Evaluation and evolution of the city distribution concept

J. H. R. van Duin

Transport Policy and Logistical Organization, School of Systems Engineering, Policy Analysis and Management, Delft University of Technology, Jaffalaan 5, 2628 BX Delft, The Netherlands

Email: J.H.R.Duin@sepa.tudelft.nl

Abstract

The historical centers of Dutch cities offer a convenient atmosphere for shopping and pleasure activities. The quality of the living environment is afflicted by the noise and air pollution of trucks. Spinning motors while (un)loading the truck cause emissions of several damaging environmental exhaust. In the early 90's the concept of city distribution centers became an issue of growing interest for Dutch municipalities. Centralized distribution, organized at a distribution center at the edge of a city, was thought to provide a firm basis for improvement of the quality of the inner city. Many positive effects were anticipated from the introduction of the city distribution center-concept: congestion reduction, gain of time, reliable delivery, economies of scale and noise reduction. In 1997 the 'real-world' implementation of city distribution centers in the Netherlands gave rise to some critical questions about its functioning. On the whole, one can conclude that the total size of demand provided for the city distribution center was overestimated. Governmental, logistic, managerial and juridical incentives have not resulted in a substantial switch towards new distribution concepts, mostly because the behavior of forwarders, government and shopkeepers was not analyzed thoroughly. Superficially evaluating the concept of city distribution centers one can conclude that the concept seems to fail.

In our view the concept of city distribution centers is still valid if not seen as a blueprint for uniform appliance. It is a first step towards the development of other, new, promising logistic concepts based on a framework of multidisciplinary performance indicators. In future, based on the lessons learned, the city distribution concept can alter towards two important directions:

1. the idea of 'shop stop stock', which means that shops provide only show windows, sales areas with samples or a virtual shopping environment. The final purchase will be electronically messaged to the city distribution center, where the real products are stocked. Finally the achieved products will be straight delivered to the buying customer at any time and place he or she wants. The 'shop stop stock' idea will provide some interesting logistical advantages.
2. the embedding of underground transportation technology as a core element of the distribution structure. Looking at the current application areas for underground transportation the spatial and environmental conditions are similar for city distribution.

So after evaluating the functioning of city distribution centers during the last five years some critical elements for good functioning have been overlooked. Taking these critical elements seriously into account the concept of city distribution must change radically into new directions. Information technology and underground transportation technology give city distribution centers good opportunities to survive or revive.

1 City distribution concept

The main initial motive for city distribution concept was the occurring nuisance caused by the heavy delivery traffic in the city center as a result of the distribution of goods and packages into the city. The traditional organization of the transport market in many small companies, plays an important role in causing the nuisance. Looking at the supply side of this market we see many small transport firms delivering relatively few packages and goods at certain addresses in the city center. From the demand side we can observe that two or three times a day the shopkeeper is supplied by one or more transport companies. These two developments are responsible for the enormous transport movements in and around the city. These transport movements, combined with the daily commuter traffic, can cause congestion in and around the city and give rise to problems with the quality of the living environment in the city.

The quality of the living environment is afflicted by the noise and air pollution of the trucks. Spinning motors while (un)loading the truck cause emissions of several damaging environmental exhaust. In the long term heavy truck loads can cause road collapses or damage to historical buildings or objects. The resulting maintenance activities cause a lot of inconveniences for shopkeepers and clients, and eventually, the municipalities will be confronted with extra expenses for these infrastructural repair works.

To tackle these problems, in the beginning of the 90's the Dutch ministry of transport, public works and water management developed some ideas about city distribution as part of a new national framework on transport and infrastructure [1]. The aim is to improve the environmental conditions, to accommodate the flow of goods into the city without interference of other traffic flows and, to maintain the nice historical shopping environment for the visitors of the town.

The initial concept of city distribution center can be defined as:

'A center for transshipment of goods with a destination in the city, located at the edge of the city with a good infrastructural accessibility. Its main purpose is to achieve a high degree of collection in the goods flows (thick) in order to supply efficient transport from the distribution center to the city center and vice versa.'

The city distribution center established on the edge of a city is well accessible for long vehicles. These trucks can unload fast because several dock stations are available at the distribution center. The distribution center takes over the truckloads and sorts them out by destination. The truckloads are transshipped into smaller, sometimes electric, vans. Most vans have permission to deliver in the inner city during specific time windows. These time windows are a barrier for other distributors, because their drivers could not be present at the same time in all cities for delivery. In this case the city distribution centers have at least in theory a competitive advantage. As another theoretical advantage the city distribution center can provide facilitation for stock keeping, value adding activities and supply chain management. Besides these logistic advantages the city distribution center also has better opportunities to create efficient delivery schedules. Five years after the first ideas we now can evaluate the success of this

promising distribution concept. Although the actual success is debatable, the evaluation of this concept forms the start for new conceptual ideas about city distribution. This paper deals with two evolved concepts of city distribution.

2 Evaluation of Dutch city distribution centers

As Van den Brink [2] phrased as a general tendency: 'It seemed to be such a promising concept'. The current city distribution centers lead a laborious existence and the cities themselves threaten to be overflowed. Reviewing the city distribution center systematically for neglected or disregarded indicators indicates the next shortcomings:

Logistic arguments

Coopers and Lybrand [3] suggested that a city distribution center should only handle goods which are not fresh, not dirty, not unpleasant to handle, not voluminous and not valuable. In Dutch these criterions became well-known under the name 'the not 5_V's'. Without any critical reactions, besides some scientific papers [4], these criterions were considered to be common sense and always formed the criterion's on which goods flows were selected for city distribution. The question however is why for instance fresh products like flowers, newspapers, fruits and vegetables can not be handled by a city distribution center. So applying the mentioned logistic criterions causes a reduction of the potential market share. This is finally reflected in low supply and low demand. Another goods flow that has not been taken into account are the returns. The collection of packing materials is gaining more and more attention within the framework of environmental discussions. Organizing an effective way for collecting the reusable packing is not an easy task. Combining the deliveries with some collections of packaging can create non empty return tours to the distribution center. Another motive for the insignificant use of the city distribution center refers to the different logistic structures for city distribution. The possible logistic structures are direct delivery (1->1), one-to-many (1->n) deliveries, many-to-one deliveries (n->1) and many-to-many (n->n) deliveries. The first two structures create often well-organized transports with a full truck load. Because of these efficient distribution lines, the stakeholders involved do not change their distribution structure. The many-to-one deliveries and many-to-many deliveries are the only candidate distribution structures to switch over to the city distribution concept. This observation could be another reason for the modest market share using the city distribution center. An argument not mentioned in the early discussions of a city distribution center, was the possible stockholding function. To provide this function the shopkeepers can obtain more sales room and the clients can directly be delivered from the distribution center. Furthermore the stockholding function can contribute to raise value towards the extra handling activity which must take place. In the current mode of implementation the city distribution center is often presented as an introduction of an extra link in the distribution chain without any apparent merits.

Economic/market arguments

The initial break-even number calculated should be around 2000 deliveries a day. This number of deliveries should be obtainable after two years. Again these demand forecasts became common wisdom under the stakeholders involved, but the results of the concept implementation showed a smaller growth of the demand than estimated. Many potential customers of the distribution center did not want to have their products transported with products of their competitors. Competitive information about orderquantities and products could be registrated or acquired by the competitors. This fear was a serious matter for some potential customers. Another omitted argument was the fact that many product flows have been clustered tensely by third parties that have organized their own transport efficiently. Some shopkeepers already organized themselves and put out a tender for the total transport demand to one carrier. This way of organizing had already led to cost reductions for carrier and customer. Later implementations also proved that the break-even delivery number was much lower than the estimated 2000 a day. More recently the calculations indicated that the number of deliveries should be at a minimum of 200 a day [5]. From these calculations we learn that the initial costs calculations were based on a full facilitated distribution center. The draft scenario for development of the distribution center was not designed for a moderate introduction guided with small expenses.

Policy arguments

The lag behind the initial estimations can also be attributed to a lack of central coordination by the government. Some cities learned from the early mistakes of other cities, but a common policy wasn't provided for by the government. The current problems with time window regulations are an indication of lacking policy. The time window regulations should be coordinated by a central party overviewing the consequences of specific time windows at certain places. In fact, not all the goods are distributed by the city distribution centers, but some carriers have to deliver in two or more cities a day. If a central coordination of time window regulation lacks, the roads in and around some cities can be even more congested. Absence of some guidelines for starting a city distribution center is another example of lacking coordination from the government. At the start of implementation the projectteam has to decide which parties should be involved, which parties should be informed etc. One of the omitted parties in case of Utrecht was the police. The supervision for controlling the time window regulations and regulated passage roads was insufficiently supported by the police. The arising workload was not predicted.

Summarising, it can be stated that the government started with a pilot project to mirror the advantages and disadvantages of a city distribution center. After this pilot project the government failed to formulate lessons learned and failed to formulate a national city-distribution-center-policy. In 1995 this progress in insight resulted in the start of a project (initiated by the government) to gain more insight in which measures should be taken to improve the urban freight transport in and around the cities at municipal, regional and governmental level.

3 Future logistic concepts for city distribution

Due to omissions of the early city distribution concept the cities will supply the inner city by traditional distribution which means that other transport companies take over the former inner-city destinations. In fact the old situation returns and growth of congestion and pollution will increase. Facing these developments the city distribution concept has to be explored for new opportunities. Opportunities for improving the city distribution can be found at the physical and intermediate organization level. The 'shop-stop-stock'-concept is based on the application of telematics at the intermediate organization level, which allows to change the distribution structure at the physical level. Applying underground transportation technology for city distribution refers immediately to the physical level. In the next two paragraphs both new directions for city distribution are worked out.

3.1 Shop-Stop-Stock-concept

The idea for this concept is basically derived from the critism that the city distribution center is often presented as an introduction of an extra link in the distribution chain without any apparent merits. In order to refute this critism the logical question came up how to raise the value of the activities in the city distribution centre. Which distribution structure provides a better logistical performance? Following the literature of supply chain management [6] the primary design of the chain should be focused on the customer, i.e. the customer service [7]. As we derive from the early concept of city distribution the primary orientation was focused on the shopkeepers, not on the customers of the shopkeepers. If we think from the customer's perspective, the customer wants to shop conveniently in the inner city. The shops could provide an extra service to the customers, because the customers should not drag along the streets with the purchased goods. In fact, the purchase and delivery can be separated. After shopping, the purchased goods will be delivered directly from the city distribution center at the address and point of time the customer wanted. The logistical advantages seem prosperous for all actors involved:

Customers
As mentioned earlier the customer can specify at what time the purchased goods have to be delivered at home. Another possible advantage can be seen from the fact that the necessity to go by car to the congested area with high parking tariffs diminishes. The customer can also decide to go to the inner city using public transport (or bicycle). This way of traveling could be much cheaper and comfortable rather than travelling by car.

Shopkeepers
As we can derive from its name the shop-stop-stock concept provide the shopkeepers the opportunity to eliminate or reduce their stocks and reallocate the complimentary floor space for convenient selling activities. A complete

elimination of stock could be impossible, because some products cannot be sold without a physical representation (clothes, shoes etc.). Another logistical advantage of this concept is that the receiving and handling activities of products are excluded from the shop and will not interfere with the selling activities. A reduction of personnel costs might be possible because some shop personnel can be sent home during expensive hours (during night shifts), because they are not responsible for the supply activities.

City Distribution Center

The supply activities do not disappear but shifts to this echelon. The handling activities can now be calculated towards an integral cost price for delivery. The costs for handling and warehousing can be shared by cooperating shopkeepers. The supply function could be maintained by the city distribution center. If shortage of stock appears, the distribution center will be fully responsible for supply. The supply of goods can be arranged by calling on closed purchase contracts between shopkeepers and suppliers. In fact the distribution center takes over the complete management of supply and delivery. When a customer buys a specific product, a message for delivery is reported to the distribution center. Combined with other customer deliveries the distribution center is able to plan more efficient transport routes and has better opportunities to assign the demand to the transport capacity in order to achieve full truck loads.

Traditional Carriers

While one of the necessary specifications of a city distribution center is good accessibility, the traditional carriers can benefit from it. If some of shopkeepers are located in the congested inner city, the transports will waste a lot of time delivering this area. Sometimes the carriers charge different transport rates for these areas or different price rate structures because in these areas the number of transported miles is not the right cost-unit, but the number of time-units spent. If these transports are eliminated, the carriers can provide cheaper transport lines between suppliers and city distribution centers

In short, applying the shop-stop-stock-concept eliminates the "extra" link in the distribution chain not at the echelon of the city distribution center, but at the echelon of the shops. The orientation is primarily focused on the customer. The ideas for this concept are derived from the post order companies. A critical note should be placed here while not all products will be suitable for inclusion in this concept. Restaurants, cafes and hotels are the shops which can not be handled with this concept. The consumption of goods is direct. In spite of this fact the distribution of goods can be arranged by the city distribution center.

Physical organization - safety, environmental and spatial aspects

As mentioned earlier the concept of shop-stop-stock reduces one transportation movement visa versa for every delivery (from dc to shop and backwards). Besides this reduction the applied transport vehicles from city distribution center

to customer can be more suited for this kind of traffic. This means that these vehicles have shorter turning radius, accommodated for silent handling and equipped with environment-friendly motors, which means with less damaging exhausts.

Intermediate organization - informatics & telematics

Through the application of the techniques in the field of informatics and telematics the concept of shop-stop-stock actually can exist. By sending a specified delivery note from the shop to the distribution center the transport activities can be organized. The shop has instantaneous access for its stock positions and can inform the customer about the state of delivery at any time. In future every client has at home also the possibility to trace its delivery. In fact all actors involved are connected by an information network. Which part of the network should be facilitated by EDI-messagehandling, internet, procurements etc. is a technical question which will not be discussed here. One issue which should receive a lot of attention is datacontrolling and datamanagement of the network. Because of the confidentiality of data, shopkeepers and customers, the provisioning of data must be secured and arranged by a independent third-party company. In practice these kind of companies are not so difficult to find anymore.

Intermediate organization - economics

As we can learn from the pilot projects the break-even number of deliveries was relatively highly (2000 a day) estimated. The later determination of the break-even number of deliveries was about 200 deliveries a day. Despite the fact that a complete cost-analysis has not been worked out (because it is beyond the scope of this research), the costs will certainly be higher than the calculated costs of the pilot projects. The facilitation of the stockkeeping function is the main cost factor. In order to set a competitive price the total demand should be at a considerable size. Cost benefits cannot be exactly calculated, because the benifits vary for each stakeholder. The customer can go by public transport, bicycle or walk to the innercity. This can lead to a reduction of parking costs and transport costs. The public transport might reach a higher utilization. The transport costs to the individual shop will disappear. Instead the costs of delivery to the customer have to be paid. The total product handling time and operations costs will probably be reduced, because of the centralization of the logistic facilities. The receiving process, the stock management, and the delivery process can be organized more efficiently than the individual processes at the shop floor.

Managerial organization - public management

A wide participation of carriers is a necessary condition for the succes of the city distribution centre. In the pilot projects the role of the city distribution center was mainly provided by a one courier and parcel service organization which is serverely competed with other companies. The willingness to cooperate, making use of offered services of the city distribution center had failed from the

beginning. The project initiative should rather follow the policies of some German cities [8], because they were able to manage a collaboration between competitive cariers.

3.2 City distribution center and underground transportation

A technology which can play a big role in future logistics is underground transportation. Underground transportation is already common technology in passenger transportation systems such as the subway. In freight transportation systems the industrial application of this technology is mainly restricted to transport by pipelines for some chemical products, oils etc. Because the congestion of road traffic is still rising the last decade, searches for new transport modes come into fashion. Looking at the plans for underground transportation projects the circumstances under which this technology is considered as an opportunity for improvement are relatively similar to the problem environment of city distribution. Since the costs of building for underground tubes are very high, we can derive that some conditions in the problem environment must be met before an underground distribution system might be suited for environmental improvement:

1. big transport volumes must be accommodated for,
2. the traveling distance must be relatively short,
3. the surface area is very congested and the transportation causes a lot of environmental nuisances and
4. the products to be transported represent high-value.

As we saw earlier the conditions in the inner city certainly meet these conditions.

Physical organization - logistics

From the logistic viewpoint, the structure of the network has to be defined. The logistic calculation must specify how many locations in the inner city should be appointed as an underground DC. Should it provide facilitations for temporary storage keeping and how far should the distribution area reach. Should the underground DC receive new freight loads, and accomodate return flows, and depot empty containers and transportation vehicles? What should be done with maintenance activities? As we have seen from the other plans for underground transportation the diameter of the tunnel, the transportation vehicles, and the goods packaging have to be integrally determined in the logistic concept.

Considering the spatial structures of the Dutch cities, the area of the inner city is not exceeding a radius of 5 kilometers. At the edge of this circle the accessibility by road is still a problem. From this point of view the distribution center should be located at the edge of a city, where the accessibility is guaranteed by most transportation modes. Reaching these sites the distance should be enlarged between 5 and 10 kilometers. Meeting these conditions the most probable design of the underground network will be double circle, a large and short tube with a total average length of 50 kilometers. At the several points of this tube temporary storage facilities have to be provided. From these underground station the fine

distribution has to be continued to the shops and customers. For a first implementation this fine distribution can be done by electric vans. A refinement of the network can be considered only if high transportation volumes can be clustered for specific regions to a sufficient extent.

Physical organization- safety, environmental and spatial aspects

The environmental conditions will certainly benefit from underground transportation. The building process can imply some nuisance for local residents, but having completed the building process environmental conditions are improved. Special attention should be paid to the safety aspects. In case of accidents the tubes have to be accessible for rescue operators. So the early designs of the network should provide some bypass facilitation's in order to gain instantaneous access. Beside the safety aspects bypass facilitations must also be guaranteed from a logistic viewpoint, because the transportation of freight has to be maintained, especially for thick flows. The demands for safety and logistic continuation give rise to design a tube for two tracks. One track can be used for normal transportation and one track for emergency and logistic bypass facilitations. The safety track should cross the transportation tracks at several places in order to raise flexibility.

- **Intermediate organization - economics**

From the economic viewpoint, we can derive from the Japanese projects that the break-even number of deliveries is not the appropriate measure to evaluate the financial position. The costs-benefits analysis is calculated in terms of driving time costs. In fact this is a better performance measure because it can been seen as a derived measurement for congestion improvement. A warning for this kind of measurement should also be mentioned here, while the implicit assumption is made that delivery times reduction leads to costs reduction. The reliability of the delivery more often leads to higher costs reductions, because more reliable stock planning can be realized.

- **Intermediate organization - informatics & telematics**

Special attention should be paid to the coordination of transportation movements. The supply of freight loads in both directions have to be coordinated while the underground station will have limited handling space. Parallel handling activities might create more room requirements, which could lead to more expenses. As with other transports, full transport loads should be aimed for. In order to meet these requirements information exchanges between users and providers must be arranged. The capability of data interchange between these actors will have a great impact on its functioning. The compression of all the freight transportation movements through one tube asks for a tight coordination.

- **Managerial organization - public management**

At the managerial level the municipalities have to take measures forbidding the access of the inner city by traditional freight transport. Another aspect of

managerial organization is the utilization of the network. Is it public infrastructure? Should one company be responsible for the total freight transportation or are other transport agencies also allowed to use the network? Should the access to the network be regulated by the municipality? Should an access place to the network be accompanied by the facilitations of a city distribution center? If law regulations exits the law rules are mainly specified till 20 meters below the surface. So far, some of the mentioned issues are not brought up in the discussions about underground transportation. Of course the technical aspects of underground transportation systems must be specified before starting the implementation. Meanwhile the managerial organization should also be designed in order to create public support. The managerial organization even determines the benefit calculations, because the organizational structure determines which costs have to be paid by whom. Should the government provide subsidiaries for underground technology?
In case of city distribution we think that the first projects initiatives should be subsidized by the government, because the benefits of such plans will exceed the frontiers of a city. Because of the tremendous investments needed for these kind of projects, we think that the projects should be based on public private partnerships. The ownership of the network could be in hands of the government while the exploitation could be arranged by private companies. The social acceptance must be supported by the ministries of transport, environment and economic affairs.

4 Conclusions

Until now the concept of city distribution centers has not been analyzed thoroughly with respect to all relevant aspects. Future applications of city distribution centers should take into account the discussed missing links. The implementation of city distribution centers might undergo complete redesign of the early ideas about this concept. The "shop-stop-stock"-concept can improve the role of city distribution centers. The customer service focus is applied in order to fill in the needs of the customers. This idea starts with the perception that the customers like a 'carfree' shopping area without having to carry the shopping bags themselves. Each customer has the opportunity to define the time and place for delivery. The stock management shifts to a higher echelon in the supply chain, which is the city distribution center. Because of the centralization of facilitations, costs reductions can be achieved. Important key factor will be the fulfillment of the distribution center by an independent company which guarantees confidential treatment of goods and information.

Searching for integration of underground transportation in the concept of city distribution shows a wide range of possible technical implementations. In fact this can be viewed as a weakness as well as a strength. The wide range of possible implementations provides a great flexibility of application. On the other hand the technical aspects are not worked out by structured concepts. Discussions

about underground technology mainly focus on the design and costs of the tubes. As a consequence aspects of utilization and the managerial organization are not looked over. These are key factors with respect to public support for this kind of technology. Finally we may conclude that the suggested new applications in this paper take care of the physical disappearance of the city distribution concept. Meanwhile the integration of these new applications in the concept of city distribution gives the concept itself a real logistical appearance.

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