Logistics Flows of Household

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A household, as a significant generator of logistics flows, can be viewed as an entity with input, output and internal flows and mutually dependent attributes describing it (function/activity, location, ordering and supply systems, size and frequency of delivery, etc.). Affiliation with an urban, suburban or rural area has a particularly significant impact on the characteristics of the logistics flows of the household. In addition, the structure of logistics flows depends on the functions of the household, changes in the environment, interactions of the household with other generators of logistics flows, as well as the role of the household and its resources in the supply chains. Effective management of household logistics requires serious research into the complex flows structure and their interaction with household attributes and changing environmental conditions. This paper presents the basic attributes of the household as a generator of logistics demands, describes various interactions with the environment, and structures household logistics flows. In addition, the basic characteristics of each category of logistics flows are presented.

Key words: *household, logistics flows, structuring, management*

1. INTRODUCTION

Logistics encompasses all systems and processes that enable the movement of material and non-material flows [1]. Logistics flows generators are all legal or natural persons who send or receive goods and belong to different functions (housing, industry, commerce, construction, catering, health, culture and art, sports and recreation, finance, etc.) [2]. Generators, objects that require the delivery and/or collection of goods, can be viewed as entities with attributes (parameters) that describe them [2], [3]. Trading, manufacturing, service and catering companies are the most often analyzed as generators of logistics flows. Optimizing of logistics flows is important for their organizers in the context of overall business success and profitability. However, given the large concentration of generators in urban areas and the mass logistical demands, coordination of flows is inevitable for the functionality of the area and is a goal of all interest groups [2], [4].

One of the key generators of logistics flows is households as private property of citizens, in which the function of housing is realized. Households usually do not generate large-scale flows at a time, but given their number and territorial dispersion, household logistics flows have a significant share in total flows. However, researches on goods and freight flows do not cover shopping tours, which account for between 45 and 55% of urban goods movement in major European cities [5] and may account for 15-20% of total vehicle kilometres [6]. Shopping tours depend on the commercial offer in the residential area, but also on consumer behavior. Consumer behavior depends on the characteristics of the urban area, such as the age structure of the population, the standard, that is, the amount of earnings, family size and lifestyle [3], [7].

A household is a physical space, managed by the consumer, where he resides alone or with other persons and performs life activities, which are enabled by acquiring, using, storing, transporting, and disposing of goods [8]. The household consists of its members and material elements: land, facilities, furniture, machinery, means of transport, appliances, other goods and materials in the possession and boundaries of the household.

The household generates certain logistical demands, input and output logistics flows, as well as internal

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logistics flows, processes and activities. From the previous statements, two interrelated aspects of household logistics can be observed. The first aspect involves household interactions with the environment, that is, the household as a generator of external logistics flows. The second aspect concerns logistics within the household itself, primarily inventory management and storage. This paper will primarily address the first aspect of household logistics.

Households can be divided into urban, suburban and rural by territorial affiliation. These types of households are characterized by certain similarities and differences in terms of: internal activities and functions, degree of independence from the environment, modes of physical access, available space, supply systems, lifestyles and logistics. The function, that is, the purpose of urban and suburban household space may be residential or residential-business, while rural households may in addition have the function of agricultural production [9]. The typical household in the inner city area is usually part of a multi-storey collective housing facility. The flows of such households are partly carried out by common infrastructure (entrance, corridor, elevator), which may condition the manner and time of realization of the flows. On the other hand, suburban and rural households are usually self-contained objects with a yard and have direct access to public roads. Agricultural production in rural households requires the existence of extra facilities in addition to the housing facility. The storage area of a rural household is usually larger than in the case of urban and suburban households, as there is a requirement for the storage of agricultural products and products that make possible agricultural production. Also, agricultural production to rural households can provide part of the goods for daily consumption, while urban and suburban households have to buy all goods for consumption. Rural households with commercial agricultural production realize logistics flows with trading, manufacturing and catering companies, selling their products to them.

Research into the area of household logistics has identified a serious lack of relevant literature. One of the causes of the lack of literature in the field of household logistics is the lack of awareness of the collective and individual interest of its study. There are papers in the literature dealing with some categories of household flows, primarily home delivery flows [10], [11], [12], [13], [14], [15], [16], [17], [18], [19] and household waste flows [20], [21], [22], [23], [24], [25], slightly less papers on agricultural household flows [26], [27]. [28], [29], [30], self-storage center flows [31], [32], [33], relocation [34], [35], [36] and evacuation flows [37], [38], [39], but there is no attempt to structure and analyze all the logistics flows of the household. This is also the main contribution of this paper. In addition, the paper analyzes the attributes of a household as a generator of logistical demands and its interactions with changing environmental conditions. This paper provides the basis for future research into household logistics, as a new and still under-researched scientific field.

The paper is organized as follows. The attributes of the household as a generator of logistical demands are described below and their interdependence is explained. After that, the logistics flows of the household were structured and their basic characteristics were given. After that, the final conclusions and future research directions are provided.

2. ATTRIBUTES OF THE HOUSEHOLD AS A GENERATOR OF LOGISTICS FLOWS

The household generates different flows that can be divided into input, output and internal. Input flows involve the delivery of goods, materials and freights to the household. Output flows involve the shipping of goods, materials and freights from the household. Internal flows include flows within and between different units of household ownership, and occur primarily in rural households engaged in agricultural production. As an object to which they come, from which they depart and where goods, material or freight flows take place, a household can be viewed as an entity with attributes that describe it: location, ownership, function/activity, size of delivery, structure of goods, frequency of delivery, supply system, ordering system, time of receipt/dispatch, etc. [40]. The type, extent, structure, frequency and law of occurrence of flows depend on the characteristics of the household. The attributes, parameters of logistics and characteristics of the logistics subsystems differ from household to household and are characterized.

The location of a household is one of its basic attributes, both from the point of view of territorial affiliation to an urban, suburban or rural area, and from the point of view of distance from other generators of logistics flows. Ownership of a dwelling facility affects storage costs and inventory levels, as households in rented dwellings typically own a smaller total space, and thus storage space [41]. In addition to housing, other functions, such as agricultural, craft and food production, provision of agritourism services in rural households, provision of legal, health and catering services to businesses, et, can be realized in the household. Each of these functions requires the realization of certain logistics flows.

The size of the delivery of household goods and materials depends on the intensity of their consumption, the supply system, the location of the household,

the structure of the goods and the frequency of deliveries. The intensity of household consumption depends on the size, demographic and socio-economic characteristics of the household [42]. Considering that household consumption is most intense during the holidays and other types of festivities, then the most extensive input goods flows as well as household waste outputs flows are realized. The most extensive material flows are the input and output flows of building materials that are realized during the construction and demolition of all or parts of household objects.

The structure of household goods depends on the diversity of consumption, which is also conditioned by different demographic (gender, age structure of household members) and socio-economic parameters (income level, employment status of household members), as well as its functions. The largest share in the total annual household expenditure in the European Union is attributed to the supply of the following goods: food products (11%), furniture, appliances, utensils and tools (5.4%), clothing and footwear (4.9%), alcoholic beverages and tobacco (3.9%) [43].

The frequency of delivery of household goods is influenced by a number of household parameters [42]: location, size, socio-economic parameters, ordering and supply system, structure of goods and size of delivery. One of the main differences between urban and rural households is the more frequent and less extensive input flows of goods and output flows of waste.

The multiplicity and the smaller distance of retail outlets from the household leads to an increase in the frequency of input flows of goods [42]. Also, due to limited space, urban households are less likely to use sorting and long-term waste storage than rural households [23].

Supply of household goods may be realized by a household, supplier, logistics provider hired by one of the parties, or participants in the crowd logistics network. Although the purchase of goods is most often carried out by households, which supply themselves from sales facilities, with the development of e-commerce and online ordering, more and more trading and catering companies are offering a home delivery service [19].

The time and manner of realization of household input and output flows depend on different parameters that can be related to:

- Household (time of presence of household members, possession of reception box and private waste receivers, location, etc.);
- Other generators of logistics flows (opening hours, time windows for delivery/dispatch, vehicle routing, etc.);
- Environmental conditions (residential house rules, traffic conditions, legal regulations, etc.).

The realization of internal flows is conditioned solely by their own household constraints and the conditions of the immediate environment. The household has the freedom to determine the time and manner of realization of the internal flow, as well as to adjust the start and end point of the flow to the realization of loading, unloading and other operations.

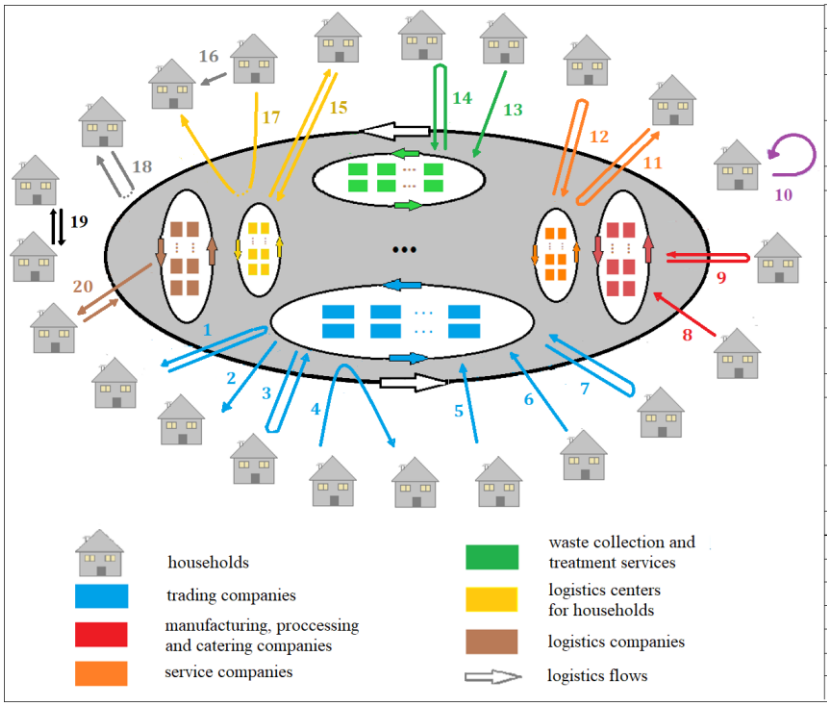
3. STRUCTURE AND CHARACTERISTICS OF HOUSEHOLD LOGISTICS FLOWS

The complexity and diversity of the logistics flows of the household stems from the specific role of the household as a space in which the function of housing is realized. The activities performed in the household, the needs of the household members and the demands made by the material elements of the household require the realization of different flows. Figure 1 shows the structure of household flows and their correlation with other generators of logistics demands. Logistics flows realizers, with the exception of households and other logistics flows generators, may be logistics providers, transport companies, postal, courier and express services that may be hired by one of the parties. The characteristics, specifics of particular categories of household logistics flows are described in more detail below.

3.1. Flows between household and trading companies

One of the most intense types of logistics flows takes place between households and various trading companies, their retail outlets or distribution centers, travelling salesmen, etc. Supply flows of goods represent household input flows, and can be done in different ways from the aspect of: picking and ordering products (information flow), paying for products (money flow), physical flow and taking over goods (goods flow).

Table 1 gives the most common combinations of information, money and goods flows when buying household goods. The traditional way of buying involves supply flow realized by household (Figure 1, Flow 1). Products are selected at the point of sale and paid in direct contact with the seller (Table 1, Flow 1a). This type of supply is realized on foot, by passenger or freight vehicle owned by the household or by public transport. More and more companies are offering 'buy online, pick up in-store' service [44], [45], which involves ordering online and pick-up goods in the retail store (Table 1, Flow 1b). Products that do not require physical distribution, such as digital products, software, information, insurance, travel tickets, are delivered electronically (Table 1, Flow 1c) [17].



	flow description
Flow 1	supply flow realized by household
Flow 2	supply flow realized by trading company
Flow 3	unsuccessful home delivery and return flow to the trading company
Flow 4	supply flow realized by participant in the crowd logistics network
Flow 5	returnable packaging flow
Flow 6	flow of household products for sale realized by household
Flow 7	flow of household products for sale realized by trade company
Flow 8	flow of household products for manufacturing or processing, realized by household
Flow 9	flow of household products for production or processing, realized by companies
Flow 10	internal flow
Flow 11	flow of goods or freights that are subject to repair, restoration and other service interventions
Flow 12	service flow for households realized by companies
Flow 13	waste flow realized by household
Flow 14	waste flow realized by responsible services
Flow 15	flow between household and logistics centers
Flow 16	direct relocation flow
Flow 17	indirect relocation flow
Flow 18	evacuation flow
Flow 19	mutual flow of households
Flow 20	flow of goods transhipped in the household

Figure 1 – Flows between households and other generators of logistics flows

Table 1. Supply flows of goods for a household

	Information flow	Money flow	Goods flow
Flow 1a	picking in-store	payment in-store	flow realized by household
Flow 1b	ordering online or by phone	electronic or in-store payment	flow realized by household
Flow 1c	ordering online or by phone	electronic payment	electronic product delivery
Flow 2a	picking in-store (for traveling salesman: in household)	payment in-store or cash on delivery	home delivery realized by trade company
Flow 2b	ordering online or by phone	payment in-store or cash on delivery	home delivery realized by trade company
Flow 2c	ordering online, by phone or in-store	payment in-store or cash on delivery	delivery to CDP by trade company, delivery from CDP to household by customer
Flow 3	ordering online, by phone or in-store, communication through the crowd logistics application	payment in-store or cash on delivery	home delivery by participants in the crowd logistics network

Supply flows of goods for household can also be organized by trading company (Figure 1, Flow 2). Home delivery is increasingly prevalent, especially with the development of e-commerce and online ordering [19].

The seller can realize the delivery with his own resources, but in most cases he hires a logistics provider to perform this task [12]. Products selected at the point of sale (Table 1, Flow 2a) or ordered electronically (Table 1, Flow 2b) are delivered according to the customer's requirements regarding the time and place of delivery.

Home delivery can be done in four ways [15]:

- Attended reception of the goods ordered at a household using delivery time windows defined by the service provider;
- Unattended reception using a reception box (refrigerated, customer-specific locked reception box installed in the household yard or garage);
- Unattended reception using a delivery box (insulated secured box that can be left on the customer's doorstep but which is returned to the retailer);
- Unattended reception using shared reception box units near the household, also known as automated Collection and Delivery Points (CDP) (Table 1, Flow 2c).

Higher population density, i.e. concentration of households in the urban area, provides significantly higher efficiency of vehicle delivery in delivery than in the case of remote rural households [16]. Rural and suburban households, on the other hand, are significantly more suited to unattended reception delivery variants from the point of view of security of shipment [16], since they most often own a yard.

Home delivery, i.e. supply flow, can be realized by other households (citizens) according to the principle of crowd delivery [46], [47] (Figure 1, Table 1, Flow 3). This method of delivery will be explained in Section 3.9.

Home delivery problems are numerous [2], [48] and more often concern the delivery itself than the product. Deliveries are made when the recipient is not at home, often late and at a high cost [19], [49]. In case of unsuccessful delivery, the shipment is often returned to the sender [19] (Figure 1, Flow 4). Unsuccessful delivery requires additional operational costs for return shipping, warehousing and re-delivery to the customer, increases the activity of delivery vehicles and other negative effects in this regard [50], but can also cause customer dissatisfaction [51].

The realization of household supply flows depends on the costs that include the price of the goods, the cost of delivery and inventory holding costs [42]. The household needs to establish a trade-off between the cost of delivery, i.e. the frequency of deliveries, and the inventory holding costs, in an effort to meet consumption [42].

In addition to input flows, output logistics flows occur between the household and the trading company, from the household aspect. Returns of product commercial packaging (Figure 1, Flow 5) are realized by the most common household. The most common example is the return of glass beer bottles. In some cases, these flows can also be realized by trading company. Trading company can integrate product distribution and return packing collection flows [52], by realizing return packing flows from households in round trip after the product has been delivered (backhauling concept).

Trading company can sell goods produced in household (fruits, vegetables, dairy products, prepared food products etc.). Flows of goods from the household to the objects of the trading company can be realized by the household (Figure 1, Flow 6), the company (Figure 1, Flow 7) or a logistics provider hired by one of the parties.

The realization of these flows requires the prior delivery of logistic units, crates for goods packing, to the household. In this case, the application of the backhauling concept can also contribute to increasing the vehicle utilization rate by integrating the flows of logistic units and flows of goods produced in household. Due to the increasing importance of food quality and environmental issues, there is a growing interest in locally produced food [26], [53], so that the volume and frequency of household output flows may increase in the future.

Households can also supply goods outlets that are their own property. Rural households can sell agricultural, food, handicraft and other products at street counters, markets or shops. Also, owners of small trading companies (most often for the sale of clothing and footwear) in the inner city area sometimes use their apartments to store goods, which they deliver to retail outlets in accordance with sales needs. As in these cases the flow realizer owns the starting and destination point of the flow, such a flow has the character of an internal flow.

3.2. Rural household flows

Rural households can realize various input, output and internal logistics flows, which are most often related to agricultural production and sale of agricultural products. The following may occur in rural household (farm) flows:

- Goods, materials and freights that enable agricultural production (fences, wires, machines, tools, seeds, fertilizers, pesticides, hives, etc.);
- Agricultural products (fruits, vegetables, cereals, dairy products, live animals, etc.) or natural resources (teas, mushrooms, flowers, wood, etc.) for their own consumption or sale;
- Other household products for sale (prepared food, handicrafts, clothing, etc.);
- By-products of agricultural production (manure, unusable and substandard products, other production wastes);
- Logistic and packaging units (boxes, crates, barrels, pallets, containers, etc.).

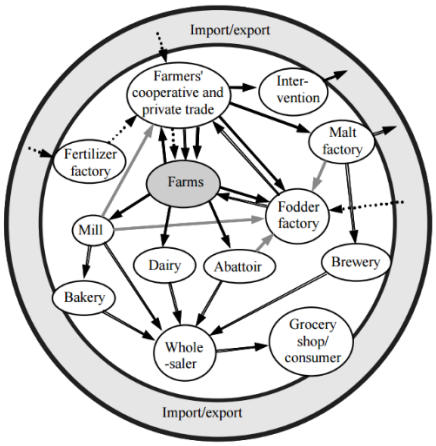


Figure 2 – Input and output flows of rural household [27]

In addition to the flows with trading companies, which are described in Section 3.1, rural households may realize flows with companies that use household products as raw material for manufacturing or processing (dairies, slaughterhouses, butchers, mills, producers of flour, sweets, juices, spirits, catering businesses, etc.) (Figure 2). These companies can be as an intermediary in the supply chain of trading companies with finished products or they can also sell products.

Flows between households and manufacturing, processing and catering companies can be realized by households (Figure 1, Flow 8), companies (Figure 1, Flow 9) or a logistics provider hired by one of the parties.

In developed countries, logistics companies deliver household agricultural products to collection or logistics centers [26], [27], [28], [29], where quantitative and qualitative analyzes, storage, drying of products and other processes can be carried out [30] and the goods are then shipped to the manufacturing or processing companies (Figure 3). Coordination of flows of related goods from the logistics point of view (milk and meat, fodder and cereals, etc.) can bring significant benefits in the utilization of means of transport [27].

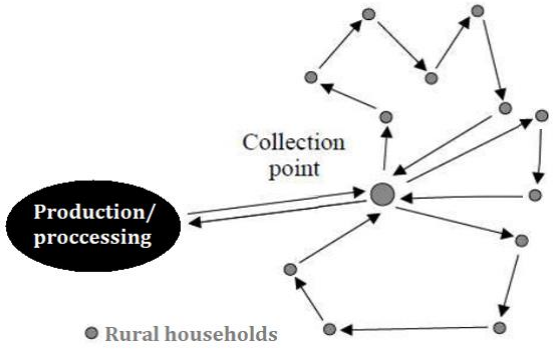


Figure 3 - Collection of agricultural products from rural households [27]

In addition to the input and output flows of goods, materials and freight, rural households generate different internal flows (Figure 1, Flow 10) (Figure 4). Within the household buildings and yards, mainly low intensity flows are carried out by the use of hand carts, motocultivators and tractors with trailers.

Households with complex manufacturing and processing plants and/or warehouses may have various means of transport and handling that can be engaged very intensively. In addition to main facility and yard with ancillary facilities, the ownership of the household may be other objects outside the yard (agricultural facilities, storage facilities, retail outlets, temporary accommodation for people and animals, etc.) and land outside the yard for various purposes (gardens, orchards, vegetable gardens, fields, meadows, forests, etc.).

Warehouses for agricultural products need not always be in close proximity to the basic household facility. Thus, grain storage facilities are located adjacent to the grain-cultivated parcels, water tanks and hay warehouses are located near stables, cold storage near orchards or the point of sale of the products, etc. Rural household flows can also be generated by a variety of temporary housing and agricultural production facilities, most commonly during the summer: cottages, cattle pens, etc.

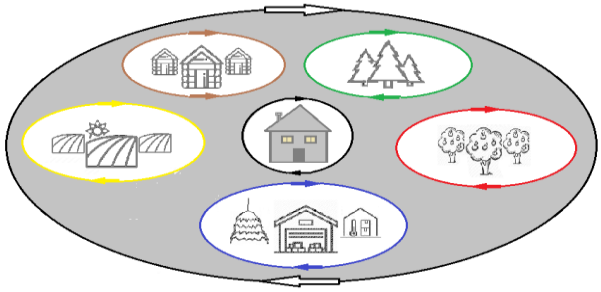


Figure 4 – Internal flows of rural household

3.3. Flows between household and service companies

Like other generators of logistics flows, households may require different types of services (servicing, repairing, cleaning and technical maintenance of facilities, installations and equipment, medical, veterinary, care and beauty services, etc.). The service may be provided at facility of service provider (Figure 1, Flow 11) or household (Figure 1, Flow 12), and the flow realizer may be a household, service provider (service companies, health and veterinary institutions, trading companies, that provide a guarantee for product repair, etc.) or a logistics provider hired by one of the parties.

When a service is provided at premises of service provider, the logistics flow consists of the elements that will be the subject of the service. These can be repair equipment, worn furniture for reparation, washing mats, pianos for restoration, live animals for veterinary examination and treatment, etc. After providing the service, a return flow to the household is realized.

Households and residential buildings often entrust specialized service companies with the activities of facility management, maintenance of heating, ventilation and air conditioning systems, energy supply systems, gardening, monitoring, cleaning, etc. [54].

Of particular importance for maintaining the functionality of residential buildings are the services of improvement, refurbishment, upgrading as well as repair building fabric [55]. In this case, service providers realize logistics flows of goods, materials, equipment, spare parts needed for the service delivery process, etc. [40].

3.4. Household waste flows

Waste management is one of the important segments of household management. Proper management of waste generation, storage, separation and disposal processes is important both because of household hygiene and its immediate environment and in the wider social context. The options for waste management from the most desirable to the least desirable are: waste prevention, reuse, recycling, energy recovery and waste disposal [56]. Household waste prevention is achieved through the procurement of adequate quantities of products, proper inventory management, storage and consumption. Effective inventory management can be achieved by applying appropriate theoretical models [57], as well as various advanced technologies and concepts such as the Internet of Things, RFID and smart devices [58], [59]. Storage and use of products should be carried out in accordance with the principles of FEFO (First Expired First Out) [60] and FIFO (First In First Out) [61], according to which products with the shortest shelf life are first taken from the storage space, so as not to waste generation has occurred due to the expiry of the product. Particular attention should be paid to the prevention of food waste generation, as the share of households in generating it globally is 40% [62]. Depending on the type of food product, appropriate packaging and storage methods are applied [61]. The re-use of products (e.g. home appliances, rechargeable batteries, glass packaging, shopping bags) can reduce waste and conserve the resources needed to produce them [63]. The role of the household in other waste management options (recycling, energy recovery and waste disposal) is preparing the waste for these operations and making it available to the competent services [25]. Waste can be separated in household (source separation) according to its characteristics and the type of treatment it will be subjected to (organic composting waste, recycling waste, hazardous waste, etc.). In 88% of municipalities in the Netherlands, source separation is taking place [23]. Waste separation is a critical component of a successful integrated waste management system [64], enhances the quality of produced compost and recyclable materials and optimizes waste incineration [65].

Household waste flows can be realized by household (Figure 1, Flow 13), waste collection services (Figure 1, Flow 14) or by a logistics provider hired by one of the parties. When the household is realizer of flow, the waste is delivered to the public waste receivers at bring collection sites [52]. Given that household waste, especially in rural areas, is often disposed of in locations not intended for this purpose [66], it is necessary to provide institutionally with adequate waste disposal infrastructure. Waste can also be collected from households [52]. These flows realize by competent utility services, secondary raw material collectors, companies that redeem certain types of waste, sellers who collect their products at the end of their working life, etc.

3.5. Flows between household and logistics centers for households

Logistics flows of goods, materials and freight are realized between households and urban consolidation centers, self-storage centers and other logistics centers (Figure 1, Flows 15 and 17). Logistics centers can perform various activities for households (packaging, delivery, storage, etc.). In practice, the service of storing winter and summer tires in car services has long been present. Special logistics centers may dispose of, store different goods, freights from the household, especially those of a seasonal nature [31] and those which are occasionally used and whose storage outside the household is economically justified.

Logistics centers play an important role, not only in the supply chain, but also in the planning of logistics and transport of the city, the region as a whole, and their location has a significant impact on the scheduling of transport flows on the transport network [2], [67], [68]. They are built in traffic-friendly locations and connect input and output flows, coordinating the flow of goods in a city, region [68]. In the urban area, under different names [40] logistics centers of different dimensions, characteristics, structures of functions and subsystems, service areas, etc. are applied. [69].

Different models of cooperation between logistics providers, shippers and/or recipients of goods and consolidation of flows can be realized through the logistics center [70]. Various effects of cooperative and consolidated delivery models have been identified in the city area [71], and in addition to deliveries, the urban consolidation center can also offer warehousing and a range of other logistics and retail value added services [72]. Seasonal storage and other center services may also be used by households [72], [73], [74]. Urban consolidation centers are involved in projects of building complex in some cities to encourage tenants to use its services [74].

Household goods, materials and freights can also be stored in self-storage centers. These centers represent a modified version of industrial warehouses, of which they are simpler in terms of design, operation and technology [32]. Most often, these are rooms with swing or roller doors, alarms and surveillance cameras, which can only be accessed by users at any time [33]. Centers can provide cardboard boxes and other packaging materials and disposal solutions, and an increasing number of centers offer the possibility of storage under special temperature conditions or for certain types of goods (e.g. wine) [33]. In addition to storage and packaging, self-storage centers can offer the rental of

vehicles, transportation and insurance of goods, materials and freight, and the most common reasons for using self-storage are the small area of housing and relocation [31], [33]. Growth in consumption and high housing prices are pushing households to seek storage services for goods, materials and freight that are not used throughout the year. Other reasons for using self-storage services are [31], [32], [32]: renovation of an apartment, organization of important life events (wedding, divorce, death) and protection of certain types of goods, materials or freights.

3.6. Relocation flows

Relocation represents the realization of the flow of goods, materials and freights of household in order to permanently change the location. Relocation flows are not frequent in the household, but are generally large in volume. There are two types of relocation flows, direct and indirect. In the case of direct relocation, the logistics flow is realized between the old and the new location of the dwelling, without storage (Figure 1, Flow 16). Indirect flows (Figure 1, Flow 17) include temporary storage in warehouses of relocation agencies and self-storage centers [31], [32], [33]. The household can realize relocation independently with its own or rented means of transport, but household usually hires specialized agencies [34].

The basic services of a relocation agency are loading at the starting point, transporting and unloading at the destination point [34]. Relocation agencies may also carry out supporting activities such as: storage, packaging, marking, disassembly, assembly and installation of furniture, cargo insurance, field assessment, estimation of jobs involved, required time and cost of relocation, informing users, collecting household waste and residues after relocation, other preparatory and final relocation operations. The cooperation of agencies and the coordination of relocation flows is exceptionally important given the high cost of empty round trips, the seasonality and the unpredictability of demand from the point of view of the starting and destination points of the flow [35], [36].

3.7. Evacuation flows

Relocation flows are similar in content to evacuation flows (Figure 1, Flow 18), which imply a temporary change of the location of people, goods, materials and freights from the endangered household and the realization of a return flow. Although public evacuation centers are active during emergencies, the most common temporary refuge for household members, goods, materials and freights during emergencies are commercial facilities (hotels, motels, etc.) and the household of friends or relatives [37]. The realization of the evacuation flow should be in accordance with the evacuation plan, coordination of flows and the official instructions of the administrative authorities [37].

3.8. Mutual flows of the households

Logistics flows can also be realized between two households (Figure 1, Flow 19). The content of these flows may be goods, materials and freights that are sold, borrowed or stored in another household. A household may sell to other households different products, most commonly agricultural, but also lend a variety of goods, materials, or freight, whereby a return flow is also realized (e.g. neighborhood borrowing of furniture needed for a household ceremony).

Goods, materials and freights of the household can be stored in specialized centers, but also in other households. Although the storage is still most commonly entrusted to neighbors, friends and relatives, with the massive development of the concept of crowd storage, the storage service will be able to be provided by any household that has the right conditions and whose members wish to provide such a service. This concept is described below.

3.9. Crowd logistics in flows of household

The concept of crowd logistics rests on the principle of connecting persons seeking logistics resources and persons offering resources of their household, that is, their own means of transport (crowd delivery) or storage space (crowd storage) [46], [75], [76]. Requests for delivery or storage of goods and acceptance of requests are made through a mobile application networking participants in the crowd logistics concept [47].

The household resources most commonly used to provide crowd storage services are cellars, spare rooms, garages or yards, while crowd delivery services are provided by vans, cars, scooters, bicycles, public transport or walking [46]. Most often, these services are provided in large cities, where the flow of people is very intense and commercial warehouses are pushed to the periphery due to the high cost of real estate [46].

In addition to transportation and warehousing services, the household may also offer transshipment resources. Logistics companies use the space of households to carry out transshipment, consolidation and deconsolidation activities, with monetary compensation to the homeowner. After consolidation/deconsolidation and eventual storage, the goods are shipped to their final destinations according to the distribution plan (Figure 1, Flow 20). In the future, households could be more actively involved in the logistics tasks of other households as well as businesses. Trading companies could, in line with Walmart, DHL and Amazon, try to involve their customers in the delivery of goods to other customers [77].

In a remote rural settlement with an elderly population, one household could procure and distribute products, store and provide other logistical services to settlement dwellers, thereby acting as a „mini logistics provider“, using existing household resources. This can bring personal economic benefits, but also facilitate and enhance the functioning of the community.

The aim of the future development and expansion of the crowd logistics concept is to strengthen the connection, the joint operation of households, as an integrated group of generators, in order to achieve synergistic effects. In this way, households as participants in different supply chains could become their significant hub from the end generators of logistics flows (Figure 5).

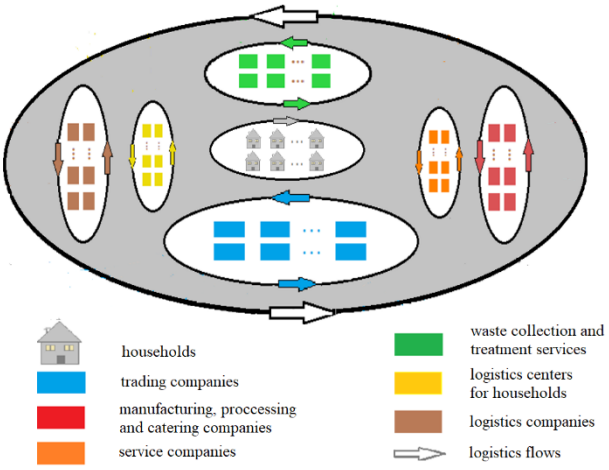


Figure 5 – Households as hub of logistics flows

4. CONCLUSION

Planning, organization and realization of logistics flows of a household is a complex and important task, given their abundance, heterogeneous structure and specificity. The analysis of logistics flows is important both for the purpose of realizing benefits in household management and in the context of coordination and optimization of logistics flows of the area.

This paper presents the basic attributes of a household as a generator of logistics demands. All logistics flows of the household were structured and interactions between household and changing environmental conditions were defined. In this way, the basic aim and contribution of this paper was achieved, which is to lay the groundwork for future scientific research in the field of household logistics. Opportunities for the development and application of crowd logistics and backhauling concepts represent one of the possible areas for future research. Home delivery, that is, the logistics of the last mile and the last yard, will surely be increasingly the subject of scholarly attention. Research on household flows should also be directed in the context of the development of omnichannel sales and logistics. Certain trends such as the development of urban gardening and agritourism may alter the traditional functions of urban and rural households, and thus their logistics, and these areas should also be subject to future research. In addition, emergency and extreme circumstances can be very common in the future [78], so research into household evacuation flows, problems of supply and inventory management of household in emergencies, etc., is increasingly interesting and needed.

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REZIME

LOGISTIČKI TOKOVI DOMAĆINSTVA

Domaćinstvo, kao značajan generator logističkih tokova, može se posmatrati kao entitet sa ulaznim, izlaznim i internim tokovima i uzajamno zavisnim atributima koji ga opisuju (funkcija/delatnost, lokacija, sistemi poručivanja i snabdevanja, veličina i frekvencija isporuke itd.). Pripadnost gradskom, prigradskom ili seoskom području ima naročito značajan uticaj na karakteristike logističkih tokova domaćinstva. Osim toga, struktura logističkih tokova zavisi od funkcija domaćinstva, promena u okruženju, interakcija domaćinstva sa drugim generatorima logističkih tokova, ali i uloge domaćinstva i njegovih resursa u lancima snabdevanja. Efikasno upravljanje logistikom domaćinstva zahteva ozbiljna istraživanja kompleksne strukture tokova i njihove interakcije sa atributima domaćinstva i promenjivim uslovima okruženja. U ovom radu prikazani su osnovni atributi domaćinstva kao generatora logističkih zahteva, opisane su različite interakcije sa okruženjem i izvršeno je strukturiranje logističkih tokova domaćinstva. Osim toga, prikazane su osnovne karakteristike svake kategorije logističkih tokova.

Ključne reči: *domaćinstvo, logistički tokovi, strukturiranje, upravljanje*