http://www.ijmp.jor.br v. 9, n. 5, Special Edition *IFLOG 2017*
ISSN: 2236-269X
DOI: 10.14807/ijmp.v9i5.836

ROUTING SOFTWARE UTILIZATION TO ANALYZE VEHICLE IDLENESS: CASE STUDY IN A DISTRIBUTION CENTER IN SUZANO

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Submission: 30/04/2018
Accept: 02/05/2018

ABSTRACT

Cargo transportation is one of the most representative activities regarding to logistics cost. Thus, it is imperative that companies committed with cost reduction searching for competitive advantage, watch out for improvement opportunities in this activity. The present research was developed with a case study in a Distribution Center located in the city of Suzano, which consisted in the simulation of delivery routes using a routing software allowing the comparison of routes created electronically and manually. The selected period was the month of October of 2016. The study used the real information of deliveries made in the period and separated them in daily basis, recreating a route for each date allowing the comparison of real operation with the suggested operation created by the routing software. The results indicated that the software utilization provides a reduction of 26.4% in the vehicles utilization and payment economy of daily rates would reach 31.63%. The study shows the company´s intention of adopting the software. Finally, it is recommended to perform other studies using other variables.

Keywords: Costs, Distribution, Routing, Technology, Transportation.

http://www.ijmp.jor.br v. 9, n. 5, Special Edition *IFLOG 2017*
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1. INTRODUCTION

One of the most important processes in logistics is transportation, according to ILOS (2012), in Brazil the logistics costs were 11.5% of the GNP at that year, and 7.1 were related to transportation, what means 61.73% of total logistics costs at 2012 in the country.

As transportation costs represent the biggest portion of logistical costs, it represents a great opportunity to achieve cost reduction, this can be reached by using information technology, more specifically routing softwares, as an allied for companies that need to improve their competitively, revising procedures and meliorating resources usage.

Nevertheless, investments on information technology by corporations are not always made in an appropriate and consistent way, that results in non-desirable results. According to Siqueira, Souza and Viana (2013), small and medium size companies may not achieve desired results by using information technology due to they do not use it companywide.

By analyzing a company processes it is possible to find improvement opportunities, even if it is a heavy user of information technology. This paper aims to show the possibility to meliorate the routing process in a logistics operator located in the city of Suzano, by using a routing software to compare with manual routing process currently in use.

Based on the assumptions above, it is possible to propose the research problem as: what is the impact of using information technologies in routing transportation activities?

This way, the main objective of the study is to analyze the delivery vehicles idleness by using a routing software, comparing the current manual operation with a simulation created by the software.

The hypothesis for the research is that the software can perform more efficiently the creation of routes, that will make possible to have a better utilization of vehicles, allowing to visualize the idleness and overloads, as well as optimize the use of the contracted fleet.

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This paper has other five parts, the second part contains the theoretical reference, the third part is the research method, the fourth is the case study development, the fifth is the results analysis and the sixth are the final comments.

2. THEORETICAL REFERENCE

This chapter presents the theoretical bases to sustain the research, treating subjects as transportation and distribution, routing and information technology.

2.1. Transportation and Distribution

According to Emoto and Lima (2007), one of the most challenging tasks to transportation professionals is the planning of physical distribution, the reason for that is the mathematical complexity involved in problem solutions to support transportation decision making.

Physical Distribution is one of the most important activities to corporations, it is fundamental to achieve high costumer service levels. A proper planning of distribution activities generates process efficiency and reliability, as well as cost reductions and positive impacts in client satisfaction.

As mentioned by Junior et al. (2012), physical distribution is composed by tasks such as transportation from producers to final customers, it can be done straight from producers to customers or through a warehouse network. To make physical distribution possible, it is necessary a to have professionals with skills to deal with warehousing, loading and unloading vehicles as well as appropriate moving equipment's. The distribution of materials planning sequence starts by choosing the suitable transportation mean, then the distribution network and finally the definition of the delivery routes.

2.2. Routing

According to Emoto and Lima (2007), routing is a process to define delivery routes or set stop places for vehicle belonging to a specific fleet, its main goal is to provide the proper materials to several geographical areas pre-established.

To Junior et al. (2013), the constrains make it hard to create routing solutions, some examples as vehicles with different capacities of weigh and volumes, restrictions to driving time for drivers, maximum speed on the roads, restricted areas for heavy trucks in some hours of the day or circulation of dangerous goods.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v9i5.836

The same authors affirm that by utilizing some routing methods, it is possible to improve resources utilization, achieving higher efficiency and reducing costs of deliveries, as well as reach a higher service level. With a correct utilization the routing softwares can provide several routes more suitable to costumer's profiles, taking in consideration each of their constrains.

2.3. Information Technology

According to Branco and Gigioli (2014), there are many routing softwares available in the market to help corporations to plan transportation and distribution. These softwares can provide satisfactory solutions to problems in this area, reducing time and efforts when compared with solutions created manually. Routing softwares work with internal algorithms able to reduce the operations costs and vehicles utilization.

As proposed by Enomoto and Lima (2007), in many companies, routing tends to be made manually, this can create solutions that are not the best option far from the optimum result. Routing software as computer systems that can provide transportation solutions based on algorithms and a data base, with its utilization it is possible to obtain information in a shorter time when compared to manual processing

3. RESEARCH METHODOLOGY

The research method utilized is exploratory, in a format of case study, as mentioned by Gil (2010), the exploratory research can take the form of a bibliographic research and a case study.

Related to the means, the research was conducted on a case study, that as mentioned by Yin (2010), has the objective to make an empirical investigation to study a contemporary phenomenon in a real life context.

This study research object is a logistics operator enterprise located at the city of Suzano, as it was not allowed to use the company´s name, from now on it will be named as Beta Logistics.

As a protocol for the case study, the research was divided in four steps. The first was the analytical part when a detailed data collection of shipments occurred from July to October of 2016 in order to verify the existence of seasonality in

ISSN: 2236-269X
DOI: 10.14807/ijmp.v9i5.836

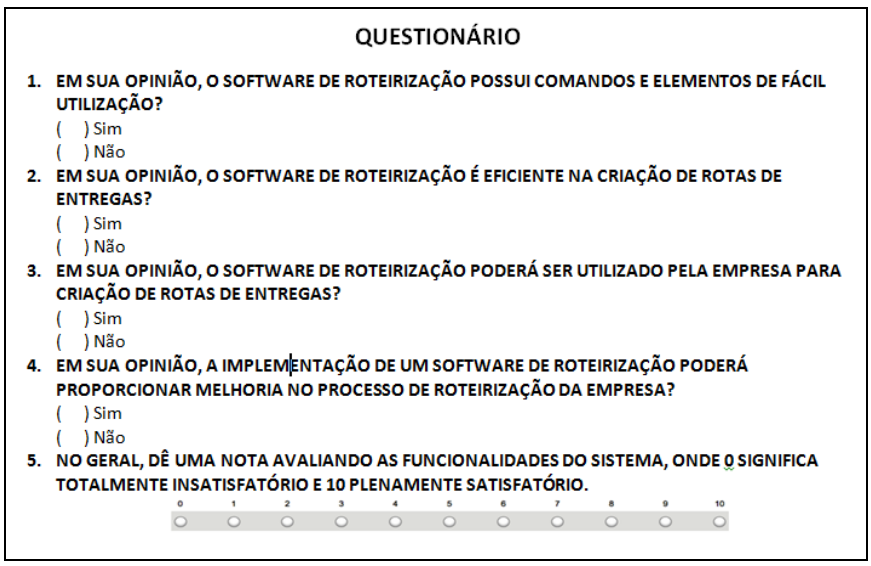
operations, as well as data compilation related to October 2016 to make the routing simulations of each of the days in study.

The second step consists basically in data insertion in the routing software using the data collection fulfilled on the first step for the month of October 2016, that makes possible to recreate daily delivery routes based on the software technical features, it will allow to compare with the collected results of manual routing performed by the company.

It is necessary to point here that the license provided by the routing software company was limited to 10 vehicles, due to this limitation, it was considered to the study the ten vehicles with a higher amount of deliveries. Nevertheless, checking the samples, it was observed a great incidence in utilization of sporadic vehicles to perform a short amount of deliveries, that makes unfeasible to study those routes.

The third step consists in the analysis of the simulations results comparing to the real situation of deliveries, the goal here is to investigate the existence of idleness.

The fourth step is to apply a quiz to have a qualitative survey with the people involved with routing routines, this makes possible to check and analyze their opinion regarding to software functionalities and viability to implement the routing software and possible improvements in the process. The quiz contains four questions as can be observed in Figure 01.



QUESTIONÁRIO

1. EM SUA OPINIÃO, O SOFTWARE DE ROTEIRIZAÇÃO POSSUI COMANDOS E ELEMENTOS DE FÁCIL UTILIZAÇÃO?
   ( ) Sim
   ( ) Não
2. EM SUA OPINIÃO, O SOFTWARE DE ROTEIRIZAÇÃO É EFICIENTE NA CRIAÇÃO DE ROTAS DE ENTREGAS?
   ( ) Sim
   ( ) Não
3. EM SUA OPINIÃO, O SOFTWARE DE ROTEIRIZAÇÃO PODERÁ SER UTILIZADO PELA EMPRESA PARA CRIAÇÃO DE ROTAS DE ENTREGAS?
   ( ) Sim
   ( ) Não
4. EM SUA OPINIÃO, A IMPLEMENTAÇÃO DE UM SOFTWARE DE ROTEIRIZAÇÃO PODERÁ PROPORCIONAR MELHORIA NO PROCESSO DE ROTEIRIZAÇÃO DA EMPRESA?
   ( ) Sim
   ( ) Não
5. NO GERAL, DÊ UMA NOTA AVALIANDO AS FUNCIONALIDADES DO SISTEMA, ONDE 0 SIGNIFICA TOTALMENTE INSATISFATÓRIO E 10 PLENAMENTE SATISFATÓRIO.

0 1 2 3 4 5 6 7 8 9 10

Figure 01: Quiz.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v9i5.836

4. CASE STUDY

To guarantee the viability of study it was collected delivery data from July to October of 2016, the data from the first three months were utilized to evaluate the enterprise´s operations as well as take evidences of seasonality existence that could distort the analysis, the last month data was taken in more detailed way to provide the possibility to visualize and recreate the routes

4.1. Data Collection

During the data collection of the period from July to September, the amount of deliveries done each day were tabulated, the total of 4,599 deliveries were performed in 76 working days, considering that there were not operations in some Saturdays and Sundays during the researched period. With this information it was possible to obtain an average of 60.51 deliveries per day.

Ins second hand, searching for a better understanding of operations peculiarities and to intent identify possible seasonal fluctuations, the information was organized by month as shown in chart 01. By this way it was possible to observe a great variation in delivered quantities from one day to another, but no seasonal fluctuations could be identified in any of the months in analysis.

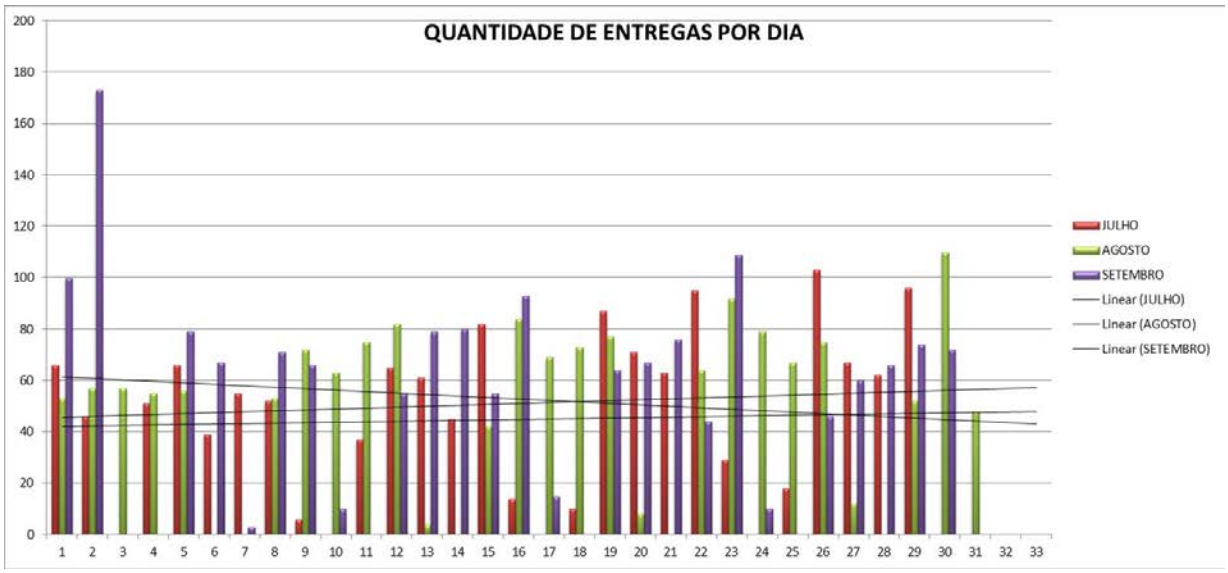
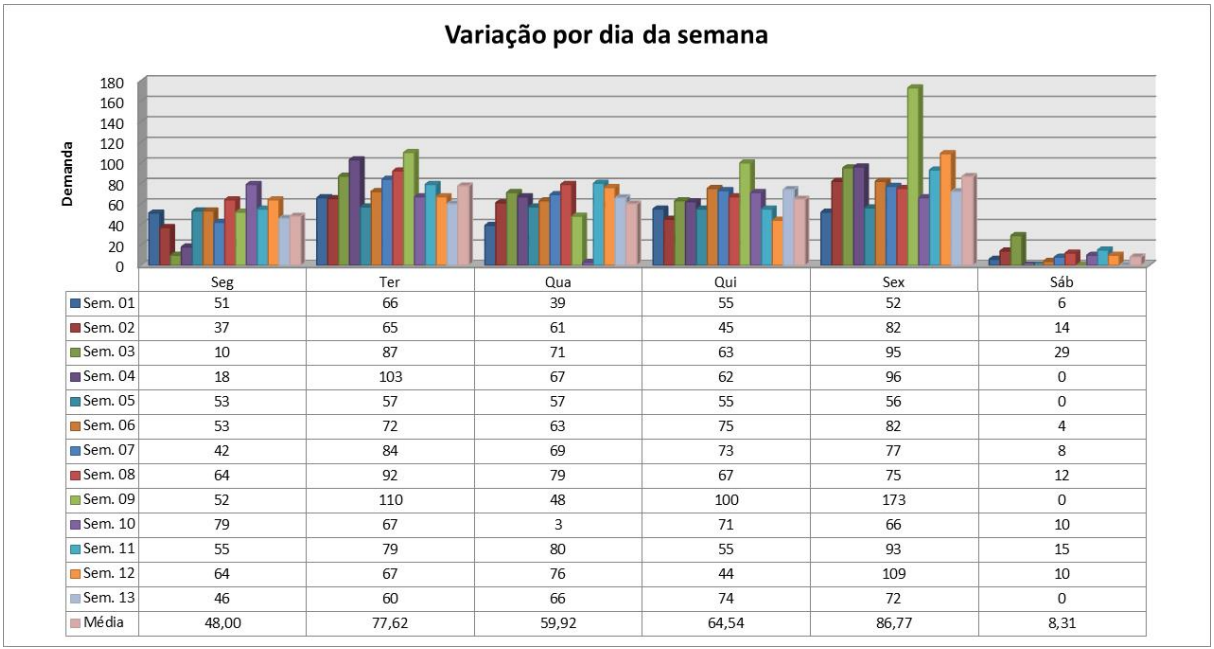


Chart 01: Daily demand analysis from July to September of 2016.

Another cut in information was done in order to analyze the demand profile on weekly basis, and as in the monthly profile, no seasonal fluctuation could be noticed, it is not possible to identify this kind of fluctuation along the days, it was only possible

ISSN: 2236-269X
DOI: 10.14807/ijmp.v9i5.836

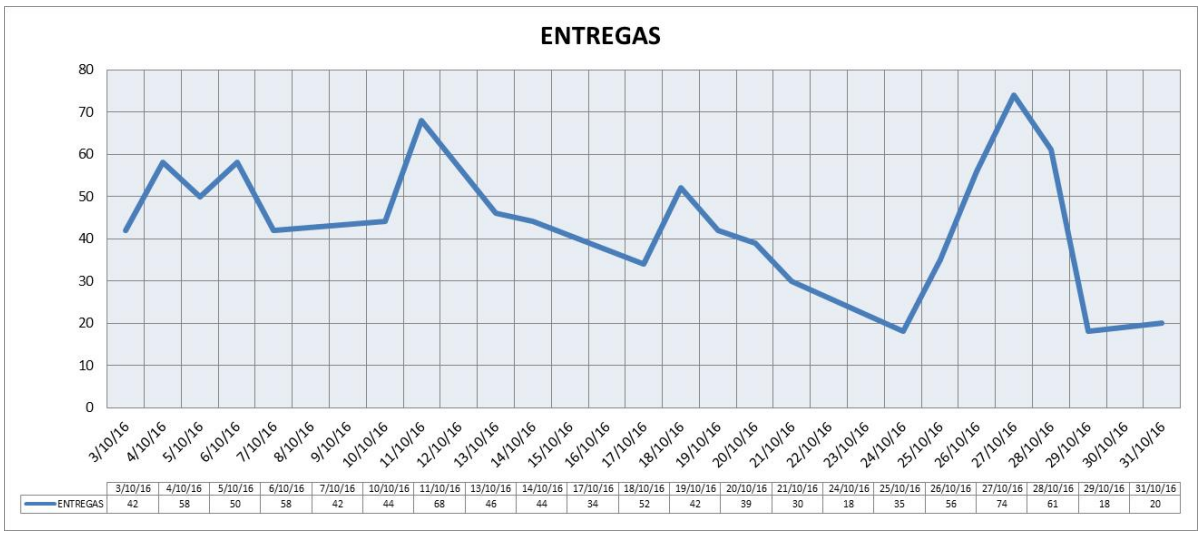
to identify a weak tendency of deliveries increase on Tuesdays and Fridays, as can be shown in chart 02.



	Seg	Ter	Qua	Qui	Sex	Sáb
Sem. 01	51	66	39	55	52	6
Sem. 02	37	65	61	45	82	14
Sem. 03	10	87	71	63	95	29
Sem. 04	18	103	67	62	96	0
Sem. 05	53	57	57	55	56	0
Sem. 06	53	72	63	75	82	4
Sem. 07	42	84	69	73	77	8
Sem. 08	64	92	79	67	75	12
Sem. 09	52	110	48	100	173	0
Sem. 10	79	67	3	71	66	10
Sem. 11	55	79	80	55	93	15
Sem. 12	64	67	76	44	109	10
Sem. 13	46	60	66	74	72	0
Média	48,00	77,62	59,92	64,54	86,77	8,31

Chart 02: Weekly demand analysis.

The same variation was identified in the data collected for October of 2016, in that month it was done 931 deliveries, with a daily average of 44.33 deliveries, this can be seen on chart 03.



	3/10/16	4/10/16	5/10/16	6/10/16	7/10/16	8/10/16	9/10/16	10/10/16	11/10/16	12/10/16	13/10/16	14/10/16	15/10/16	16/10/16	17/10/16	18/10/16	19/10/16	20/10/16	21/10/16	22/10/16	23/10/16	24/10/16	25/10/16	26/10/16	27/10/16	28/10/16	29/10/16	30/10/16	31/10/16
ENTREGAS	42	58	50	58	42	44	68	46	44	34	52	42	39	30	18	35	56	74	61	18	20								

Chart 03: October of 2016 demand analysis.

This variation may justify the sporadic contracted vehicles during the period as shown on table 01.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v9i5.836

Table 01: number of sporadic vehicles per month

Working days per month	Vehicles amount
1	41
2	9
3	4
4	2
5	2

Source: created by the authors

Thus, to make the research feasible, it was made an option to recreate the routes only to the vehicles with continuous services, mainly because as mentioned before, the license provided by the software provider allowed to register ten vehicles. So, it was selected among the regular vehicles working, the ten which performed more deliveries during the month, as detailed on table 02.

Table 02: Most utilized vehicles on October of 2016

Vehicle	Working days	Total deliveries	Average deliveries/day	Total weight (Kg)	Average weight/day (Kg)
VUC1	19	140	7.37	60002	3158
VUC2	17	114	6.71	40623	2389.59
VUC3	12	82	6.83	30162	2513.50
VAN1	16	74	4.63	28168	1760.5
TRUCK	10	70	7	64677	6467.70
TOCO1	12	62	5.17	30397	2533.08
TOCO 2	18	56	3.11	16764	931.33
TOCO3	6	34	5.67	17564	2924.33
VAN2	7	33	4.71	82489	1178.29

Source: created by the authors.

Finishing the data collection stage, based on the information, the ten chosen vehicles made 689 deliveries in total, with 123 different locations. That information allowed the recreation of routes, so it was possible to analyze the vehicles performance, as well as idleness and fleet reduction opportunities.

4.2. The Routing Software

To the study it was utilized a routing software named Rout easy, it is a multi-route software, available to work as an online platform, it allows the creation of several delivery routes by inserting data manually or by data charge from a data base in excel platform.

INDEPENDENT JOURNAL OF MANAGEMENT & PRODUCTION (IJM&P)
http://www.ijmp.jor.br v. 9, n. 5, Special Edition *IFLOG 2017*
ISSN: 2236-269X
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The registration of delivery sources is very simple, can be done by introducing the ZIP code from the street, then the user completes the information of building number, after it is necessary to attribute a name to that origin location.

The vehicle registration needs a insertion of more variables to reflect the real conditions of the available fleet. Therefore, the software has eight pre-defined vehicles models: motorcycle, car, utility, VUC, toco, truck and eighteen-wheeler. As the user selects each kind of vehicle it is possible to make adjustments in the configuration such as weigh capacity, maximum volume, average speed, minimum load, maximum number of deliveries, maximum journey time and circulation constrains. The number of registered vehicles varies according to the contract with the customer, to the study it was available to register the amount of ten delivery vehicles.

After setting the working parameters of origins and vehicles it is possible to start the delivery route creation. The data insertion related to customers such as addresses, weigh, volume, time spent on client facilities and client constrains, can be done manually or be uploaded to the software using a standard spreadsheet extracted from the software, containing all the information about a specific delivery batch as shown in Figure 02.

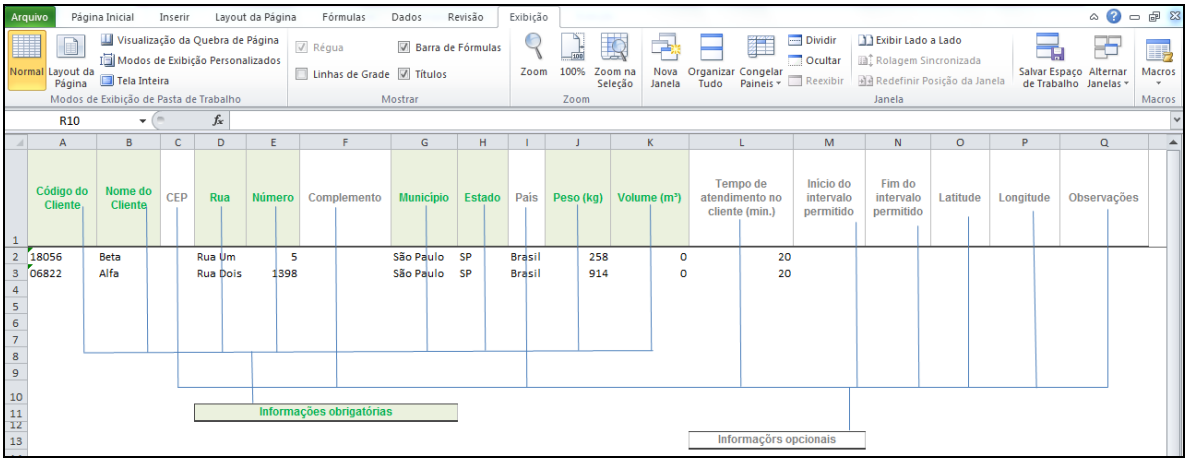

Figure 02: standard spreadsheet to upload data in the routing software.

After inserting the data of deliveries in study, the software prepares the routes following the stablished parameters and create route reports in PDF and MS Excel formats. All the programed routes are stored by the software and can be recovered or deleted by the users if necessary.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v9i5.836

4.3. Routes Rebuild

As prior mentioned to rebuild the routes there was a data selection based on the ten most used vehicles, with a total of 689 deliveries during the month, along the twenty-one working days registered. The data inversion was made by using the standard spreadsheet shown in Figure 02, this made possible to check the data accuracy before uploading to the software.

After checking, the spreadsheets were dismembered in twenty-one spreadsheets named according to the date of shipments.

Regarding to parameters fed in the software, some standard data were settled as shown on Table 03. It is important to emphasize that it was assumed an average speed of 30 Km/h, taking in consideration Zandonade and Moretti (2012) study that found out an average speed in the city of São Paulo and considering that the origin of shipments is located out of the central belt of the city, it was added 3 Km/h, justifying the settled.

It was adopted a daily working journey of eight hours and a displacement time of one hour, which means that a loaded vehicle leaving Suzano at 7:00 am, making a lunch stop of one hour, will return maximum at 6:00 pm. The minimum vehicle load and occupation, as well as stop time in customers were settled based on peculiarities of the company, on average 20 minutes.

Table 03: routing software parameters

Item	Parameter
Average speed (Km/h)	30 Km/h
Minimum vehicle occupation (%)	60%
Maximum trip journey (hours)	10 hours
Average stop time in customers	20 minutes

Source: created by the authors

The specifications of vehicles were settled on the software according to each piece of equipment characteristics, also the daily charges since the company does not use its own fleet, but rent the vehicles to fulfill its needs, these data are shown on Table 04.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v9i5.836

Table 04: vehicle parameters

Vehicle	Daily fee	Weight capacity (Kg)	Allowance to central area in São Paulo.
Utility	R$ 220.00	620	Allowed
Van	R$ 250.00	1500	Allowed
VUC	R$ 380.00	3500	Allowed
Toco	520.00	6000	Not allowed
Truck	590.00	12000	Not allowed

Source: created by the authors

After setting and parameter and uploading data, routes were created on daily basis so all the selected deliveries to the study were included. The results are commented on chapter 5, results analysis.

5. Results Analysis

Regarding to the quantitative analysis of new routes created by the software, a comparison with real results from October operations was conducted to provide an idea of impact caused by the new method.

In a first moment the analysis showed differences in total deliveries quantities, after a deeper evaluation it was noticed that the inconsistences were created due to many deliveries were to companies cities far in the countryside area of São Paulo State, and the routing software excluded them automatically.

The reason for those exclusions were the constrains inserted in the software regarding to maximum working time per day as well as minimum vehicle loading, so the software excluded since the great distance meant to exceed the maximum working journey, in other hand, the software did not create new routes to excluded deliveries due to minimum load for vehicles.

As it was a significant amount of deliveries excluded, around 10% with destination to the State countryside, as shown in table 05, all the routes were checked and recreated, then identified the non-completed deliveries. It made possible to create new routes to the countryside areas by using more flexible rules to these cases and adopting a travel speed of 80 Km/h.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v9i5.836

Table 05: Percentage of deliveries to São Paulo metropolitan area vs Countryside

Date	% countryside deliveries	% metropolitan area deliveries
10/03/2016	0	100
10/04/2016	11.9	88.1
10/05/2016	14.29	85.71
10/06/2016	2.33	97.67
10/07/2016	5.88	94.12
10/10/2016	19.44	80.56
10/11/2016	9.62	90.38
10/13/2016	12.50	87.50
10/14/2016	0	100
10/17/2016	16.67	83.33
10/18/2016	10	90
10/19/2016	22.58	77.42
10/20/2016	0	100
10/21/2016	0	100
10/24/2016	80	20
10/25/2015	20	80
10/26/2016	4.26	95.74
10/27/2016	2.13	97.87
10/28/2016	13.95	86.05
10/29/2016	0	100
10/31/2016	83.33	16.67
Total	10.6	89.4

Source: created by the authors

Using this procedure made possible to accomplish 100% of deliveries and have the recreation of all routes. The results with the routing software were very satisfactory, confirming the existence of idleness and proving the possibilities of fleet optimization.

Another important information is the significant reduction in the amount of contracted vehicles , considering the whole month it was possible to reduce from 125 vehicles to 92 in the simulated situation, it is important to emphasize that on October the 10th and 24th it was necessary to increase the quantity of vehicles to fulfill the same demand, but even with the increase the payment values were reduced due to the utilization of smaller and cheaper vehicles, allied to a better exploitation of the resources.

The qualitative analysis was performed by introducing the software to key people in distribution process in the company, their positions were, transportation and warehousing coordinator, distribution supervisor and the technician responsible for routing process.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v9i5.836

Table 06: saving results comparison current process vs software routing

		Real data October 2016		Simulation October 2016		Results	
Date	Deliveries	Vehicles	Fee	Vehicles	Fee	Vehicles reduction	Fee reduction
10/03/2016	21	4	R$1,530.00	2	R$760.00	50%	50.33%
10/04/2016	42	8	R$3,110.00	5	R$1,960.00	37.5%	36.98%
10/05/2016	42	7	R$2,890.00	7	R$2,430.00	0	15.92%
10/06/2016	43	6	R$2,640.00	5	R$2,160.00	16.67%	18.18%
10/07/2016	34	8	R$3,240.00	5	R$2,250.00	37.5%	30.56%
10/10/2016	36	6	R$2,430.00	7	R$2,110.00	-16.67%	13.17%
10/11/2016	52	10	R$4,010.00	7	R$2,860.00	30%	28.68%
10/13/2016	32	7	R$2,650.00	4	R$1,370.00	42.86%	48.3%
10/14/2016	33	5	R$2,260.00	3	R$1,280.00	40%	43.36%
10/17/2016	24	5	R$2,180.00	4	R$1,500.00	20%	31.19%
10/18/2016	40	7	R$3,020.00	6	R$2,210.00	14.29%	26.82%
10/19/2016	31	6	R$2,640.00	4	R$1,440.00	33.33%	45.45%
10/20/2016	30	7	R$2,380.00	3	R$1,280.00	57.14%	46.22%
10/21/2016	28	5	R$1,980.00	3	R$1,420.00	40%	28.28%
10/24/2016	10	2	R$1,040.00	3	R$720.00	-50%	30.77%
10/25/2015	30	6	R$2,270.00	5	R$1,620.00	16.67%	28.63%
10/26/2016	47	7	R$2,680.00	5	R$2,090.00	28.57%	22.01%
10/27/2016	47	7	R$2,650.00	5	R$1,750.00	28.57%	33.96%
10/28/2016	43	8	R$3,110.00	6	R$2,080.00	25%	33.12%
10/29/2016	18	3	R$1,140.00	2	R$900.00	33.33%	21.05%
10/31/2016	6	1	R$520,00	1	R$250.00	0%	51.92
Total	689	125	R$50,370.00	92	R$34,440.00	26.4%	31.63%

Source: created by the authors

There was a short training to present the software functions, then they prepared routes for the demand on the day the survey occurred, after that they answered the quiz from figure 01 and gave their opinion on the software. Both affirmed that the software is easy to use and efficient on building routes, and they believe it suits the company needs, and can be used to route the deliveries.

After all it was requested to attribute a grade varying from zero to ten, where zero means totally unsatisfactory and ten means fully satisfactory, the average was 9.33.

6. FINAL COMMENTS

Based on the research results, it is possible to affirm that the routing software used provided significant earnings on costs and efficiency, as well as quality in routing.

ISSN: 2236-269X
DOI: 10.14807/ijmp.v9i5.836

Nevertheless, to achieve good results it is necessary well-trained uses with good knowledge of available functions in the software and companies' routines, these two things help to analyze the routes quality and if necessary make adjustments such relocate deliveries excluded from routes due to the stablished constrains.

It is very important that vehicle parameter is accurate in information such as load capacity and constrains, other important issue is to know customers characteristics, so the software will operate to fulfill all these parameters and get better results.

With more time using the software it is possible that users can be able to give feedback to improve the utilization and reduce even more the excluded deliveries.

Finally, is important to emphasize that the study was conduct with a limited time, the simulations had as main objective optimize the vehicles reduction, but the routing software also has options to reduce distances. So for future studies, it is recommended to compare gains created by using other functionalities, and if possible to make a longer evaluation of software implementation and check the learning curve to have a better picture of the advantages obtained.

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ISSN: 2236-269X
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