ROUTE PLANNING OPTIMIZATION PROBLEM AT A LOGISTICS COMPANY

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Abstract

A 21th century company's main goal is to increase their income and decrease their expense, even so they give great attention to social responsibility, the protection of the environment and other factors, because if does not prospers the company, then it cannot properly strive for their goals. In the light of the current keen competition on the market is essential to minimize the expenses. In the case of a logistics company one of the most determinative cost is the shipping related expenses. To minimize the amount of money spent on shipping a good solution can be the fuel cost reduction.
In this study I aimed to minimize the fuel consumption with the optimization of routes. To find the best possible solutions I chose the LP Simplex method, using a highly beneficial add-on of Microsoft Excel called Solver.

Keywords: *cost optimization, route planning, fuel minimization, Solver, LP Simplex method*
JEL classification: *R41*

Introduction, actuality of this issue, raising questions

One of the 21th.century's frequently mentioned and determining factor is the consumer society. The dynamism of the economy, the continuing technological development and the fact that the geographical distances are bridged by the information technology make the trade almost borderless. Our life is being assisted by newer and newer fast advancing devices, which can be used in many parts of our daily life. For a long period only the positive consequences of the ongoing development and globalization was mentioned. However, in the last decade more and more recognized their disadvantages too. The rapid technical development, the shortened product lifecycles result an increasing volume of waste. Which often threatens the environment and the human health, because of the modern (and mostly artifical) materials.

From my point of view the current use of non-renewable resources, in the light of the gradually resources increased caution because, according to the recent studies, our oil supplies are limited, which will have foreseeable consequences, so the optimization of shipping is not only important because of its cost-effectiveness but also in the aspects of environmental awareness.

The importance of this issue is further strengthened by the fact '... the interpretations of complex systems' processes are not always coherent, moreover the results are not always consistent either. The internal operation of the systems and the prediction of the critical factors' which have significant effects on the results can be difficult for a number of reasons, therefore the IT - system of decision support is not satisfying, despite the fact that it could be useful in many.' (Gyenge-Kozma, 2015)

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Through mathematics difficult and complex economic problems can be solved. In my study I would like to explore the possibilities of a hazardous waste transport and disposal company's transportation and development cost-optimization with mathematical methods of decision-making and Operations Research.

Materials and methods

The analysis in this study was solved by using of operation research based on Ferenczi et al. (2002). The calculations used in the optimization were made based on the company's and the competitors'' public data. I solved the cost optimization with a routing process using the Excel add-on called Solver, applying the LP Simplex method.

Route planning optimization problem by a logistics enterprise

A firm concerned with transport of dangerous goods wants to minimize their transportation costs. By examining the data from the company management has concluded that one way of minimizing costs is, to optimize the distance traveled by the vehicle, so a route must be determined in which vehicles take the shortest path between the stations. To solve the optimization's process I chose an add-on of Microsoft Excel called Solver and the LP Simplex method. One great advantage of the computerized solution is that it simplifies the calculation tasks in a way that manual counting becomes completely unnecessary. So it calculates the given objective function and the associated solutions extremely fast.

The investigated problem is that we must go through from the departure site, all Hungarian site of Lukoil network with using the available vehicle fleet and human resources. The hazardous waste must be transported to the appropriate site, then the vehicle must be returned to the departure site.

To transfer the problem into an Excel table I need the following data:

- addresses of the vehicle's starting and ending location
- addresses of the delivering sites of Lukoil network
- the amount of hazardous waste which needs to be transferred from each delivering site
- addresses of the operating locations
- the purchase prices (/kg) of the operating locations
- the cost of transporting vehicles per kilometer, which I determined as 228 HUF/km based on preliminary studies

Let's assumed the following: firstly, the hazardous waste is delivered with a vehicle which has infinite capacity, so it can transport any number of goods at the same time, secondly we can take waste from more transfer destination, without dropping off the first shipment to the recipient site, thirdly for every transfer destination there is only one recipient site to where transfer is possible, and finally it is possible to transport any number of goods to the receiving destination. However we cannot take into account the toll, driving time requirements and consumption data.

To handle the volume of the data I divided the national Lukoil filling station network into 3 different regions, so having a region of western Hungary, eastern Hungary and Budapest. I restricted the further analysis to the western Hungarian region which region contains 24 Lukoil filling stations (transferring station) and 6 operating stations (receiving station).

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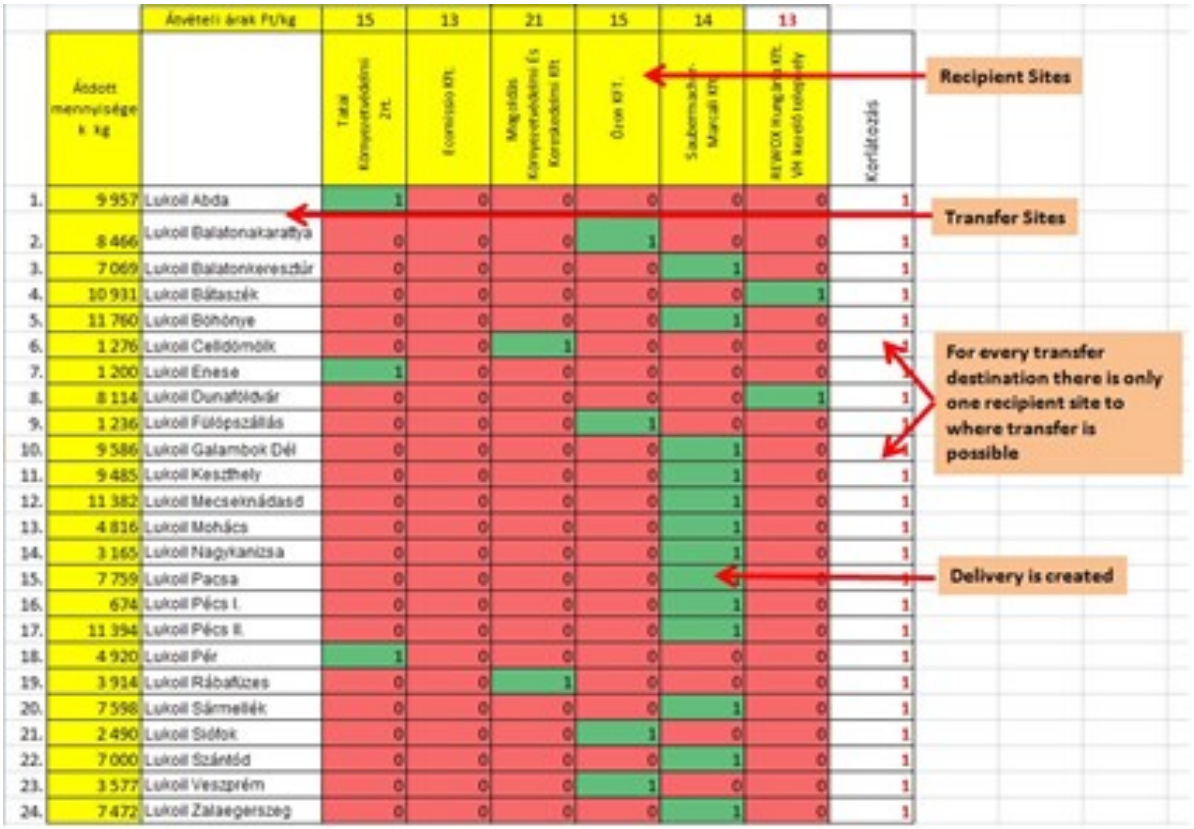
In all cases I included the receiving station of RewoxHungáriaLtd.'s in Szentes even though it is located in the eastern part of Hungary, because I'm curious that under what price and distance circumstances they would transport hazardous waste to the hazardous waste station in Szentes.

We can achieve the minimization of cost in two major steps.

First, we should determine the ideal recipient site for every transfer site. The goal is to deliver the given amount of hazardous waste to the receiving station where they take the waste over in the best price and as close to the transferring station as possible. The process is illustrated by the Figure 1.



	Átvételi árak Ft/kg	15	13	21	15	14	13	
	Átadott mennyiségek kg	Tatai Környezetvédelmi Zrt.	Kromisio Kft.	Magoldis Környezetvédelmi És Kereskedelmi Kft.	Ürsi Kft.	Saubermacher-Marcali Kft.	REWOX Hungária Kft. VH kerető telephely	Korlátozás
1.	9 957	Lukoil Abda	1	0	0	0	0	0	1
2.	8 466	Lukoil Balatonakarattya	0	0	0	1	0	0	1
3.	7 069	Lukoil Balatonkeresztúr	0	0	0	0	1	0	1
4.	10 931	Lukoil Bátaszék	0	0	0	0	0	1	1
5.	11 760	Lukoil Böhönye	0	0	0	0	1	0	1
6.	1 276	Lukoil Celldömölk	0	0	1	0	0	0	1
7.	1 200	Lukoil Enese	1	0	0	0	0	0	
8.	8 114	Lukoil Dunaföldvár	0	0	0	0	0	1	1
9.	1 236	Lukoil Fülöpszállás	0	0	0	1	0	0	1
10.	9 586	Lukoil Galambok Dél	0	0	0	0	1	0	1
11.	9 485	Lukoil Keszthely	0	0	0	0	1	0	1
12.	11 382	Lukoil Mecseknádasd	0	0	0	0	1	0	1
13.	4 816	Lukoil Mohács	0	0	0	0	1	0	1
14.	3 165	Lukoil Nagykanizsa	0	0	0	0	1	0	1
15.	7 759	Lukoil Pacsa	0	0	0	0		0	1
16.	674	Lukoil Pécs I.	0	0	0	0	1	0	1
17.	11 394	Lukoil Pécs II.	0	0	0	0	1	0	1
18.	4 920	Lukoil Pér	1	0	0	0	0	0	1
19.	3 914	Lukoil Rábafüzes	0	0	1	0	0	0	1
20.	7 598	Lukoil Sármellék	0	0	0	0	1	0	1
21.	2 490	Lukoil Siófok	0	0	0	1	0	0	1
22.	7 000	Lukoil Szántód	0	0	0	0	1	0	1
23.	3 577	Lukoil Veszprém	0	0	0	1	0	0	1
24.	7 472	Lukoil Zalaegerszeg	0	0	0	0	1	0	1

Figure 1. Interpretation of Assignment Matrix

Source: own construction

Once we have this matrix, we need to define the objective function, which in this case is to minimize the cost of whole transportation task. To determine the objective function we need to use the following formulas:

transporter vehicles' cost/km * (1. Table's and 2 Tables sumproduct) + 3. Table's sum

In this case the objective function is 2,618,825 HUF, this is the lowest cost, which is enough to transport the hazardous waste from every transfer site to a waste station. (Figure 2)

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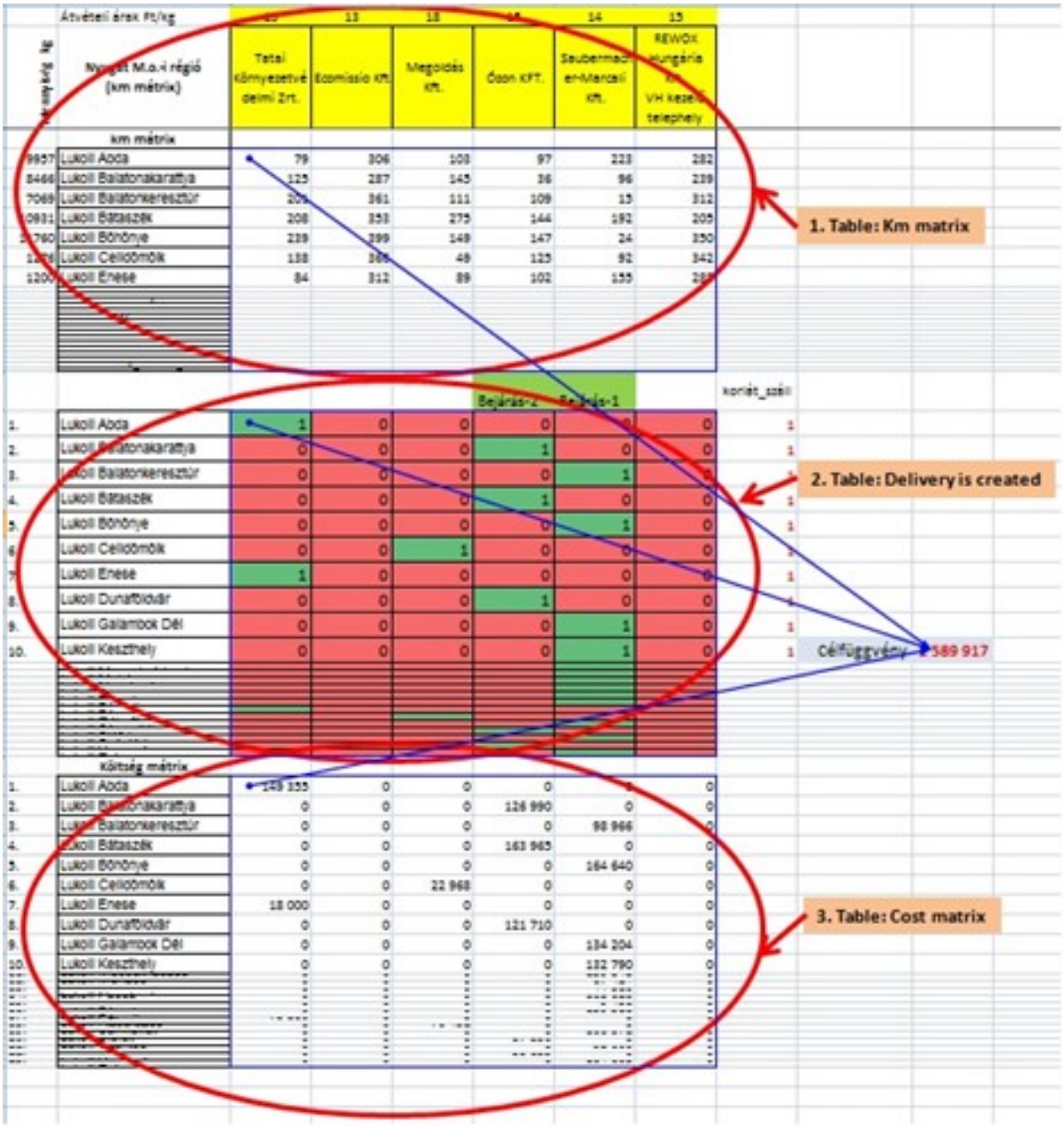

Figure 2. Interpretation of Assignment Matrix

Source: own construction

In this case the following correlations were diagnosed between the 24 transfer sites and the 6 recipient sites, so we can see which recipient sites are the best matches for every transfer sites. In the 2nd Figure 1 means that the delivery is created and 0 means that it does not.

So the procedure described above can be interpreted to solve any routing problem for the transport of any kind of goods. The point is that we got the route, which allows the company to minimize shipping cost.

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	Átvételi árak Ft/kg	15	13	21	15	14	15	
Átadott mennyiségek ig		Tatai Környezetvédelmi Zrt.	Loomissio Kft.	Megoldás Környezetvédelmi (1) Kereskedelmi Kft.	Ózon KFT.	Saubermacher-Marcali Kft.	REWOX Hungária Kft. VH kiszáló telephely	Korlátozás
9 957	Lukoil Abda	1	0	0	0	0	0	1
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7 000	Lukoil Szántód	0	0	0	0	1	0	1
3 577	Lukoil Veszprém	0	0	0	1	0	0	1
7 472	Lukoil Zalaegerszeg	0	0	0	0	1	0	1

Figure 3. AssignmentMatrixinthe Western region

Source: own construction

As we can see in the Figure 3 every transfer site has exactly one recipient site where the wares are shipped to. It means the first problem is successfully solved. Based on the calculations 4 single centre tours generated which are the following:

1. single centre tour: LukoilAbda – LukoilEnese LukoilPér TataiKörnyezetvédelmi Ltd.
2. singlecentre tour: LukoilCelldömölk LukoilRábafüzes Megoldás Ltd.
3. single centre tour: LukoilBalatonakarattya – LukoilBátaszék – LukoilDunaföldvár – LukoilFülöpszállás – LukoilSiófok LukoilVeszprém Ózon Ltd.
4. Star tour: LukoilBalatonkeresztúr – LukoilBöhönye – LukoilGalambokDél – Lukoilsinglecentre tour: – LukoilMecseknádasd – LukoilMohács – LukoilNagykanizsa – LukoilPacsa – LukoilPécs I. – LukoilPécs II. – LukoilSármellék – LukoilSzántód LukoilZalaegerszeg Saubermacher-Marcali Ltd.

The second step is to determine how we can further reduce the costs of the transports. This means we have to determine the shortest route during the single centre tour. I will present this process in the 4 case of the 4thsingle centre tour.

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The task is to find way to transfer the single centre tour into a ringroad. So it will take less km to deliver the materials to Saubermacher-Marcali Ltd.

A traversal method should be developed so that the departing and arrival station need to be the Rewox Hungária Ltd. site in Szentes, we should only stop once at every 13 transferring stations and the hazardous wastes must be delivered to the recipient station of Saubermacher-Marcali Ltd. The goal is to determine the objective function, what can minimize the kilometers traveled. Determining the objective function:

4th. Table's and 5th. Table's sumproduct

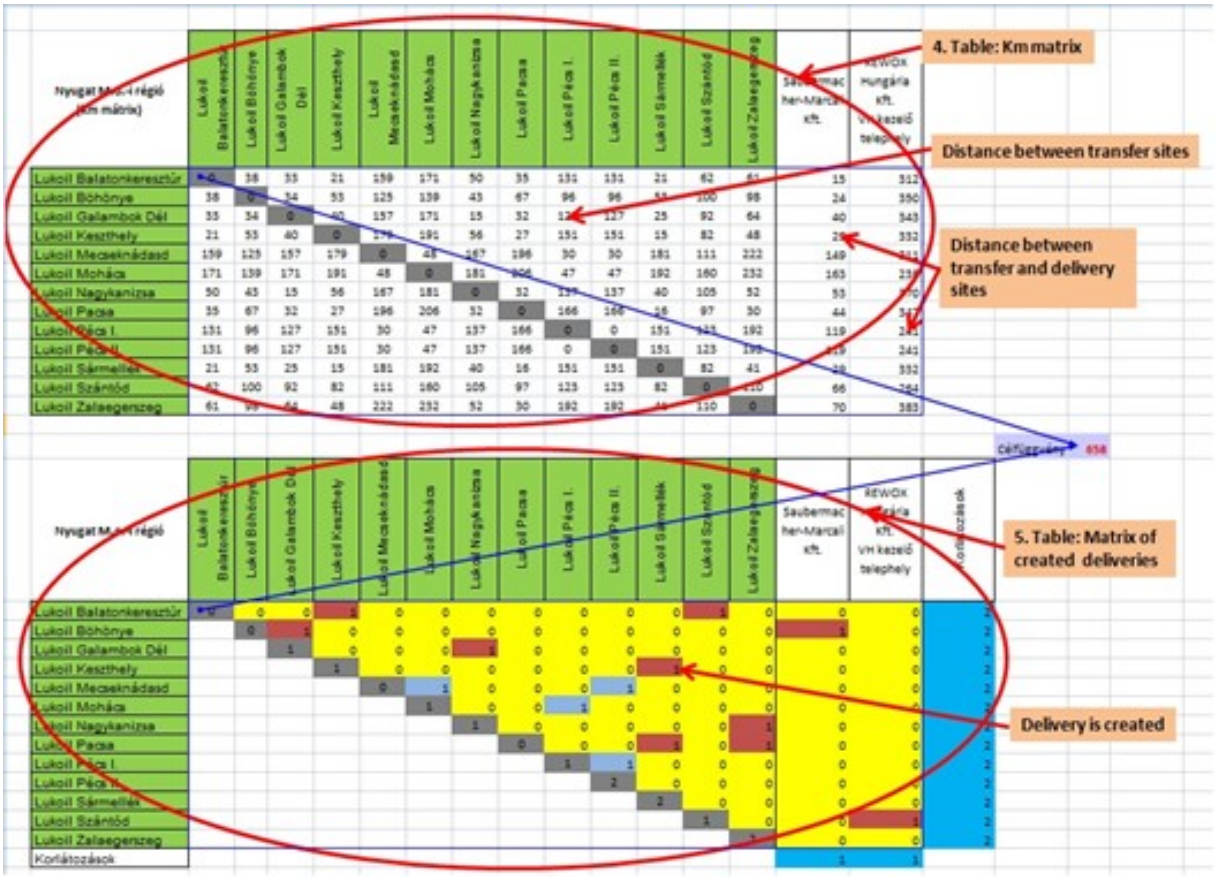

Figure 4: Interpretation of Assignment Matrix

Source: own construction

In this example the object function is 658 km, so the shortest distance between the sites that have to be visited is 658 km.

The Figure 5. shows the order in which the transport must be carried out. The table above displayed on the map shows, that the shortest way can be achieved with the vehicle traveling around the locations in 2 separate roundroad.

If we improve this solution further with a heuristic way we can get the route which is really the most cost-effective. Among other things, this is the reason why there is a great need for an experienced logistics specialist's knowledge, because the computing solution often cannot accurately model the reality. I present the manually corrected tour on the map below.

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Figure 5: Roundroad

Source: own construction

Conclusions and recommendations

In my study I concluded that a firm concerned with transportation can achieve cost reduction if it can find the best tour with the suitable route planning process. As a result the shortest route can be realized. In addition, it was found out that there is need for a professional's knowledge, even if we use a computerized solution, as they might need of his heuristic correction.

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