ZONAL TRANSPORT COLLABORATION IN GOODS TOWARD BETTER URBAN ENVIRONMENT -ITS POTENTIAL AND BARRIERS-

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abstract: Zonal transport collaboration of urban goods distribution is expected as a effective strategy for the better city environment. The paper deals with this topic from various point of view: theoretical analysis, descriptive case study, modeling analysis to estimate the effect and the discussion on the practical matters.

1. PREFACE

This paper deals with the zonal collaboration system of pick-up and delivery of urban goods by trucking firms for consolidation transport. Chapter 2 and 3 illustrate the urban freight-related problems and the policy options to tackle them. Then Chapter 4 theoretically discusses the basic nature and economic mechanism of collaboration transport as one of the policy options. After Chapter 5 shows the current situation of a case of the zonal collaboration in Fukuoka, Chapter 6 tries to estimate the effect of this system on traffic and environmental situation by the modeling analysis approach. Finally, Chapter 7 discuss the barriers before the zonal collaboration system and its future.

2. TRAFFIC AND ENVIRONMENTAL PROBLEMS IN URBAN GOODS DISTRIBUTION

The physical distribution has been developing together with the increase in the level of income, consumption and production. It is doubtlessly contributing to the economic growth and the national welfare. At the same time, the basic form of goods transport has been changing year by year, into "frequent and just-in-time" delivery of "small-lot and multifarious" goods, due to the diversification of consumers' preference and to the comparative increase in "stock-cost". As this brought the miniaturization of trucks, the drop in loading efficiency, more than 75% of retailers and 50% to 55% of other industries complain about the increase in urban goods transport cost [1]. As far as the economic market mechanism functions well, these cost increase can be automatically fed back to the final consumers and be adjusted efficiently. From this sense this itself does not matter anyhow.

However, in addition to these intra-market effect, it brings also the external diseconomies such as congestion-related traffic problems and environmental deterioration in cities, which can not easily nor automatically be reflected to the market (It is a well-known fact that congestion related-phenomenon fundamentally accompanies the "external effect"). "Air-pollution and noise by automobiles", and "inconvenience caused by vehicle's on-road parking" are taking the top (26%) and the second (19.6%) position in terms of the number

among the complaints of residents concerning their urban living condition [2]. As the matter of fact trucks are accounting for 70.1% of the whole NOx emission in Tokyo city in 1985 [3].

3. POLICY OPTIONS AGAINST THE PROBLEMS

It is doubtless that the upper mentioned problems cannot be mitigated merely through the improvement of private sector's service-production because of (1) the fundamental nature of the externalities. But there will be additional grounds of the intervention of the public sector:

(2) To shoulder the higher risk of investment for small individual industries so as to enjoy the scale of economies

(3) To protect the distribution industries from the viewpoint of social policy, which are consisted of comparatively small companies, keep the employment in the industries of goods transport

Being based on these grounds, several types of policy options as followings can be the potential countermeasures to tackle the upper mentioned problems:

a) Technical regulation, subsidy or incentive policy to promote the environment-friendly technologies

b) Infrastructure-oriented physical distribution policy such as the construction of public truck terminals or public truck-bay for loading/unloading of trucks

c) Regulation, control and incentive policy in land-use or city planning

d) Traffic management policy concerning goods transport such as time regulation in the road use of truck-traffic

e) Information sharing on transport among private transport industries

f) Internalization of the external diseconomies through taxation or other financial devices

g) Collaboration in goods transport

Although there are considerable examples of the policy options when we look around the cases in Anglo-Europe countries 4), the consensus that the public sector should contribute for the goods distribution so as to achieve the social optimum, is still not yet sufficiently accepted in Japan. However, the concept of goods-transport collaboration is the most expected measure in a few traffic demand oriented policies.

4. BASIC CONCEPT AND TYPOLOGY OF GOODS-TRANSPORT COLLABORATION

There are several different types of collaboration cases in goods transport. They can be classified in several ways. The first and easy grouping is appearance based way as followings:

<A> Bilateral collaboration of goods transport to utilize the non-used capacity of return trip of trucks mostly by manufacturers: Types of goods for this exchanging transport have usually little similarity. For example, processed foods and textiles....

<B> Multilateral collaboration in pick-up or delivery transport either in wholesalers or

in retailers, specially in similar kind of goods: Such as merchandise delivery to consumers from multiple department stores, collaborating delivery of milk or fresh foods for franchising chain of retailers, wears or textile goods by wholesalers.

<C> Multilateral collaborating transport of cargo delivery by trucking companies in a large tenant building to save the delivery cost for in-building movement. There are several cases in Tokyo and Osaka.

<D> Multilateral collaboration by trucking companies in a specific urban region for zonal pick-up and delivery transport of consolidated general cargo. The case that the author deals with in this paper is the only one example which has been continually and fully implemented, although several local governments or other semi-public sectors are now trying to introduce here and there. There's similar outlooking type of collaboration to the case: Collaborating transport of trucking companies in rural areas. But this should be classified in B because of the reason shown in the following chapter.

Another classification way is "effect and motivation" oriented way; Is it effective? and Can private firms obtain economic motivation for collaboration? To prepare for this classification, we should firstly list up the possible effects of collaboration in both supply and demand sides.

Supply side effect:

SE1: Reduction of cost of private firms by the collaboration, fruit of which will be finally transferred to consumers

SE2: Reduction of whole cost for the society including the external diseconomies

Generally the first effect accompanies the second one simultaneously to some extent. It means that if the collaboration would be introduced being based on the cost-reduction motivation of private firms, we can expect the positive effect on the environment or traffic congestion. If so, would private firms begin the collaboration in any case when it could bring them the private cost reduction? The answer is negative. We must also consider an effect on the demand side:

Demand side effect:

DE1: Improvement in the level of service for the customers by the collaboration and then the expansion of demand function.

DE2: Collaboration will hardly affect the level of service nor the demand function

DE3: Demand function for individual participant-firms to the collaboration might be reduced by the controlled individual accessibility to the customers.

The combination of these supply and demand sides consists of six types, but it will be sufficient to show a few typical types as follows:

Type 1: High SE1 + DE1

When the region has too low geographic density of demand so that individual firms could provide or maintain the reasonable level of transport service, collaboration system will be able to bring both the better efficiency of supply and better level of

service, such as the frequency of transport or the geographical coverage of service. In other expression, the collaboration will produce the economy of scale or the economy of scope in this case. Figure-1 illustrates the effect of the collaboration of this type on the orthodox quantity-price plane. Both producer's and consumer's surplus are expanded.

Therefore, the collaboration will automatically introduced by private firms activity, as far as their basis of behavior is on the economic rationality. However, the accompanied social effect on environment or traffic flow, as a whole, cannot be expected as much as the following Type 3, as the "density" of demand, transport or traffic is comparatively lower in this case. In this sense, there will be no much ground for the public sector to promote this type of collaboration actively at least from the viewpoint of (1) in Chapter 1.

Type 2: High SE1 + DE2

Different between Type 1 and 2 is just on the difference in the demand side effect. The purpose of this collaboration for firms is simply "cost reduction", whereas type 1 focuses also on the service=revenue side. Most of the upper mentioned discussion can be adapted also here.

Many of the already existing examples except <D> of collaborating goods transport will be classified mostly into Type 2 and some into Type 1. According to 5) in the reference, most of the firms involved in the existing collaboration systems report that they could enjoyed some sort of the improvement in transport efficiency: 72% of the firms among them claimed the affirmative answer to "the cost reduction by the collaboration".

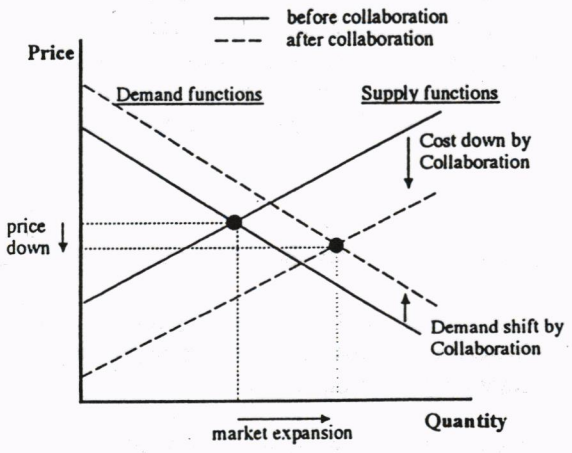

Figure-1 Type 1 Collaboration

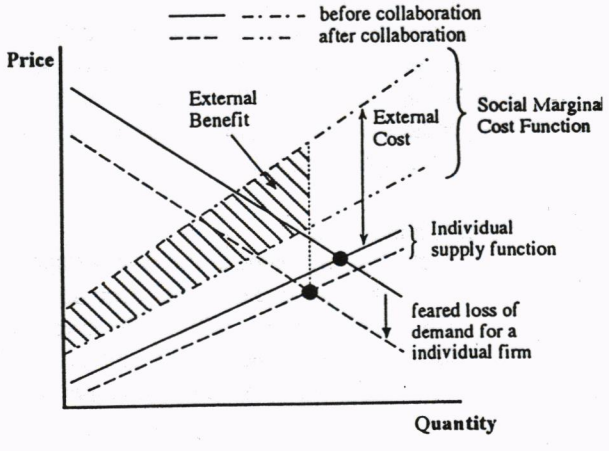

Figure-2 Type 3 Collaboration

However, 6) is reporting that currently starting collaboration systems often focuses not only on cost-side but more on the demand development side, that is, type 1. But more important and serious type in terms of the social effect type is the following Type 3:

Type 3: High SE2 + DE3

This type is almost the opposite case to Type 1. In urban region under much competitive market with enough demand density, the improvement of the service level cannot be expected because it is already fully attained by private firms. Moreover, for individual firms it is even possible that it would loose its demand in the worst case. Therefore, the expected gain by the collaboration for individual firms is sometimes non-positive even if that would provide the supply cost reduction. This fact means that it will not be introduced automatically only through private market mechanism. On the contrary, as the activity density of the goods transport is so high, that it is likely to obtain the much social and environmental effects by the collaboration. Figure-2 shows the situation of this type.

Case <D> which is the subject of the paper is basically classified into this type. It is clear that this is really the place for the public support.

5. A CASE STUDY ON GOODS TRANSPORT COLLABORATION IN FUKUOKA

5.1 Historical background

The urban collaboration system was firstly tried in Japan in 1978, so as to ease the traffic congestion of mid-city for the delivery of consolidated cargo transport in the city center of Fukuoka, which is the eighth largest city in Japan with 1.2 million population, by the promotion of the local office of Ministry of Transport. In this stage the collaboration system was just based on the cooperation of some trucking companies. However, the system could not survive for long due to several social, industrial and technical reasons.

In 1987 the collaboration system was resumed in a new style to save the traffic congestion and urban environment promoted by the Fukuoka Association of Trucking Firms and other governmental agencies. Important dimensions of this system were as followings:

1) The system based on an multilateral transport agreement by many trucking firms to resolve the possible troubles.
2) Two of the trucking firms were appointed as work-firms for zonal collaborating transport. Others were expected to consign their pick-up and delivery cargo to the work-firms.
3) The collaboration system covered the region of Tenjin 1st and 2nd districts.

Recently the system was positively revised to the new step. In 1993 a new private company, "Tenjin Collaborating Transport Co.Ltd." named after the geographical place of central Fukuoka city, was established to deal with the zonal collaboration transport, whose capital was collected from 36 trucking firms and four local banks. A new truck terminal was constructed for the zonal collaborating transport by the firm. All of the collaborating operation was turned over to the firm by the previous system in September, 1994. The region covered by the collaboration system was also extended almost twice into Tenjin 1st to 5th divisions.

5.2 Fundamental dimensions of the system

Region for the zonal collaboration system is currently covering approximately 0.7 square kms with 4 thousand enterprises and 1.6 thousand retailers, which is the most concentrated urban center of Fukuoka. The collaborating transport firm has a truck terminal of 9,000m^2 land space, having 33 berths for delivery trucks and 6 berths for stem trucks, and owns 28 trucks, most of trucks are 2 ton size in loading tonnage. Its capital is approximately 100 million yen. According to its financial plan, the annual revenue from commission income and the expenditure for transport service will be both 300 million yen and be equalized.

Figure-3 illustrates the development of the number of cargo carried by the collaboration system. The collaboration system has been managing fairly well in total number of cargo, if the long-continued Japanese recession is considered. However, it is clear that the system It does not mean the basic demand for pick-up cargo is not growing, but collaboration system has been capturing mainly just the delivery goods to the region. This will be discussed in chapter 6 again.

Table-1 shows the estimated annual demand for pick-up and delivery transport of Tenjin 1st and 2 nd region. The biased ratio of pick-up cargo in the collaborating transport is here also clear. Table-2 illustrates the transport share of the system. It contributes 1/3 of the transport of commercial trucks, and 16% of the whole transport. This share is not so sufficient in a sense. However, it should be reminded that the excess demand which brings the traffic jam in the city is in general no more than 10 to 15% 8).

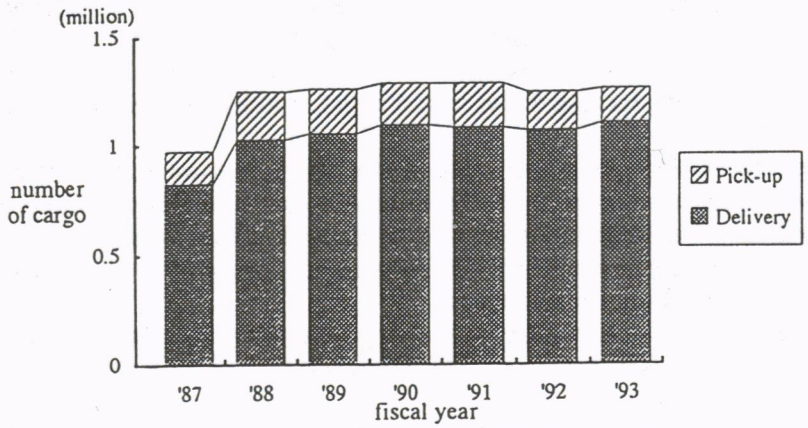

Figure-3 Development of Cargo carried by the Collaboration System

Table-1 Estimated Annual Demand for Goods Transport for Tenjin 1st and 2nd District, 1994

(thousand)

Categories	Wholesalers/ Retailers	Other Industries	Total
Pick-up	2,158 [40%]	634 [47%]	2,792 (41%)
Delivery	3,224 [60%]	730 [53%]	3,954 (59%)
Total	5,392 (80%)	1,354 (20%)	6,746 (100%)

[Source: Association of Japanese Trucking Companies 7)]

Table-2 Transport Share in Regional Cargo Transport for Tenjin 1st and 2nd District,1994 Annual number of cargo base

Commercial trucks:	50.8%
- Individual transport	(35.0%)
- Commissioned transport by the Collaboration System	(15.8%)
Private trucks:	49.2%
Total	100.0%

[Source: Association of Japanese Trucking Companies 7)]

6. MODELING OF PICKUP-DELIVERY TRANSPORT AND EVALUATION OF EFFECT OF THE COLLABORATION CASE 9)

6.1 Model building

Collaboration system is expected to improve the transport efficiency and then the traffic situation. The authors developed a macroscopic model which can simulate the management behavior of trucking companies to determine the size of zonal transport trucks which equals the load capacity, the number of delivery zone (equivalent to the size of the delivery zones) and the parking interval of zonal transport trucks along streets for pick-up and delivery, under a given demand density, and other given parameters such as driving speed of trucks, the occupancy of streets and so on.

The whole structure of the model is illustrated in Figure-4. Basic strategy of trucking companies is assumed to be "*cost and time minimization considering the demand elasticity to the level of service*". Once these fundamental variables are determined, all other traffic related values, such as number of trucks, running kms of trucks, whole parking time of trucks, parking time for one stop....., can be easily calculated.

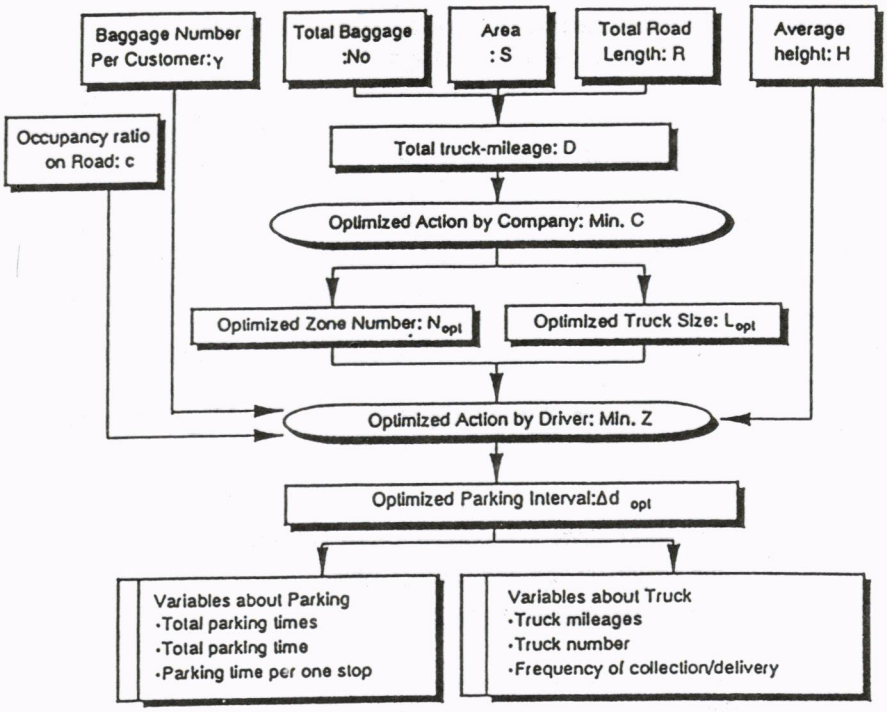

Figure-4 The Whole Structure of the Model

To simplify the situation practically, the following basic assumptions are introduced:

1) Distribution area is homogeneous from every point of view: demand density of cargo, architecture, street....etc.
2) Cargoes are homogeneous in size, weight....etc.
3) Trucks are utilized to maximum capacity.
4) All decisions are made under the rational behavior

Concerning three decision variables Δd, L_t and n whereas:

Δd: parking interval (decision variable)
L_t: load capacity of zonal trucks (decision variable)
n: number of zones in the region (decision variable),

following three equations are derived, based on the assumption.

$$\Delta d=[2 \cdot L_0 \cdot t_1 \cdot V_H \cdot D/(L_t \cdot n)]^{1/2} \quad (1)$$

$$L_t=K_1 \cdot (D \cdot N_0)^{1/3} \quad (2)$$

$$n=K_2 \cdot (D \cdot N_0)^{1/3} \quad (3)$$

where,

$$D=f(R,S,N_0) \quad (4)$$

$$t_1=g(c) \quad (5)$$

K_1: constant
K_2: constant

S: area of the region
R: street length in the region
c: average occupancy of street in the region
N_0: number of cargo demand
D: zonal drive distance
L_0: capacity of short-distance carriage cart
t_1: parking difficulty
V_H: speed of horizontal carriage

6.2 Model Estimation

The model was applied to the actual data of transport acquired through some original survey by the author and the existing statistics in Fukuoka district in 1991, and unknown constants K_1, K_2, and unknown functions $f(\cdot)$, $g(\cdot)$ were estimated. The results are:

$$K_1=0.0094\,[\text{ton}/(\text{m}\cdot\text{piece})^{1/3}] \quad (6)$$

$$K_2=0.0321\,[(\text{m}\cdot\text{piece})^{-1/3}] \quad (7)$$

$$D=f(R,S,N_0)=0.832\cdot R\cdot[1-\exp(-5000\cdot N_0/S)] \quad (8)$$

$$t_1=g(c)=0.214+0.0559\cdot c \quad (9)$$

whereas, the dimension of variables are S [m^2], R[m], c [%], N_0 [piece] and D [m].

Using several complimentary parameters together with the estimated model above, such as driving speed, average speed of vertical carriage in buildings, average height of buildings and so on, all important indices which can illustrate the traffic situation can be derived.

6.3 Evaluation of the Effect of Zonal Collaboration System

To evaluate the effect of the zonal collaboration in Fukuoka in 1991, the estimated model was applied for "with-without" test. The case of "with" is "with collaboration" case. For this case, several traffic related indices were calculated, applying the model into the actual situation with the cargo demand data carried by the collaboration system. For "without" collaboration case, the existing demand which is the same as the former case was assigned into 30 participant trucking firms due to the commission document, and then the model was applied again to each firm one by one. The results of "without" can be calculated by summation or the average of the results of each firms.

Table-3 shows the result of simulation acquired by the application of the model onto the case of Fukuoka. The fact that the whole number of trucks, the running kilometers of trucks are particularly reduced is suggesting that the collaboration system has the expectable potential to improve the environmental and traffic load of urban goods transport. If truck vehicle kms reduces by 70% after the collaboration system, and if the system shoulders 15% of whole demand (shown in the previous chapter), it is estimated that the collaboration in Fukuoka reduced the environmental and traffic load by 10.5%. This value remarkably rises to 35% if the share increases to 50% which is almost equivalent to the share of commercial trucks in the region.

The table also suggests that the size of trucks grows and that the parking time for one stop keenly increases after the collaboration. It implies that the quality and the quantity of road infrastructure or parking facilities will be more required for the collaborating transport.

Table-3 Effects of Zonal Collaboration in Fukuoka

Items	Dimension	Without	With	Effect
Load capacity of truck	[tons]	0.3-2.2	3.6	
Number of zones	[zones]	1-7	13	
Number of trucks	[vehicles]	75	26	Δ65%
Vehicle kms	[kms/day]	815.8	251.4	Δ69%
Vehicle kms in the region	[kms/day]	104.8	17.4	Δ87%
Number of parking	[times/day]	502	139	Δ72%
Total parking time	[hours/day]	100.4	82.9	Δ17%
Parking time for a stop	[minutes]	12.0	35.8	198%

1991 base, [source: 8)]

7. BARRIERS AND EXPECTED FUTURE OF THE ZONAL COLLABORATION SYSTEM

As discussed in chapter 3, the collaboration transport of this type will be the most effective in terms of environmental and traffic load, but the most difficult to be introduced from the viewpoint of market mechanism. Tenjin does not yet succeed to capture the enough amount of pick-up cargo from trucking firms, although it has been sticking to its ideal for more than eight years. Public sectors like Kawasaki city are studying the feasibility to develop a zonal collaboration system in other cities, but Fukuoka is still the only one example of zonal collaboration right now. The Tenjin collaboration company is really intending to move itself to the hybrid public-private company in the future. It means the zonal collaboration is still on the way to the success.

The serious reason why this type would not easily be introduced is firstly, laying on the nature of trucking industry. Transport is of course its only or major activity field, while the transport is just the supporting activity for other industry. In other industries the marketing activity has been considerably separated at present from the physical goods-transport activity. The collaborating transport is nothing but cost reduction for them. However, the collaborating commissioned system of goods transport means the isolation from the market=customers for trucking companies, as their "drivers" are not just drivers but "salesmen" at the same time.

On the other hand, the industry of consolidation truck transport has the nature of the scale economy, because they must equip large scale terminals and advanced sorting machines as well as integrated information systems, network effect is also significant. Consequently the market will become concentrated or oligopolistic as it is really is.

Therefore, if the demand is potentially higher, and the market will become something like a "*prisoner's dilemma*" situation among oligopolistic participants.

In this context, they have two options:

Choice of Collaboration:
- can enjoy the fruit of cost reduction, if his rival also choose this option.
- shall lose the customers, if his rival takes the *scoop* option.

Choice of *scoop* - to forestall the market:
- can enjoy the merit of market capture, if his rival takes the collaboration option.
- same as the present situation, if the rival choose the same option.

As far as they adopt the maxi-min strategy, that is, intending to maximize the minimum expected gain, they all will choose *scoop* option other than collaboration option unless there's any effective counter device against forestalling.

Therefore, to promote the separation of marketing activity and the transport activity, or to develop any other complimentary device for the compensation of this risk are keys for the future of the zonal collaboration. Public sector's initiative or commitment is doubtlessly so helpful for this problem. In Tenjin's case, most of the related public sectors are all involved in the organization to promote the new system. In addition to this, followings will be also the required or desirable backup measures:

1) public support for the construction or improvement of facilities for collaborating transport
2) public infrastructure improvement, especially on parking facilities for efficient goods transport: In Tenjin district, on-road payable parking slots exclusive for trucks are recently equipped as the first case in Japan.
3) effective traffic enforcement

8. Conclusions

The important conclusive points of this study are as followings:

1) Transport collaboration in urban-goods transport is one of the most expected measures against traffic and environmental current problems.

2) Many types of transport collaboration are already existing. They can be classified mainly into two types: private cost reduction + the improvement of the level of service, social cost reduction + the feared reduction of the level of service.

3) Zonal transport collaboration belongs to the latter, and needs the public support or intervention based on the ground of the externalities.

4) A remarkable example of the zonal collaboration in Fukuoka is a well-being managed case, which shoulders 15% share of the urban goods-transport. However, the least amount of pick-up cargo reveals the fundamental nature and the problem of the zonal collaboration system.

5) In the case of Fukuoka, the effect of the zonal transport collaboration was evaluated. For example, it may reduced the vehicle kms of the captured demand by 70%. It means that the existing system reduces the whole regional traffic and environmental load by 11%.

6) If the system carries the whole share of commercial truck transport, the traffic and environmental load will reduce by 35%.

7) At the same time, the size of trucks and the parking time of truck for one stop load/unload grows due to the increase of demand density for one truck. Therefore, the improvement of parking related infrastructure becomes more and more expected.

8) Non-separation of the marketing activity and the transport activity in trucking industry brings the serious effect on the transport collaboration scheme. Public sector's contribution to this point is particularly expected for the better future.

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