus transit system;

- Establishment and management of special bus transit funds;
- Exclusive right of using legal bus lanes and the matching facilities;
- Traffic signal priority technology for bus transit and the management measures;
- Procedures of rapid treatment of traffic failures and accidents;
- Laws and regulations on the management of urban bus passenger transport market access;
- Regulations on the administration and penalties on illegal passenger transport activities;
- Advanced bus transit technical standards;
- Indicators of bus transit service evaluation;
- Accounting standards on bus transit costs and expenses;
- Technical standards on bus lane facilities; and
- Safety measures for urban bus lane facilities.

2. Policies on Traffic Demand Management

- Policies on reasonable control of the development of traffic facilities;
- Differentiated parking charges and traffic jam charges;
- Building projects' traffic impacts evaluation system;
- Guiding policies for traffic means;
- Measures to restrict total traffic volume; and
- Measures on the regulation and control of the time and space of traffic flow.

3. Harmonious city management mechanism

- Legalized city management system;
- City management mechanism with well coordinated planning, construction and management;
- Education system on new urban traffic concepts; and
- Bus transit-oriented traffic management mode (such as traffic signal priority).

4. Passenger transport management

- To regulate the urban bus passenger transport order;
- To suppress and punish illegal passenger transport activities;
- Effective passenger transport monitoring and control system.

5. Bus transit operation

- Competition mechanism for bus transit market;
- Modern bus operation and dispatch system; and
- Passenger service system.

In conclusion, BRT is a complete system. To realize the goals in bus transit development, not only requires Kunming to technically construct a BRT system, but also to develop a good BRT assurance system. Only then can Kunming realize the expected benefits of BRT, and finally establish a modern traffic system with bus transit at its core.