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*hard logistics HL,*
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# TECHNOLOGICAL LOGISTICS HL AS A FACTOR IN DISTRIBUTION NETWORK EFFECTIVENESS

The development of the theory of distribution organisation, *SoftLogistics* ***SL***, has reached the stage, where it has become necessary to consider the physical features of distribution tools, such as trucks and material handling equipment. There are a number of technical solutions of *HardLogistics* ***SL***, considerably increasing the economical effectiveness of the whole supply chain. The problem discussed in the paper treats the whole supply chain, but it is most important in the area of the supply network, where connections between means of transportation (trucks) and materials handling equipment (craned and forklifts) are most vital.

# LOGISTYKA TECHNICZNA HL JAKO ELEMENT EFEKTYWNOŚCI SIECI DYSTRYBUCJI

Rozwój teorii organizacji odstaw dystrybucyjnych *SoftLogistics* ***SL*** osiągnął stan, przy którym niezbędne stało się uwzględnienie cech fizycznych narzędzi dystrybucji, jakimi m.in. są pojazdy samochodowe oraz urządzenia przeładunkowe. Istnieje wiele rozwiązań technicznych logistyki narzędziowej *HardLogistics* ***SL***, wpływających w istotny sposób na efektywność ekonomiczną całego łańcucha dostaw. Problem poruszony w referacie dotyczy całego łańcucha logistycznego, jednakże największe znaczenie ma w sieci dystrybucji, gdzie stopień powiązania środków transportu dalekiego (pojazdów samochodowych) ze środkami transportu bliskiego (urządzeniami przeładunkowymi) jest największy.

## 1. INTRODUCTION

A significant proportion of goods is supplied in palette units. Therefore, among means of transport used in a supply chain, (Fig.1) an important role is played by trucks equipped with lifting devices, which are especially convenient in cases where palette units have to be handled. Such devices include: truck loaders, lifting tables, forklifts and loading platforms (Fig.2).

The commonly applied selection criteria for these devices are their basic parameters, e.g. their load capacity, manufacturer and price. This kind of approach does not ensure

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optimal economical efficiency. The selection procedure for such a device should consider – apart from technical and cost aspects – also the impact of technical and operation parameters. Economically efficient selection of a technical solution for materials handling problems within a supply chain affects also the other elements of the logistic system and belongs to the domain of *„HardLogistics" HL*, and is an important supplement to the decision processes of *„SoftLogistics" SL*.

Transport in logistics [1][2], especially in the supply domain, generates a significant proportion of the entire system's costs. This regards especially distribution. These costs can be minimised through proper aggregation of trucks and materials handling equipment, which requires all factors influencing the economical efficiency of transport services to be considered. The importance of reducing transport costs in the supply chain is illustrated in Fig.3. The relation between economical efficiency and aggregation of a truck with a lifting device can clearly seen in channels of removal, too.

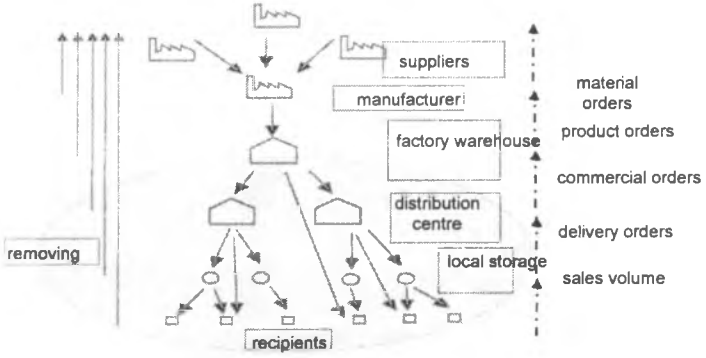


Fig.1. The supply domain in the logistic system

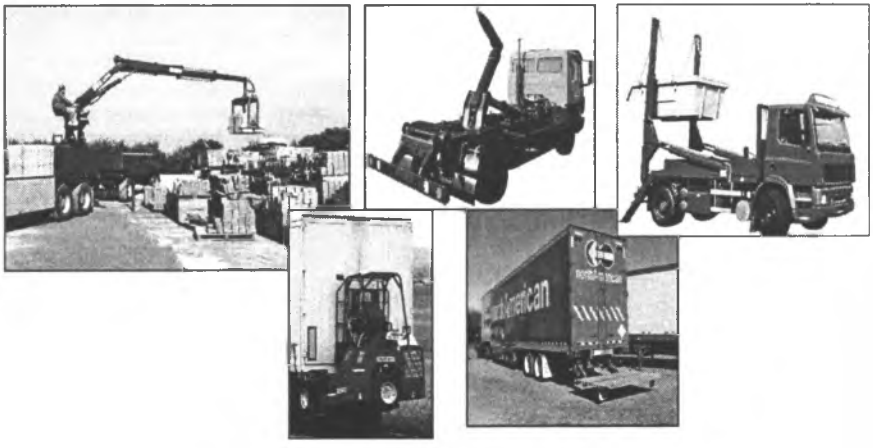

Fig.2. Lifting devices on trucks in the supply chain

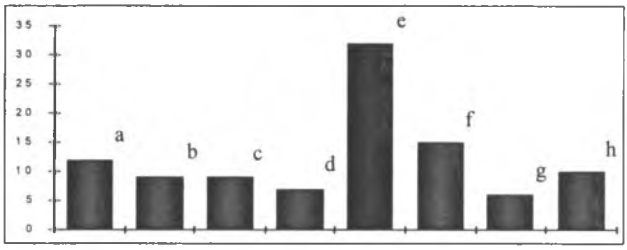


Fig.3. Structure of costs of a logistic system [3]

*a- supply transport, b- materials, c-purchasing and storage costs, d- production, e- distribution transport, f- warehousing and forwarding, g- distribution financing, h- sales management*

Lifting devices on trucks are a source of added value [4], expanding the range of services not only by handling the goods, but also by delivery of the goods to a specific location; for example, a portable crane makes it possible to deliver a palette to a higher floor or roof of a building.

## 2. TECHNICAL AND OPERATING CONDITIONS FOR INSTALLATION OF LIFTING DEVICES ON TRUCKS

Mounting a crane often involves:

1. selecting the mounting point (between the cab and the cargo space or behind the cargo space, on the so-called rear overhang),
2. reinforcing the chassis frame (see Fig.4, 5), by adding an auxiliary frame, which – geometrically and mechanically – corresponds to the chassis frame and is coupled with it,
3. shifting or shortening the cargo space – or both,
4. installing a power supply for the crane, e.g. installing a hydraulic pump with its power supply (e.g. a power take off at the truck's gearbox), and a control system for crane's power supply,
5. shifting the rear axle beam with the towing attachment.

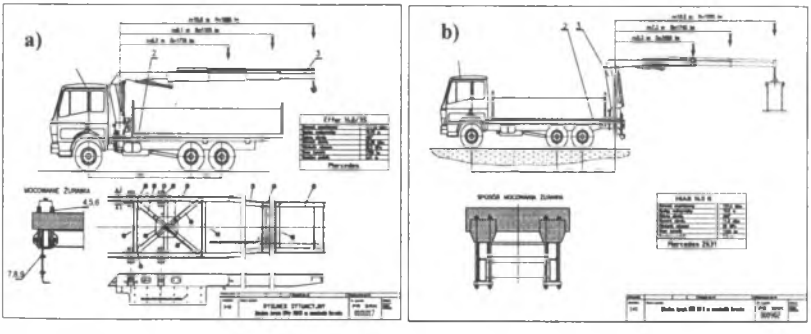


Fig.4. Additional frame for installation of a loader

The size of the crane, defined by its lifting capacity $Q$ and its lifting moment $M_Q$, should be adapted to the size of the truck. One of the technical parameters of a crane, connected with the lifting moment $M_Q$, is its mass. The weight of the crane and the construction elements necessary to install it (Fig.4) is an additional load for the truck (Fig.6) and must be considered with regard to:

1. the overall strength of the vehicle, as its load capacity is reduced,
2. the steerability of the empty vehicle when it has a crane mounted at the back of the cargo space (the weight of the crane reduces the pressure of the truck's front axle beam).

Cranes should be selected considering the whole range of expected operating tasks. This obvious statement is usually understood as lifting capacity $Q$. However, operating conditions determine not only the lifting capacity, but also the required lifting moment $M_Q$ and the lifting characteristic (the largest mass that can be lifted within the crane's reach).

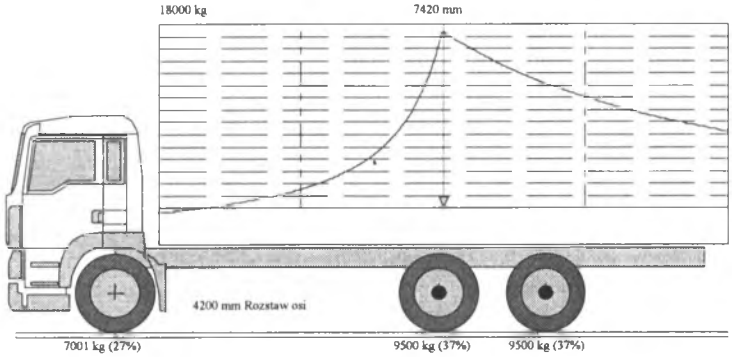


Fig.5. Allowable load of the chassis frame of a MAN TGA 26.350 6x4 truck (frame is not reinforced)

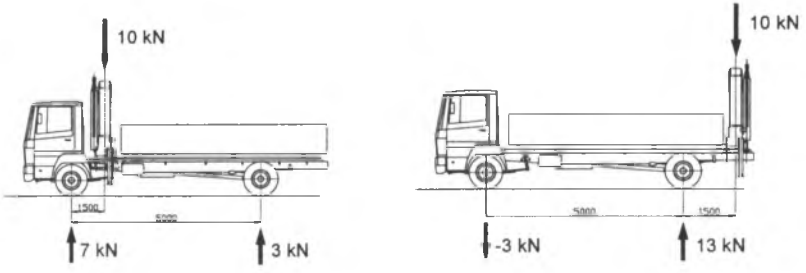


Fig.6. Influence of weight of the crane on a vehicle's axle loads

Proper selection of the crane bears fundamental significance to operating efficiency. Basic criteria include: the operating environment, the crane mounting point, the size of a single batch of goods to be handled. Additional criteria, derived from the basic ones, allow for a comparison of cranes available on the market.

## 3. TECHNICAL AND OPERATING CONDITIONS FOR INSTALLATION OF LIFTING DEVICES ON TRUCKS

The technical and operating conditions are presented in simplified form, as a case of delivery of a batch of goods on palettes, via road transport. An arbitrarily chosen on-board crane is the lifting device (optional). A full analysis will also include all other typed of lifting devices, i.e. forklifts installed under the chassis frame or on the rear overhang, rear or side loading platforms, which can be straight or folded.

It is assumed that the road transport company operates in the palette-packed goods distribution sector. There exists a specific supply of shipments $P_r$, which are transported over an average distance $S$. The transport is done by trucks, which have a specific load capacity. A truck *may* be equipped with a crane and *may* tow a trailer.

Five possible truck configurations were assumed. These configurations are presented in Fig.7, together with their denotations.

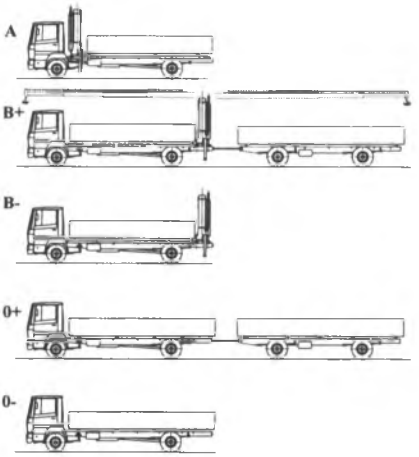


Fig.7. Variations of crane mounting on a truck

Transporting unit *A* is a truck equipped with an on-board crane mounted behind the cab. The crane size has been selected accordingly to the size of the truck. Transporting unit *B+* consists of a truck with a crane (mounted at the back of the cargo space) and a trailer. After disconnecting the trailer, truck *B+* becomes truck *B-*. A truck without a crane has been designated by the symbol: *0+* in the case, where it has a trailer, and 0-, when it does not. For this truck, goods are loaded and unloaded using rented handling devices.

In each of these configurations, identical initial technical and operating parameters of the truck and crane were assumed for identical supply tasks. These parameters were then corrected accordingly to the operating requirements – mainly the reduced load capacity of a truck carrying a crane (see Fig.6) by approx. 40% (configuration *A*) or approx 50% (configuration *B*) and reduction of cargo area by more than 20% as a result of shortening of the cargo space in a truck equipped with a crane.

## 4. EFFICIENCY ANALYSIS AND SELECTION OF A *HL* SOLUTION

A comparative analysis of the economical efficiency of a transporting unit should be supplemented with elements of technical and operating analysis.

Goods' handling in the supply chain is often performed at network nodes with limited accessibility of loading, unloading and storage sites. Technical limitations of this kind may determine the choice of the handling device.

The economic part of the analysis should consider the crane's operating costs, including costs resulting from obligatory maintenance and checkups. On the other hand, in the case where a lorry is not equipped with a handling device, the analysis should consider the cost of renting one.

A comparative analysis was carried out for the economical efficiency of five versions of a transporting unit (see Fig.7). The analysis considers more than 60 parameters, including the influence of the crane installation on the truck. Thus, obligatory costs of maintenance, registering and regular UDT technical inspections are considered. Salaries for UDT-certified drivers (who are authorised to operate a crane) have been differentiated from salaried for non-UDT-certified drivers (Fig.8).

Other operating parameters that were differentiated include the cruising speed of different types of trucks, goods handling time according to the chosen handling method and rental costs when using borrowed equipment – see [5].

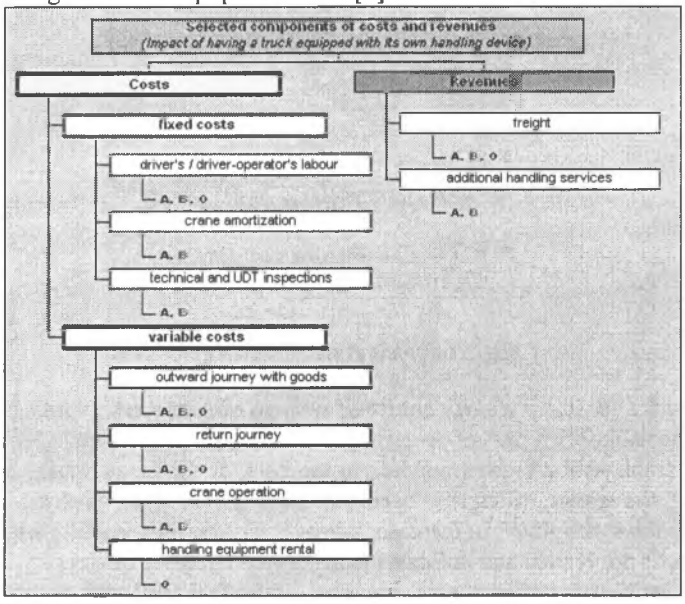


Fig.8. Structure of costs and income

The aim of hard logistics *HL* is selection of devices. The criterion for selection of devices for supply transport is maximisation of profit gained from operating a truck.

A sound selection of a handling device should be performed in a formalised manner, in accordance with a verified procedure. This procedure, besides preliminary partial criteria, resulting from managerial decisions, should contain measuring instruments to compare different devices within a range narrowed down by these criteria.

The initial criterion is defined accordingly to the transport company's strategy and includes elements of *SL – SoftLogistics* and *HL – HardLogistics*. The *HL* criteria are formulated on the basis of *SL* criteria. Depending on these assumptions, *HL* criteria can be made in the form of filters, gradually narrowing down the scope of optimal choice. Here are some examples of such filters– starting from the simplest:

- $F_1$ indicator = *price of the crane /lifting moment* allows for comparison of devices with regard to the price of a unit of crane size,
- $F_2$ indicator = *crane mass / lifting moment* classifies devices with regard to engineering quality and workmanship

$$g = \frac{c_z}{G_z}$$

and ending with the more complex ones:

- $F_3$ indicator = *relative unit price of a* **devices** *operating potential*

$$m = \frac{M_{Q\max} \cdot R_h}{K_i}$$

- $F_4$ indicator = *price of a* **devices** *quality*

$$w = \frac{1}{l \cdot G_z \cdot K_i} \cdot \left[ n \cdot M_{Q\max} \cdot R_h + k \cdot \left( R_{\max} - R_h \right) \right]$$

where: $c_z$- price of the crane, $G_z$- weight of the crane, $M_{Qmax}$- highest lifting moment, $R_h$- longest hydraulically controlled reach, $K_i$- investment costs, $R_{max}$- maximum reach, *k, l, n* – weight coefficients.

For example, Fig.9 presents the value of the $P_3$ indicator for several cranes:

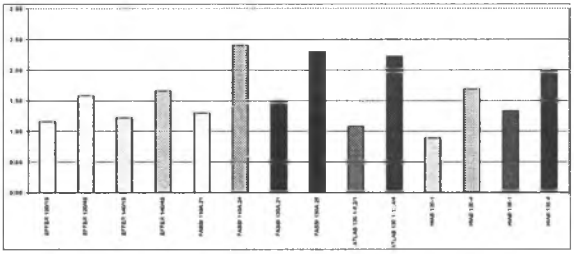

Fig.9. Relative unit price indicator of the operating potential of selected cranes

The device selection filter should be developed especially carefully, due to its significant impact on the efficiency of a transporting unit, especially in the domain of

supplies, where transport routes are relatively short, and the number of handling operations is large (see Fig.10).

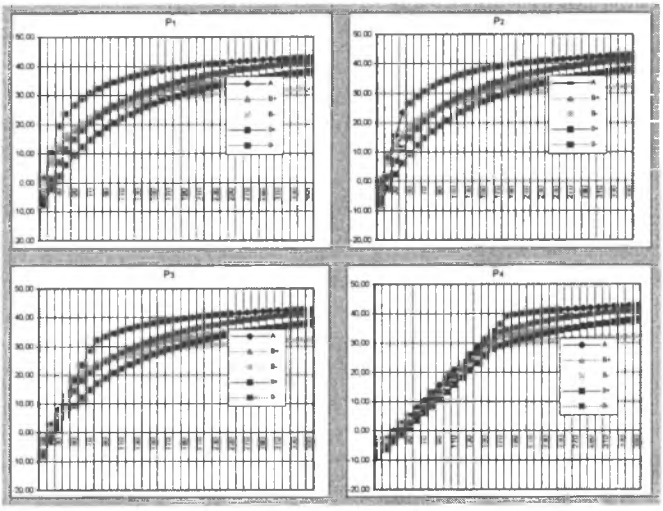

Fig.10. Relative economical efficiency versus mileage and goods supply

## 5. FINAL REMARKS

The dynamic development of logistic systems, which has its source in the economic and information technology sciences, has made a full circle. Logistics, as an economic and organisational discipline of science, whose development was made possible due to the existing technical potential, is reaching a state of saturation and the system-oriented approach to the supply chain cannot neglect the influence of technical solutions any longer.

This regards especially the domain of distribution and storage. Therefore, closer co-operation between soft logisticians and hard logisticians is inevitable, where soft logisticians have knowledge of economics, organisation and management, and the hard logisticians have the task of expanding their technical skills with basic logistic knowledge.

## BIBLIOGRAPHY

[1] SKOWRONEK CZ., SARJUSZ-WOLSKI Z., Logistyka w przedsiębiorstwie, PWE Warszawa 1999.
[2] GOŁEMBSKA E., Logistyka jako zarządzanie łańcuchem dostaw. AE Poznań 1994.
[3] SAVY M., STELLA Workshop ICT, Innovation and the Transport System Arlington, VA. 15 –17.01.2002.
[4] BEIER F.J., RUTKOWSKI K., Logistyka, Szkoła Główna Handlowa Warszawa 1998.
[5] TARKOWSKI J. , IRESTÅHL B., LUMSDEN K., Transport – Logistyka; Instytut Logistyki i Magazynowania, Poznań.

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