DESIGNING AND EFFECTIVENESS OF VIRTUAL LOGISTICS CENTERS

Vladimír Modrák

Technical University of Kosice

Abstract: This paper investigates the creation, benefits, obstacles and further development areas of virtual logistics centers. Its main focus is on designing and effectiveness of multi-integral logistical centers. Also other aspects, like impacts of ICT on the development of virtual logistical centers and the development stages of SCM are presented. Moreover, the paper outlines some pitfalls of this development trend in an effort to provide pertinent practitioners and other involved with a more complex view of this issue.

Keywords: . logistics center, network, supply chain, material flow, logistics services

1. Introduction

Considering the fact that we are standing at the threshold of the so-called knowledge economy and of expanding e-technologies, we might not be amazed, when we come across the term 'virtual organization'. On the other hand, like in another fields of virtual life, also in this field it does not mean the elimination of classic business models. In this relation, such questions arise about virtual logistics centers (VLC) as are, a reference model of VLC, steps of their creation, effectiveness of virtual logistics centers, and others. The mentioned ones represent the main subject of the research interest of this paper.

2. Literature review

In generally, a progress in virtual life is close connected to information and communication technology (ICT) development [1]. ICT represents a highly efficient tool for data collection, but its use is much wider. It offers companies a wide range of possibilities for increasing competitiveness. For example, it allows organizations to create closer partnerships with their customers, suppliers and business partners. It means that organizations are capable of using the potential of ICT for the modernization of a number of managerial processes, which also include supply chain management (SCM).
Besides the basic area of securing the transfer of information between companies in a supply chain (SC), the potential of ICT has recently been used significantly for the integration of information and material flows and for a higher degree of cooperation between companies. This fact had also impact on development of integrated supply chains. The reason for their creation was claimed in respect of establishment close relationships and in the creation of unified procedures aimed at increasing the effectiveness of the whole logistical chain. In

these terms, SC is characterized as a network of mutually interconnected companies that share the fulfilling of promises to the final customers [4] [10].
The interest in the implementation for ICT in SCM has grown recently along with the change in the orientation of logistics management from internal attention to the overall company strategy focus, whose interest was to integrate relations with suppliers and distributors [9]. It was caused by the realization of the need of integrated information flow management in individual SC by production companies as well as by logistics companies. An effort to react to this new situation has manifested itself in the development and implementation of integrating information systems (IS) in a supply chain. Integrated IS are currently increasingly used in e-commerce. Those applications include, for example, the e-mail, the Internet, Electronic Data Interchange (EDI) and Extranet [6]. It practically places greater demands on logistics from a physical point of view and with regard to its ability to coordinate physical flows [3].
Thanks to the onset of advanced ICT in SCM also a development of virtual companies is expanding. According to Davidov & Malone [5], the virtual company of the future will look in the eyes of an observer as being almost limitless. Despite of that, skeptics are already gathering arguments against such visions. Birchall & Lyons [1] stressed that in the near future only intelligent organizations will be able to react to the rapidly changing business environment. In this sense, Kalakota & Robinson [7] pointed out, that the design of a new model of business should be able to create alliances that emerge whenever there is a need of a new type of response to the customer's growing requirements. From the other perspective, only a minor part of companies offering logistics services take care of all logistics activities of their customers [11].

3. Methodology

Firstly, an overview of literature documents impact of ICT on virtual logistics development. The aim is to point out parallels in the theoretical research concerning virtual logistics and aspects related with the development of SCM. In the procedure that follows, a deductive approach, in which substantial properties of objects or phenomena are separated from the not substantial ones, is used. A precondition for a correct deduction is the analysis of an object, which is investigated, in relation with its environment.

4. Designing of virtual logistic centers

A logistical center (LC) is considered to be a supply – distribution node, which provides a wide range of logistical services for customers [8]. Along with transport and handling processes, it carries out activities that are connected with the complex support of production and with the sale of the product. LCs are set up as complex services based on sharing work of specialized companies, which provide logistical and other services connected with the implementation of supply chains in line with the needs of individual customer services. In that they use suitable location in the region, depending on the concentration of the necessary infrastructure, involving in particular a high capacity warehouse and accessibility for transport. The main roles of an LC include:

- Connection of different transport modes into transport chains,
- Design and implementation of complex logistics networks,
- Various logistical tasks (internal company transport, storage, commissioning, packaging, distribution, and so on),
- Preparation, implementation and maintenance of the needed infrastructure for cooperating companies,

- Preparation, implementation and maintenance of a needed information, control and communication system.

The integration of tasks into an LC envisages effective cooperation between the production, sales, service and transport companies and all consumers. From the producer's perspective it means, for example, that tasks related with the procurement of materials and the sale of products are dislocated from the company. Those tasks are considered to be not characteristic or natural to the production process. The dislocation of tasks and the application of the Just in Time (JIT) concept in the production, supply and distribution decrease storage costs and the implementation of physical flows, and it increase the competitiveness of products. The application of a program, combined transport organized by a plan, rationalizes and ecologizes transport processes.
Functions of logistics centers depend on the portfolio of logistical services that are provided and links between them. According to the significance of services in the creation of added value for the customer, logistical services can be classified into three groups:

a) Basic logistical services
b) Additional logistical services
c) Other services

a) The basic logistical services have the biggest share of the added value, which results from the assessment of the whole quality of preparation and implementation of an ordered integrated supply chain. Basic logistical services solve the arrangement of transport, physical transport, handing of material, including storage, dispatching and distribution.
The arrangement of transport cannot be imagined without marketing of road, railroad, water or air transport services. The knowledge of their existence and of references, transport terms and conditions, and a flexible reaction to changes in the type of transport are significant bits of information for planning, implementation and operative control of the physical flow, from the place of existence to the place of consumption, so that they meet the customer's requirements and bring profit
Transport systems have the key role in the transport of materials, as without them it is not possible to secure a reliable integrated physical flow by a supply, production or distribution processes. Transport has to adapt flexibly to the conditions of the international, nationwide and internal company transport, including multimode transport. The application of JIT in the planning of supply deadlines and in the control of transport chains is a logical precondition for the economic effectiveness of transport, as supply chain processes are becoming more transparent, while more progressive minimization of stock occurs.
For the storage and stock management, the LC currently uses the latest technology in its building as well as operation. High-rise warehouses, equipped with shelf systems, with the capacity of tens of thousands of paletted units, and operated by automatic shelf loaders, tens of meters high, are being build. Automated conveyor or car systems solve the horizontal transport. Robotic systems are applied in the depalleting as well as palleting and packaging of consignments. In separate zones, besides customs or consignment storage, technological operations related with precise division of input materials or with the final assembly of products can be done.
The type of finishing operations and steps in them are specified precisely by a concrete order from the customer. Usually, the assembly of products according to the concrete order from the customer, packaging of products into retail and transport packaging, marking of products and packaging, etc. are usually done.

b) Additional logistical services increase the feeling of satisfying the customer's request and the added value of the value-creating chain of implemented logistical services. They contain such activities as leasing of machines and mechanisms, custom declaration,, insurance, consulting, re-qualification and so on.

c) Other services complement the synergic effect of complex services of the most advanced logistical center. The customer usually uses the highest added value of implemented supply chain. Those services do not need to be used in all supply chains, but their presence increases the competitive advantage in the fact that they are located at the places of concentration of logistical services and of their effective integration into supply chains. This is the case of postal and banking services, hotel, restaurant and healthcare services, property security services, marketing communication support services through advertising, promotional materials and exhibitions.

The providers of logistical services concentrated into a portfolio of services of an LC are companies and institutions whose core business corresponds with the specifics of the required services necessary for the implementation of supply chains of various development stages, up to complex supply chains. It is the case of particularly the following types of businesses:

a) Organizations providing basic logistical services:
   - Transport companies, private transport agents;
   - Forwarding agents;
   - Wholesale warehouses, storage areas;
   - Packaging factories;
   - Installation companies;
   - Division workshops;
   - Information and communication technology operators;

b) Organizations providing supplementary logistical services:
   - Repair, maintenance and service companies and businesses involved in repairing and servicing transport and handling machines and equipment;
   - Leasing companies hiring out transport and handling machines and equipment;
   - Petrol pumps;
   - Customs;
   - Consulting offices;
   - Insurance offices;
   - Training equipment (driving schools, schools for operators of handling equipment, etc.)

c) Organizations providing other services:
   - Post offices;
   - Banks and their affiliate offices;
   - Hotels and restaurants;
   - Outpatient clinics and other.

The building of the portfolio of services of an LC is a gradual process, which has four development stages. Only in unique cases the design and implementation of an LC that provides all services is chosen.

In the first development stage the portfolio of services consists only of services in which work operations of non-technological character are done, but they should be able to meet transport needs of supply and distribution processes.

In the second development stage, services carried out by technological operations are added. The portfolio of services in the third development stage, specifically by leasing, repair and maintenance of machinery and equipment, including the provision of requalification services, is extended. The LC provides complex services in the fourth development stage.
It should be pointed out, however, that the structure of the portfolio of services of a certain development stage may contain selected services from all groups and their selection may be influenced by local conditions at the place of implementation of the LC.

5. Effectiveness of virtual logistic centers

Architecture of virtual logistical centers is naturally reflecting progressive trends in supply chain concepts that are characterized by coordinated mutual cooperation and strategic partnership of dispersed logistical capacities along the vertical as well as horizontal lines. In a creation of virtual logistical centers it is necessary to take into account the following obstacles:

- The current competitors, providing services of the same character, may have natural fears that they could lose their independence when contemplating an idea that they should start cooperating in the interest of providing complex logistical services;
- Mistrust of possible synergic effects that would be capable of supporting effectively the development of logistical activities of the participating partners;
- Incompatibility of logistical information systems.

In their overcoming, one may start from the following attributes of those centers. The substance of the virtual LC architecture is that the scale of such offered logistics services does not depend on the building of new, highly demanding logistical capacities in terms of investment, but on effectively managed cooperation of available vital capacities of logistical resources that already exist. Available capacities are considered to be those resources that, with their functional properties, technical condition, technical and economic parameters, operational readiness and innovation potential, can be integrated into a virtual logistical system.
The spatial integration of the Virtual Logistic Center is limited by multimodal transport availability, and it also is necessary to take into account:

- Envisaged transport intensity between locations;
- Envisaged transport volumes between locations;
- Throughput of roads between locations;
- Throughput of roads in the locations;
- Time necessary for integration;
- Costs of integration.

The provision of integrated logistics services requires the use of capacities of diverse resources, which include buildings, machinery and equipment, as well as the workforce. Individual or group use of available capacities depends on the customer's specific requirement and on the most effective way of meeting it.
In designing a multi-integral concept of a logistics center, a modular and hierarchical architecture is used as a starting point according to Fig. 1 [12]. In general, we can use the following vertical sorting of resources:

- Stable resources;
- Organizational and management resources;
- Mobile resources.

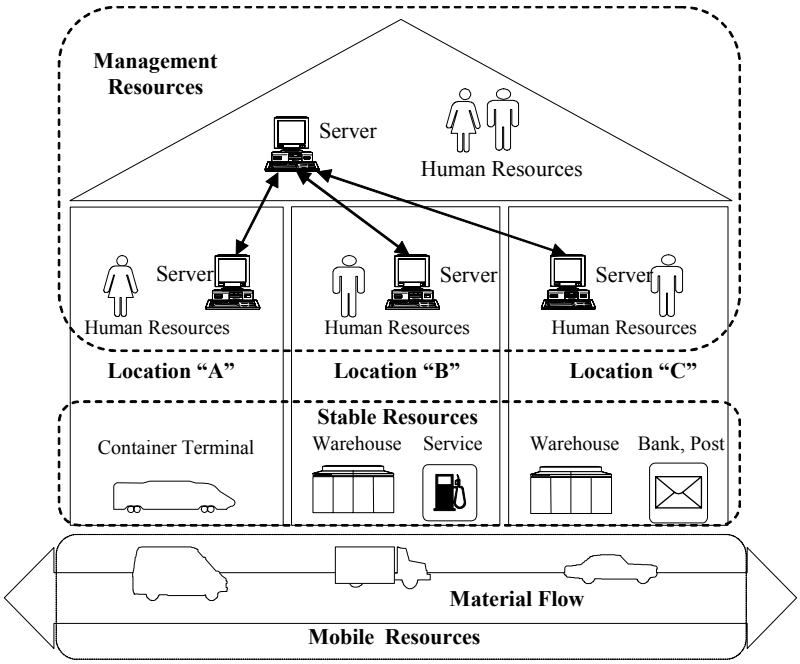

Figure 1 A reference architecture of the multi-integral logistics center

Stable resources are considered to be immovable and movable property, like lands, buildings and machines placed in individual locations. Such resources are, for example, acceptable roads, warehouses, reloading points, stations, container terminals, ports, airports, heavy lifting machines, etc.

Mobile resources are all machines and equipment, human resources and financial capital of companies that can be considered realistically in the structure of a logistical center being created. It is possible to have the above resources available without local limitations, in line with planned logistical services.

We consider information systems of logistics companies and the whole communication infrastructure of individual locations, including the management and servicing potential, to be organizational and management resources, which are coordinated by a multiintegral management system.

It looks that stabile resources even further significantly influence the structure and architecture of the model. With their technical and economic parameters, stable resources limit the extent and territorial coverage of the provided basic and supplementary logistical services. The designed spectrum of logistical services should accept the possibilities of the creation of integrated services by allocating supplementary services to the basic ones. By an analysis of links between locations and characteristics of provided logistical services through stable resources, we can learn that the concentration of services in various decentralized locations may result in the growth of transport volumes.

The decentralization of locations of a virtual logistics center will also show positively in the decrease of the capacity load of the transport routes by the dissipation of transport routes between individual locations and by the optimization of transport chains. Economic influences of decentralization may be evaluated on the basis of real configuration of the deployment of individual resources of the logistical center and specific requirements on the provision of complex logistical services.

The economy of transport between locations in terms of the provision of logistical services does not depend only on technological conditions, but also on transport parameters that are related with the services. The components of those parameters can be divided into the following two groups:

- Internal parameters:
  - Transported volume (daily, monthly, yearly)
  - Transport intensity (number of handling units)
  - Transport distance (distances between locations)
  - Transport costs (sum of costs)
  - Transport time (sum of times).
- External parameters:
  - Increase in the load of traffic along transport routes;
  - Worsening of the characteristics of residential areas, recreational areas and protected areas along the transport routes between locations;
  - Increase in the noise levels along the transport routes between locations;
  - Increase in the level of pollution of the air along transport routes between locations;
  - Worsening of road transport safety indicators.

The above parameters influence the extent of designed complex logistical services. Estimated negative influences can be decreased or completely eliminated in the case when adequate infrastructure does exist between locations, or if it is going to be completed in the near future. In the application of a multi-integral model of a logistics center, a justified dilemma emerges; it concerns the choice between the realization of a multi-integral model and a classic high-capacity model of a logistical center.
Knowing about the following dependencies should substantially influence the decision-making:

- Internal transport costs realized at a specific technical level will proportionally correspond with the changes in the transport volume.
- External transport costs will grow more progressively with the transport volume, as a consequence of special factors. The degree of progressiveness will depend on the use of the transport agents' capacity. The costs grow moderately up to the planned use, but beyond the critical point the costs grow more progressively.
- As a result of permanent negative influencing of the surrounding environment, forces, so-called compensation costs will arise in investment activities, which aimed at reducing negative impacts. Those costs have to be born by involved businesses that form a multi-integral model.

By analyzing the relations, one can come to a conclusion that investment costs of the realization of missing capacities are relatively high, but after the implementation stage, in the utilization phase, further growth is not as progressive as in the case of other costs (Fig. 2). The point at which the total transport costs curve crosses the capacity development costs curve is considered to be the limit point of effectiveness of a multiintegral concept of logistics centers. Beyond that limit of transport costs it is more effective to implement logistical capacity in a classic way, by building up a centralized high capacity logistics center.

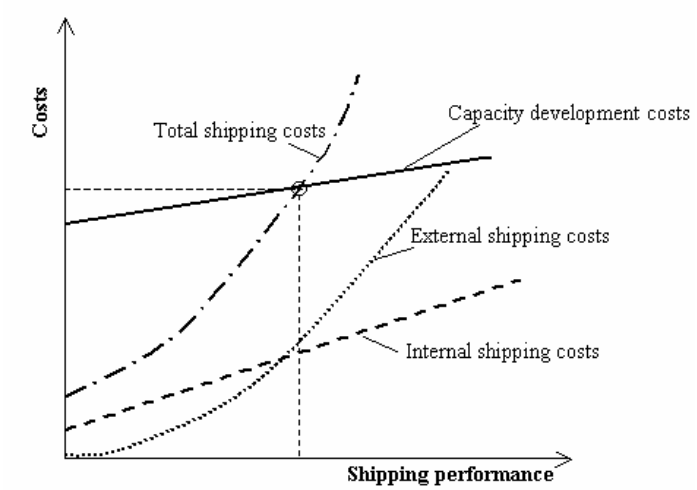

Figure 2 The cost curves that determining break point
of effectiveness of a multi-integral concept of logistics centers

If the economic assumption of the multi-integral concept of LC favorable, it is possible to move to the implementation of framework tasks in its building in the following order:

- Physically isolated horizontal structured VLC resources should be integrated into a central management and information system.
- The information system between individual levels and locations has to be equipped with modern information and communication technology.
- It is necessary to create conditions for effective work of the management of business processes, which solves the provision of the ordered logistical services by the application of supply chains.

6. Conclusion

It is clear visible that companies tend to pick up their distribution activities by integrating themselves into multi-integrating distribution chains. It practically means a change of an accent on the logistical practice from securing storage operations and the subsequent distribution to complex logistical processes focused on the satisfaction of needs of individual retail units. The competitive advantage is manifested by the integration of logistics services and by the increase in the efficiency of material flows through virtual logistics centers. In relation with the virtuality in business, we can meet optimistic as well as pessimistic characteristics of that concept. According to the optimistic view, exactly those smaller forms will correspond with organizational structures that will be the most frequent ones in the future. From that point of view virtual companies meet the requirement of a dynamic capability to meet variable requirements of the market. The need to create a larger team in the past can be explained by an effort to overcome the handicap of narrow specialization of individuals who have not been able to solve more complex tasks individually. Modern information and communication technologies currently provide the individual with much wider opportunities, which is significantly and positively reflected in the development of the theory and practice of management.

Virtuality brings with itself also some limitations, which are related with the key area of each company – the human resources. It is, for example, in the case of the need to fine-tune sensitive personnel issues by the manager towards his subordinate. Then the disadvantage of

the computer communication is that it does not allow the use of elements of non-verbal communication. Similarly, computer communication allows introducing elements of business identity only marginally. Virtual teams are not allowed such a creative discussion as in the case of immediate communication, when inspiration for new ideas occurs on the principles of brainstorming. Nevertheless, from the future standpoint it is very important that intellectual capabilities are becoming the basis of the so-called intelligent company that will be efficient to react to the increasing competitive conditions.

Acknowledgements
This work has been supported by Ministry of Education of Slovak Republic grant MVTS NoT/06-024-00.

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