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SUCCESSFUL SPATIAL DEVELOPMENT REQUIRES COMPREHENSIVE MOBILITY, REPRESENTED ON AN EXAMPLE OF A MIDDLE CENTRE IN CHINA

ABSTRACT

Increasing demand of traffic is in strong interaction with spatial as well as economic development. The resulting problems particularly appear in countries with high population density and high development potential. New solutions are necessary to ensure long-term successful development, which are also of great interest for developed industrialised countries to manage traffic problems.

KEY WORDS

mobility, integrated planning, growth of traffic, rail-based public transportation systems, transportation systems design

1. MOBILITY - WHAT IS IT?

We find the term "mobility" today very often in quite different connections. Mobility plays an important role in several areas of life. The colloquial use of the term "mobility" is taken very far. Mobility is described as the capability for movement, agility and frequency of residence change. [DU96] [BR06] Therefore mobility seems to be a very positive, desirable feature. Accordingly, it is often required that mobility be insured or improved. However, in order to accept or improve mobility it is first necessary to determine precisely what mobility is. Because of the complex use of the term "mobility", a universal, comprehensive definition does not appear purposeful. From the scientific point of view, different kinds of mobility are to be distinguished. There are specific definitions for mobility quite evident for different scientific fields of application. In medicine, mobility is separated between psychological and physical one. In the sociological sense, Sorokin [SO27] refers to mobility as the change of the social position of a human being and distinguishes horizontal and vertical mobility. In this case, mobility contains the movement of persons from a social position to another one (in particular, the rise or descent; change of the social status) as well as the variation of the living or working place. In the first-mentioned cases, we speak of vertical mobility, and the last one is horizontal mobility. „Mobility" is described by demographics simply as people changing location. Population mobility is the basic human activity, practised by individuals. In most mobility typologies, the term embraces migration, which implies the severing of roots in one place and their establishment in another, a practise which is normally associated with the Western world. It also includes circulation, which involves periodic changes in residence following some kind of a cycle. The influence of mobility upon people and places is substantial, and yet the concept of mobility remains elusive. [WEB01]

This small selection of definitions already shows the obvious difference in the use of the term "mobility". But all these definitions are not very suitable for describing mobility in the field of transportation systems design.

Traffic contains the local change of persons, goods and news [PI34, S. 2]. Consequently, the product in traffic is its local change. Like in all other sectors of economy, the aim consists in an appropriate production. The under- and overproduction influence the development negatively. The evolutionary process attempts to balance the missing and excessive capacities. If this does not succeed to a sufficient extent, revolutionary changes are necessary. The invention of the movable steam engine was such a revolutionary change of traffic, for example, at the beginning of industrialisation. This resulted in new possibilities of mobility. Therefore, mobility does not mean local change. And mobility is not a local change as frequent as possible nor as long as possible. Mobility in the context with transportation systems design can be described as the possibility for the appropriate local change as required.

2. HOW MUCH MOBILITY IS NECESSARY?

The appropriate local change is subject to interior and external influences. The interior influences result

from transportation system design itself. In particular, they concern the effectiveness of traffic. The basic actuating variables are quickness, punctuality and safety. Since local change is initiated primarily fundamentally not by transportation systems design but rather by external factors, the action possibilities are rather low to the mobility of the transportation system although an insufficient transportation systems design can be quite mobility impeding. The external influences deciding on the demand for local changes result from economic, social and political structures. Therefore, mobility does not depend in the first place on the transportation systems design but on the general social conditions. The economic development as the basis for social development requires corresponding mobility. Since local change is always connected also with expense, general social conditions should be arranged so that mobility demand can be fulfilled with minimum of local changes for maximum economic growth. The demand for local change is determined by policy, economy as well as other living conditions and not by the priority question of the transportation systems design. Regulation of traffic demand accordingly cannot be the priority task of the transportation systems design. Yet, transportation research can predict developments and highlight the consequences involved.

On the one hand, transportation systems design has to react to the changing traffic demands due to varied general living conditions. On the other hand, transportation systems design is an important precondition for continuous economical development. The establishment of the efficient transportation system and in particular the required infrastructure represents an important political organisation instrument. Therefore, there exists obviously a direct interaction between the transportation systems design and the economic growth. The question is often asked whether transportation systems design should follow or precede the economical evolution.

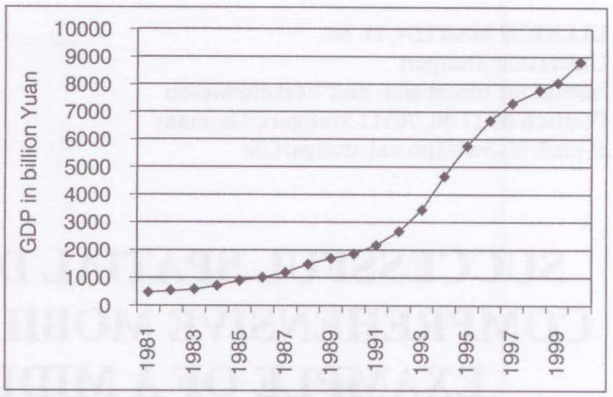

Figure 1 - Development of GDP in China 1981– 2000 (1€ = 7.1 Yuan) [CSY01]

3. CURRENT SITUATION IN CHINA

In China, an impressive development has been taking place over the last twenty years. Despite regional and global crises, the gross domestic product (GDP) increased continuously (Fig. 1). From 1981 to 2000, an increase of 1.814% is to be found. The dynamics of growth has been getting stronger since the nineties. However, this economic development has taken quite a different place in various regions. In the hubs of conurbation, a comparably quite high level which forms the basis of further growth was already achieved (Table 1). In rural areas the GDP is much lower in spite of the strong growth in comparison with the agglomeration centres. On the other hand, the population density in the agglomeration centres is already today high (Table 2). An increased migration of the rural population into the cities, already densely inhabited today can be braked only by homogeneous economic growth. This is most important considering that several assumptions [US00] are based on the marginal decline in population in China only since the year 2040 (Fig. 2). Outside the large conurbations, the Middle

Table 1 - Gross domestic product (GDP) in selected provinces of China 1985-1995 compared with Germany [GG97], [XSY01], [MN02/2] (data based on current prices)

Area	Population in Mio.	GDP in billion Yuan (1 € = 7.1 Yuan)		GDP/Capita in Yuan (1 € = 7.1 Yuan)		Increase of GDP/Capita in %	
	1985	1995	1985	1995	1985	1995	von 1985-1995
Beijing	9.6	12.5	25.7	139.5	2,677	11,160	416.9
Shanghai	12.2	14.2	46.7	246.3	3,828	17,345	453.1
Jiangsu	62.1	70.7	65.2	515.5	1,050	7,291	694.4
Xuzhou in total	7.1	8.5	5.6	41.1	789	4,835	612.8
Xuzhou core of the City	0.8	1.5	2.0	17.6	2,500	11,733	469.3
China in total	1,041.5	1,202.4	837.7	5,763.4	804	4,793	596.1
Germany	77.7	81.8	6,621.7	12,786.4	85,221	156,313	183.4

Table 2 - Density of population (Year 2000) [CSY01], [XSY01], [WEB02-1], [WEB02-3]

Country / City	Population in Mio.	Area in qkm	Density of Population in capita/qkm
China	1,261.832	9,572,419	132
Beijing in total	13.820	16,800	823
Beijing Urbanized Area	7.500	518	14,479
Beijing Core of the City	2.663	87	30,609
Shanghai in total	16.740	6,341	2,640
Shanghai Urbanized Area	9.000	550	16,364
Shanghai Core of the City	6.297	290	21,714
Xuzhou in total	8.964	11,258	796
Xuzhou Core of the City	1.606	1,038	1,547
Deutschland	82.071	357,020	230
Berlin	3.383	892	3,793

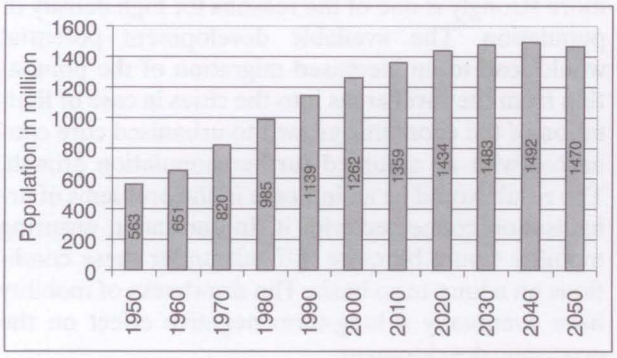

Figure 2 - Growth of population in China [US00]

Centres played the key role of great significance for the future development. The economic upturn of these numerous Middle Centres can provide a decisive contribution to the increase of the living standard outside the urban structures, too, by its radiation into the rural area and also by the smaller towns around urban centres.

Figure 3 - Centre of Xuzhou City (Photo: Author)

Xuzhou, near the East Coast, is a typical example of such a Middle Centre (Fig. 3). The Xuzhou City is located in the Northwest of Jiangsu province, in the East of China (Fig. 4, Fig.5). It is connected with the four provinces Jiangsu, Shandong, Henan and Anhui, and along the roads and rivers with the economic districts of Shanghai and Round Bohai, included in the Chinese Economic strategy, in the East Open Belt and Middle-West Region along the sea. It is the central city and the trade centre of the Huaihai Economic Region which is at the border region of Jiangsu, Shandong, Henan, Anhui provinces. It is adjacent to Lianyungang, the East head of the Asia-Europe Bridge, and it is the central city of this region. Its area covers 11,258 km^2, which is 11% of the total area of Jiangsu province. Its total population is 8,964,400 people. The size of the core of the city is 1,038 km^2 with a

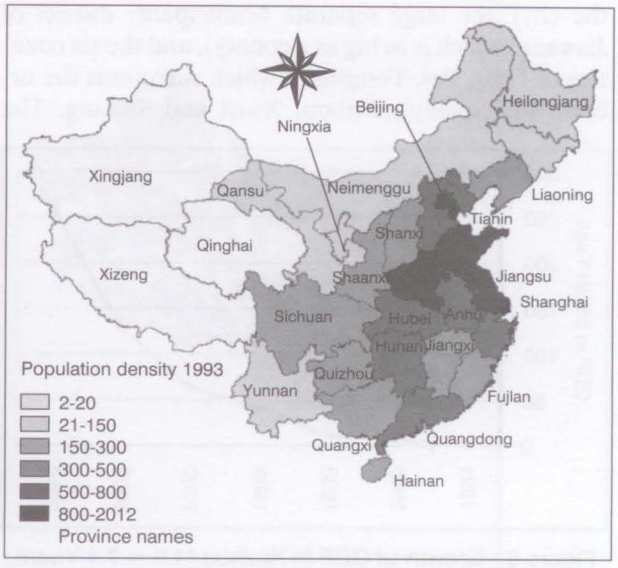

Figure 4 - Location of Province Jiangsu in China (Map of Density of Population) [WEB02-2]

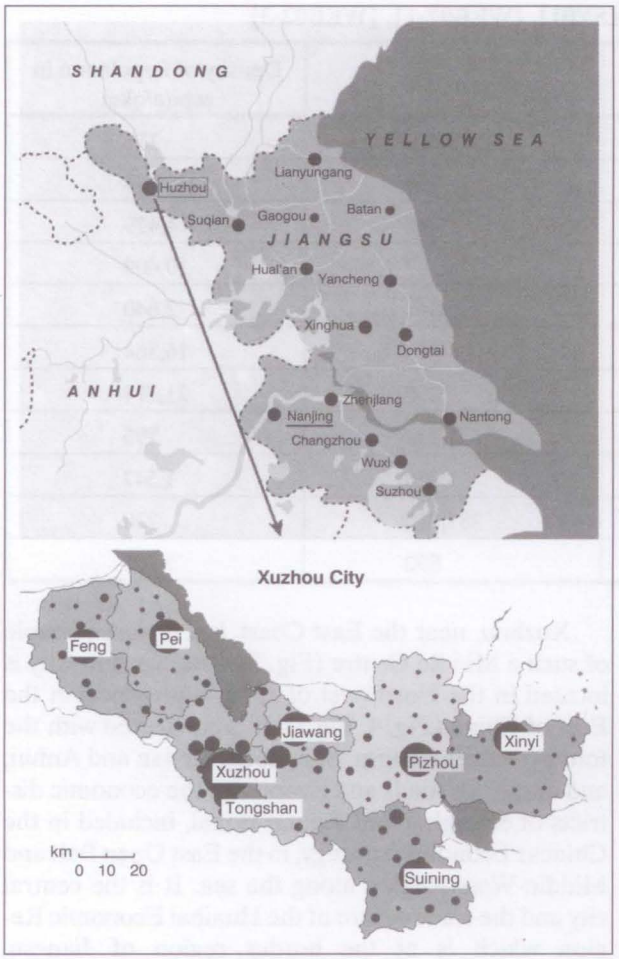

Figure 5 - Location of Xuzhou in the Jiangsu Province [WEB02-2]

population of 1,606,100. The GDP of Xuzhou is 64.45 billion yen in 2000. Xuzhou City comprises 8 Regions defined as follows: the urban area of the Xuzhou Municipality (which has four districts – form the core of the city), the large separate Municipality district of Jiawang (which is as big as a county), and the six counties of Feng, Pei, Tongshan (which surrounds the urban Municipality), Pizhou, Xinyi and Suining. The counties are named after their principal administrative towns. The counties and the district Jiawang are comprised of the spatial administrative units of the county town resp. district town, and of a collection of administrative areas called either "towns" or "townships". A "township" is made up of villages and has no separately administrated urban centre. A "town" is the expression for an area consisting of a separately administered urban area (with some central functions) and a separately administered rest area also called a "township", again comprised of villages. There is a certain parallel in this – from the point of view of terminology – complicated situations with the German Stadt- und Landkreisen. The combined expression "town/township" is often used as a simplification.

The demanding goal for the growth of GDP in Xuzhou (Fig. 6) is based on the development objectives of the Peoples Republic of China. The geographical position in the East of the country developed more strongly is one of the reasons for high density of population. The available development potential would lead to an increased migration of the population from the rural areas into the cities in case of limitation of the economic growth to urbanised core connected with an assumed further population growth. The result would be an increase in the problems of urbanisation connected with it. In particular, ensuring mobility would be quite difficult under these conditions on a long-term basis. The drawbacks of mobility have eventually a long-term negative effect on the economic development.

The currently still low level of motorization in Xuzhou (Table 3) is in contrast to the already high

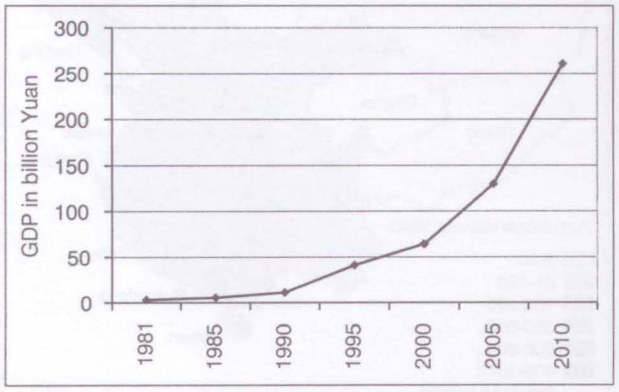

Figure 6 - Growth of GDP in Xuzhou (1 € = 7.1 Yuan), from 2000 to 2010 with a planned growth rate of 15% annually in average [XSY01], [XMP01]

Table 3 - Number of cars in Xuzhou (Year 2000) [XSY01]

Number in total	Taxi	Private Cars	Company Cars
66,700	7,000	15,000	44,100

Figure 7 - Normal daily traffic in Xuzhou (Photo: Author)

density of traffic (Fig. 7). The number of cars in private ownership is very low. Yet, the high number of taxis and company cars must be considered in assessing the current traffic situation.

The economic growth in developed industrialised countries has always been connected also with an increased traffic growth. In the sector of passenger traffic, the increase concentrated mainly on the motorised individual traffic. A short-run separation of the growth of economy and traffic is doubtful in many cases (cf. [RO99]). A long-term disproportionate traffic growth of motorised individual traffic (that means especially the increase of traffic capacity) in relation to the growth of GDP - as previously, in the Western industrial nations - is not possible in China, because of

- population development,
- limited infrastructure resources and
- dynamics of the development.

Therefore, new solutions must be found in order to ensure mobility under these specific conditions, for the future as well, as a precondition for further successful development.

4. INTEGRATED PLANNING AS PRECONDITION FOR SUCCESSFUL DEVELOPMENT

The basic principles of city and regional planning as they are used in the agglomeration centres of developed industrialised countries, can only serve in a conditional manner as the basis for the future development in Middle Centres of China. In the agglomeration centres of the Western industrialised countries, the public track-guided short-distance traffic dominated mass transportation in the second half of the 19th century and at the beginning of the 20th century. After this period cars started to dominate more and more the urban traffic. Because of the high density of traffic (especially of cars) in agglomeration centres connected with a number of the resulting negative effects, the new solutions for transportation systems design in the public sector, the public track guided short-distance traffic, have experienced revival in the recent years. This development took place over a period of time of about 150 years. The GDP rose gradually in the process of this development to today's level. The structure of the cities has always adjusted itself gradually to these changed constraints over the years.

The pressure which results from the population development (Fig. 2) and forces a demanding growth of GDP in few years (Fig. 1, Fig. 6), requires a solution that will skip over the described development phases of the agglomeration centres of the Western developed industrial countries. This is, however, only possible if the separate regional development and transportation systems design turn into an integrated planning. The planned growth of GDP referring to quinquennial periods in the considered region is defined as the primary goal. Here, the planned development of the GDP of the whole country as well as that of the leading industrial centres serve for guidance. The considered region comprises the Middle Centre (including the core of the city), the sub-centres (county towns) and the rural areas outside the urbanisation. For model design, the whole region is subdivided into various characteristic cells (spatial units).

At first, the integrated planning process aims to achieve an adjustment of the GDP per person in the different cells. The total growth of the GDP of the considered region should be ensured simultaneously. This goal is achieved by iteration of regional planning and transportation system planning. According to every planning increment, the GDP to be expected is determined for every cell and the complete region.

The objective functions employed must cover the fundamental objective of long-term development of Xuzhou into a powerful and successful region (with attractive metropolitan and distributed urban areas) in the North of Jiangsu Province. All of the following fields must therefore be considered by the objective functions calculated by modelling:

- the economic development (investment, production, employment),
- the "attractiveness" of Xuzhou, e.g. composite indicators of the available infrastructure regarding accessibility of the spatial units of the City as places for economic investment and as places for living and bringing up families, for working and recreation, and
- the environmental field (conceptually separate regarding the environmental aspects of the attractiveness) in the sense of retaining capacity and potential for development in the far future.

5. COMBINATION OF DIFFERENT COMPONENTS OF THE TRANSPORTATION SYSTEMS

No available means of transportation can meet the future mobility requirements in high quality level alone, even with a hypothetical reduction of the predicted traffic growth rates. Therefore, improvement of effectiveness of the transportation systems, in particular the inter-modal connection to form "Networks for Mobility" is an extremely important task of transportation research. [MN02]

Some aspects of the Xuzhou Master Plan regarding transportation system design are further described [XMP01]. An expressway system will be built in

Huaihai interprovincial macro-region. An expressway framework has been constituted in Xuzhou City. In order to enforce Xuzhou´s hub function, the construction of two additional expressways is proposed. Construction of a railway system in Huaihai inter-provincial macro-region is proposed. On the basis of the existing four railway lines (Longhai, Jinghu, Xuzhou - Huaibei and Xuzhou - Pei county railways), the state--owned railway company should be reformed and a rail-based urban transportation system established to link the central urban areas with the peripheral sub--centres as well as the various functional zones inside the central urban districts. A high-speed railway station of the line connecting Beijing and Shanghai should be located conveniently to other modes. The modern airport of Xuzhou located about 45 km outside the city centre in the Southeast and connected with it by an expressway at present has huge unused capacities and can be improved as the new economic growth point.

The connection of the long distance transportation systems with the urban and suburban transportation has the key function for the further development of the whole region.

A promising solution consists in the implementation of a track-guided transportation system as the backbone of public local passenger traffic (Rail Based Public Transportation System - RBPTS), that is, linked effectively by low-resistant interfaces with other traffic modes. The first studies have confirmed this estimation.

Since the designed scenario contains investment measures to build up a RBPTS in the core of the city and the surrounding area, consideration of the change in modal split (modes: on foot, bicycle, two-wheeled motorised transport, three and four wheeled motorised transport, bus) is needed in the Xuzhou Planning Model, depending of course on the distance or travel time. It is inevitable that many assumptions will be needed here, especially with respect to the future levels of car ownership (vehicles < 2.8 t) and the acceptance levels of the – with respect to time, slowly–increasing network of the RBPTS, including the transfer levels from the other modes. The design of both intra- and inter-modal interfaces need particular consideration in the RBPTS. That's why the change of modal split becomes an important sub-model in the planning process.

The modal split sub-model, in association with the trip generation sub-model, is necessary in order to help reveal road congestion (in terms of travel times), the demand for parking facilities (dependent also on policy in this respect) and motor vehicle caused pollution (in terms of emission volumes), all of which, together with other factors, are relevant for the evaluation of the introduction of a RBPTS.

An evaluation with regard to the successful set-up and the achieved quality is possible by means of the criteria from [HC02]. In this case, six essential indicators for success of the light rail system are:

- the number of light rail passengers per population,
- a similar indicator for public transport passengers in general,
- growth in light rail use,
- growth in public transport use,
- light rail passengers per track-km,
- light rail passenger-km per track-km.

On account of the available database, eleven different factors influencing the success by means of correlation and multivariate regression methods were determined:

- average light rail speed,
- population density in 300 m light rail corridors following the lines,
- monthly fare, relative to the country's GDP / capita,
- percentage of new light rail vehicles,
- peak headway in minutes of light rail service,
- park and ride spaces per light rail track-km,
- pedestrians street length per city population,
- percentage of passengers using travel tickets,
- light rail network density (track-km per population),
- number of public parking spaces in the city centre according to the city centre size,
- other suburban rail provisions.

The analysis of an evaluation on the basis of [HC02] must be practised very carefully with consideration of the specific conditions. In [HC02] the existing systems were investigated in highly industrialised agglomeration centres. The national GDP per person 1999/2000 varies between 19.5 T € / 138.45 T Yuan in Melbourne and 34.1 T € / 242.11 T Yuan in Zurich [HC02] compared to 1.01 T € / 7.19 T Yuan in Xuzhou. Car ownership related to 1999/2000 varies between 286 (Tyne and Wear) and more than 800 cars per 1,000 inhabitants (Dallas, Portland and other) [HC02] compared to 7 cars per 1,000 inhabitants in Xuzhou (Table 3).

[DO02] shows an approach for a general model which considers inter-modal aspects of an integrated planning as well as evaluation. A specific model for application in Middle Centres of China on the basis of a RBPTS is at present being developed at the Stuttgart University [SU03].

6. CHANCES AND RISKS

With economic growth and increasing real income a great increase will occur in the demand for transportation and therefore for vehicles and transportation

infrastructure. All of commercial, manufacturing, governmental and private ownership of vehicles will increase with growth of production and income, on the private side including the effects of social change resulting in an increase in travel distances and eventually in changes in mobility. The danger of designing Xuzhou municipal area and its surrounding catchment area to conform only to road traffic with a corresponding loss of attractiveness, if a rail-based public transport system (RBPTS) is not introduced, is large.

There is specific danger in the immediate future of a large increase in two-wheeled motorised traffic (Fig. 8), a common phenomenon in many Asian countries. Only firm institutional measures can avoid this danger which poses environmental and technical traffic control problems.

An additional danger consists in the fact that the private ownership of cars is a strong motivation factor that may under no circumstances be underestimated in China as well. In contrast to the industrialised countries with stagnating or negative population growth, a significant extension of living space per person cannot become effective as a motivation factor in China because spatial extension is naturally limited by high density of population and further population growth. Yet high motivation of people is essential if the ambitious economic growth objectives should be achieved. The increase in the number of cars causes a corresponding adaptation of street infrastructure, including public parking spaces, private parking places, garages and so on. But metropolises as Hong Kong or Tokyo also show how fast the limits are reached here. The success of a planning model based on a restricted growth of motorised individual traffic depends significantly on the fact whether the alternative motivation factors are found for the people.

A future metropolitan Xuzhou area (consisting of the core of the city and its surrounding area) will benefit from the introduction of a RBPTS because:

- it reduces the demand for road transportation considerably, especially in the central urban areas,
- it therefore reduces moped and car ownership and their usage, reducing air and noise pollution, saves valuable land in the central area and investment potential, which might otherwise have to be used to accommodate the increasing road traffic,
- the attractiveness of the Municipality will be increased and agglomeration disadvantages decreased, and
- stations, in particular at public transport nodes, provide opportunities for the development of urban sub-centres of high economic activity and residential density equipped with attractive pedestrian zones (providing the opposite of a road traffic only approach).

Figure 8 - One of countless bicycle parking spaces in Xuzhou (Photo: Author)

The introduction of RBPTS to cover regional passenger demand has similar advantages, in particular, stations provide a focal point for suburban development and a light railway system can be simultaneously employed as a tramway in suburban settlements. Regular services to the nearer county towns would improve their accessibility and (along the alignment) connect them much better with their towns and townships.

Within the planning period until 2020 social changes will continue, in particular freedom of choice in the housing, employment as well as education will increase. The ongoing officially encouraged urbanisation process and expansion of the large urban settlements will help to reduce the level of dichotomy between the urban and rural populations. With increasing income and the change in mobility the demand for recreation, sport and cultural areas and facilities will increase.

Water pollution and the irretrievable consumption of land (especially where there are very good soils or forest areas) for settlement and transportation purposes have to be adequately considered in the planning process. Also, the fact that there are sensitive seismic areas due to coal mining prohibits the location of certain economic activities or the allocation of certain functions to such areas. Ecological considerations, therefore, will have to be restricted to formulating spatial and sector boundary conditions on investment projects. Environmental indicators will be developed and controlled in the planning process and included in the objective functions used for optimisation.

To ensure mobility in the sense of the possibility for the appropriate local change as result of an integrated planning process and a precondition for a long-term successful development does not only set an example for comparable regions, of which there is a whole series in China and in which several hundred

million inhabitants live, but also gain important knowledge about the development of agglomeration centres in the developed industrialised countries.

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ZUSAMMENFASSUNG

MOBILITÄTSSICHERUNG ALS VORAUSSETZUNG FÜR EINE ERFOLGREICHE ENTWICKLUNG AM BEISPIEL EINES MITTLEREN ZENTRUMS IN CHINA

Die wachsende Verkehrsnachfrage ist unmittelbar sowohl mit der räumlichen als auch wirtschaftlichen Entwicklung verbunden. Die hieraus entstehenden Probleme werden in Ländern mit großer Bevölkerungsdichte und hohem Entwicklungspotenzial besonders deutlich. Die Sicherung einer langfristig erfolgreichen Entwicklung erfordert neue Lösungen, die auch für die Bewältigung der Verkehrsprobleme in hochentwickelten Länder interessant sind.

SCHLÜSSELWÖRTER

Mobilität, Integrale Planung, Verkehrswachstum, schienenbasiertes öffentliches Verkehrssystem, Verkehrssystemgestaltung

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