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WAREHOUSING SYSTEMS IN DISTRIBUTION OF GOODS

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ABSTRACT: Warehousing, as economical process in supply chain, includes a series of specific functions, such as: receiving of goods, consolidation on freights categories for storage according the principles of management at distribution center level, transport of goods to and from the storage place, storage, picking the products for delivery, their assortment, packaging and invoicing, forwarding, transshipment. New warehousing and transport technologies of goods, associated with innovations in the field of informational and communications technologies permit an advanced management of storage areas. By means of their specific functions, warehouse systems are becoming, more and more, fluidization elements of distribution processes, generators and regulators of freight flows.

1. INTRODUCERE

Warehousing has a strategic role in freight distribution channel, as well as in the logistics costs related to distribution process. Added value generated by the warehousing derives from consolidation functions of shipments, products' assortments, clients servicing, and protection against unforeseen events.

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2. FREIGHTS WAREHOUSING SYSTEMS

Distribution center is a notion more and more used in stead of warehouse term. The difference is more than a semantic one. The distribution center could be a warehouse or a depot, either a storeroom or even a logistics platform, without storage facilities, with tasks in transshipment. The logistics platforms dedicated for transshipment tend to replace the storage centers from different levels.

In what is concerned the location decision of distribution centers, this is one of most difficult problems because their construction is costly and difficult to modify.

The underlying decisions in warehousing are related to the possession of warehousing spaces, the option between centralization and decentralization, the number, dimension, locations and the type of storage items. The larger the number of warehouses in logistics system is, the smaller are the transport costs and the lost sales, but bigger are the warehousing and storage costs. At European level is taking place a process of reducing the number of warehousing levels, a process of centralization of distribution patterns, the traditional models with four levels being replaced by them of two levels.

The decision to use the private or pubic warehousing examines the total cost and is affected by the in transit freights volumes, the variation of demand, density of market, the special requirements for physical control, the necessities for customer service, the security and use requirements. In a public warehousing system, the storage spaces in warehouse could be trade by auctions according the existent requirements. The evolved information and communication technologies enable the negotiation of storage spaces for each type of item in real time. On the other hand, private warehousing offers a series of advantages: a more efficient control of goods, flexibility, more reduced costs on long term, as well as a series of intangible benefits.

The warehousing systems, identified in supply chain as nodes, with role in regulation of goods flows, are confronted, first of all, with the problem of management of disposable space. Finding the optimal solution is a problem of option between efficient of storage space and the direct access at stored goods, most of the times maximal use of space determining the inadequate access at stored freights. On the other hand, maximizing the access at stored products induces high cost of capital on product unit, due the underutilization of storage space [2].

It doesn't be neglected also, the operation costs that grow when the warehouse space is maximal used. Increasing the number of stored loading units is generating high human resources cost, by growing the number of needful personnel for handling them, as well as a more difficult control of inventories and a higher risk of goods damage, determined by the superposition of a large number of loading units.

3. DESIGN OF WAREHOUSING SYSTEMS

The main principles for the design of a distribution center consist of: optimal location of storage spaces, efficient use of handling equipment for materials, use of an effective storage plan, space minimization for the movements and the use of maximal height of the building.

Spatial structure, organization into the warehouse has to be realized taking in account the logical order of different specific operations. This depends on the freight characteristics, the additional processes appropriate to different goods with special warehousing and handling requirements.

The special conditions of temperature, ventilation for some types of goods determine distinctive locations in the warehouses, with specific facilities and equipments. The warehouse dimension has to take in account the different functions of the different spaces. The entire surface of the warehouse is calculated as sum of areas allocated to storage, receiving, dispatching, handling and transport, to different technological operations (packing, unpacking, sorting, labeling, preparing of delivery), the personnel access, the equipment overhead.

Storage capacity of a warehouse depends on the whole available build space and, therefore, on the theoretical estimated storage capacity. In warehouse management, an important indicator is the use rate of warehouse capacities, being known the yearly flows of materials that are in transit through the warehouse.

The most important area of a warehouse integrates the storage area S_d and the area for the transport and handling of goods S_m. The storage area is determined function of the maximal stock that could be stored Q and the specific loading on surface unit p[t/m^2]:

$$S_d = \frac{Q}{p} \quad (1)$$

The handling area is determined by the width of aisles necessary for handling and transport, taking in consideration a needful safety space between the equipments and the storage spaces of goods during the movement operations. Taking in account the necessary space for access, handling, picking, aisles, sorting and processing, as well as the transport of vehicles and handling systems, this is multiplied with a multiplication factor, in practice, being used 3 value.

There are, also, a series of types of models related to planning in the warehouse, one of these concerning the determination of products types and associated quantities stored in a storage area. These models envisage also the minimization of wage costs in order picking and re-supply of those areas. Such a plan for location of products could be:

a) fixed, static, by assignment of a determined space for each product;

b) dynamic, that supposes the assignment of storage areas for different products groups and the effective storage place being established with specific methods.

In the same class of planning problems in warehousing management could be included the minimization problems of transport distance and time of vehicles or picking systems, to collect the delivery orders. Orders delivery supposes picking of stored products, their assortment for clients with large required range of products and making the load units. When these orders could be delivered immediately, they are directed to a loading area. Thus, they'll take place in the proximity of shipment area, in buffer space allocated for goods to be forwarded.

4. DETERMINATION OF NEEDFUL HANDLING SYSTEMS AND VEHICLES FOR INTERNAL TRANSPORT

Determination the number of handling and transport means could be realized based on estimated handled and transported quantities in the warehouse. The number of handling operations is determined by the location of products in the distribution center. Consequently, the handling systems are selected function of storage system and storage coefficient C_s, definite as ratio between the storage height *h* and the width of needful space for handling *l*.

$$C_s = \frac{h}{l} \quad (2)$$

In determination of necessary handling and transport systems, in addition to the direct costs of handling and transport, could be taken in consideration also the associated cost for freights, waiting the handling and transport means for loading/unloading operations C_a, as well as the afferent cost of handling systems that wait because of freight scarcity C_u [3], costs which are determined with the relations:

$$C_a = \overline{m} \cdot c_a \quad (3)$$

where c_s represents the average cost of waiting time on unit load;

$\overline{m}$ - average length of load units query that are waiting for handling;

respectively:

$$C_u = \overline{t_u} \cdot s \cdot c_u \quad (4)$$

where c_u represents the average cost of vehicle waiting time on time unit due to the lack of freight ;

$\overline{t_u}$ - average waiting time of handling systems;

s – number of handling means;

Location of areas with diverse functions in warehousing systems and the allotment of load unit to storage spaces have to envisage the reduction of associated costs of freight transport within the warehouses. Optimization function can be formulated:

$$\sum_i \sum_j C_{ij} = \min \qquad (5)$$

where C_{ij} represents the cost associated to the transport of a unit from product j from receiving point to *i* storage area and from that to the dispatching point.

There could be taken also as optimization criterion the minimization of transport time of freights within the warehouse [1].

For appropriate distribution of goods at storage places it is necessary to take in consideration the characteristics of different products. It is realized, hereby their allotment by groups and, subsequently, the identification of every freight unit within the group. It is supposed the fact that every freight group has allotted a distinguish space for storage.

It being known the got in and out quantities on freight types, respectively the number of load unit there could be determined the number of movements from receiving area to storage place function of maximal loading capacity of transport vehicles (tab.1.):

Table 1. Number of movements from receiving point – storage – dispatching point

Freight type	**Entered quantities**	**Exited quantities**	**Races no. R-S**	**Races no. S-E**
M_1	a_1	b_1	nc_{r1}	nc_{e1}
M_2	a_2	b_2	nc_{r2}	nc_{e2}
M_3	a_3	b_3	nc_{r3}	nc_{e3}
…	…	…	…	…
M_n	a_n	b_n	nc_{rn}	nc_{en}

where R – receiving point;

S – storage place;

E – disapatching point;

nc_{ri} - number of movements from receiving point to storage places for freight i;

nc_{ei} - number of movements from storage places to dispatching point for freight i;

$$nc_{ri} = \sum_{j=1}^{m} nc_{rij} \ , \qquad (6)$$

$$nc_{ei} = \sum_{j=1}^{m} nc_{eij} \ , \qquad (7)$$

where nc_{rij} –number of movements from receiving points r to storage places j for freight i;

nc_{eij} –number of movements from storage place j to dispatching point e for freight i;

There are identifying, for every freight type, the distances from receiving points to storage places, for entered freights and also the distances from storage places to dispatching points, for exited freights. (tab.2):

Table 2. The distances from receiving points – storage – dispatching points

	S_1	S_2	S_3	…	S_j	…	S_m
Entrance	d_{r1}	d_{r2}	d_{r3}	…	d_{rj}	…	d_{rm}
Exit	d_{1e}	d_{2e}	d_{3e}	…	d_{je}	…	d_{me}

where d_{rj} – the distance from receiving point to storage place j;

d_{je} – distance from storage place j to dispatching point.

It is possible to obtain a matrix of transport costs multiplying the number of movements between the receiving area and the storage one with cost on distance unit c_u and the distances from the second table (tab.3.):

Table 3. Costs matrix of movements within the warehouse

	S_1	S_2	S_3	…	S_m
M_1	C_{11}	C_{12}	C_{13}	…	C_{1m}
M_2	C_{21}	C_{22}	C_{23}	…	C_{2m}
M_3	C_{31}	C_{32}	C_{33}	…	C_{3m}
…	…				
M_n	C_{n1}	C_{n2}	C_{n3}	…	C_{nm}

where C_{ij} represent the total costs of transport within the warehouse of freight i that is stored at storage place j :

$$C_{ij} = (nc_{sij} \cdot d_{rj} + nc_{eij} \cdot d_{ej}) \cdot c_u \qquad (8)$$

5. CONCLUSIONS

Warehousing of goods, one of the key elements in freight distribution, knows a stage of transformations generated by a long series of innovations in technologies direction. New warehousing and transport technologies of goods, associated with innovations in the field of informational and communications technologies permit an advanced management of storage areas. By means of their specific functions, warehouse systems are becoming, more and more, fluidization elements of distribution processes, generators and regulators of freight flows. Just in time techniques used in delivery of goods, integrated management of supply chain reconfigure the activities that take place in supply chain nodes, generating new warehouse systems.

REFERENCES

[1] Cataramă I. (1993) – Transport industrial. Teoria generală a maşinilor şi instalațiilor pentru manipulare de mărfuri, UPB, Bucureşti

[2] Gattorna, J.L. (1999) – Managementul logisticii şi distribuției, Ed. Teora, Bucureşti

[3] Hagiac R., Dinescu I., Georgescu C. (1977) – Transportul paletizat şi containerizat al mărfurilor, Editura Tehnică, Bucureşti