Factors Influencing Transport Productivity of a Freight Transport Company

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Abstract

The purpose of this paper is to examine what are main factors influencing trucks productivity of a freight transport company in Mexico. This study employed factor analysis to determine if there were a relationship between variables and multiple regression analysis to determine which factors had significant impact in delivery times. Data collected were analyzed using SPSS 23. Regarding factor analysis, it was used Kayser-Meyer-Olkin test to prove if a factorial analysis could be performed, resulting in reduction of variables from 7 to 2 – with a KMO of 0.91 the results are suitable for factor analysis – and Bartlett's sphericity test to test resulting in 0.0 – which means data structure is suitable – indicating factor analysis and data are useful to achieve research objective. Hence, this study is the base to improve service quality and client perception, by increasing number of fulfilled deliveries. This research is important for the company since it will provide insights about the performance of their logistics process and variables to be controlled to improve trucks efficiency and productivity.

Keywords
Freight transport, trucks productivity, factor analysis, ANOVA, multivariable analysis.

1. Introduction
Freight transport system is part of essential activities for the economy of each country (Kulovic, 2016; Bouguerra et al., 2016) and Mexico is not the exception, besides road freight transport is the most used modal transport due to low costs (Zamora Torres and Mora Zimbon, 2018). Hence, it is important for logistics company to measure efficiency and productivity of their operations. Moreover, no matter in what industry companies are involved, they use key performance indicators (KPI) to collect data regarding real performance of processes, defining a KPI as a quantitative verifiable representation to measure to what extent goals are met (Arango Serna et al., 2016). Moreover, since logistics operations and delivery times of freight transport companies have high impact for manufacturing companies as a cost driver for logistics processes and customer satisfaction (Sambracos and Ramfu, 2014).

Quality service and operations efficiency should be an objective assessment regarding KPIs as mentioned by Šimková et al., (2015) which should be based on factors affecting transport service; but identify those factors is a challenge for companies, since are internal and external factors affecting operational performance, so this research is focused in a case study of a freight transport company whose service quality is affected by social factors (such as road blocking or climate),

2. Freight Transport

Logistics activities are important for countries' economies, and for third party logistics company it is a core business function to provide a bridge between supply and demand for goods, resulting in a complex business process (Sambracos and Ramfu, 2014).

In order to improve their operational effectiveness, companies pursue distinctive strategies in marketing, production, logistics and service deliver (Havlicek et al., 2013), introducing corporate governance where possible (Thalassinos and Zampeta, 2012). Hence, quality delivered by the business can be understood in terms of efficiency, quality, inputs specialization, company strategy, and presence of related and supporting industries (Porter, 1990).

2.1 Freight Transport Performance Measurements

Operational activities are core for any business, and they must be focused in ensuring competitive advantage of the company, including freight transport companies. So, it is important to understand factors impacting operational performance of companies, since, as mentioned by Gargasas (2019), competitive advantage emerges from organizational ability to differentiate itself from competitors in the eyes of customers, and part of these advantage are offering the lowest price with high quality while earning higher profit. So, accurate KPIs are important to measure operations and service, such as delivery times, number of collections on time, number of late deliveries, distance travelled by number of trips, percentage of complaints total, number of overloads, number of vehicle traffic infringements, truck drivers turnover, truck age, driver breaks, scheduled maintenance, unscheduled maintenance, waiting and excess service time, and vehicle planning times (Šimková et al. 2015; Arango Serna et al., 2016; Villarreal, 2016).

2.2 Impact of Freight Transport Time

Freight transport Time affects replenishment rates and supply chain lead times, which is the total time elapsed between an order placed to the supplier and received in the customer facilities, and as a result, it will have a negative impact in the materials inventory replenishment time (Sambracos and Ramfu, 2014; Van-der-Vorst, 2003). Also, sourcing transportation time is affected by different factors measured by the KPIs related to main sources of waste types of logistics operations such as collections on time, distance travelled, number of overloads, number of vehicle traffic infringements, truck age, waiting and excess service time, scheduled and unscheduled maintenance, and truck driver turnover.

On the other hand, increasing delivery transport time will delay material replenishment for the customers and consequently customer satisfaction will be affected since fill rate is not as much as offered. Moreover, delivery transport time will not affect directly to the third-party logistics company, but to the customer operations and inventory management, so it will perceive a low value of service offered since the logistics chain take into account creation of value added, price, quality, customer satisfaction and improvement of efficiency of factors affecting delivery times, so it is important to help to plan the process in terms of (Knowles, 2011).

- To plan process goals and parameters: Implementing quality management systems.
- To evaluate positive and negative process factors: Develop, implement and evaluate process.
- To arrange process goals: By implementing management systems based on key performance indicators.
- To control actions: By providing recommendations for continuous improvement.

3. Methodology

3.1 Research Design

This study was carried out using a quantitative research design, since the objective is to have statistical conclusions regarding collected data to provide actionable insights, so the company can use results to improve efficiency of the logistics system. This research includes a correlational design to establish the relationship between logistics performance – measured through the number of completed deliveries – and different delay times identified from data for each route.

3.2 Sample Size
It was necessary to collect 25 random set of data for each route type to provide enough amount of accurate computation using SPSS software. Sample size selected each period randomly across period 2019 from June to September.

3.3 Data Analysis
IBM SPSS Statistics software was used to test and evaluate the main factors identified from truck logs for different routes. Options used to analyze data were factor analysis, so it was able to reduce the number of variable, after that multivariable regression analysis was applied to determine a mathematical model to predict the impact of each variable to the number of travels fulfilled.

3.4 Data Collection
The methodology followed for this research work was the collection of data regarding times from truck logs. Since data were unstructured, they were cleaned and treated before analyzing them, so they were able to be analyzed. Moreover, since data were about 52 different routes, it was used a Pareto Chart to select most important routes regarding revenues. Selected routes were long routes, whose tanker trucks capacity were up to 63 tons (doubles). Moreover, it is important to mention that all units were assigned full time to each route, and they were working at the same route all analyzed period. Data collected were about the following variables:

- **Number of completed deliveries**: Number of deliveries completed per month of each route.
- **Operator type**: Operators are classified by types considering years of working for the company, route types travelled, and license type: (A) Truck drivers with at least five years working for the company, license type C/E, they are experienced in high risk and long routes (longer than 120 km), (B) Truck drivers with at least two years working for the company but least than five years, license type C/E (transport of high risk material), and experience in long and medium risk routes (longer than 120 km), (C) Truck drivers with less than two years working for the company, they have low experience in risky routes, license type C, and they have been working in short routes (less than 120 km).
- **Corrective Maintenance issues**: Delay time, in hours, related to corrective maintenance for each unit.
- **Load issues**: Delay time, in hours, related to issues related to the truck overload.
- **Driver Issues**: Delay time, in hours, related to excess of idle time of truck driver.
- **Operational Issues**: Delay time, in hours, related to lack of sources like fuel, deposits, or other issues related to traffic department planning.
- **External Issues**: Delay time, in hours, related to external factors such as road blocking, weather conditions, accidents, etc.
- **Client issues**: Delay time, in hours, related to lack of authorization for product load/unload.

4. Results and Findings
4.1 Selected Routes
There were selected 6 routes, representing 17.1% of routes, using Pareto Chart (Figure 1), which represent 69.7% percent of revenues.

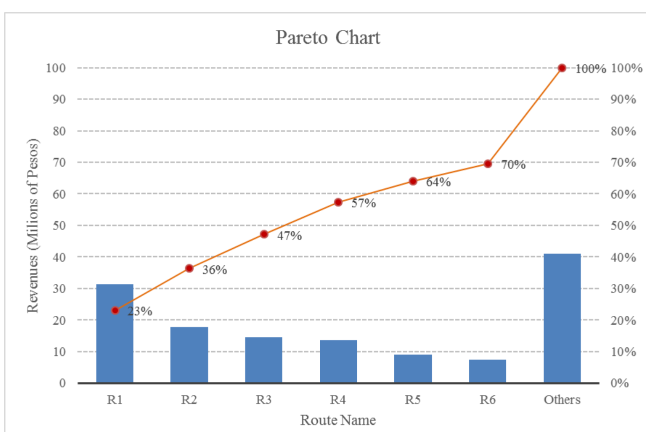

Figure 1. Pareto Chart for Routes

4.2 Factor Analysis

In order to make factor analysis, data for operator type was not considered since this technique only works with quantitative variables such as interval or ratio (Marder, 2011) and operator variable is a nominal variable. So, KMO and Bartlett-s Test (table 1) were applied and regarding obtained results, it can be said variables can be reduced, since Kayser-Meyer-Olkin Measure is greater than 0.6 (Cecchetto and Pellanda, 2014), $KMO = 0.91$, also, the Bartlett's Test of Sphericity with a significance level of $p < 0.05$ it is concluded that there are correlations between variables (Ibid.; Chauhan et al., 2018).

Table 1. KMO and Bartlett-s Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.910
Bartlett's Test of Sphericity	Approx. Chi-Square	989.168
	Df	21
	Sig.	.000

Total variance explained (table 2) for components is about 84.22% - which is shown by those components with eigenvalues greater than 1 explained by two components (Chauhan et al., 2018).

Table 2. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.685	66.928	66.928	4.685	66.928	66.928	4.373	62.474	62.474
2	1.210	17.291	84.219	1.210	17.291	84.219	1.522	21.746	84.219
3	.519	7.408	91.627						
4	.194	2.765	94.392						
5	.170	2.432	96.824						
6	.122	1.738	98.562						
7	.101	1.438	100.000						

Extraction Method: Principal Component Analysis.

On the other hand, rotated component matrix (table 3) shows that Corrected Maintenance issues and Completed deliveries are correlated in component 2, which an inverse effect, it means, the higher maintenance time, the less completed deliveries and component 1 is made up variables: load issues, driver issues, operational issues, external issues and client issues, which are able to be classified as Logistics issues.

Table 3. Rotated Component Matrix

	Component	
	1	2
Completed Deliveries	-.017	-.894
Corrective Maintenance Issues	.314	.769
Load Issues	.910	.137
Driver Issues	.925	.166
Operational Issues	.942	.162
External Issues	.940	.125
Client Issues	.905	.208

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

4.3 Multiple Regression Analysis

In order to use the multiple regression analysis, it was added the variable driver type, which is nominal and can be converted to values. Moreover, since for the factor 1 (Logistics issues) is made up by variables measured in minutes, they can be added. Hence, ANOVA analysis (table 4) was carried out with a significance level of $p = 0.05$, which shows that the model is significant, it means, at least one of the variables impact number of deliveries completed since the significance of the model has a value of 0.00, which is less than p-value of 0.05.

Table 4. ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	77.823	3	25.941	29.679	.000[b]
	Residual	128.484	147	.874		
	Total	206.306	150			

a. Dependent Variable: Completed Deliveries

b. Predictors: (Constant), Logistics Issues, Driver Type, Corrective Maintenance Issues

On the other hand, the correlation value shows that the model (table 5) is explained in 61.4% by the variables with an association force of 37.7%.

Table 5. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.614[a]	.377	.365	.93490

a. Predictors: (Constant), Logistics Issues, Driver Type, Corrective Maintenance Issues

b. Dependent Variable: Completed Deliveries

Table 6 shows variable with higher impact in delivery times is corrective maintenance issues, with a significance level of 0.00, while driver type and logistics issues are not significant to the model. Moreover, through the collinearity analysis (VIF) it can be said that there is no problem of multicollinearity for the model.

Table 6. Coefficients

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	4.026	.254		15.834	.000	3.524	4.529					
	Driver Type	-.031	.119	-.017	-.258	.797	-.267	.205	-.026	-.021	-.017	.999	1.001
	Corrective Maintenance Issues	-.219	.024	-.612	-9.008	.000	-.267	-.171	-.614	-.596	-.586	.917	1.090
	Logistics Issues	-.001	.007	-.005	-.074	.941	-.014	.013	-.182	-.006	-.005	.917	1.091

a. Dependent Variable: Completed Deliveries

Running the model as a Simple Linear Regression Model coefficient (table 7) for corrective maintenance issues is calculated to be -0.22, it means, there is an inverse relationship between deliveries completed and corrective maintenance time, it means, the higher the maintenance time, the less number of deliveries completed.

Table 7. Coefficients for Simple Linear Regression Model

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	3.968	.098		40.591	.000	3.775	4.161					
	Corrective Maintenance Issues	-.220	.023	-.614	-9.494	.000	-.266	-.174	-.614	-.614	-.614	1.000	1.000

a. Dependent Variable: Completed Deliveries

Finally, by considering coefficients values from Table 7, and the equation for a Simple Linear Regression Model as $y = \alpha + \beta x$, equation to determine corrective maintenance impact in the logistics operations is given by:

$$y = \alpha + \beta x = 3.968 - 0.220$$

5. Conclusion and Recommendations

This study recommended that company should pay special attention to maintenance, since it is the factor affecting meaningfully the supply chain performance of the logistics company from the case study. Hence, in order to reduce those times, it is important to implement a preventive maintenance program, which should be planned to be carried out when equipment has low utilization due to low demand, also, make a general check to the trucks with highest idle times in order to focus in the reduction of idle time to improve equipment productivity. Also, the analysis and classification of truck types by age should be performed, so they oldest can be assigned to flat routes where their performance cannot be reduced by type of road and service can be performed efficiently. Moreover, it is important to standardize truck logs to reduce data manipulation manually, since all data had to be cleaned before any analysis could be performed, which reduces visibility of logistics issues to make decisions regarding any route, impacting negatively in customer service level and reaction times are longer, increasing delivery times and, consequently, impacting manufacturing times from customers. Hence, it should be implemented KPIs to measure process efficiency regarding maintenance and equipment utilization.

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Biographies

Felix Bueno is a Doctorate student from UPAEP. He earned his B.S. Industrial Engineering with minor in Systems Engineering and his Master of Engineering in Quality and Productivity Systems from ITESM University, Mexico, BS. in Software Development from UNADM, Mexico, MSc. Logistics and Supply Chain Management from University of Hull, United Kingdom. He is a certified Advanced Robotics Process Automation Professional, by Automation Anywhere and UiPath, Black Belt, by American Society of Quality, TOGAF, by the Open Group, and Project Manager, by Project Management Institute, with experience in process improvement and quality management. He has lead projects from different industries related to process improvement of Shared Services Centers, Oil and Gas, Retail, Pharma, Financial Services, Freight Transport, Energy and Education. His projects include working with ISO9001 standards, Enterprise Performance Management, Business Process Reengineering, Lean Six Sigma, Robotics Process Automation, agile frameworks, ITIL framework, logistics, Activity-Based Costing, inventory management, scheduling. He is member of PMI, Open Group and ASQ.

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