STATISTICAL HEURISTIC MODEL OF INTERNAL PASSENGER TRANSPORT OF METALLURGICAL ENTERPRISE

Dušan MALINDŽÁK [1], Renata PIĘTOWSKA-LASKA [2]

[1]*Technical University of Košice, Košice, Slovakia, EU, dusan.malindzak@tuke.sk*

[2]*Rzeszow University of Technology, Rzeszow, Poland, EU, rlaska@prz.edu.pl*

Abstract

The article describes a case study of internal transport solutions for persons of executive managers, dispatchers, maintenance staff, referents in the company spread over large premises of technological facilities, warehouses, administrative buildings, managerial centers, transport routes (metallurgical complex, chemical factory) where passenger cars are needed for staying and communicating. The solution can be to assign them to personal service, which often leads to inefficient use for capacitive and economic reasons. The headquarters system of the internal taxi service on the basis of detailed frequency, performance and time analysis and analysis of shipments between individual objects can be more economical and more efficient solutions, especially for large industrial enterprises.

Keywords: Metallurgical enterprises, internal transport of persons, MK-TAXI

1. INTRODUCTION

Metallurgical enterprises, due to large aggregate sizes, large production volumes, large volumes of stored raw materials, transport routes, media distribution are occupying several kilometers of squares [1-3]. The provision of transport of workers within their premises from the entrance hub is mostly realized by bus transport. However, the movement of managers, controllers, maintainers, etc., is being realized by personal cars whose use is inefficient. This article describes one of the possible solutions, reducing the cost of personal transport of persons, while maintaining flexibility [4-7].The article case study deals with a solution in an enterprise where production technology, warehouses, transport system is allocated in the area about 5 x 2 km. Senior management works in the HQ building on the edge of this area, but middle non-productive management and most of the administration works in the administrative center (AC) distant from HQ about 2 km outside the production area. Part of foreign middle management lives in a hotel (DT) situated about 20 km from HQ (see **Figure 1**) [1]. Carriage by passenger cars shall in particular ensure the following transport operations:

- Transportation of personnel (managers, maintenance staff, officers) within the technological area.
- Transport of persons between AC and HQ (meetings, negotiations, consultations...).
- Ensuring transport to and from work between DT and HQ, especially in the morning from 7:00 - 8:00 hours and in the afternoon between 15:00 - 17:00 hours.

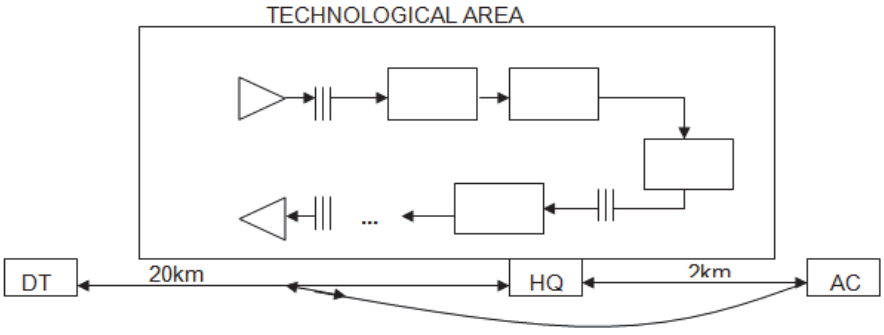

Figure 1 Layout of investigated objects of metallurgical company

Mid-level managers, referents, maintenance staff were assigned for the personal use 386 passenger cars. The cars were leased from the leasing company. In addition to these cars, top managers also had more than 100 pieces of passenger cars available, but the solutions did not concern these cars. The goal of the project solution was to leave the cars in the personal use of the groups to the workers who use cars efficiently (the efficient criteria of the efficient car use were defined by the top manager responsible for the transport in the company). Other workers who do not meet the criteria will be returned cars to the leasing company. However, it is necessary to design a transport system that will ensure their transport needs, but at a lower cost and thus also environmental impacts [8-10].

2. ANALYSIS OF PASSENGER CAR USE

For the purposes of the project, statistical analysis, frequency of use of cars, mileage, as well as analysis of the number of cars currently used were applied (see **Figure 2**) [1]. Each car has its "driving orders book". We come out of the assumption that the project was implemented in year *N*. Since staff using cars for personal use did not know that such a project would be solved, we assume that *N* - 1 year behaved naturally and that cars used ulcers when they really needed to secure the operation of the company. From the travel instructions, the year *N* - 1 was selected for information: car number, mileage, driving time, from-to, reason for use.

Following the agreement of the company's decision-makers and the management of the company, the criteria for the keeping of cars for personal use by the workers were set:

1) If the car was used at least 8 times a week - $C1_J$.
2) The car has driven an average of more than 60 km per week - $C2_J$.
3) The car was used more than 5 times while driving more 40 km per week - $C3_J$.

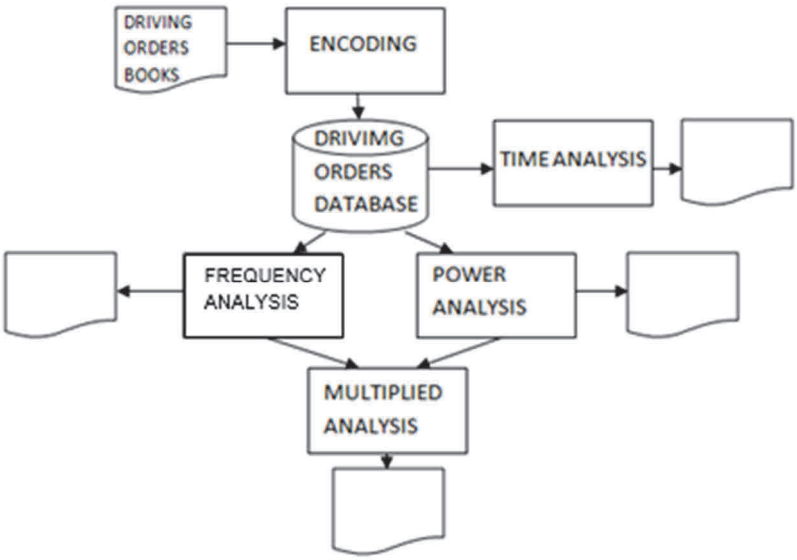

Figure 2 Sequence of analysis steps of the use of passenger cars

Frequency analysis

From the drive database, every week for every car *J* the frequency (the average number of car uses) $C1_J$ was calculated. Those whose if $C1_J > 8$ the car *J* remained in the personal use of the worker ($P1$).

Power analysis

From the drive database, the average number of km $C2_J$ was calculated. Cars with $C2_J > 60$ remained in personal use of workers (P2).

Multiplied analysis

It analyzes the use of cars in terms of the logical component of both the previous criteria of frequency and power. If the car *J* is *P*1 > 5, and at the same time *P*2 > 40, the car is left in the personal use of the *P*3 worker. Criteria $C1_J$, $C2_J$, $C3_J$ fulfilled *P* cars: *P* = *P*1 + *P*2 + *P*3. In this case, it was *P* = 67 cars. In addition to these analyzes, transport analyzes were carried out between the HQ, AC and DT objects whose methodology and results are described in the design part of article.

3. DESIGN OF THE NEW PASSENGER TRANSPORT SYSTEM

Up to 40 % of all off-site transfers have been made between AC and HQ between 8:00 and 14:00, because most of the administration and management are working on the first shift. Transport between DT and HQ resp. DT and AC is from 6:30 to 8:00, and back in time between 15:00 and 17:00. This resulted in the proposal:

1) Transport between DT and HQ, respectively DT and AC is realized by a ten-place minibus that sails 3 times in the morning from 6:30 to 8:00 hours from DT to HQ and AC and from 15:00 to 17:00 hours returns to the transport of workers.
2) From 8:00 to 15:00 the same minibus operates as a shuttle between AC and HQ within 20 minutes.
3) The transport solution within the metallurgical plant's technological area but also between HQ, AC and DT is realized in the form of its own taxi service (MK-TAXI). The question is how many taxi cars are needed to ensure an adequate level of transportation. To determine the number of MK-TAXI cars, a time analysis of the database of journeys was processed to determine how many cars were used concurrently throughout the day. The results are captured in **Figure 3**, which states that at most, about 6 cars were used at the same time: From 3 to 6 cars were used in the time between 7:00 and 10:00 hours; At the other time, less than 2 cars were used at the same time.

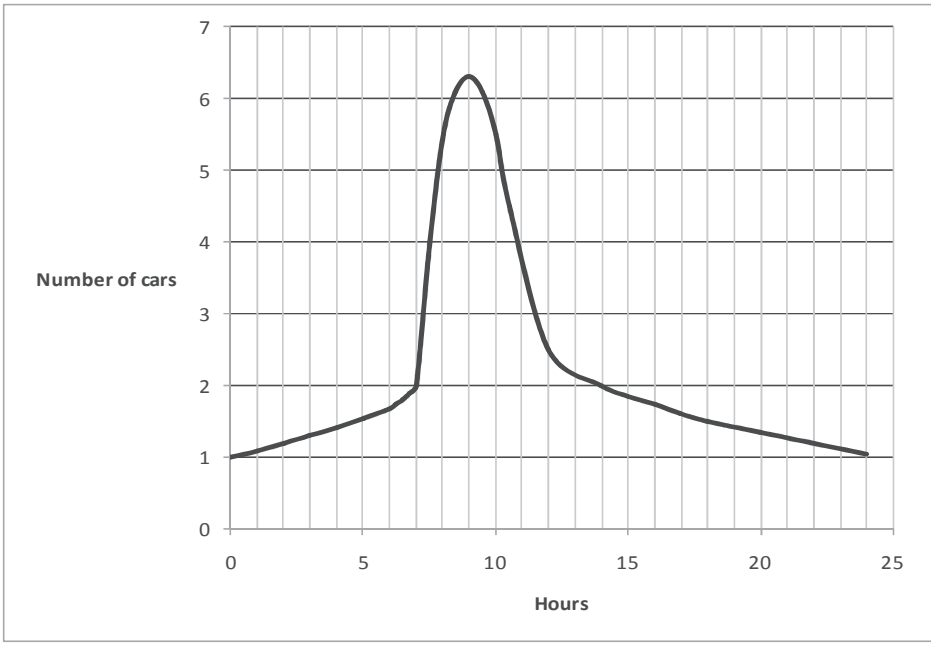

Figure 3 Current car use curve during the day

From the above, the proposal has resulted in:

- At the time of the first shift from 7:00 to 15:00 will provide the operation of MK-TAXI 6 cars.
- During the second and the third shifts 2 cars will provide the operation of MK-TAXI, which also provide emergency transport.

Passenger handling:

- The MK-TAXI will be managed by the Central Dispatcher Department of the metallurgical enterprise. The transfer requester calls the MK-TAXI number, where it defines: the place where the requires, the type of car and the time of arrival. The MK-TAXI dispatcher will provide a car for this transfer.
- The minibus will have its own fixed timetable and will be controlled by the Metallurgical Transport Department of the company.

4. CONCLUSIONS

Implementation of the proposed passenger transport system resulted in a return of about 300 passenger cars to the leasing company. For the operation, car insurance, maintenance, the cost of the first year after application was reduced about 1.3 million €, even taking into account the wages of 9 drivers. In the second year, a stable saving was set at 0.8 million €. This case study highlights the possibility of an effective solution for in-person passenger transport for large-scale enterprises. Each enterprise is specific, but the idea and methodology is applicable in enterprises of a similar nature (and was applied in two other enterprises).

REFERENCES

[1] MALINDŽÁK, D., KAČMÁRY, P., OSTASZ, G., GAZDA, A., ZATWARNICKA-MADURA, B. and LOREK, M. *Design of Logistic System (Theory and Applications)*. 1st ed. New York: Open-Science Publisher, 2015. p. 300.

[2] PRIBULOVÁ, A., FUTÁŠ, P., BARICOVÁ, D. Processing and utilization of metallurgical slags. *Production Engineering Archives*, 2016. vol. 20, no. 2, pp. 2-5.

[3] BARICOVÁ, D., PRIBULOVÁ, A., DEMETER, P., BUĽKO, B. and ROSOVÁ, A. Utilizing of the metallurgical slag for production of cementless concrete mixtures. *Metalurgija*. 2012. vol. 51, no. 4, pp. 465-468.

[4] AMBRIŠKO, Ľ., MARASOVÁ, D. ml., GRENDEL, P. and LUKÁČ, S. Application of logistics principles when designing the process of transportation of raw materials. *Acta Montanistica Slovaca*, 2015. vol. 20, no. 2, pp. 141-147.

[5] STRAKA, M., MALINDZAKOVA, M., TREBUNA, P., ROSOVA, A., PEKARCIKOVA, M. and FILL, M. Application of Extendsim for improvement of production logistics' efficiency. *International Journal of Simulation Modelling*, 2017. vol. 16, no. 3, pp. 422-434.

[6] MALINDŽÁK, D., GAZDA, A., MALINDŽÁKOVÁ, M. and VITKO, D. The Basic principles and rules for heuristic model creation In metallurgy. *Metalurgija*, 2013. vol. 52, no. 4, pp. 549-552.

[7] AMBRIŠKO, Ľ., CEHLÁR, M. and MARASOVÁ, D. The rate of stable crack growth (SCG) in automotive steels sheets. *Metalurgija*. 2017. vol. 56, no. 3-4, pp. 396-398.

[8] STAS, D., LENORT, R., WICHER, P. and HOLMAN, D. Green transport Balanced Scorecard Model with Analytic Network Process support. *Sustainability*, 2015. vol. 7, no. 11, pp. 15243-15261.

[9] STAS, D., LENORT, R., WICHER, P. and HOLMAN, D. Approaches to analysis of the green transport level. In *Lecture Notes of the Institute for Computer Sciences Social Informatics and Telecommunications Engineering*. Vol. 166. Cham: Springer International Publishing, 2016, pp 704-712.

[10] STAS, D., BURCHART-KOROL, D., LENORT, R., WICHER, P. and HOLMAN, D. Environmental assessment of internal company transport based on Life Cycle Assessment methodology. In *CLC 2015: Carpathian Logistics Congress*. Ostrava: Tanger, 2016, pp. 491-496.