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# ASSESSMENT OF THE USE OF FORKLIFTS IN THE MATERIAL HANDLING PROCESS

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***Abstract:***
*The paper deals with assessment of the use of forklifts in the selected operation. It was made on the basis of calculations of three selected indicators - the coefficient of time utilization, the coefficient of time utilization of partial operations and the coefficient of average load. The assessment was performed on consecutive phases - the observation and measurement, the processing of measured values and the calculation of indicators. Conclusions were evaluated based on the obtained values.*

***Key words:***
*Manipulation, assessment, indicators.*

## INTRODUCTION

Material handling is the professional movement, warehouse and guidance of material (raw materials, semi-product and products) throughout manufacturing, circulation and warehousing. Material handling represents the integrated chain of material movement within the company. Handling process consists of handling operations (main and auxiliary) necessary for its implementation. Handling operations ensure removing the material from the place of occurrence to the place of consumption. There are three main handling operations: transport, reloading and warehousing. The material handling incorporates a wide range of manual, semi-automated and automated equipment and systems [1]. The economical operation principles be followed when handling material such as the reduce handling to a minimum, to minimize transport distance of movement, the fluent movement with minimal interruption, the standardized handling equipment and the like. Material handling performance can be characterized by several indicators [2].

## 1 THE ASSESSMENT METHODOLOGY OF USING FORKLIFTS

The assessment was made on the basis of selected operational indicators. There were selected indicators for assessment: the coefficient of time utilization $c_t$, the coefficient of time utilization of "n" handling equipment $c_{t_n}$, the coefficient of time utilization of partial operations $c_{t\,po}$ and the coefficient of average load capacity $c_L$ [3, 4].

The coefficient of time utilization is given by simple formula

$$c_t = \frac{t_a}{t_r} \cdot 100 \quad [\%] \tag{1}$$

where $t_a$ - the actually worked hours of machines, the time worked of a forklift in the monitored
period in hours (min); i.e. time after which the device delivers the performance,
$t_r$ - the number of hours in which the individual devices were available.

The coefficient of time utilization of "n" forklifts is given by formula

$$c_{t_n} = \frac{\sum_{i=1}^{n} t_{a_i}}{t_r \cdot n} \cdot 100 \quad [\%] \tag{2}$$

The coefficient of time utilization of partial operations is given by:

$$c_{t\,po} = \frac{t_{a_{po}}}{t_r} \cdot 100 \quad [\%] \tag{3}$$

where $t_{a_{po}}$ - the actually worked hours of machines on the respective partial operations (loading,
unloading, transhipment, movement).

The coefficient of average load capacity is given by formula

$$c_L = \frac{q_m}{C_{FL} \cdot n_r} \cdot 100 \quad [\%] \tag{4}$$

where $q_m$ - the average manipulated mass of material for the monitored period in tones,
$C_{FL}$ - a forklift load capacity, in tones,
$n_r$ - the average number of rides for the monitored period.

The assessment procedure was realized in three phases.
The first (preliminary) phase; the first phase steps are:
1. Selection and characterization of handling equipment in operation.
2. Observation and measurement of selected parameters of handling equipment.
The second phase - the processing of measured values.
The third phase - the results (calculation of indicators) and discussion.

## 2 THE FIRST (PRELIMINARY) PHASE

A handling equipment assessment was performed in the selected operation - small distribution warehouse. The function of this warehouse is to store products and to fulfill orders of external customers. For evaluation were selected forklifts. A forklift (also called a lift truck, a fork truck, or a forklift truck) is a powered industrial truck used to lift and move materials at short distances. A forklift realizes a typically activities in warehouse: receiving, storage, picking and moving to the loading place, loading of vehicles. These activities are realized in two working shifts. The five forklifts ware deployed in the first work shift. Two forklifts were deployed in the second work shift. Table 1 presents the realised activities in the work shifts [4]. Table 2 shows the parameters of deployed forklifts.

***Tab. 1*** *The warehouse activities*

| | | |
|---|---|---|
| 1st work shift | 06:00 - 10:00 | - removal of picking goods by loading onto transport vehicles, on the basis of incoming orders, |
| | 09:00 - 14:00 | - unloading of ordered goods and storing in racks,<br>- removal of goods for direct customers (the direct purchase in warehouse), |
| 2nd work shift | 14:00 - 16:00 | - unloading of ordered goods and storing in racks,<br>- removal of goods for direct customers (the direct purchase in warehouse), |
| | 16:00 - 21:00 | - picking of goods, by received orders, into the space of expedition, that distribution will be realized on the following day,<br>- movement of materials within warehouse (relocation). |

***Tab. 2*** *Forklifts parameters*

| | **Jungheinrich** | **Linde** | **Gekkon** | **Baumann1** | **Baumann2** |
|---|---|---|---|---|---|
| work shift | 1st and 2nd | 1st | 1st | 1st and 2nd | 1st |
| load capacity [kg] | 3750 | 4000 | 1750 | 4000 | 4000 |
| power drive | electrical | electrical | diesel | electrical | diesel |
| lift [mm] | 5000 | 5200 | 4015 | 4500 | 4500 |

It was necessary to perform time measurement directly in the operation for the calculation of selected indicators.

The following data were monitored:

- the type of handled material,
- the direction of movement (e.g. vehicle - rack),
- transport distance,
- the number of driving with/without load,
- weight of the load,
- loading time,
- driving time,
- unloading time,
- time losses during operation.

The data collection was done in three independent working days. The data collection was realized in two work shifts.

## 3 THE SECOND PHASE - THE PROCESSING OF MEASURED VALUES

The obtained data for each forklift for different measurement days were summarized to daily records [4]. Figure 1 shows the number of forklifts turnovers for 1st and 2nd work shift on the first day of measurements. During the first monitoring day, forklifts realized 342 turnovers. The forklift Jungheinrich performed the largest number of cycles during the day, 37 % of total turnovers. The average transport distance is 75 m, on a forklift turnover during the monitored day.

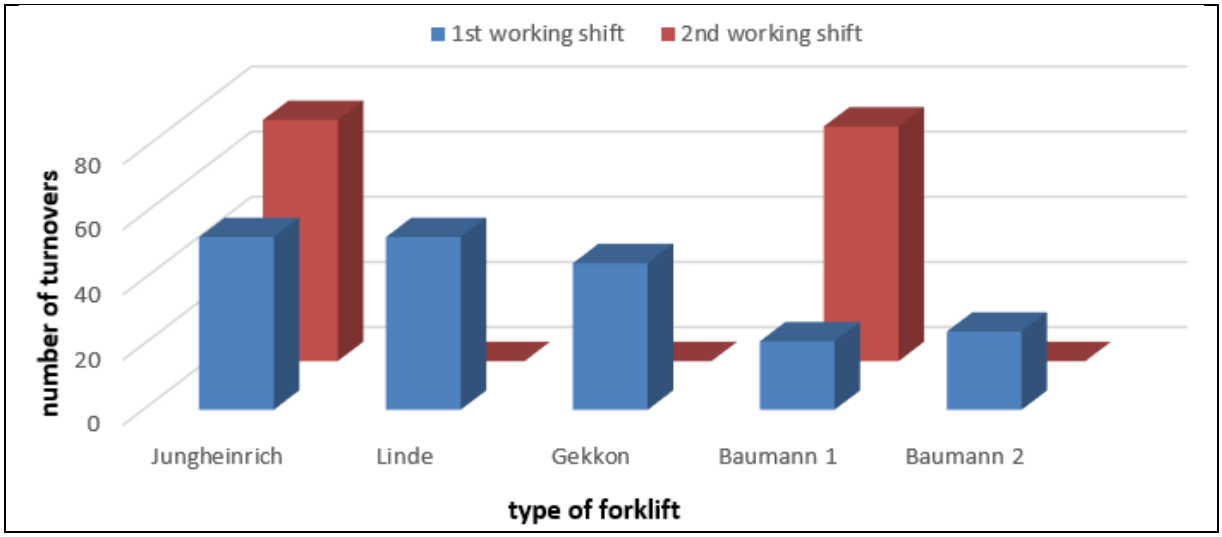


***Fig. 1*** *The number of forklifts turnovers on the first measurement day*

Tables 3 and 4 show the average values obtained from measurements over three days, for each forklift and work shift.

***Tab. 3*** *The average data for 1st working shift*

| | Jungheinrich | Linde | Gekkon | Baumann 1 | Baumann 2 | Overall |
|---|---|---|---|---|---|---|
| working time [min] | 246 | 338 | 281 | 113 | 124 | 1102 |
| transported volume [kg] | 25450 | 19215 | 19825 | 11250 | 15250 | 90990 |
| loading time [min] | 43.5 | 69.5 | 58 | 36.5 | 45.5 | 253 |
| unloading time [min] | 62.5 | 84.5 | 87 | 37.5 | 36.5 | 308 |
| driving time with/without load [min] | 101 | 123 | 108.5 | 36.5 | 46 | 415 |
| average distance [m] | 3720 | 4870 | 4350 | 1400 | 1960 | 16300 |

***Tab. 4*** *The average data for 2nd working shift*

| | Jungheinrich | Baumann 1 | Overall | The sum of 1st and 2nd work shift |
|---|---|---|---|---|
| working time [min] | 376 | 321 | 697 | 1799 |
| transported volume [kg] | 16850 | 23650 | 40500 | 131490 |
| loading time [min] | 83 | 92 | 175 | 428 |
| unloading time [min] | 86 | 101 | 187 | 495 |
| driving time with/without load [min] | 137.5 | 87 | 224.5 | 639.5 |
| average distance [m] | 5890 | 4660 | 10550 | 26850 |

## 4 RESULTS AND DISCUSSION

Data from Tables 2, 3, 4 and Figure 1 were the basis for calculating indicators from chapter 1. Table 5 shows the parameters input to the calculation and calculated parameters according to equation (1), (3) and (4).

***Tab. 5*** *Input and calculated values*

| Parameters | Jungheinrich | | Linde | Gekkon | Baumann1 | | Baumann2 |
|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 1st | 1st | 1st | 2nd | 1st |
| $t_a$ [min] | 246 | 376 | 338 | 281 | 113 | 321 | 124 |
| $t_r$ [min] | 445 | 445 | 445 | 445 | 445 | 445 | 445 |
| $t_{a_{po}}$ [min] | 106 | 169 | 154 | 145 | 74 | 193 | 82 |
| $q_m$ [kg] | 25450 | 16850 | 19215 | 19825 | 11250 | 23650 | 15250 |
| $C_{FL}$ [kg] | 3750 | | 4000 | 1750 | 4000 | | 4000 |
| $n_r$ | 53 | 74 | 53 | 45 | 21 | 72 | 24 |
| $c_t$ [%] | 55.28 | 84.49 | 75.95 | 63.14 | 25.39 | 72.13 | 27.86 |
| $c_{t\,po}$ [%] | 23.82 | 37.97 | 35 | 33 | 16.63 | 43.37 | 18 |
| $c_L$ [%] | 12.8 | 6.07 | 9.06 | 25.17 | 13.4 | 8.21 | 15.88 |

The coefficient of time utilization of five forklifts is 49.52 % in the first work shift, calculated according to the equation (2).

The coefficient of time utilization of two forklifts is 78.31 % in the second work shift, calculated too according to the equation (2). If in the calculation were included other tree non-working forklifts, the calculated coefficient would be reduced to 31.32 % in the second work shift.

The average value of coefficient of time utilization of all work forklifts is 57.75 % during both work shifts. On the basis of calculations it can be concluded that the forklifts over time are not adequately exploited on a given site.

As shown in Table 5, a coefficient of time utilization of partial operations (loading and unloading) is in the range of 18-43 % for each forklift during the work shift, calculated according to equation (3).

Figure 2 shows the percentage of time utilization of partial operations (loading and unloading), from the actual time worked forklifts (in the equation (3) the value of $t_r$ was replaced by the value $t_a$). As shown in Figure 2 partial operations accounted for 44-66 % of the time worked forklifts (blue colour). The residual time is a movement of the forklift - a movement in the horizontal direction (red colour).

Table 5 shows that the coefficient of average load capacity is very low in the range of 6-25 % calculated according to equation (4). The low value of the coefficient is caused because by the forklifts manipulated bulky but lightweight material. For this reason, the load capacity of forklifts used in operation is not sufficiently utilized. It can be concluded that all forklifts are oversized for the conditions.

## 5 CONCLUSIONS

The paper indicated assessment of forklifts time utilization and their load in operation. Based on the measurement and calculation of selected indicators it can be concluded that forklifts are used incorrectly in the operation. That finding has advantages and disadvantages.

The advantage is that the current number of forklifts represents a sufficient reserve in case of increase operations in the future. The disadvantage is that incorrect use of forklifts

have a negative impact on the financial side of business (maintenance, regular inspection, moral deterioration, etc.).

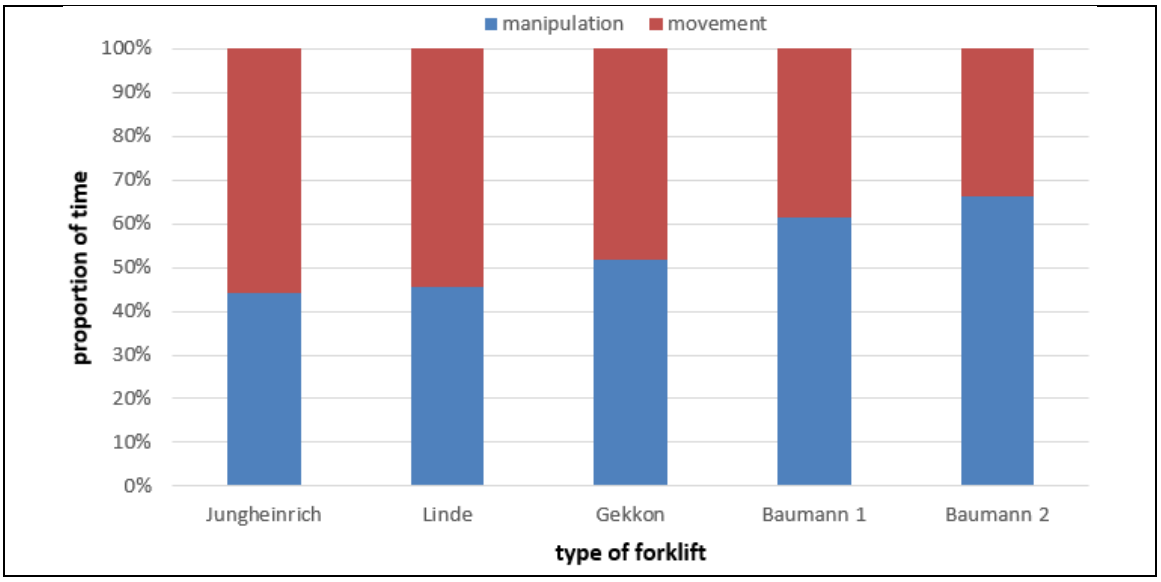


***Fig.2*** *The proportion of time for the movement and manipulation operations (loading and unloading)*

It would be appropriate to conduct a thorough financial analysis of the operating costs of forklifts for the operation, in this case [5].

A further possibility is to calculate the required number of forklifts based on historical data [6]. The calculated required number of forklifts subsequently verified by simulation. If is necessary the reducing of current number forklifts, it is required be suitably selected as choose appropriate type of the forklift also type of reduction process (disposal, divestment, etc.) e.g. on the basis of multi-criteria evaluation [7].

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**References**

[1] Šaderová, J., and Rosová, A., 2015, "Passive and active elements of logistics in transport, handling and storage" TU, Košice, 126 p. [CD-ROM] (in Slovak).

[2] Rosová, A., 2010, "Controlling and logistics of industrial plant 2," ES F BERG TU, Košice, 96 p. (in Slovak).

[3] Šaderová, J., 2002, "The time utilization of the hydraulic excavators and frontal loaders in OPC Čierna nad Tisou," Transport & Logistics: the International Journal, 2(3), pp. 95-101.

[4] Sabol, Ľ., 2013, " Indicators of manipulation in the selected company," F BERG TU, Košice, p. 65 (in Slovak).

[5] Teplická, K., 2015, "Process view of the company costs and their impact on efficiency," VŠB - TU, Ostrava, 66 p. (in Slovak).

[6] Klapita, V., and Ližbetin, J., 2010, "Warehouses and storage," Žilinská univerzita, Žilina, 132 p. (in Slovak).

[7] Andrejiová, M., Kimáková, Z., and Marasová, D., 2013, "Using AHP method at the determination of the optimal selection ctriteria of conveyor belts," Annals of Faculty Engineering Hunedoara - International Journal of Engineering, 11(2), p. 155–160.