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Local distribution and collection for environmental and social sustainability – tricycles in central Beijing

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ABSTRACT

Goods distribution is a growing proportion of intra-urban transport worldwide due to changes in supply chains and e-commerce, yet has received scant attention in research. Cities have opted for a regulatory approach to truck movement and deliveries at a local level but few have tried to develop a systematic approach to management. Following certain suggestions in the literature, a hierarchical deliveries approach is being adopted in some new developments in Europe and Australia using light vehicles at the local level. In East, South and South-East Asia, where 3-wheeled non-motorised vehicles have been a mainstay of goods and people transport for several decades, they are under renewed pressure from city governments. This study of the tricycle in Beijing examines their role for packages delivery, food and beverage distribution and waste and recycling services, which covers nearly all of the uses of utilitarian tricycles in northern Chinese cities. Drivers (n = 97) were interviewed, their usual trips were mapped, and the subsequent trip was recorded using a geo-positioning system. These trips were compared with trips executed by small, motorised vans, favoured since 2014 by Beijing government. Operations can be divided into four categories according to delivery chain organisation, field operations and vehicle type. Motorised alternatives to the tricycle are shown to be uncompetitive in terms of time, cost and energy efficiency. This first detailed examination of the operations of the tricycle in a Chinese city provides a useful base for consideration of local distribution services organisation and a possible model for cities outside China.

1. Introduction

Building efficient transport infrastructure is increasingly central in the Chinese urban modernisation drive. Although efficiency as a goal in such planning remains both unclear and universal, efficiency is usually associated with new technologies. So it is with goods distribution, which has assumed a prominent and expanding part of the transport system, within China and throughout the developed world. The low-tech systems that emerged in 20th century China, including the bicycle and tricycle, adapted to the high urban densities and modest road infrastructure of pre-modern and early socialist Chinese cities, are difficult for the decision-making class to accept. They point, with some justification, to the developed world's abandonment of such low-tech solutions to distribution and collection, although pedicabs have re-appeared in many of those same cities.

In the meantime, the distribution of goods, recycling activity and waste collection are a major and growing part of the urban transport system worldwide. The difficulties of achieving an adapted and coordinated approach to this transport sector afflict many other countries (Munuzuri et al., 2012). Nevertheless, there has been increasing attention on the part of transport specialists in recent years, in part because of the substantial negative impact these activities are having on the transport system, the ambient environment and on quality of life. While the sector continues to evolve largely according to the needs and aspirations of shippers and receivers–that is, with little reference to the environment in which they operate – there are few innovations in the system as a whole, and in methods of delivery in particular.

As discussed below, the literature has largely focussed on the macro-level issues of logistics organisation. Several authors suggest a multi-tiered system would help solve the environmental and logistical problems at the local level. Arguably, that is the nature of the system currently in place in Chinese cities today, and the reason for investigating how it works at the local level. The tricycle fleet operations used for distribution activity in many Asian cities provide us with interesting lessons on the geographical extent of the operations, the types of distribution and collection, as well as the social and environmental externalities. Such vehicles have different names by locality although generally consist of two fixed wheels in the rear supporting a carrier, a single seat for the driver and one wheel in front (三轮–*san lun* or 三轮车–*san lun che* in written Chinese with Mandarin pronunciation respectively) (Fig. 1). In Beijing as well as in many other Chinese cities, the dominant tricycle goods transport fleet may be joined by rickshaws–

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Fig. 1. The typical human-powered working tricycle in Beijing.

pulled two-wheel vehicles–and e-bikes but the latter types remain uncompetitive because of energy requirements in the first case and limited capacity in the second.

Several studies have examined the role of such vehicles in Beijing, Dhaka, and Delhi, among other cities, as discussed below. The present study contributes to this literature by considering in detail the daily operations of a fleet of such vehicles in central-west Beijing where they continue to constitute the major means for such distributive activities. Such systems, including the one researched here, are under threat from city-level policy change in Beijing and many other cities in north China in 2015, so it is particularly important to document them should they disappear in favour of motorised vans and trucks. Since it seems highly likely that new, more environmentally acceptable systems will adopt at least some of the characteristics of operating tricycles, it seems much easier to learn from an existing system than to invent a new one *ex novo*.

2. Background

The organisation of the city has been partially dependent historically on how goods are distributed (Cau and Cochoy, 2012). This link has gradually been severed by the independent development of motorised logistics and fast road networks. Today, distribution activities relate more to the needs of providers and shippers as networks have been scaled up and new technologies introduced (Dablanc, 2007). The traditional logistics platforms of railyards, harbours, and local warehousing and distribution facilities are fast disappearing, leading to suburban trucking operations that service the entire urban area at high cost both in terms of travel distance and environmental nuisance.

Distribution movement is increasing rapidly with Internet-based shopping and low inventory retailing. In France, it is estimated that each job generates one distribution movement per week (Dablanc, 2007). Direct-to-door deliveries have led to the rapid growth of city-based shipping firms. For example, food retailers may receive many individual deliveries per day, when historically they accessed centrally located wholesale food markets on a single trip. Those retailers are also increasingly engaging in home deliveries or contracting with firms that do so.

City-based delivery vehicles may account for 20–30% of the total vehicular fleet in European cities (Dablanc, 2007). The nature of such motorised vehicles is such that they contribute a disproportionate share of pollutants, a growing problem worldwide but a critical issue in China. The transport sector as a whole is a major contributor to greenhouse gas emissions. Even if a rapid move to more sustainable transport technologies occurs, major reductions in vehicular movements are recommended to reduce the contribution to greenhouse gases (Committee on Climate Change, 2014). Many efforts in local communities to restrict truck movement have been spurred on by motor vehicle noise and danger to pedestrians.

Transport planning has paid little attention to logistics activities, in spite of their rapid growth. City leaders in Europe have generally been reluctant to intervene because of feared costs to economic growth (Marsden et al., 2014; Lindholm, 2010), undoubtedly the case in China as well where economic growth remains the paramount concern of city leaders. Although highly detailed information is now available on all vehicular movement in the city, planning continues to emphasise supply and efficiency. In Beijing, where frequent hazardous levels of air pollution occur, controls in the transport sector have touched almost exclusively on passenger automobiles. A shift to motorised logistics will contribute to poor air quality, already blamed for more than 1.2 M premature deaths per year in China (Yang et al., 2013). Many cities worldwide have regulated truck movements by time of day or weight. Many cities in China restrict the movement of so-called long vehicles or container trucks to nighttime, in an effort to reduce accidents and improve daytime traffic efficiency, although at high environmental cost.

Cities have been slow to innovate on distribution activities or to take a systems approach to their management (Hesse and Rodrigue, 2004). Proposals for satellite transfer facilities to small, energy-efficient vehicles in local areas have been followed up in only a handful of cases (Crainic et al., 2004). Mini-warehouses are also suggested as a way of favouring modal shift to smaller vehicles for final delivery or pick-up (Munuzuri et al., 2005). An example is Stockholm's Hammarby Sjöstad and the old city, where local logistics platforms are used to transfer goods to small electric vehicles for all deliveries within those areas (Goldman and Gorham, 2006). In central-west Beijing, there are numerous local distribution centres for daily consumption goods, as well as local depots for recycling and waste collection. However, these depots are also under threat, including one in our study area.

Early pedestrianisation schemes in Europe envisioned more deliveries using non-motorised means from peripheral unloading facilities, but most deliveries in such areas are made today by truck and van, regulated according to time of day and number of visits. In historic city cores in Europe, a pre-automobile street system is poorly adapted to the needs of deliveries or motor traffic in general. The suggested approaches involve better management of the street space, conversion of street parking to logistics or outright closure of such areas to private car traffic (Munuzuri et al., 2005). In Beijing, official discourse also sees most of central Beijing as poorly adapted to the needs of modern transport. Rather than limit the incursion of vehicular traffic, however, local government is working to promote access for private vehicles, in an effort to "modernise" the historic core. On the other hand, the local government has paid significant attention to logistics, for example by attempting to organise at the metropolitan scale and controlling access to pedestrian areas such as Wangfujing.

Given the lack of research into the operations of working tricycles in the Chinese context, we have three research aims in the present work: 1–Investigate the types of operations by purpose, organisation and vehicle type; 2–Investigate the spatial extent of the working tricycle in the Beijing urban area; 3–Compare the operating cost of the non-motorised tricycle for the distribution operations with the government-supported motorised alternative.