Optimisation of Transfer Process in Selected Company

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Abstract: *Our study is focused on a new proposal of transportation design system in selected company and on comparison of new system with currently used system. This system is designed for Západoslovenská vodárenská spoločnosť, a.s. (West Slovakia Water Company). Currently, transportation assignments are realized based on area allocations for individual departments. This system is not effective, because it does not consider the shortest shipping distances. Optimization design is based on proposed method, which considers defined conditions. According to proposed method, it is possible to determine optimal design of transportation assignment for more damages together. It is possible to allege, based on study results, that time required for transportation activities was reduced by 47.43% and shipping distance was reduced by 14.66%.*

Keywords: *transportation system, transportation assignment, transportation distance, lorry, fuel consumption*

INTRODUCTION

A development of transportation is characterized by maximal effort to increase the speed, reliability and quality of products delivery in goods transportation, when modern technical devices of computer technique are used. It is also important, at any human activity, to ensure sustainable development without any damage and endangering of the environment, nature and humans, so next generations would live under acceptable conditions. Uncontrolled quantity growth of direct road transportations for long distances with intensive negative effects on environment and human health is a reason for fast reactions, research and new designs application. Optimalization of transportation and shipping routes is one of the options.

It is necessary to realize transferred products analyse, before the optimal variant of transportation vehicle is selected:

- according to nature (solid, bulk, liquid etc.),
- according to products protection requirements at transportation.

In accordance with transportation companies' requirements, it is necessary to realize an analyse of transportation stability of selected nature (group) of products, which is conditional to company' working regime.

Transportations, considering stability, are divided to:

- systematic, regular transportations, which are characterized by stability during planned time period,
- seasonal transportations, characterized by monthly or quarterly irregularity during planned time period,
- one-time transportations (e.g. overweight load transportation).

Based on individual transportation companies locations (suppliers and consumers), it is necessary to estimate individual shipping distances:

- analyse of conditions and method of loading and unloading,
- examination of the possibility to utilize such kind of transportation organisation and management, which will enable to use different variants of trailer utilization,
- detection of the transportation vehicles type,
- analyse of road network considering road factors,
- detection of the most effective kerb weights of transportation vehicles,
- selection of vehicle fleet structure – vehicles, towing vehicles with semitrailers, trailers,
- modification and modernization of transportation vehicles (Kočovský, 1980).

Time irregularity is possible to solve by:

- time optimalization of transportation requirements management,
- creation of such transportation vehicles capacity, which would cover increased seasonal transportations management,,
- combination of both mentioned options.

According to its conditions, transportation assignment belongs to linear programming assignments. The assignment can be solved by special methods, which could be divided into two groups according to character of obtained results:

Approximate methods – simple and relatively fast methods, which give only approximate results approaching more or less optimal solution.

Accurate methods – methods, which give optimal results by progressive improvement of initial solution. They require initial solution, which is obtained by one of approximate methods.

MATERIAL AND METHODS

Západoslovenská vodárenská spoločnosť, a.s. is realizing its activities within west Slovakia region by means of lorry and personal transportation. Whereas subject of company's activities is diversified, utilization of vehicles within the company is diversified in significant degree. Regarding this company, it is not effective, in many cases not possible, even excessively costly to optimize all transportation activities.

Determination of problem and definition of requirements

Our study is focused on optimalization of transportation activities, which are essential for damages elimination, which occur within the area administered by company. In this case, company is realizing a transfer of workers, essential technology and backfilling material in the area of damage. Within the frame of optimalization, our study is focused on optimalization of backfilling material transfer in the area of damage. The essential quantity of backfilling material is reported by operating engineer to dispatcher right after damage inspection. Whereas all reported damages are dealt with on the next day, dispatcher has all essential information to solve transportation assignment and he can choose the areas for vehicles to send.

Currently, lorries are sent in the area of damage elimination from individual departments considering area allocation, while distance from the area of damage to department is not considered. Individual departments do not own equal quantity and capacity of vehicles, another factor, which is not considered and needs to be considered within optimal operation.

Definition of time unit

During damages eliminations, time for the damage elimination is the most important factor for Water Company, because that is the crucial factor affecting the restoration of drinking water supply for customers. Whereas time for transportation activities is affected by travelled kilometres, it can be assumed, that such optimalization design would positively affect the economy of transportation.

Because of a little rugged area (considering mountains) of The Danubian Lowland, we can assume approximately identical road network without large superelevations. To evaluate the time essential for damage elimination, it is necessary to define time unit concept, which is, in this case, time essential for backfilling material transfer. Because of flat type area and approximately equal road network, time unit is derived from kilometric distance between area of damage and department. Whereas time unit expresses a velocity of backfilling material transfer, this parameter is derived from the distance travelled to the area of damage and does not consider the distance travelled back to department

Damage characterization

Západoslovenská vodárenská spoločnosť, a.s. is dealing with random damages, which

occur at the process of maintenance and management of drainage and water supply system. The occurrence of damages is very difficult to assume, so dispatching department is essential, where all damages are reported and recorded to system. Team of mechanics or local mechanic, who examine occured situation and report essential material for damage elimination to dispatching department, are sent in the area of damage occurrence. Reported damages are always dealt with on the next day.

Based on literature review, Vogel's Approximation Method (V.A.M.) was selected for adjustment considering requirements of Západoslovenská vodárenská spoločnosť, a.s. V.A.M. is one of the simplest method, giving relatively acceptable results approaching optimal solution (Kaspar,1995).

RESULTS

Optimalization of transportation was realized in the Nitra department, covering Nitra, Vráble and Zlaté Moravce stations. The table represents vehicle capacities, which are at disposal at individual departments.

Table 1 Vehicle capacity at individual departments

Area	Type of vehicle	Vehicle brand	Vehicle capacity, t
Doprava Nitra department	TGS	MAN	12
Doprava Nitra department	TGS	MAN	12
Doprava Nitra department	A S3	AVIA	4
Zlaté Moravce department	S3	TATRA 815	10
Vráble department	S3	TATRA 815	10

Optimization of transportation assignment is based on real case, which occurred in company. Dispatcher recorded requirement to eliminate four damages in the areas of:

- Beladice – with reported requirement for backfilling material of 8 t
- Čeľadice – with reported requirement for backfilling material of 15 t
- Vinodol – with reported requirement for backfilling material of 15 t
- Ladice – with reported requirement for backfilling material of 14 t

Solution of transportation assignment with currently used system

Currently, all transportation assignments for damage elimination on drainage and water supply system are realized based on area allocations for individual departments. Allocated area for department is not selected based on the smallest action radius of vehicles. Actual area service function of vehicles of individual departments originated during last decades based on actual possibilities and different restrictive factors of Water Company.

Table 2 represents a realization of transportation assignment according to area allocated to individual departments. Actual state of realization is evaluated based on time essential vehicles expressed in time units, distance between department and area of damage, considering the case, when vehicle needs to return, when material requirement is higher than vehicle capacity.

Table 2 A result of actual design

Damage	Vehicles	Time unit	Distance, km
Čeľadice	Vráble department	60	80
Vinodol	Doprava Nitra department	38	38 x 2
Beladice	Zlaté Moravce department	11	11 x 2
Ladice	Doprava Nitra department	66	22 x 4

Optimalization design of transportation service

A design of optimalization of transportation operations is based on the same assignment as actual state. An assignment is to transfer backfilling material for damage elimination from three departments to four located areas. The options of material transfer with lorries, damage requirements together with distances between areas of damages and departments are presented in table 3. Vehicles, which are at disposal at departments, are presented in table 1.

A solution of assignment will be realized by three departments, which communicate between theselves and damages will be allocated considering a design of transportation assignment.

Table 3 Input data

	Čeľadice	**Vinodol**	**Beladice**	**Ladice**	***Options***
Vráble	20 km	15 km	20 km	19 km	*10 t*
Nitra	15 km	19 km	18 km	22 km	*28 t*
Zlaté Moravce	18 km	30 km	11 km	13 km	*10 t*
Requirements	*15 t*	*15 t*	*8 t*	*14 t*	

Adjusted Vogel's Approximation Method is used to solve transportation assignment. The table of Input data will be extended by one row and by one column, which will be used to record differentiation, which is a difference in the second lowest and the lowest distance in given row and given column (table 4). Table 4 will present recorded row and column differences (differentiations) r(i) and s(j).

We will detect the highest differentiation and we will assign required quantity of material to the lowest rate (distance) in given column. In our case, we will solve damage in Beladice with a ZM vehicle from Zlaté Moravce (table 5). Vogel's Approximation Method is indicating that after this step, the capacity is reduced by given value, i.e. material at disposal in Zlaté Moravce department is reduced from 10 t to 2 t. Our adjustment of Vogel's Approximation Method is considering our assignment design, where all damages occur together and our effort is to solve all damages in the shortest possible time interval, so given ZM vehicle from Zlaté Moravce will not be used in the next step.

Whole process will be repeated in the next step. We will solve a requirement in Čeľadice with a NR1 and NR3 vehicle from Nitra (table 6) based on calculated differentiations. We will not use those NR1 and NR3 vehicles in next calculations regarding previous statement.

Last step of approximation analyse is required, based on differentiations, to solve damage in Vinodol. Considering capacity, one vehicle cannot solve an assignment by itself, so NR2 vehicle from Nitra a VR vehicle from Vráble are sent in the area of damage. We used our whole capacity (vehicles), however; damage in Ladice is still unsolved. We will realize an analyse to solve transportation assignment considering minimalization of shipping activities within the shortest possible time.

Table 4 Input data with vehicle records

	Čeľadice	Vinodol	Beladice	Ladice	Material at disposal in vehicle	Differentiation
NR 1	15	19	18	22	12 t	3
NR 2	15	19	18	22	12 t	3
NR 3	15	19	18	22	4 t	3
VR	20	15	20	19	10 t	4
ZM	18	30	11 $^{8\,t}$	13	10 t	2
Required material	15 t	15 t	8 t	14 t		
Differentiation	3	4	**7**	6		

Table 5 Solution of first damage in Beladice

	Čeľadice	Vinodol	Beladice	Ladice	Material at disposal in vehicle	Differentiation
NR 1	15 $^{12\ t}$	19	18	22	12 t	4
NR 2	15	19	18	22	12 t	4
NR 3	15 $^{3\ t}$	19	18	22	4 t	4
VR	20	15	20	19	10 t	4
ZM	18	30	11 $^{8\ t}$	13	10 t	2
Required material	15 t	15 t	8 t	14 t		
Differentiation	5	4	7	3		

Table 6 Sequentiality of assignment solution

	Čeľadice	Vinodol	~~Beladice~~	Ladice	Material at disposal in vehicle	Differentiation
~~NR 1~~	~~15~~ $^{12\ t}$	~~19~~	~~18~~	~~22~~	~~12 t~~	~~4~~
NR 2	~~15~~	19 $^{12\ t}$	~~18~~	22	12 t	3
~~NR 3~~	~~15~~ $^{3\ t}$	~~19~~	~~18~~	~~22~~	~~4 t~~	~~4~~
VR	~~20~~	15 $^{3\ t}$	~~20~~	19	10 t	4
~~ZM~~	~~18~~	~~30~~	~~11~~ $^{8\ t}$	~~13~~	~~10 t~~	~~2~~
Required material	~~15 t~~	15 t	~~8 t~~	14 t		
Differentiation	~~5~~	4	~~7~~	3		

To solve this assignment, we need to use one of the vehicles, which were already sent for damage elimination. 14 t of backfilling material is essential for damage elimination, any of vehicles cannot solve an assignment by itself, because of their capacity, and i.e. two solutions need to be selected. Possible alternatives of transportation assignment design are presented in table 7.

Table 7 Alternatives of time intensity for shipping activities minimalization

Alternative	Route	Time intensity
1	Nitra – Vinodol – Ladice	51
2	**Vráble – Vinodol – Ladice**	**47**
3	Nitra – Vinodol – Nitra – Ladice	60
4	Vráble – Vinodol – Vráble – Ladice	49
5	**Zlaté Moravce – Beladice – Zlaté Moravce – Ladice**	**35**
6	Nitra – Čeľadice – Nitra – Ladice	52

Table 7 indicates that damage can be solved, when VR vehicle is sent from Vráble to solve the damage in Vinodol and after that, without return to department will solve the damage in Ladice.

According to previous analyse, the damage in Vinodol will be solved by NR2 vehicle from Nitra with the capacity of 12 t and partially by VR vehicle from Vráble, which will fill up 3 t of backfilling material.

Damage in Ladice will be also solved by ZM vehicle from Zlaté Moravce, which will solve the damage in Beladice before, return to department in Zlaté Moravce, load the material in maximal capacity of 10 t and partially solve the damage in Ladice. The damage in Ladice requires 14 t of backfilling material, the rest of the material of 4 t will be filled up by VR vehicle from Vráble.

VR vehicle will be sent from Vráble with a maximal material capacity of 7 t, solves the damage in Vinodol with 3 t of material and drives to Ladice, to solve the damage with 4 t of backfilling material. By the time of VR vehicle arrival, the damage in Ladice will be partially solved by ZM vehicle from Zlaté Moravce, according to table 7, which will fill up material in the capacity of 10 t (table 8).

Table 8 Final table of optimalization values

Damage	Vehicles	Time, time unit	Distance, km
Čeľadice	NR 1 + NR 3	15	30 x 2
Vinodol	NR 2 + VR	19	34 x 2
Beladice	ZM	11	11 x 2
Ladice	ZM + VR	47	26 + 51

A comparison of currently used system with proposed optimalization design

According to comparison of solution of transportation assignment by currently used system and by optimalization design can be alleged, that time required for backfilling material transfer was reduced, economy was improved, transportation distances were reduced, which are not subject of department and allocated area, but are the subject of dispatching department management, which can evaluate the most optimal design considering proposed method.

Next table represents a total saving in compared parameters, when transportation assignment was solved by currently used system and proposed optimalization measurement.

Table 9 Comparison of optimalization design with original system

	Time units	Distance, km
Original design of assignment solution	175	266
Optimalization design of assignment solution	92	227
Difference	83	39
Difference, %	**47.43**	**14.66**

CONCLUSION

Our study is focused on optimalization of transportation process in selected company. For company, optimalization of such character has economical, organisational, and ecological importance. Optimalization of transportation activities should be primary under practice conditions. Companies, which are using their own transportation, could save financial capital, could use their fleet effectively and could reduce time required for transportation activities realization considering properly selected optimalization design. Proposed optimalization design for company is beneficial in all three mentioned areas. Optimalization of transportation assignment reduced time required for damage elimination by 47.43% compared to original system and reduced travelled kilometres by 14.66%.

Our result can be used by Západoslovenská vodárenská spoločnosť, a.s., but our results can be used by other companies, which have their own transportation department. Considering practice conditions, proposed method can be adjusted, respectively completed by other conditions, which is a result of given company's requirements.

ACKNOWLEDGEMENTS

Supported by the Ministry of Education of the Slovak Republic, project VEGA 1/0857/12 "Reduction of unfavorable impacts of agricultural and transport machinery on environment".

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