Research on Trip Characteristic during Urban Developing

——Taking Shanghai for Example

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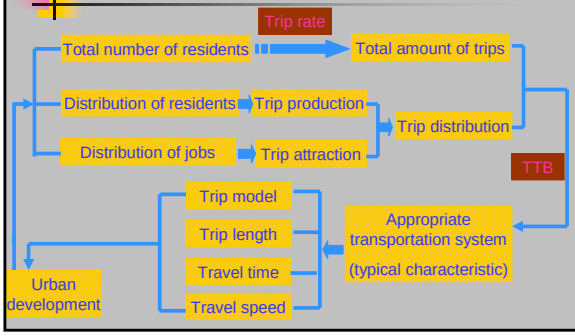
Question：Appropriate Size of a city?

Many factors affect the appropriate size of a city. Urban transportation is one of the most important elements. Topic of presentation

- The change of trip characteristic during urban development .
- Adaptability of transportation system during urban expanding.
- Mutual restriction between urban size and transportation capacity.

General Idea



Content

- Research source
- Population (total number and distribution)
- Jobs (distribution)
- Trip distribution
- Typical trip characteristic
- Conclusions

0. Research source

- The first comprehensive transport survey of Shanghai， 1986
- The second comprehensive transport survey of Shanghai， 1995
- The third comprehensive transport survey of Shanghai， 2004

1. Population

1.1 Total number

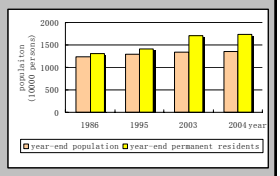
1.2 Spatial distribution

1.1 Total number

Increase of population：

- Year-end population ①
- Year-end permanent residents ②

Year	① (10000 persons)	② (10000 persons)	Growth rate per year (%) ①	②
1986	1232	1296	/	/
1995	1301	1415	0.6	1.0
2003	1341	1711	0.4	2.4
2004	1352	1742	0.8	1.8



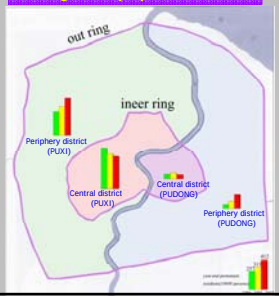
1.2 Spatial distribution

Population ( ) in different zones:

zone		area (km²)	1986 ② (10000 persons)	1986 Density (person/ km²)	1995 ② (10000 persons)	1995 Density (person/ km²)	2003 ② (10000 persons)	2003 Density (person/ km²)
Central district	PUXI	79	439	55570	396	50127	368	46582
	PUDONG	31	46	14839	57	18387	41	13226
	Total	110	485	44091	453	41182	408	37091
Periphery district	PUXI	294	257	8741	313	10646	412	14014
	PUDONG	239	45	1883	80	3347	156	6527
	Total	533	302	5666	393	7373	569	10675
Central city		642	787	12259	846	13178	977	15218
Suburb		5698.5	509	893	569	999	735	1290
Overall city		6340.5	1296	2044	1415	2232	1712	2700

1.2 Spatial distribution

Changes of population



Summary：

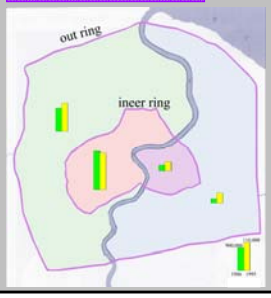
- During 1986~2004，density of population in central district declined，while in periphery district it increased. The whole central city's population density increased.

2. Jobs

2.1 Jobs distribution

2.1 Jobs distribution

Changes of jobs



Compared with population distribution(1986~1995)：

zone		Growth rate of population	Growth rate of jobs
Central district	PUXI	9.8%(-)	5.9%(-)
	PUDONG	23.9%(+)	60.9%(+)
	Total	6.6%(-)	1.8%(-)
Periphery district	PUXI	21.8%(+)	22.6(+)
	PUDONG	77.8%(+)	142.6%(+)
	Total	30.1%(+)	39.6%(+)
Central city		7.5%(+)	9.6%(+)

2.1 Jobs distribution

Summary：

- The change of population distribution in central city is inconsistent with the change of jobs distribution. The central district PUXI is a case of it. This inconsistence，that is the unbalance between residence and jobs， could result in travels whose length is probably very long.

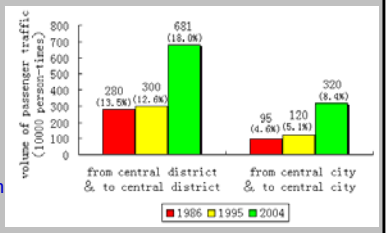
3. Trip distribution

3.1 Distribution in typical zones
3.2 Summary

3.1 Distribution in typical zones

Central district PUXI and Central city

- Central district
  Volume from and to central district take on incremental trend.
- Central city
  Volume from and to central district has been increased from 1986.



3.2 Summary

- Although the density of population in central district PUXI declined，the transfer volume of passenger traffic increased instead of decreasing.
- The density of population in central city increased，accordingly the transfer volume of passenger traffic increased.

☞ Reducing the density of population only in central district is not sufficient，the essence is to reduce the transportation demand intensity.

4. Typical trip characteristic

4.1 Trip length
4.2 Trip model
4.3 Travel time
4.4 Travel speed

4.1 Trip length

Average trip length

zone	year	Volume of passenger traffic (10000 person-times per day)	Turnover volume of passenger traffic (10000 persons.km per day)	Average trip length (km)
Central city	1986	1302	6702	5.1
	2004	2307	15455	6.7
suburb	1986	766	2236	2.9
	2004	1483	10084	6.8
Overall city	1986	2068	8938	4.3
	1995	2365	10643	4.5
	2004	3790	25539	6.7

☞From 1986~2004

- The average trip length in district increased from 5.1km to 6.7km.
- As for the overall city，it increased from 4.3km to 6.7km.

4.1 Trip length

Trip length of different trip models

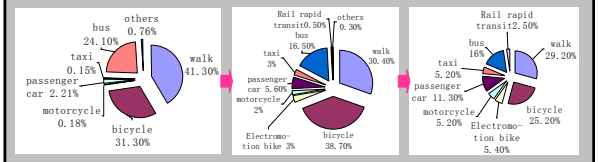
unit：Km

Trip mode			walk	bicycle	Electromo-tion bike	motorcycle	passenger car	taxi	bus	Rail rapid transit
zone	district	1986	2.0	4.2	/	6.4	12.3	10.3	8.7	/
		2004	2.0	4.5	7.2	11.1	18.1	9.2	8.0	12.5
	suburb	1986	1.4	3.8	/	5.1	10.9	12.5	7.9	/
		2004	1.9	4.5	7.2	11.9	16.9	5.2	9.1	11.5
	Overall city	1986	1.9	4.0	/	5.6	11.9	10.7	8.6	/
		2004	2.0	4.5	7.2	11.8	17.6	8.1	8.2	12.4

☞ In the past 20 years，the average trip length of walk and bicycle are unchanged. The average trip length of mobility model（motorcycle、passenger car、taxi、bus、rrt）increased from 8.1km to 11.6km.

4.2 Trip model

Model split by person-times

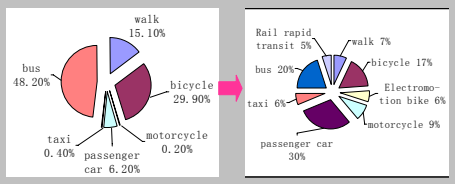


1986 1995 2004

- Sum of mobility model (③):
  1986：27.4%； 1995：27.9%； 2004：40.2%

4.2 Trip model

Model split by persons.km



1986 2004

- Sum of mobility model (④)：
  1986：55%； 2004：70%

4.2 Trip model

Person-times V.S persons.km

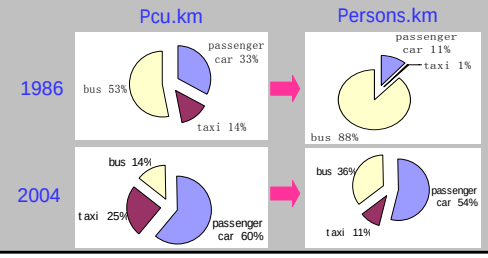
- mobility model

year	1986	2004
Persons.km (10000)	4619	17631
Person-times (10000)	567	1524
Average trip length (km/time)	8.1	11.6

☞ The increase of average trip length of mobility model shows that the activity space of residents extend remarkably during urban expanding.

4.2 Trip model

Efficiency：Usage of road



4.2 Trip mode

Pcu.km VS persons.km

- efficiency comparison between bus、passenger car and taxi

Assume index of taxi is "1"

year	bus	Passenger car	taxi
1986	31.1	6.3	1
2004	5.5	2.0	1

☞ Bus is the most efficient one of these three modes while taxi is the most uneconomical one.

4.2 Trip mode

Pcu.km VS persons.km

- efficiency change of bus、passenger car and taxi

Assume index of 1986 is "1"

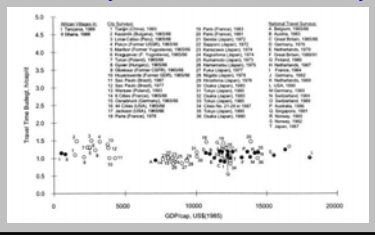
year	1986	2004
bus	1	0.3
Passenger car	1	0.5
taxi	1	1.5

☞ From 1986 to 2004， the efficiency of taxi are improved. but the efficiency of passenger car and bus declined.

4.3 Travel time

Trip restriction：travel time budget (TTB)

- TTB is usually consistent （about 1.1h/day）



4.3 Travel time

TTB of Shanghai (central city)

Year	Trip rate (times/person.day)	average travel time (h/time)	TTB (h/person.day)
1986	1.91	0.49	0.93
1995	1.97	0.59	1.18
2004	2.36	0.55	1.30

☞ TTB of Shanghai increased a little since 1986 mainly because the rise of trip rate.

4.3 Travel time

Average travel time of different modes (central city)

	1986	1995	2004
walk	13	19	17
bicycle	21	35	22
Bus & rail rapid transit	48	62	58
Other passenger car	55	55	37

☞ Compared with 1995，the average travel time of all trip modes in 2004 declined.

4.4 Travel speed

Average travel speed (central city)

Due to the trip restriction of TTB，the increase of average trip length require necessarily the improvement of average travel speed.

Year	Average trip length (km/person-time)	Average travel time (h/person-time)	Average travel speed (km/h))
1986	5.1	0.49	10.4
2004	6.7	0.55	12.2
Growth rate	31.4% (+)	12.2%(+)	17.3%(+)

4.4 Travel speed

Average travel speed of mobility modes

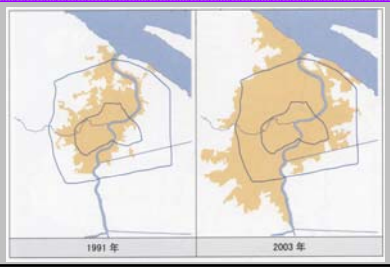
	Year	Average trip length (km/person-time)	average travel time (h/person-time)	average travel speed (km/h)
Bus (RRT)	1986	8.0	0.8	10.0
	1995	6.6	1.03	6.4
	2004	8.4	0.97	8.7
Other passenger car	1986	12.0	0.92	13.1
	2004	14.7	0.62	23.7

☞ The average travel speed of public transportation system were improved since 1995. the speed of other passenger cars increased since 1986.

5. Conclusions

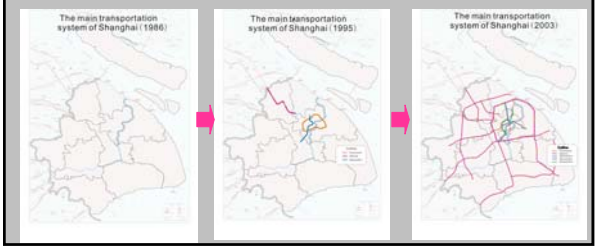
5.1 Urban expanding

Spatial expanding of area constructed



5.2 Transportation development

Development of main transportation system
（highway、express way and rail rapid transit）



5.3 Conclusions

- With urban expanding，the population and positions in the city will be redistributed. This kind of redistribution will result in the change of characteristic of transportation accordingly.

Assume index of 1986 is “1”

year	population	jobs	Trip rate	Trip generation	Trip mode (mobility)	Trip length	Person.km	Pcu.km (road)	Travel time	Travel speed
1986	1	1	1	1	1	1	1	1	1	1
1995	1.06	1.04	1.11	1.14	1.16	1.05	1.23			
2004	1.39	1.10*	1.32	1.83	2.69	1.56	2.53	16.43	1.17	1.34

Thanks !