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INTERMODAL LOGISTICS PROCESSES SUPPORTED BY ELECTRONIC FREIGHT AND WAREHOUSE EXCHANGES

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Nowadays, modern companies operate in a common logistics network. In a modern approach, these networks of companies are called virtual enterprises, whose main purpose is the maximal fulfillment of customer needs and process optimization. The electronic freight and warehouse exchange is a good basis for building virtual enterprises, and that may be a new way to support the reorganization of the supply chains, and to rethink the connections within the intermodal network.

Firstly, the paper presents the need of intermodality. On the other hand, it details the benefits and the critical evaluation of intermodality. It presents the general transshipment processes and techniques then evaluates the containers based on their main features. On this basis, the paper describes the electronic freight and warehouse exchange as a member of cloud supply chain. Moreover, the paper contains the new challenges and opportunities of electronic freight and warehouse exchanges as complex logistics providers.

Keywords: Supply Chain, Intermodality, Container, Online Logistics Exchanges, Optimization

1. Introduction

The role of the intermodal logistic processes and related services are continuously changing and developing due to the spreading of transportation processes. One of the most frequent attribute of the service functions is the implementation parameters (for example, place and material requirement), which are being changed, so the logistics system must be able to follow them flexibly. Because of the complexity, at any given time and location the implemented service requires cooperation between multiple logistics subsystems which are connected together only with the common management system and the endpoint of materials flow. One of the possible surface to satisfy the ever growing and changing claims if these services are supported by electronic freight and warehouse exchanges to perform the logistics processes.

2. Critical Evaluation of the Intermodality

The intermodal shipments evolve their effects typically on two areas. The first one is the preparatory phase and the other is the phase of activities, which are tightly connected to the freight. The preparatory phase includes processes, which bring the transportable goods into suitable condition for transport according to the prescribed rules. Such rules belong to packaging and unit load forming, then setting up goods and transportation units with labels with appropriate information on it, and equipping it with barcodes as an adequate identification. Recent years considerable technological advances can be seen in the first phase due to the usage of advanced technologies [1].

The development of the present advanced packaging and unit load forming technologies has positive effects to reduce cost, and it helps to achieve the safer, flexible, environmentally-friendly and regularly supervised transportation. The second phase has significantly more preferred properties in term of intermodal transportation. The optimal choice of the transportation modes is an advantageous and desired solution of environmental and economic aspects. The modern information system has also a big role in the precise alignment of combined transportation. It provides vehicle and load tracking, moreover it ensures the being of permanent monitoring functions. The electronic freight and warehouse exchanges are separate and special parts of the information systems. The reasonable solutions of the material activities are closely related to the freight (or just transhipment tasks), and the optimal choice of the transhipment equipment are the two major roles of the terminals. Because the major part of the container transhipment (as a mount point) there takes place, to improve these terminals is a further task of the intermodality optimization [2].

These transport modes have significant advantages. The most important benefits are for tending to environment-friendly (green logistics) format and for creating balance of transport ways (modal split), besides it ensures the reasonable and coordinated connection between them. Moreover, with reasonable combination of these mentioned transportation modes the overall transportation cost (which is the most important factor in logistic systems) might be significantly reduced. The optimal operating conditions of the established logistics network are the integrated subsystems, and the fact that these subsystems should be adequately connected. The organization of combined transport, as well as the development involves a significant financial investment. The reason is that the parts of the transport chain, namely: the transportation facilities, the transhipment equipment, and the storage- and transhipment areas, which are used in the supply chains need to have special properties. The intermodal freight is a transport mode has substantial resources due to its positive effects on the environment. Because of this reason the European Union provides significant financial support for development and implementation [1], [3].

Figure 1 shows a domestic intermodal network with main terminals and major railway lines which are having significant role in the international relations. The most important container and combined terminals, which link the most transport subsectors and operate as logistic service centre in the country, are located in Győr, Záhony, Csepel and Szeged. In addition, the logistic services, which belong to the cities like Miskolc, Debrecen, Nyíregyháza, Szombathely, Székesfehérvár, Sopron, Nagykanizsa and Pécs also, have high transportation volume [4].

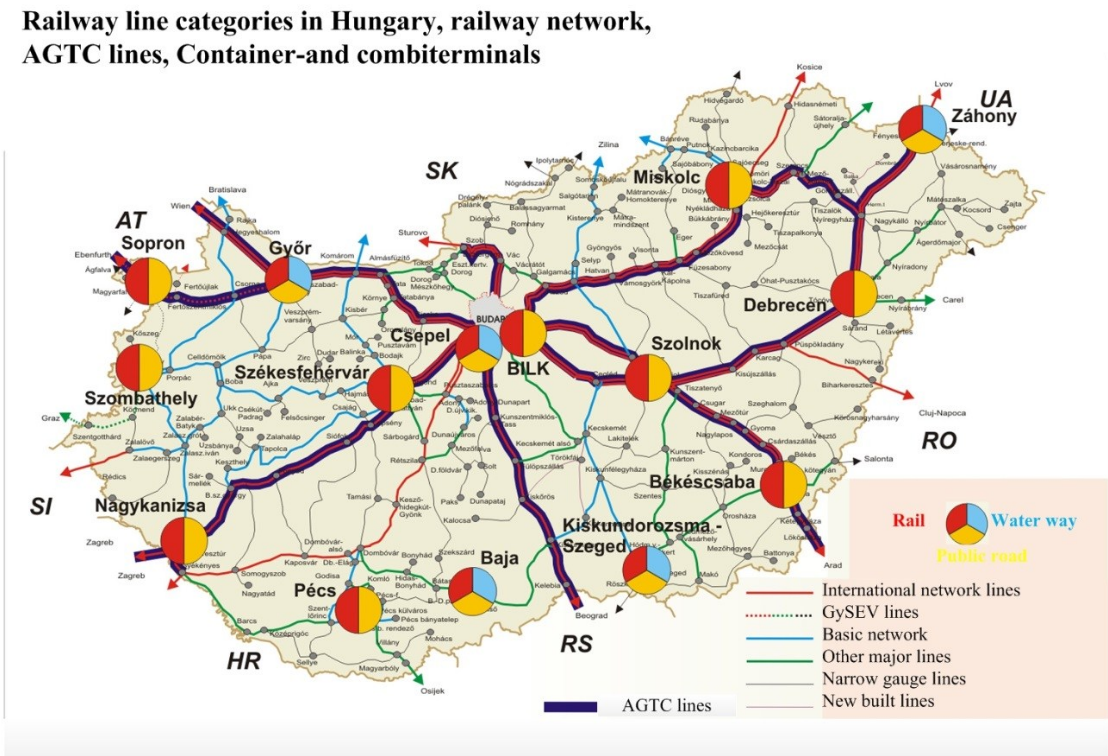


Figure 1. Railway line categories in Hungary, railway network, AGTC lines, Container-and combiterminals

3. General and Special Transhipment Processes

The transhipment of containers may take place at the container and combined terminals, or in the premises of carriers and freight forwarders. Because of the fact that supply chain's both participant functions a sender place as well as recipient place, so these transfer points need to be changed into container transhipment suitable places. Possible indirect modes of transhipment are as follows: containers are picked with spreader (upper corner unit), with crane (lower corner unit), with crane (fork pockets), with forklift (fork pockets), with ACTS/ARC (All-round container, Abroll-container), with Mobiler and with support foots. The objects of investigation are common containers in terms of transportable goods, supplemented with swap bodies and scrollable all-round containers [5].

In addition to the above described general transhipment technologies, must be mentioned special systems too, like RTS, HCTS, NETHS processes. The RTS is a positioning system which equipped with laser scanner at the container transhipment of trains. It enables the long haul trains to quickly unload their cargo in their short stop time at intermediate stations [6].

The HCTS system (Horizontal Container Transhipment) enables horizontal container transhipment. With the help of this system, the container can be raised without exceeding the height of loading gauge in the load- and unload procedure [6].

The NETHS (NeuweilerTuchschmid Horizontal System) is used at small and medium sized terminals for transhipment of containers. This system was developed in Switzerland. While handling of the system all of the elements are electrically driven. The apparatus is divided into two opposing independent parts, which can be shifted by a common alignment. The two sub-functions are working as a jaw, allowing receiving different types of containers [6].

4. Complex Analysis of the Containers in Terms of Transportable Goods

It is necessary to separate containers according to transportable goods, like bulk and liquid and separate bulk goods. We can supplement these well documented distributions with own analytical results with occupancy indicators of the volume and finally with the possibilities of the adaptability. The summary is shown in Table 1. The occupancy indicators can be separated to six intervals, the first is the worst, and the sixth is the optimal solution. The intervals upper and lower limits are the follows [7], [8]:

- 0-65%: 1
- 66-70%: 2
- 71-75%: 3
- 76-80%: 4
- 81-85%: 5
- 86%-: 6.

The categories of the transportable goods and transhipment techniques have similar categories. The container is:

- suitable to use the transhipment technology and suitable for transport the good: 2
- rarely suitable to use transhipment technology and rarely suitable for transport the good: 1
- not suitable to use the transhipment technology and not suitable for transport the good: 0.

Besides the mentioned aspects, the possibility of the adaptability has a significant role in the analysis too. We can define five classes to the evaluation of the possibilities of adaptability:

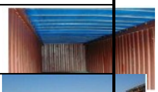
- not convertible containers: 0
- limited, rarely convertible containers: 1
- limited, often convertible containers: 2
- convertible containers: 3
- optimally, always convertible containers: 4.

Based on data from the Table 1, the containers can be ranked as follows:

1. According to the most relevant aspects, the optimum types of the containers are the box containers, which have beneficial functional and technical parameters, besides provide the goods protection.
2. The following group of containers are the open top containers, which only differs from the box containers in the goods protection. This type not always provides protection, or not in the appropriate extent.
3. The advantages of the flexi tanks have a big role in the normal and special transport too. The third group of the containers is the flexi tank, which has advantageous properties, like convertibility and occupancy indicators of the volume [7].

Generally we can state, that the box containers can be suggested in the transaction of intermodal logistics processes supported by electronic freight and warehouse exchanges.

Table 1. Comparison table for the container types and swap bodies

Container types	**Occupancy indicators of the volume**	**Packet goods**	**Bulk**	**Liquid**	**Transferability, manageability**					**Adaptability**	**Final score**	**Containers**
					spreader +upper corner unit	**crane +lower corner unit**	**forklift +fork pockets**	**ACTS**	**Mobiler**			
Box containers	6	2	1	1	2	2	2	2	2	3	23	
Open top containers	6	1	2	1	2	2	2	2	2	2	22	
Flat rack containers	1	2	1	1	1	2	2	0	2	1	13	
Reefer containers	3	1	0	1	2	2	2	2	2	2	17	
Isolated containers	3	1	0	1	2	2	2	2	2	2	17	
Ventilated containers	3	1	0	1	2	2	2	2	2	2	17	
Collapsible containers	3	2	0	0	2	2	2	2	2	1	16	
Tank containers	6	0	0	2	2	2	2	2	2	0	18	
Bulk containers	6	0	2	0	2	2	2	2	2	0	18	
Flexi tanks	5	0	0	2	2	2	2	2	2	4	21	
Swap bodies	6	2	1	1	0	2	0	0	2	2	16	

5. Electronic Freight and Warehouse Exchanges as Cloud Service Providers

The electronic freight and warehouse exchange facilitates a forum for logistics service providers to advertise their service supply, such as transport and storage capacities on the worldwide web; whereas consigners can choose the offer, which suits the best their needs (transport and storage tasks). The cloud (cloud computing: [9]) structure of the electronic freight and warehouse exchange is shown by Figure 2.

The freight and warehouse exchange (as cloud computing service provider) offers the following main services [10]:

- e-commerce toolbar (agile information and communication techniques):
  - advertising and searching freight/storage tasks/capacities in a simple catalogue,
  - automatic offer sending based on individual settings,
  - tenders/auctions,

- multi-criteria decision supporting algorithms (to choose the best offer), [11], [12], [13],
- optimization algorithms (optimize the logistics processes),
- other functions (e.g. statistics, blacklists, data maintenance, etc.).

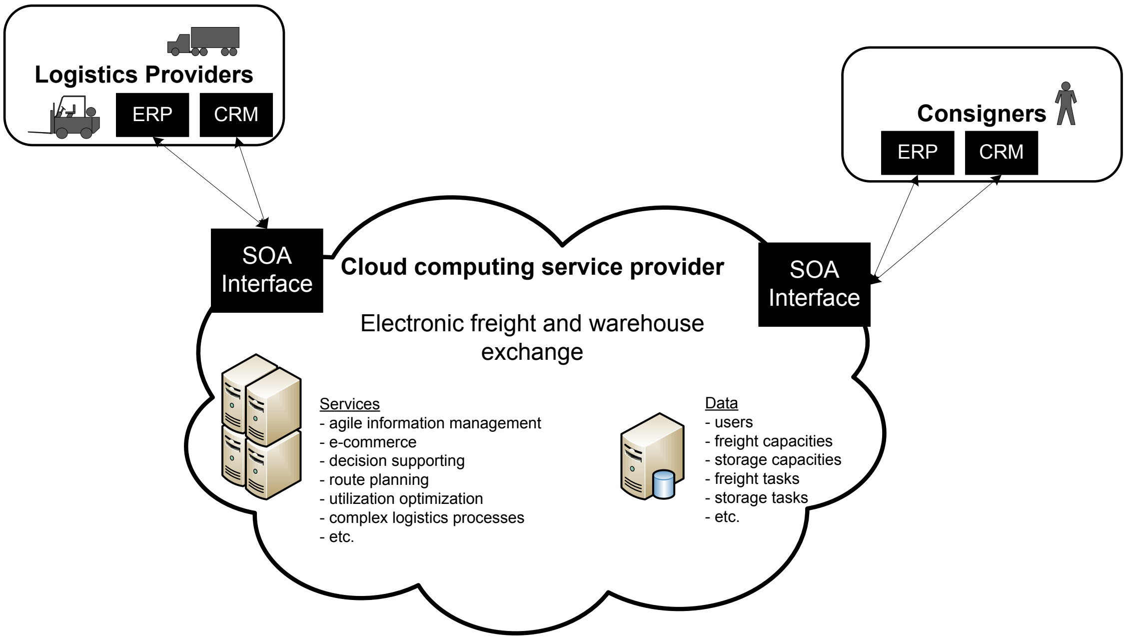


Figure 2. The cloud model of electronic freight and warehouse exchange

The electronic freight and warehouse exchange has three participants: consigners, logistics providers, and the cloud computing service provider. The aims of the electronic freight and warehouse exchange: to advertise freight/storage capacities/tasks, to choose suitable offers based on e-commerce methods and complex optimum criteria [14], to support complex logistics processes (e.g. combined transportation, city logistics, etc.), [15].

Over the current known applications, the electronic freight and warehouse exchanges are able to provide such logistic processes, in which the information and communication deficiencies between the participants cause the more significant problem. The role of freight and warehouse exchanges in complex logistics problems (city logistics, combined transportation) may be viewed as the route planning systems: the processes (e.g. tours, utilization) can be optimized by handling demands and capacities in one system. With the help of these exchanges the logistics providers can improve their own logistics processes; moreover, the capacities are harmonized by the sharing of transport and storage [16], [17] capacities (virtual enterprises are formed). In addition, through the coordination they are able to establish collecting-distributing routes, to organize back haul, and through this to reduce the number of vehicles. In this way, support of complex logistics problems (e.g. city logistics: [18], combined transportation) will be possible.These exchanges are suitable for organizing the transport and storage processes of the multimodal logistic centres (combined transport and city logistics). Therefore, these exchanges can provide the green logistics principles, mostly through the decreasing number of the trucks and the decreasing measure of the exhausted fumes. In other words, freight and warehouse exchanges are one of the “simplest”, but still the most efficient way of optimizing complex logistics processes (see example Figure3). Moreover, the freight and warehouse exchanges can be an excellent example of cloud supply chains [19].

To prove this thesis, an ant colony algorithm was developed (BA_ACO), [15]. In case of freight and warehouse exchanges, we have to define a complex objective function. On one part of the total transport route, the freight tasks are transmitted together and then with the help of an intermodal centre the freight tasks are transferred (multimodal transportation with rail/river). The objective functions: minimal transportation performance increase; maximal total mileage reduction; maximum use of the rail/river vehicle [10], Fig. 3. The modelling logic was completed with a factor which helps to take into consideration the demand of the surplus logistic services. These problems can be solved by ACO (ant colony optimization), which is an optimizing algorithm [20] developed by Marco Dorigo [21], [22] based on the modelling of the ants' social behaviour. In the electronic freight and warehouse exchange similar problem emerges as the ants' search for food: the target is the agile performance of freight/storage tasks offering the higher profit.

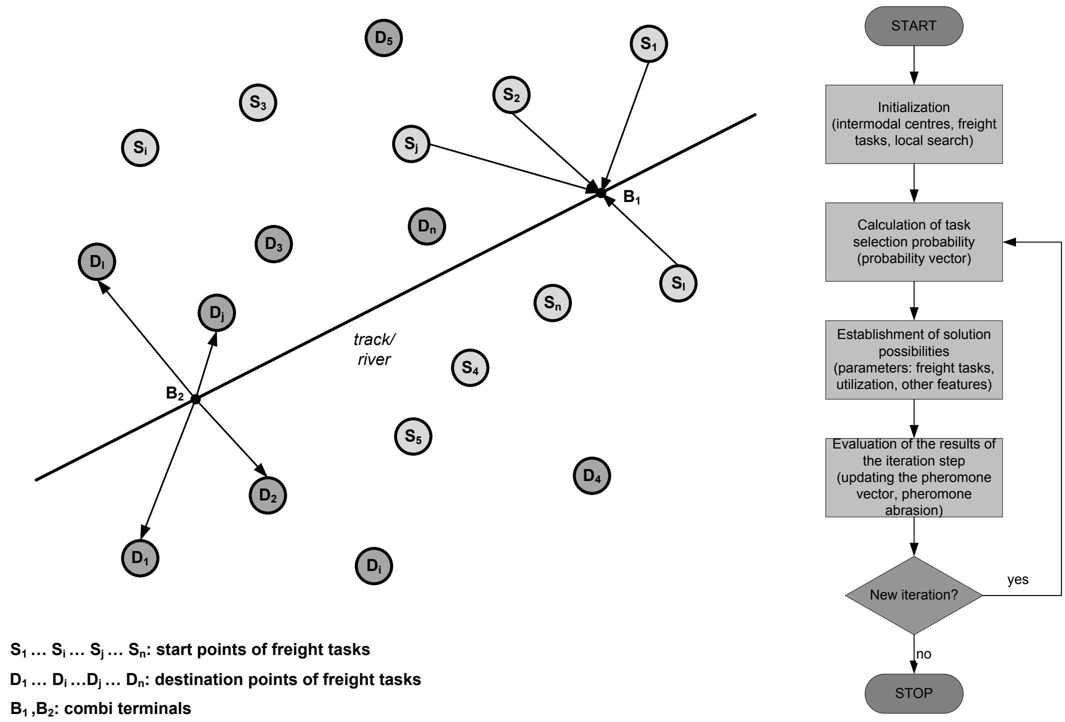


Figure 3. Multimodal transportation supported by freight and warehouse exchange: the model layout and the ant colony algorithm (BA_ACO)

6. Intermodal Supply Chain Supported by Electronic Freight and Warehouse Exchanges

The simplified system model of the conventional supply chain can be shown on Figure 4. The main features of the current supply chain system (+: positive features, -: negative features):

+ The wholesalers have extensive relationships with retailers and manufacturers, so they manage the demands.
- The wholesalers perform the freight and storage tasks, but they do not have:
    - suitable stock capacities,
    - suitable freight capacities,
    - logistics know-how.
- In the case of wholesalers the logistics processes are non-core.
- Due to the above-mentioned problem the current logistics system (e.g. combined transportation system) is not optimal.

To solve the above-mentioned problems, the electronic freight and warehouse exchange is expressly useful. The conventional supply chain can be modified, as shown on Figure 5.

The main features of the modified supply chain system:

+ The wholesalers are responsible for the information processes; they manage the demands of retailers.
+ The logistics providers (storage providers, transportation providers, logistics centres) perform the physical freight and storage tasks, whereas they have:
    - suitable stock capacities,
    - suitable freight capacities,
    - logistics know-how.

+ Electronic freight and warehouse exchanges perform the supply-demand (capacities-tasks) harmonization; the decision supporting and the optimization (shown functions in Figure 2).
+ In the case of logistics providers and electronic freight and warehouse exchanges the logistics processes are core.
+ Due to the above the modified logistics system (e.g. combined transportation system) may be optimal.

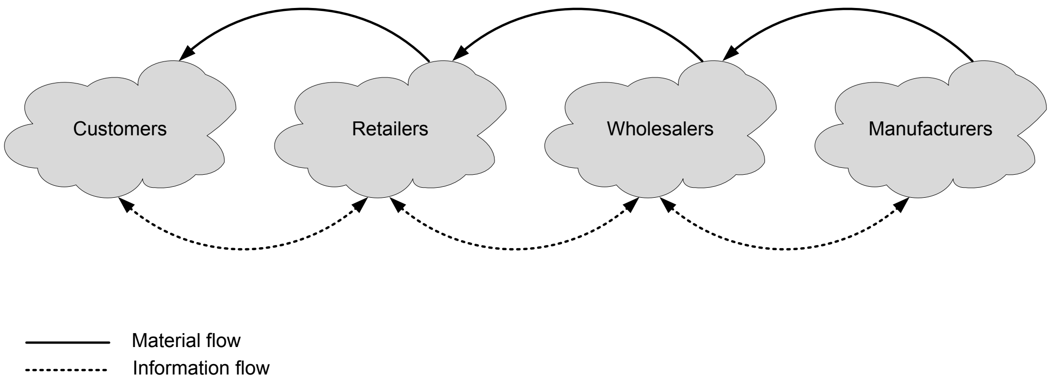


Figure 4. The simplified system model of the conventional supply chain

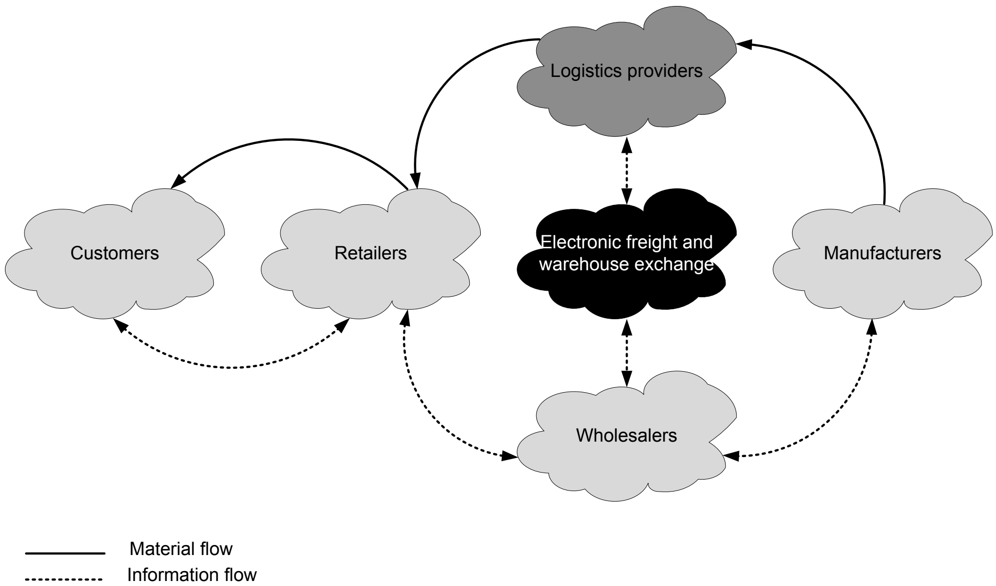


Figure 5. The simplified system model of the supply chain supported by electronic freight and warehouse exchanges

7. Conclusions

Consequently, green logistics systems, e.g. ***green combined transportation supply chains*** can be realized. In addition, this system is beneficial not only for the individual actors (e.g. retailers, wholesalers, logistics providers, manufacturers, intermodal centres) but also for the national economy. The future plans include further development of algorithms and tests in real supply chains, e.g. supply chains of drink industry or other possible combined or complex city transportation system.

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