Savchenko, L., Polishchuk, V. and Grygorak, M. (2019). "Interaction of participants of urban freight consolidation of different levels", *Management and entrepreneurship: trends of development*, 3(09), pp. 89-106. doi: https://doi.org/10.26661/2522-1566/2019-3/09-07

LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Received:
1 July, 2019
1st Revision:
1 August, 2019
Accepted:
5 August, 2019

UDC: 656.029.4:656.135

DOI https://doi.org/10.26661/2522-1566/2019-3/09-07

INTERACTION OF PARTICIPANTS OF URBAN FREIGHT CONSOLIDATION OF DIFFERENT LEVELS

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Abstract

The **purpose** of this publication is generalization of research on the types of urban consolidation, classification of systems for urban freight consolidation by levels, consideration of participants at each level and schemes of their interaction, as well as analysis of direct and reverse flows that accompany this interaction. The works of domestic and foreign scientists on the problems of urban freight transportation and use of consolidation for their solving are the **theoretical and methodological basis** of the research. Data of official statistical and analytical materials of ministries and departments of Ukraine and world agencies made up the Information basis. When solving the tasks set, methods of economic analysis, systematization, generalization, comparison were applied. The **results** of the work are classifications of consolidation schemes for urban distribution, urban consolidation centers and their participants. Different levels of urban consolidation allow flexible application of the idea of consolidation to cities of various sizes and topologies, while reducing congestion and improving environmental situation in the city. The forward and reverse flows between various participants in the urban distribution system are evaluated. The prospect of the study is to consider the schemes of consolidation of different levels and an assessment of their economic and socio-ecological efficiency. The **limitations** of the results obtained are their applicability exclusively for urban areas and for consolidated transportation between cities. The presence of all levels of freight consolidation can be economically feasible only for cities with population of over 1 million inhabitants with corresponding long delivery distances. The **practical significance** of the study lies in the possibility of using the proposed classification and schemes of direct and reverse flows in the design of urban distribution schemes with the involvement of consolidation centers at various levels.

Keywords: urban distribution, freight consolidation, urban consolidation center, two-tiers consolidation, participants of urban freight distribution, direct and reverse flows.

JEL Classification: R40, R22, O18.

INTRODUCTION

Urban freight transport plays an important role in meeting the needs of citizens and urban businesses, but at the same time it damages the environment of the city, increases congestion, which causes discontent among residents (Nuzzolo et al, 2019).

According to a study of Traffic Index – 2018, in 2018 Kyiv is in the 13th place in the world in terms of traffic congestion. Kyiv's congestion bypassed Tokyo, Rome, London, New York, which are respectively at 25, 31, 40, 42 rating. Considering the lack of a municipality or government improvement program, the situation requires immediate and intent attention from researchers.

Among the alternatives aimed at mitigating the negative external effects of freight traffic related to the concept of urban logistics, an urban consolidation center or city distribution center (UCC and UDC) can be proposed, which is an important factor for increasing efficiency of the logistics process in the city (Correia et al, 2012).

With the increase in the size of the city, the duration of delivery also increases. The concept of consolidation in a large city with high traffic density plays a vital role (Browne et al, 2005).

According to case studies in sustainable urban transport #10, published by GIZ GmbH, the main purpose of urban consolidation centers is to reduce the need for freight vehicles to deliver goods to urban areas (city center, an entire city or a specific large object such as a shopping center).

For example, Browne et al (2011) describe an implementation of a micro-UDC in London where electric vans and tricycles arc used as delivery vehicles for the last mile delivery. With the new system in place, significant reductions on total distance (by 20%) and CO2 – equivalent emissions (by 54%) are reported although the distance per parcel rose by 349%.

LITERATURE REVIEW

The topic of consolidation of small shipments has long been studied by world and domestic scientists (R. Larina, 2005; A. Kotenko et al, 2014; L. Savchenko, M., Lysenko et al, 2018). However, unfortunately, the search for domestic materials on the topic of urban consolidation and its role in improving urban logistics has not been crowned with success. At the same time, global experience is quite broad. Urban distribution and consolidated deliveries were have been researched by J. Allen, N. Ananda, M. Browne, A. Campagna, K. Chwesiuk, V. Correiaa, T.G. Crainic, L. Dablanc, R. Duina, A. Galelo, P. Gianessi, S. Gragnani, A. Guerra, K. Hassall, J. Leonardi, R. Macário, C. Macharis, L. Oliveiraa, K. Ogden, H. Quaka, L. Persia, N. Ricciardi, P. Storchi, M. Sweet, E. Taniguchi, L. Tavasszya, RG Thompson, G. Valenti, M.P. Valentini, S. Verlinde, F. Witlox, A. Woodburn and others.

In Traffic Index – 2018. various levels of consolidation of freight road transport in cities and interactions of participants in urban delivery schemes with its goods flows and revenues are considered. Dablanc (2007) mentioned that many projects involving the installation of only one UCC were unsatisfactory in large cities with high population density and a high concentration of commercial, administrative and cultural activities. Thus, for large cities that require a long-distance transportation in the city, a network of CC, possibly of different levels of consolidation, should be used.

In the study on the classification of urban consolidation and UCC (Allen et al, 2015), classification was made into three groups, each of which has a different classification attribute (without general principle of classification). Browne et al (2005) classify UCC into two groups according to the number of clients that are served through consolidation — UCC for one company, UCC for several companies. Thus, consolidation for B2B format is assumed.

Also Browne et al. (2005) stated that consolidation schemes may vary depending on the size of the geographical area they serve (a small area, such as the narrow historical center of an urban area, a specific shopping area, or a larger, more diverse geographical area to the whole city/town). Verlinde et al (2012) are talking about classification by the number of "tiers" or "echelons". It can be named "levels" as well. Two types of configurations – single and multi-tier were mentioned there.

Hassall (2009) notes that most urban logistics projects involve so-called *single-level* systems based on UCC, that is, systems in which delivery schemes are performed from one UCC to city

consumers. Such systems are well suited for small cities. But for large cities, it can be considered as a poor decision. There is a possibility of reverse flow, when the UCC also receives the cargo collected in the city and prepares it for a long part of the journey to another city or region [13].

Optimization for location of facilities (Taniguchi, 1999) and real-time routing of vehicles (Taniguchi, 2001) methodologies have been proposed for single-tiered systems. Gianessi at al. (2015) consider location decisions on a single tier only.

For large cities, *three-level* systems were proposed, for example, for Amsterdam and a *two-level* system for Rome (Crainic et al, 2009; Gragnani et al, 2004).

With a *two-tier* scheme, the first level of the UCC is located on the outskirts of the urban zone, the second level of the system consists of so-called *satellites*, where cargo arriving from the first level UCC and other external points can be transferred and integrated into vehicles adapted for use in dense urban areas (Crainic et al, 2015). Existing objects such as parking lots, bus stations or railway stations / stops can be used as satellites (Crainic et al, 2009; Crainic et al, 2004). It is assumed that middle vehicles (urban-trucks) move between UCC of the 1st and 2nd levels, and cargo vehicles of light vehicles (city-freighters,up to 3.5 t) carry out deliveries from UCC of the 2nd level (Hassall, 2009; Baldi et al, 2019).

According to Chwesiuk (2008) UCC can be divided into three categories:

- local – performing services to specific trade areas (e.g. Broadmead-Bristol, England), city centres (e.g. La Petite Reine-Paris, France) or the whole city (e.g. Monaco);
- on the serviced area where there is only one owner it is usually built as a unit performing services on a specified location; the owner may influence other tenants to make use of the UCC; examples of such consolidation centres functioning at airports can be Heathrow Real Urban Consolidation Centre or Hadowhall Shopping Centre;
- special projects of a UCC for other purposes not connected with retail customer service (e.g. centres for building materials at Heathrow and in Stockholm); such centres attend to a single location or perform their services only at specified time.

As we can see from a review of literary sources, the topic of classification of urban consolidation of freight traffic has been raised repeatedly, however, at the moment, there is no unity in this regard.

The issue of participants in the urban distribution process is also interesting for many scientists. So, for example, Ananda et al (2012) divide stakeholders in the urban freight domain in two categories:

1. Public sector stakeholders that include traffic authorities, infrastructure authorities, municipalities, railway terminal/port authorities etc. These all stakeholders can be termed as "administrator".

2. Private sector stakeholders that include producers, suppliers, shippers, freight forwarders, trucking firms, truck drivers, shopkeeper, receivers etc. This long list of private stakeholders can be stratified to shipper, carrier and receiver according to leg of transportation activities.

In contrast to private stakeholders, administrator is interested in achieving the overall objective, i.e. reducing the total social cost (Ogden, 1992; Taniguchi and Tamagawa, 2005; Macário et al, 2008).

We believe that such an enlarged view of the stakeholders of urban distribution is insufficient and requires clarification.

PAPER OBJECTIVE

The purpose of the article are analyses and summarizing of interaction of participants of urban freight consolidation of different levels.

Research tasks:

- to summarize research on the types of urban consolidation;
- to classify urban cargo consolidation systems by levels;

- to considerate participants at each level and the patterns of their interaction;
- to analyze direct and reverse flows that accompany this interaction.

The subject of the study is distribution of small shipments in a dense urban traffic.

METHODOLOGY

The works of domestic and foreign scientists on the problems of urban freight transportation and use of consolidation for their solving are the theoretical and methodological basis of the research.

Information basis is made up of data of official statistical and analytical materials of ministries and departments of Ukraine and world agencies.

When solving the tasks set, methods of economic analysis, systematization, generalization, comparison were applied.

RESULT AND DISCUSSION

We propose to consider the authors' approach to classification of consolidation in the urban distribution (UD), based on the number of consolidation points (levels) in the supply chain:

0-level: no consolidation, goods are delivered from a supplier to a receiver directly.

1-level: goods arrive from a supplier to a macro UCC (or mini-UCC, or micro-UCC), thereafter deliver to a receiver.

2-level: goods arrive from a supplier to a macro UCC, then to a mini UCC, thereafter deliver to a receiver. There may be other interaction schemes, for example, mini-UCC and micro-UCC, or macro-UCC and micro-UCC (sequential connection of two different levels of UCC in a chain).

3-level: goods arrive from a supplier to a macro-UCC, then to a mini-UCC, then a micro-UCC, thereafter deliver to a receiver (consecutive inclusion in the chain of three UCC of different levels - macro, mini and micro).

Based on the proposed aforementioned tiered (level) consolidation model for UD, we propose tier (level) classification of UCC:

- macro-UCC, which consolidates goods for the whole city or its significant part. The macro-UCC allows to exclude transportation of non-consolidated goods on intercity routes;
- mini-UCC consolidates goods to service a district of a city or several districts, is located within the city (location based on the principle of minimizing the distance to customers of the service region);
- micro-UCC consolidates cargo for delivery to the area of the city district with pedestrian delivery by couriers.

Let's consider the main possible participants in the process of UD. Based on the research studied, it is proposed to classify all possible direct participants (stakeholders) in urban delivery to:

1) senders (suppliers);
2) recipients (customers, clients);
3) micro-UCC;
4) mini-UCC;
5) macro-UCC;
6) other participants (3PL logistics operators, carriers, freight forwarders, the municipality and government, other road users, residents of the city).

Further in this article the last group of participants of the UD is considered indirectly.

At any level of consolidation, it is convenient to divide urban traffic by zones with size and territorial boundaries those may differ for different cities depending on their conditions, restrictions and characteristics. Thus, micro-consolidation can be considered to serve the pedestrian goods delivery zone, mini-consolidation - to serve the city district, macro-consolidation - to serve the

whole city or a large part of it (for example, in the case of Kyiv, it would be expedient to use the macro-center for servicing the left and right banks of the Dnipro river to avoid congestion on bridges and large distances between points of the route of delivery).

Further, for the convenience of understanding the relationships between all participants in the urban delivery process, it is proposed to divide those into 2 groups:

- internal (located within the zone);
- external (located outside the zone).

Since it is the first fivestakeholders that are directly involved in the city delivery process, we will consider possible options for urban distribution at different levels. At the same time, for each level, interactions are considered either within the zone, or between the zone and the external environment, or in the external environment.

For further analysis, each major participant in the urban transportation process is assigned a two-digit number, where the first number is the number of the participant according to the classification, the second number is a sign of being inside or outside the viewing zone (1 - in the zone, 2 – out of the zone) (Fig. 1).

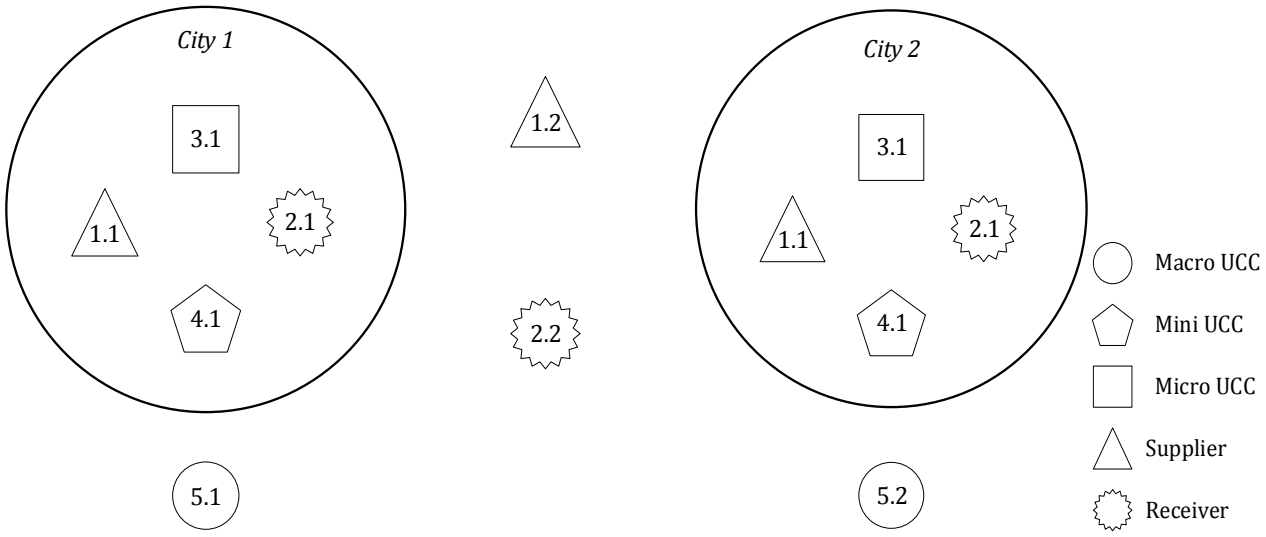
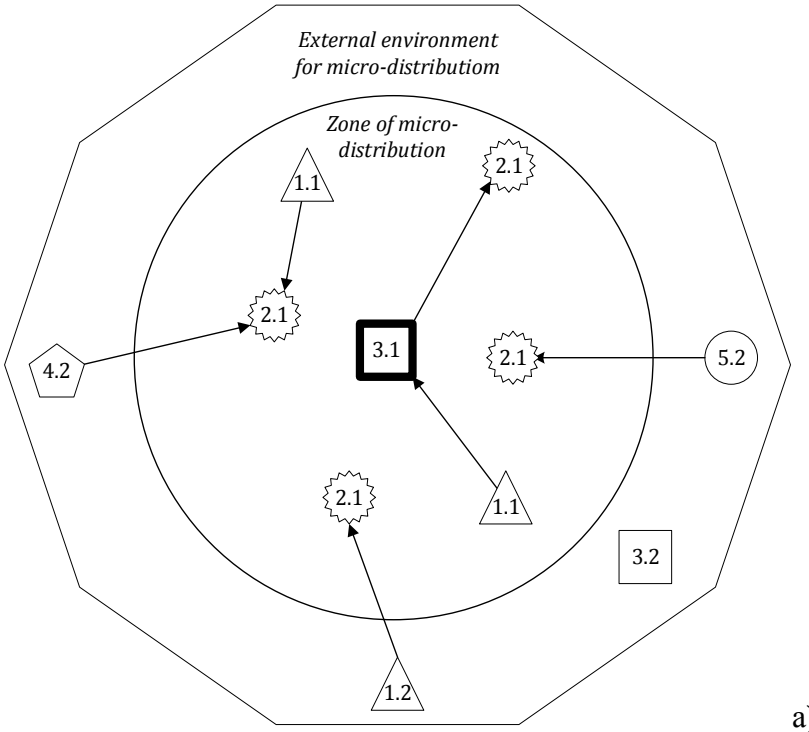


Figure 1. Possible participants in the urban distribution process

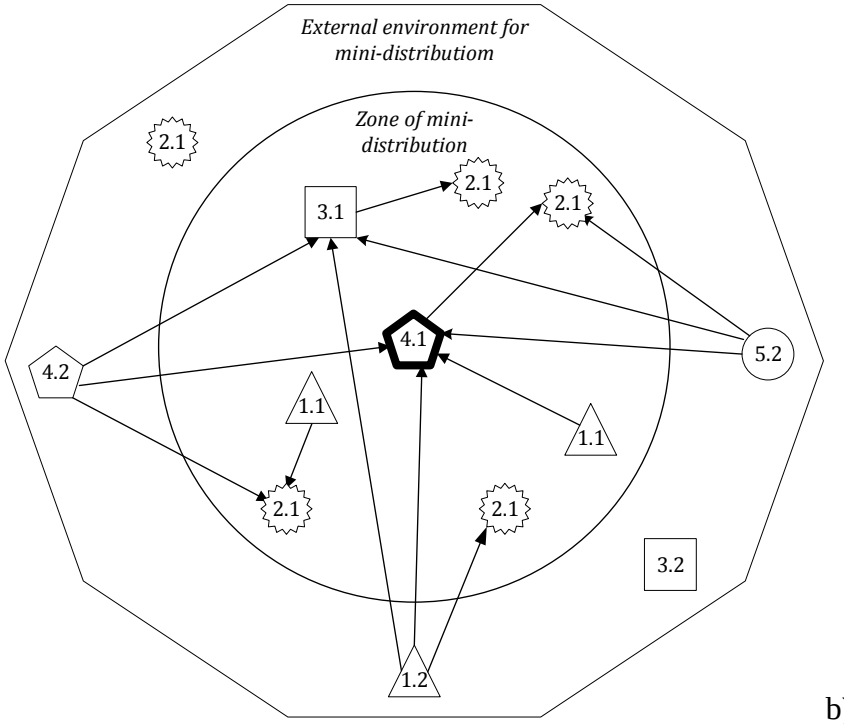
Source: own study

Fig. 1 shows a diagram of possible participants in the distribution process of the two cities. As can be seen, it takes into account both intercity participants and non-urban, however, having outgoing or incoming flows associated with cities.

Consider the interaction of stakeholders in the process of UD at different levels of consolidation (Fig. 2).


External environment
for micro-distributiom
Zone of micro-
distribution
1.1
2.1
2.1
4.2
3.1
2.1
5.2
2.1
1.1
3.2
1.2

a)


External environment for
mini-distributiom
Zone of mini-
distribution
2.1
2.1
3.1
2.1
4.1
5.2
4.2
1.1
1.1
2.1
2.1
3.2
1.2

b)

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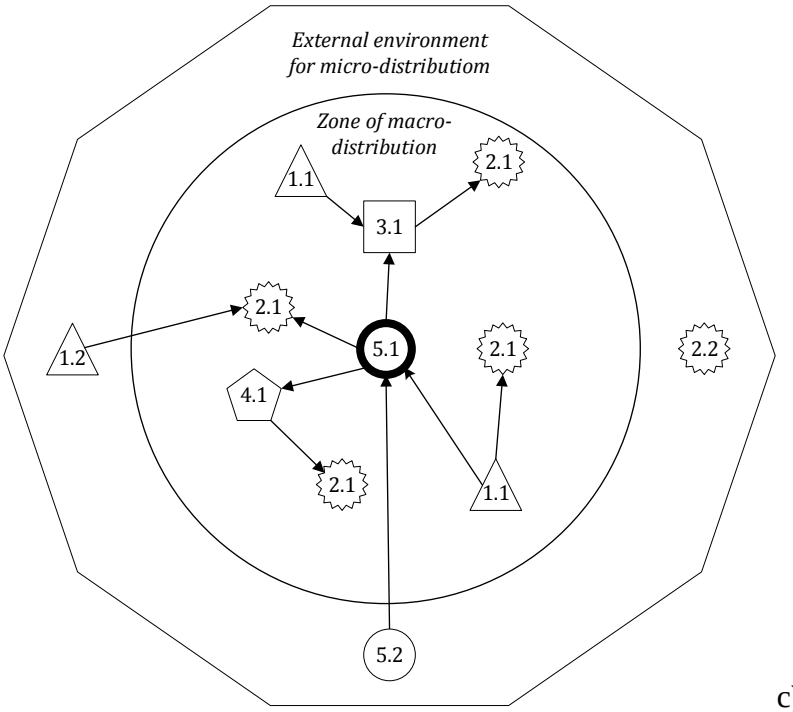

c)

Fig. 2. The interaction of stakeholders of the UD at different levels of consolidation:

a) micro-consolidation; b) mini-consolidation; c) macro-consolidation

Source: own study

The choice of delivery scheme and rational level of consolidation depends on:

- volume-dimensional characteristics of the cargo, the possibility of its transportation in the consolidated batch;
- distance from the sender to all levels of consolidation centers;
- distances from all levels of consolidation centers to the recipient;
- the distance between the sender and the recipient;
- existing restrictions on intercity transportation;
- the cost of cargo handling at all levels of consolidation centers.

Let’s consider the example of a sender-receiver supply chain with micro-UCC. Such options are possible:

- the sender is in the zone of micro-consolidation (1.1);
- the sender is outside the zone (1.2).

The external participants for the micro level are:

- external senders (1.2);
- external macro-UCC (5.2);
- external mini-UCC (4.2).

All recipients of the micro level are in the zone of micro-consolidation, i.e. theyare in category 2.1.

Since a micro-UCC participates in delivery to end customers only who are in a radius limited around it, the external micro-UCC does not participate in the interaction.

Let’s consider the flow of goods between all the above participants in the UD process. To do this, we will compose a square matrix and evaluate each cell in the context of the existence of flows, the direction of these flows and their possible features.

For convenience, define the different types of flows:

- direct (or forward), the direction of which corresponds to the direction of movement of the material flow from the sender to the recipient;

- reverse, showing return flows, the direction of which is opposite to the direction of direct flows.

We will also analyze the absent flows, in the absence of interaction between the participants of the urban distribution system. Each corresponding table contains comments in those compounds that are not typical.

During the flow analysis process, it was revealed that the matrix of possible connections is not symmetrical, since interactions between participants in the supply chain of urban freight almost always go in one direction (according to the direction of the cargo movement from the sender to the recipient).

It is necessary to give the features of the classification. An internal UCC serves recipients or a lower-level UCC in a certain territory (within a certain zone). An external UCC is one that is outside the range of a certain level of consolidation system.

Direct and reverse flows, as well as their features are given in Table 1.

Table 1 shows two interaction options:

- “yes” if interaction is possible;
- “no” if interaction is not possible (not exists).

Also listed comments to non-standard cases of interaction.

According to the base table 1, a sample of direct (Table 2), reverse flows (returns) (Table 3), bidirectional direct flows (Table 4) and absent flows (Table 5) was carried out.

As you can see from the Table. 2-5, among the flows there are two symmetric matrices - for couples with no interaction and for couples with bidirectional flows of goods (not returns). While the direct and reverse flow matrices are asymmetric.

Depending on the boundaries of the zone being analyzed, it is necessary to consider those pairs of interactions stakeholders that correspond to tabular ones.

CONCLUSIONS

Summarizing the above material, it can be noted that the topic of urban distribution is increasingly relevant due to the increasing urbanization of the population and the development of electronic commerce. Difficulties associated with the movement of vehicles in the conditions of dense urban traffic, are a problem both for the participants of urban distribution, and for residents of the city. A way out of the current situation may be the consolidation of urban cargo flows. Different levels of urban consolidation allow to apply flexible the idea of consolidation to cities of various sizes and topologies, while reducing congestion and improving the environmental situation in the city. The prospect of the study is to consider the schemes of consolidation of different levels and an assessment of their economic and socio-ecological efficiency.

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Table 1

The existence of direct and reverse flows between possible participants in the process of urban cargo delivery

O \ D	Participant marking	Internal sender	External sender	Internal recipient	External recipient	Internal micro-UCC	External micro-UCC	Internal mini-UCC	External mini-UCC	Internal macro-UCC	External macro-UCC
		1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2
Internal sender	1.1		**no**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
External sender	1.2	**not**		**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
Internal recipient	2.1	**no (or just returns)**	**no (or just returns)**		**not**	**no (or just returns)**	**not**	**no (or just returns)**	**no (or just returns)**	**no (or just returns)**	**no (or just returns)**
External recipient	2.2	**no (or just returns)**	**no (or just returns)**	**not**		**no**	**no (or just returns)**	**no (or just returns)**	**no (or just returns)**	**no (or just returns)**	**no (or just returns)**
Internal micro-UCC	3.1	**no (or just returns)**	**no (or just returns)**	**yes**	**no (too small coverage radius)**		**no**	**no (or just returns)**	**no (or just returns)**	**no (or just returns)**	**no (or just returns)**
External micro-UCC	3.2	**no (or just returns)**	**no (or just returns)**	**no (too small coverage radius)**	**yes**	**not**		**no (or just returns)**	**no (or just returns)**	**no (only return flow is possible if there is no external macro and mini UCC)**	**no (or just returns)**
Internal mini-UCC	4.1	**no (or just returns)**	**no (or just returns)**	**yes**	**yes**	**yes**	**yes**		**yes**	**yes (returns, flow to other city)**	**yes (returns, flow to other city)**
External mini-UCC	4.2	**no (or just returns)**	**no (or just returns)**	**yes**	**yes**	**yes**	**yes**	**yes**		**yes (returns, flow to other city)**	**yes (returns, flow to other city)**
Internal macro-UCC	5.1	**no (or just returns)**	**no (or just returns)**	**yes**	**yes**	**yes**	**yes (if there is no external macro- and mini-UCC)**	**yes**	**yes (if there is no external macro-UCC)**		**yes**
External macro-UCC	5.2	**no (or just returns)**	**no (or just returns)**	**yes (possible, if there is no internal UCC, large consolidated cargoes)**	**yes**	**yes (possible, if there is no internal UCC, large consolidated cargoes)**	**yes**	**yes (perhaps, if there is no internal macro-UCC, large consolidated cargoes)**	**yes**	**yes**	**yes**

Source: own study

Table2

The existence of direct flows between possible participants in the process of urban cargo delivery

O \ D	Participant marking	Internal sender	External sender	Internal recipient	External recipient	Internal micro-UCC	External micro-UCC	Internal mini-UCC	External mini-UCC	Internal macro-UCC	External macro-UCC
		1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2
Internal sender	1.1										
External sender	1.2										
Internal recipient	2.1										
External recipient	2.2										
Internal micro-UCC	3.1										
External micro-UCC	3.2										
Internal mini-UCC	4.1									**flow to other city**	**flow to other city**
External mini-UCC	4.2									**flow to other city**	**flow to other city**
Internal macro-UCC	5.1						**if there is no external macro- and mini-UCC**		**if there is no external macro flow to other city UCC**		
External macro-UCC	5.2	**if there is no external macro- and mini-UCC**		**if there is no internal UCC, large consolidated cargoes**		**if there is no internal UCC, large consolidated cargoes**		**if there is no internal macro-UCC, large consolidated cargoes**			

Source: own study

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Table3

The existence of reverse flows between possible participants in the process of urban cargo delivery

O \ D	Participant marking	Internal sender	External sender	Internal recipient	External recipient	Internal micro-UCC	External micro-UCC	Internal mini-UCC	External mini-UCC	Internal macro-UCC	External macro-UCC
		1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2
Internal sender	1.1										
External sender	1.2										
Internal recipient	2.1										
External recipient	2.2										
Internal micro-UCC	3.1										
External micro-UCC	3.2									**if there is no external macro and mini UCC**	
Internal mini-UCC	4.1										
External mini-UCC	4.2										
Internal macro-UCC	5.1										
External macro-UCC	5.2										

Source: own study

Table4

The existence of bidirectional direct flows between possible participants in the process of urban cargo delivery

O \ D	Participant marking	Internal sender	External sender	Internal recipient	External recipient	Internal micro-UCC	External micro-UCC	Internal mini-UCC	External mini-UCC	Internal macro-UCC	External macro-UCC
		1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2
Internal sender	1.1										
External sender	1.2										
Internal recipient	2.1										
External recipient	2.2										
Internal micro-UCC	3.1										
External micro-UCC	3.2										
Internal mini-UCC	4.1										
External mini-UCC	4.2										
Internal macro-UCC	5.1										
External macro-UCC	5.2										

Source: own study

Savchenko, L., Polishchuk, V. and Grygorak, M. (2019). "Interaction of participants of urban freight consolidation of different levels", *Management and entrepreneurship: trends of development*, 3(09), pp. 89-106. doi: https://doi.org/10.26661/2522-1566/2019-3/09-07

Table 5

The absent flows between possible participants in the process of urban cargo delivery

O \ D	Participant marking	Internal sender	External sender	Internal recipient	External recipient	Internal micro-UCC	External micro-UCC	Internal mini-UCC	External mini-UCC	Internal macro-UCC	External macro-UCC
		1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2
Internal sender	1.1										
External sender	1.2										
Internal recipient	2.1										
External recipient	2.2										
Internal micro-UCC	3.1				**coverage radius is too small**						
External micro-UCC	3.2			**coverage radius is too small**							
Internal mini-UCC	4.1										
External mini-UCC	4.2										
Internal macro-UCC	5.1										
External macro-UCC	5.2										

Source: own study

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ВЗАЄМОДІЯ УЧАСНИКІВ МІСЬКОЇ КОНСОЛІДАЦІЇ ВАНТАЖІВ РІЗНИХ РІВНІВ

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Міський вантажний транспорт відіграє важливу роль у задоволенні потреб городян і міського бізнесу, але в той же час він завдає шкоди навколишньому природному середовищу міста, збільшує затори, обумовлює невдоволення мешканців. Метою статті є узагальнення досліджень про види міської консолідації, класифікація систем міської консолідації вантажів по рівнях, розгляд учасників кожного рівня і схем їх взаємодії, а також аналіз прямих і зворотних потоків, які супроводжують цю взаємодію. Теоретичною і методологічною основою дослідження є роботи вітчизняних і зарубіжних вчених з проблем міських вантажоперевезень і застосування консолідації для їх вирішення. Інформаційну базу становлять дані офіційних статистичних та аналітичних матеріалів міністерств і відомств України та світових агентств. При вирішенні поставлених завдань застосовувалися методи економічного аналізу, систематизації, узагальнення, порівняння. Результатами роботи є класифікація схем консолідації міської дистрибуції, міських консолідаційних центрів і їх учасників. Різні рівні міської консолідації дозволяють гнучко застосовувати ідею

консолідації до різних за розміром і топологією міст, знижуючи при цьому рівень заторів і покращуючи екологічну ситуацію в місті. Перспективою дослідження є розгляд схем консолідації різних рівнів і оцінка їх економічної і соціально-екологічної ефективності.

Наукової значимістю роботи є отримання нових теоретичних положень щодо класифікації схем міської консолідації вантажів, а також їх учасників. Узагальнено та проаналізовано можливі схеми взаємодії між учасниками процесу міської дистрибуції. Практичне значимість дослідження полягає у можливості використання запропонованої класифікації та схем прямих та зворотних потоків при проектуванні схем міської дистрибуції з залученням консолідаційних центрів різних рівнів.

Ключові слова: міська дистрибуція, консолідація вантажів, міський центр консолідації, дворівнева консолідація, учасники міської дистрибуції, прямі і зворотні потоки.

ВЗАИМОДЕЙСТВИЕ УЧАСТНИКОВ ГОРОДСКОЙ КОНСОЛИДАЦИИ ГРУЗОВ РАЗНЫХ УРОВНЕЙ

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Городской грузовой транспорт играет важную роль в удовлетворении потребностей горожан и городского бизнеса, но в то же время он наносит ущерб окружающей природной среде города, увеличивает заторы, чем обусловливает недовольство жителей. Целью статьи является обобщение исследований о видах городской консолидации, классификация систем городской консолидации грузов по уровням, рассмотрение участников каждого уровня и схемы их взаимодействия, а также анализ прямых и обратных потоков, сопровождающих это взаимодействие. Теоретической и методологической основой исследования являются работы отечественных и зарубежных ученых по проблемам городских грузоперевозок и решениям с их консолидацией. Информационную базу составляют данные официальных статистических и аналитических материалов министерств и ведомств Украины и мировых агентств. При решении поставленных задач применялись методы экономического анализа, систематизации, обобщения, сравнения. Результатами работы является классификация схем консолидации городской дистрибуции, городских консолидационных центров и их участников. Разные уровни городской консолидации позволяют гибко применять идею консолидации к различным по размеру и топологии городам, снижая при этом уровень заторов и экологическую ситуацию в городе. Оценены прямые и обратные потоки, протекающие между различными участниками системы городской дистрибуции. Перспективой исследования является рассмотрение схем консолидации разных уровней и оценка их экономической и социально-экологической эффективности.

Научная значимость работы состоит в получении новых теоретических положений по классификации схем городской консолидации грузов, а также их участников. Обобщены и проанализированы возможные схемы взаимодействия между участниками процесса городской дистрибуции. Практическая значимость исследования заключается в возможности использования предложенной классификации и схем прямых и обратных потоков при проектировании схем городской дистрибуции с привлечением консолидационных центров различных уровней.

Ключевые слова: городская дистрибуция, консолидация грузов, городской центр консолидации, двухуровневая консолидация, участники городской дистрибуции, прямые и обратные потоки.