

Work Unit City: A Study of the Transport Design for Chinese Small City Urban Form

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Abstract

Facing environmental degradation and peak oil, western countries have begun to deliberate over the compact city form to decrease energy consumption and air pollution. In the rapid process of urbanization, China however is adopting western sprawling development pattern. In fact, there is a strong organizational basis for Chinese energy-saving development, namely work unit, that is now losing its dominant role. In Chinese cities, the work unit (Danwei), a typical example of centrally planned economy and communism, is not only the critical place for employment, but also the minimal social organization and basic cell for urban form and transport network. During the long period after 1949, the pattern of factory-based community had been pervasive in nearly every Chinese city, which was exclusively prominent in resource-oriented cities such as Daqing and Dongying (oil city), Datong (coal city) and Anshan (steel city) etc. A case study explores basic structure and transportation networks of work unit that is represented by 'small and all-inclusive' manifestation comprising all kinds of facilities and social services within walkable distance. Based on the qualitative analysis relating to adaptive potentials of work unit in the context of energy constraints, a number of future transition plans are proposed to favour urban sustainable development. The risk to the work unit is its high dependence on the presence of factory, in fact, with the massive collapse of state-owned enterprises in the 1990s, the function of work unit started to diminish in the course of economic reform. Yet its efficient spatial form and stable social structure still provide references for designing organic urban form with high resilience to energy constraints.

1. INTRODUCTION

When it comes to energy crisis or possible oil depletion, for the time being, it is not extremely serious to arouse public interests on energy conservation in many western countries including New Zealand. It is optimistically believed that the oil resources are still abundant enough to be extracted for several hundreds of years. In fact, the peak oil and subsequent decline is no longer a subject of speculation, it is emerging as a relevant planning issue (Krumdieck, 2010). Despite the possible oil supply decline, the massive oil demand from developing countries such as China and India has maintained rapid growth. It is widely acknowledged that China is gradually becoming one of the most powerful economies in the world in the next decades. The energy requirement from China has increasingly grown with the rapid economic growth and strong ambition for modernization. In 1993, China became a net oil-importing country and until now more than half of oil consumption in China is imported from abroad, which likely continue to increase in the future (Figure 1). As might be imagined, the whole world would not sustain the giant demand from China if it continues current extensive development. Therefore the difficulties in addressing China's energy consumption problems are not only its own issues, but to some extent the common concerns for all human kind.

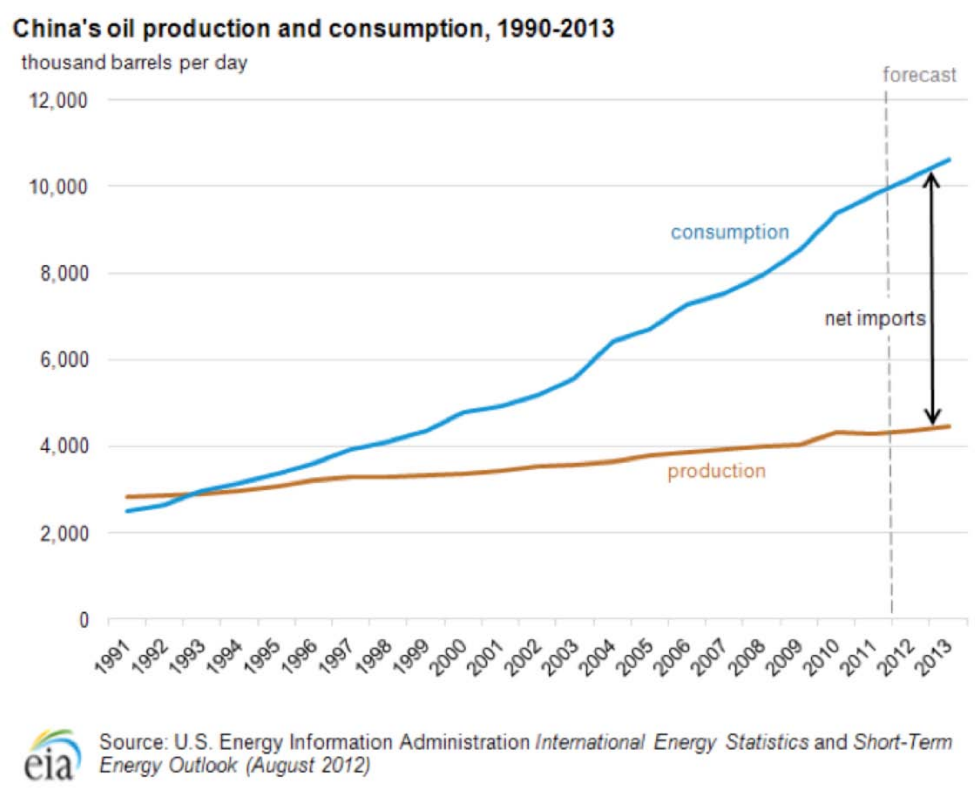


Figure 1. China's oil production and consumption

According to the IEA statistics, the transportation sector accounted for over 40% of oil demand in 2010, with motor gasoline, gas/diesel oil being the main transportation fuels (IEA, 2012), it is therefore necessary for Chinese decision-makers to understand transport energy use at various levels to address energy security, climate change mitigation and environmental pollution abatement. In reaction to these issues, there are two pathways to sustainable transport systems: One is the development of technical innovation (e.g. new

energy vehicles and new materials), the other one is the enforcement of social management policy (e.g. pricing systems, transportation rules and restrictions on driving). Apart from that, transport energy use has been correlated with urban form, e.g. the spatial land use and transport system (Kenworthy and Laube 1999). It is widely acknowledged that the locations of human activities determine the spatial interactions or trips in the transport system, which is also the basic rationale of traffic models (Wegener, 2014). Basically, urban form and transport are mutually intertwined, the changes in transport system could affect urban development and location choices of households and enterprises, and the changes in land use could influence the number of trips and mode choices (Waddell, 2014).

Facing environmental degradation and peak oil, western countries have begun to deliberate over the compact city form to decrease energy consumption and air pollution, China however is resembling early western urban sprawl pattern during its urbanization, which leads to particularly acute transportation problems such as traffic congestion and air pollution. Due to the resource availability problems in China, there is not enough space for transport infrastructure to accommodate a large vehicle fleet and the negative impacts of massive motorization in China will be more serious if the dependence on motor vehicle is not effectively controlled (Kenworthy & Hu, 2002). Accordingly it is necessary for China to explore development potentials in existing systems to promote the sustainability of economy, society and environment.

In fact, there is a strong organizational basis for the Chinese energy-saving strategy, namely the work unit, that is now losing its dominant role. During the long period of Communist regime in mainland China, the work unit (Danwei), a typical example of centrally-planned economy and communism ideology, was not only the critical place for employment, but also the minimal social organization and basic cell for urban form and transport network. It had played an important role in managing Chinese daily life, but with the social development especially as the consequence of market-oriented economy, diversified living styles and varied requirements increasingly marginalize the work unit but with more demand for energy use. This paper intends to re-examine the function of work unit in the history of Chinese development and its implication in future urban transport planning. It begins with the review of the history and background of the work unit. Then it describes the basic structure of the work unit and relating transportation network using an oil city as a case study. The analysis on the adaptive potential of the work unit for constrained oil supply is then presented, which is followed by the transition plan for future urban transport design. .

2. A historical review of work unit in China

The work unit (Danwei), in a sense, was an outcome of Communism ideology instead of the result of urban natural growth. According to classic Marxism theory, the socialization of human life is the radical characteristic of socialist society. In this society, the state-owned enterprise is responsible for the allocation of property including food, salary, welfare and living services etc. In addition, the Chinese traditional gregarious living habit based on intimate human relations such as the same blood and workplace made it possible that the compact community is widely acceptable by most people. For example, most people living in the same village in Chinese rural areas have the same family name, which means they might be originally from the same ancestor. Therefore, wherever property acquisition can accommodate it, the workplace becomes the principal unit around which domestic and social activities are linked, Danwei has become a term used to signify this spatial integration of

work, residence, and social life in cities organized by the Communist Party of China (CPC) (Bjorklund, 1986).

Prior to Chinese economic reform starting in 1978, the pattern of factory-based community had been pervasive in nearly every Chinese city, which was distinctively prominent in resource-oriented cities such as Daqing (oil city), Datong (coal city) and Anshan (steel city). Even among comprehensive megacities like Beijing and Shanghai, the legacies of work unit are still visible everywhere. It was not only an economic organization for industrial production, but also a rigid political hierarchy to avoid social chaos and free migration. Lü & Perry (1997) argued that as a basic unit in the CPC political order, the Danwei is a mechanism with which the state controls members of the cadre corps, monitors ordinary citizens, and carries out its policies. Once one had an opportunity to work as a formal employee in a state-owned factory, it meant that the essential living needs including jobs, housing and medical care would be guaranteed, which was deemed as a stable social status without too many concerns on subsistence. In particular, the work unit assumed the full responsibility of housing provision for its employees, this system left the employees no choice but to live in houses allocated by their affiliated Danwei, because there was virtually no housing market from which one might buy or rent a house (Wang & Chai, 2009). In the aspect of socioeconomic organization, this special institution is represented by 'small and all-inclusive' manifestation comprising all kinds of facilities and social services (schools, hospitals, parks, grocery stores etc.) within walkable distance, the purpose of which is to act as an accessory service to support industrial production. Figure 2 (Miao and Zhen, 2009) depicts a sketch of a small-scale work unit enclosed by walls in Beijing. Living in apartments allocated by their factory, employees can buy food in local grain store or eat in centralized canteens, go to work by walking or riding bicycle, send their children to kindergarten or school, enjoy free medical treatment in local hospital and so forth. However any departure to other places must be permitted by superior officials, which is also applicable to any entry into the work unit likewise. Moreover they didn't have too many choices to enjoy spare time due to the restriction from political circumstance.

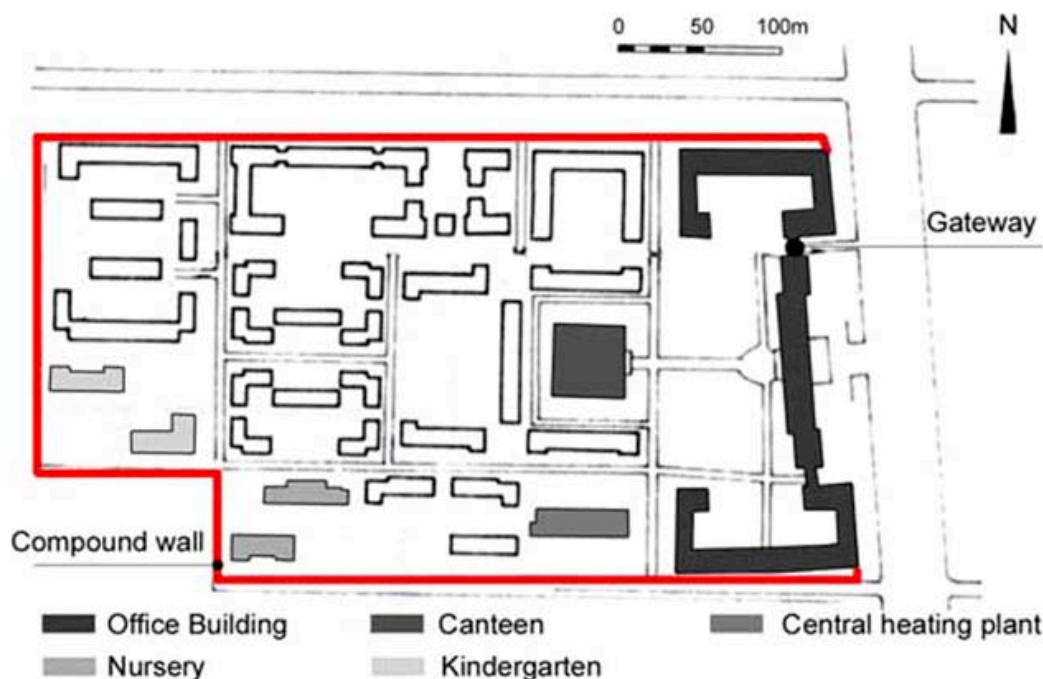


Figure 2. A small-scale walled compound (danwei) with one entrance, Beijing (Miao and Zhen, 2009)

After Deng Xiaoping's reform and open policy being implemented from 1978, China steadily extricated itself from the bondage of ideology and stepped on to the market-oriented route into modernization. At the same time, the state-owned enterprises and accompanying work unit community were affected by the liberalization of Chinese economy as well. Some free markets were permitted to exist in the work unit, which indeed facilitated local life. The authority gradually relaxed its grip over the work unit to make local people have more freedom to choose their own activities. Especially from 1992 when CPC determined to implement overall market economy, the state-owned enterprises (SOE) encountered huge challenges from private companies and foreign competitors. Some SOEs were completely bankrupt, some industries vital to national security and development fortunately survived but with large transformation in many aspects. For employees in the closed factories, the ultimate destiny were unemployment and the loss of relating welfares from former employers, which obliged them to find other chances outside the work unit to sustain their livings. Although some SOEs perform better than before, their social responsibility for their employees is gradually shrinking. Thus the work units previously affiliated to them have undergone substantial changes. Many facilities including schools, hospitals and parks either become independent or are transferred to local city council to manage. People have now more freedom to choose their own life and the function of work unit fails to meet growing diversified requirements thanks to socioeconomic development.

3. A case study: The Spatial structure and transport network of work unit

The forms of work unit in China are different in accordance with the function of cities. In the aspect of scale, a large-sized work unit tended to have separate residential compounds adjacent to the compound containing the industrial plants and administrative offices. Indeed, the sheer size of some of these Danwei gave them the appearance of small cities or industrial towns (Bray, 2005). A smaller work unit usually was enclosed by walls and could

only provide basic needs for their employees such as dormitory, canteen and medical clinic, which is popularly distributed in large old cities. In this paper, a classic work unit city called Dongying is introduced as an example to analyze its spatial structure and transport networks.

Dongying is a newly built oil city in the north of Shandong Province with the purpose of serving the production and infrastructure of local oil field (Shengli Oilfield), which is located near the Yellow River estuary into the Bohai Sea (Figure 3). At the 2010 census, there are around two million people living in its administrative area of 7923 km², one fourth of which are employees and their families affiliated to Shengli oilfield. A large portion of the local economy is dependent on oil and relating industries. The per capita GDP of Dongying is ranked 4th among Chinese cities. With the close connection with Shengli Oilfield, Dongying is a classic work unit city and has its unique characteristics. Before it was established in 1983, there were approximately 30 subordinate companies distributed around this area, which had different functions for oil production. For instance, Huanghe Drilling Company is a secondary work unit specializing in drilling procedure before extracting underground oil. For a long period even after the establishment of Dongying city, the leadership of Shengli Oilfield also played the role in city government administration. With the improvement on city function and for the sake of efficient management, Dongying city is now on the way out of its adherence to the oilfield.



Figure 3. The location of Dongying

Dongying city is divided into the west district as the base of Shengli Oilfield, and the east district as the site for municipal government. Figure 4 shows the basic structure and organizational relationship of Dongying city and Shengli oilfield. The base of oilfield is surrounded by different work units (green-colored) with transportation networks to each other, there are three counties called Kenli, Guangrao and Lijin under the jurisdiction of Dongying government. For the majority of employees in the oilfield, the base of oilfield is traditionally viewed as their own city center. In the city center the best services and facilities of Dongying including upmarket restaurants and shopping malls, first-class hospitals and high schools

are centralized along an east-west road. With respect to the transportation system, a fairly complete basic trunk network between inner-city and inter-city has been established. Only one freight-based railway connects the oilfield with another oil refinery south of Dongying. As a production-oriented city, the tourism and cultural facilities of Dongying are inadequate due to its harsh natural environment and short-term historical accretion. For relatively wealthy people, the enjoyment in traveling to other cities is more fascinating than just attending local activities. With the construction boom in property development nationwide, the living amenities in the city center have attracted people formerly living in work units to buy houses in good areas. While more population and vehicles are aggregated in the city center, congestion and overcrowding are becoming more serious than before. Generally for the employees and their families living in all kinds of subordinate work units, the sense of belonging to the oilfield is stronger than their concerns on Dongying's development.

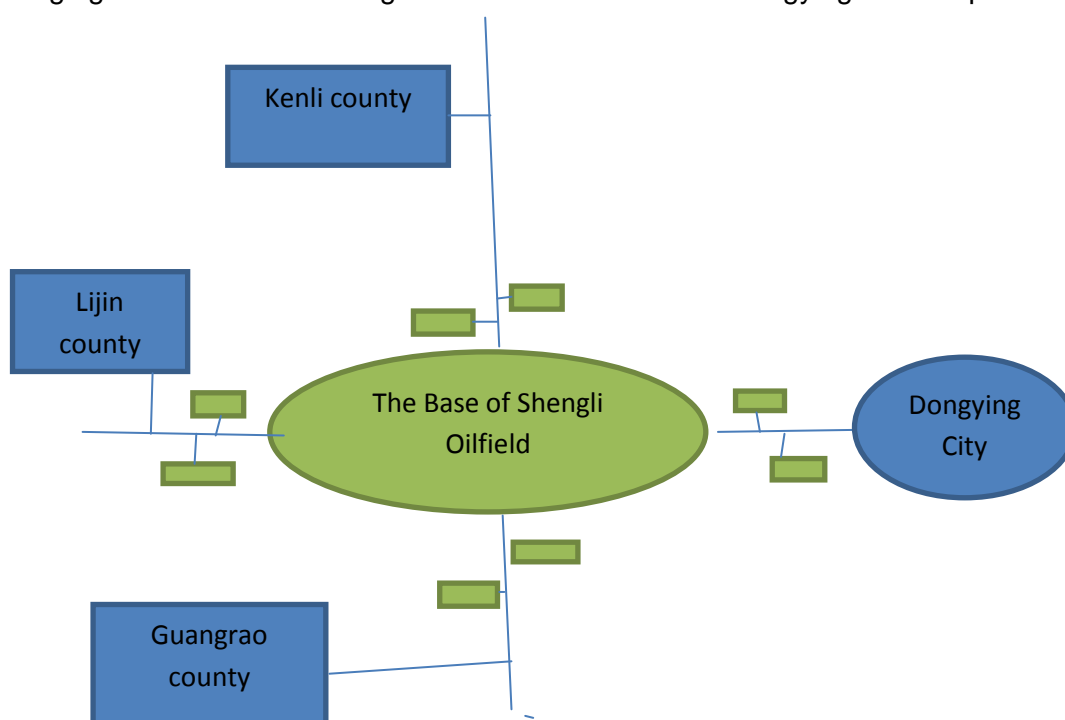


Figure 4. The city-oilfield compound structure of Dongying

Take Huanghe Drilling Company (HDC) as an example (see Figure 5 and Figure 6), it lies between the city center and another county town called Kenli with the distance of about 6 km and 8 km respectively. It is populated around 50000 people in the area of 3 km² where almost all kinds of institutions and facilities are distributed in a compact way. Some subsidiary work units belonging to HDC and other drilling-related companies are also located in this area, the majority of people living in unified apartments is comprised of HDC's employees and their families. Besides, there is an agriculture site called Dongan in the east of HDC to provide food as well as solve employment problems for some employee's wife and children. Even though a small number of employees live in other places outside HDC, the company bus can offer convenient transportation for them to choose. The necessary facilities such as schools, hospitals, markets and parks cover local basic needs. The minimum distance to the fringe of city center is about 6 km, the average number of the trips to city center per month for local people is assumed to be 1~2. There are several road networks connecting work units with city center, through which people can ride a bus or car, even cycling to city center is not unusual at the present time. For most of the year,

inhabitants residing in different apartment blocks can access to the workplace, schools, hospitals, park, supermarket in around 5~10 minutes by walking or cycling. There are few roads crossing the community that connect main transport networks outside, the mixed walking streets and pathways are most common in this area.

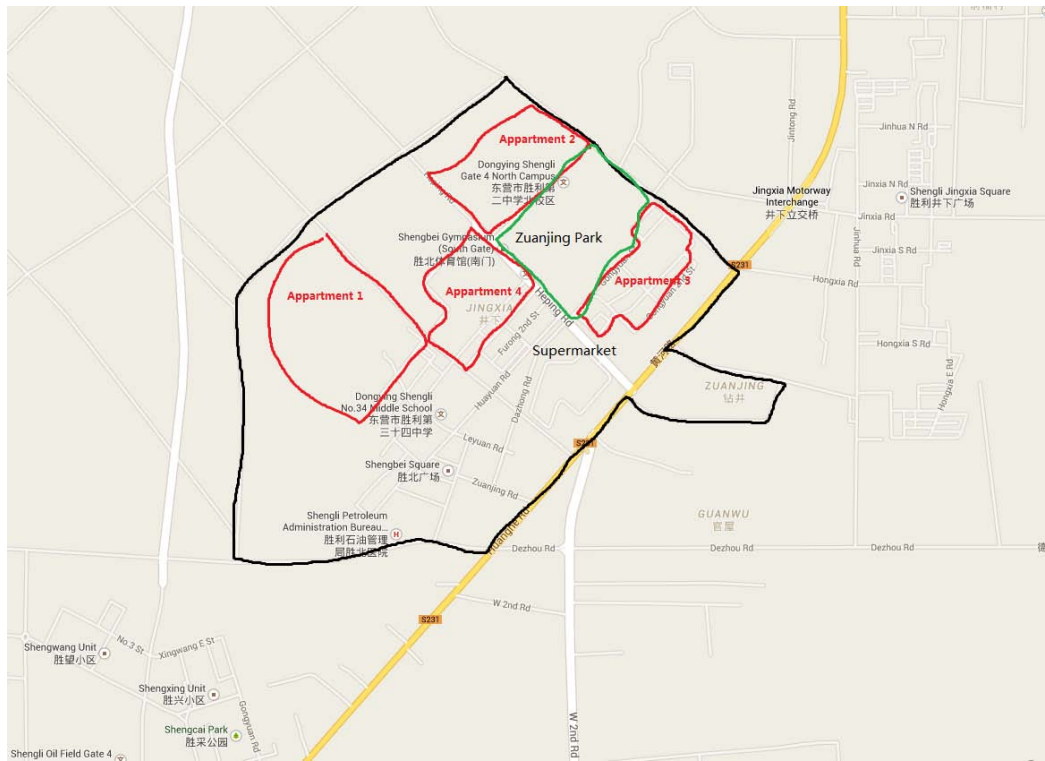


Figure 5. The basic spatial structure of Huanghe Drilling Company

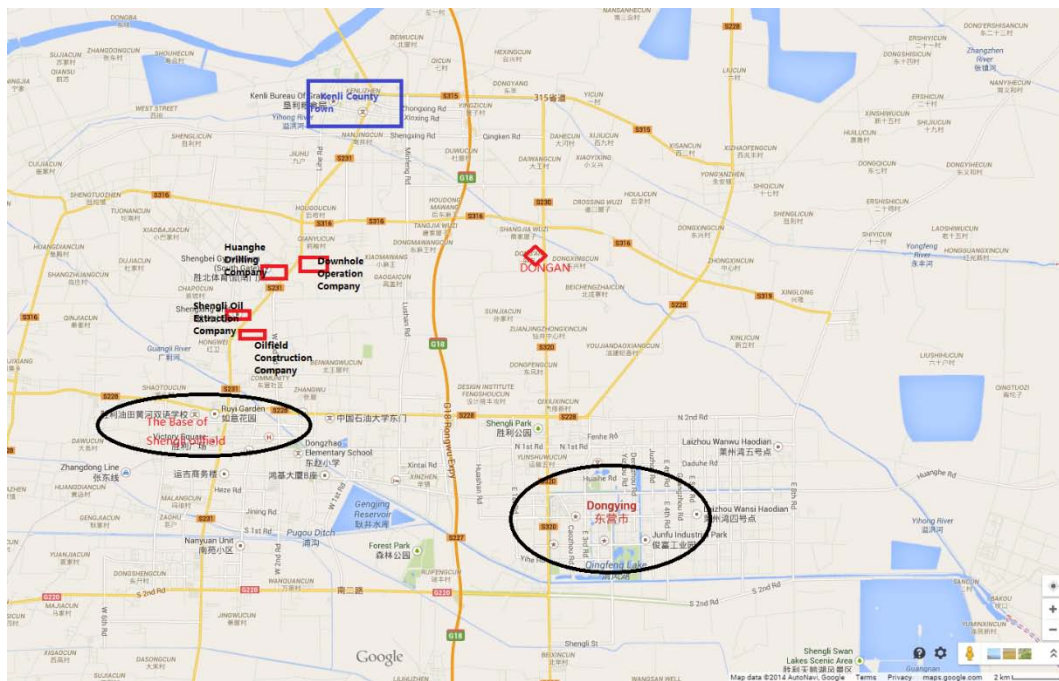


Figure 6. The location of HDC in Dongying

Before 2000, cycling was the main transport mode for most families living in work units. Typically for the people living within the distance of 5 km, cycling to city center was preferable if they want to avoid the inconvenience of taking a bus. As the quality of life is gradually improved, car ownership has been on the rise. However most cars are mainly used by young employed people, walking and cycling are still widely pervasive among old people and students. In addition, some new graduates are subject to the work arrangement, they have to work in other work units or the city center, which leads to an increasing divergence between their jobs and housing with their parents.

4. Adaptive Potential of the Work Unit

In the course of urban development in China, the urban sprawling form is a prevailing tendency to meet future economic requirements. Theoretically, it might be inevitable that the market economy encourages more freedom in the migration of production factors including capital, resource, technology and labor force. However the blindness of market power and the disorder in economic transition will result in excessive energy use and random expansion, which would in turn deteriorate environmental protection and social harmony. Being a legacy of centrally-planned economy, the work unit as described above also supports the view that more balanced jobs-housing relationships may lead to shorter commuting trips, increased usage of non-motorized transport mode, and reduced travel, which may imply less energy consumption and less emission of air pollution (Cervero, 1989). Therefore, finding inner-city potentials to realize the balance between development and energy constraints would be significant to cope with future possible peak oil or energy shortage.

Active Mode Accessibility (AMA): Accessibility is defined as the ability to access goods, services, activities, and destinations or “what, and how can it be reached, from a given point in space” (Bertolini et al., 2005; Yigitcanlar et al., 2007). At present, accessibility is gradually becoming a good metric to evaluate urban transportation systems. AMA is defined as the proportion of activities that can be reached by human-powered transportation (such as walking, running and cycling). It is obvious that AMA is negatively related to oil use, an urban transportation system with higher AMA is less reliant on oil for transportation. Generally for the city center, the accessibility is very high on account of its convenient connectivity and densely distributed facilities. In the case of work unit, the shorter distance coverage and all-inclusive micro-facilities also make it more accessible by all kinds of modes. By analyzing the spatial structure in HDC, we can assume that the AMA to key destinations of work unit is 100%, the minimum transportation energy use is 0, which explicitly indicates that the work unit is resilient to energy risks such as fuel price shock and possible energy shortage.

Self-sufficient ability for sustainable living: Because of remote geographical location and adverse natural environment, the original design for Shengli oilfield was to be concentrated on self-sufficient development so that all necessities could be satisfied as much as possible. As mentioned in the case of HDC, there are plenty of agriculture sites where they are suitable for plants to grow, which provide food for employees in work units in a way of welfare. Until recently, the work unit assumed the responsibility for the procurement of welfare including some food and daily necessities unavailable in local environment. Also domestic gas and electricity are provided by oilfield and local power grid respectively, which somewhat reduce the reliance on outer energy resources. In addition, some collective living facilities such as factory canteens, leisure square and retirement center bring certain convenience for local inhabitants. For the older generation of employees mostly coming from

poor villages, the necessary services basically meet their primary needs. It is believed that with the improvement on living quality and progress in society, more advanced requirements would not be locally satisfied and as a consequence, the trade with outside places would become frequent resulting in more energy use eventually. However this pattern of inward development associated with the supply of necessities still retains enormous potentials to achieve energy conservation and harmonious growth.

Demographical mobility: It is well known that social stability is the cardinal task for CPC to manage and control Chinese people. Any form of riot and disorder would not be tolerable by CPC government, which is also a key criteria for evaluating local official political achievement. For a county with the largest population on the world, stable social structure and less mobility ought to be a sensible way to approach the balance between economic growth and social harmony. Noticeably, the population in Dongying is relatively small and the distribution of population density is uneven. Apart from the highest density in the long narrow area between the base of oilfield and the city government, most people live in work units and county towns separated by undeveloped lands. Compared to the growing urban mobility, the daily commute in Danwei community is always 'static', of no energy consumption (Chen, Zhu & Ren, 2012). In general, for the work units 3 km away from city center, most activities can be performed within the area of work unit, which leads to a high AMA and a limited mobility in the city area with less energy use. For the work units closer to city center, the demographic mobility to city center is higher but essential activities inside work unit are still prevailing. However on weekends, the requirement for consuming and entertainment in city center certainly activates travel demand and subsequent urban mobility.

Localized Employment: At present, after solving problems of food and clothing, the prime concern for China government is just how to help younger generation to find appropriate jobs regardless if it is a state-owned or a private enterprise. In Chinese context, a stable job has been regarded as a representation for personal future development. Owing to the one-child policy and Chinese tradition, a large number of employees prefer their children to work and live with them. In fact, most younger people choose to work in Shengli Oilfield after graduation and the oilfield has been responsible for localized employment although it is opposite to the requirement of reformation and management. Even if some younger people don't work at the same work unit as their parents, they can take a company bus to commute every day. Accordingly, localized employment not only facilitate family reunion but also shorten the distance of jobs-housing commute.

5. Transition Plan for Future Sustainable Development

As a newly built city, Dongying has great space and opportunities to achieve sustainable urban transportation systems. However it is estimated that some new trends would be emerging in the future along with the infrastructure of Dongying, which could be detrimental factors for its resilience to energy constraint:

- a.** Some people begin to move out of the work unit to buy affordable commercial housing instead of welfare apartment.
- b.** The car ownership is on the increase although to a greater extent it is a representation of social status rather than practical necessity.
- c.** The new facilities and constructions are primarily situated in the city center.

In reaction to above issues, Shengli Oilfield and Dongying city should make best of the work unit with regard to the concerted development of energy, environment and society. Based on the efficient application of work unit, some transition plans should be explored as follows:

5.1 The distance between housing and work units is supposed to be as short as possible.

Owing to the growing demand derived from social development, more lands would be used for housing. Since the authority of land management has been transferred to Dongying city government, the work units of Shengli Oilfield have more difficulties in building welfare apartment for their employees in their own area. As a result, the collective land purchase funded by the oilfield has begun to arise in some places, but the locations are far away from work units. To resolve this problem, the coordination between the city and the oilfield is crucial to offer best geographical position for surrounding work units. In light of the advantage in the flexible connectivity among different work units, the multiple coverage housing site with high AMA to adjacent work units could be found through GIS tools.

5.2 Realizing a reasonable distribution of facilities in accordance with socio-economic situation and work unit geographical characteristics

As far as the current situation is concerned, the essential requirements including primary education, medical service, supermarket have already been satisfied with a high AMA in each work unit, the attraction of new facilities in city center and the increase of car ownership nevertheless contribute to the augment in vehicle trip. According to Dongying's development plan (Dongying Planning Bureau, 2010), the future focus will arrange new facilities and housing along the long narrow area between west district and east district, which neglect the requirement from inhabitants living in work units outside city center. Take HDC as an example, if some shopping malls and leisure centers could be built in Kenli county, not far away from HDC, there would be at least three advantages: (1) It could be seen as a political achievement for local officials to promote local economic prosperity. (2) It could attract more people in neighboring work units to come for consumption. (3) The bypass flow to the north would alleviate traffic pressure and subsequent congestion in city center.

5.3 High-density redevelopment between work units

Based on the fact that a vast tract of land between work units has not been fully utilized, it is useful for Dongying city to pay more attention to the mixed land use and strategic development with high AMA to each work unit in pursuit of health, security and sustainability. Actually, the oilfield has made some efforts to merge some geographically adjacent work units into one community in terms of administration. However the connections between them are limited and the matching facilities still remain separated from each other. More importantly, the homogeneous level of service and similar facilities among work units decrease the mutual mobility resulting in more trips to city center for higher level consumption. Therefore, redeveloping land use and upgrading the level of existing facilities would be more challenging to realize truly organic combination of work units.

5.4 Implementation of city multifunction

For an oil-reliant city as Dongying, the single economic structure is an adverse factor to adapt to changing circumstances. The greatest risk of work unit is its high dependence on the presence of factory, in fact, with the massive collapse of state-owned enterprises in the 1990s, the function of work unit started to diminish in the course of economic reform. Fortunately some resource sectors crucial to national security have survived in the shock of reformation thanks to government protections. However facing the challenges from possible oil depletion, Dongying city has to reconsider its future pathway toward sustainable development. In association with the location of work unit, the oilfield and city could cooperate together to realize the balance between economic structure transition and energy conservation. For example, the ample land resource could be fully exploited for more crop planting and animal husbandry aiming at self-sufficiency and convenience for work units. Since each work unit owns one or more agriculture sites, the holistic integration of housing, jobs, site location might optimize AMA and efficiency.

6. Conclusion and Discussion

It is undoubted that China will grow into a giant economy stimulating world energy requirement in the next decades. Nonetheless the risk of peak oil and the accompanying imbalance between world oil supply and demand would be a serious obstacle for China to overcome. Although some technical progress make us more confident about building an environmentally friendly society in the future, the feasibility of renewable energy transport is still far away from reality on account of troubles in its commercialization and popularization. Therefore, it is necessary for us to redirect our thoughts from the problem-solving at the bottom end of transportation systems to the upstream design with ground-breaking ideas. In face of the predicament between development and sustainability, especially during the process of urbanization in China, how to design urban form in consideration of energy constraints and comprehensive harmony is a challenging issue for China government.

The current imitation of western sprawling urban form in China is worth serious consideration in terms of sustainability, furthermore, the enhancement on efficient use of public space and maximization of collective interest should be highlighted during city construction and land conversion in the long run. Although the work unit is a little obsolete in terms of economic growth, its compact design and complete function for basic necessities still offer a good foundation for future transition plan. As a production of centrally-planned economy, the original thought of work unit was just to facilitate employee's living without considering whether or not it is energy-consuming, but interestingly, it has great potential to resist the future risk of energy crisis and high resilience to possible oil shortage in that its high AMA and all-inclusive services indeed decrease physical travel requirement. In the case of Dongying city, the coexistence of oilfield enterprise and city government can organically integrate the work unit with urban form to basically achieve the urban-industrial-economic complex with less transportation energy use.

In the light of qualitative analysis on work unit in this paper, more rigorous and quantitative investigation should be strengthened in future works. In addition, in view of the particularity of oil city, the scale of local oil industry would presumably shrink given the possible oil depletion in the future, resulting in less localized employment and recession of city economy, which also could negatively affect its sustainable development.

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