Feasibility between Two Models for the Control of Fleet Idleness: RFID Antennas vs Electronic Fences (Telemetry)

André Garófalo Chaves[1], Rômulo de Araujo Lima Filho[2], Ricardo Moreira da Silva[3]

[1,2,3] *Department of Production Engineer, Federal University of Paraiba, João Pessoa, Brazil*

[1]andre.garofalo@gmail.com

[2]romuloalfilho@yahoo.com.br

[3]ricardomoreira0203@hotmail.com

Abstract **- Optimizing the use of resources within organizations without decreasing the level of quality of service is a constant and recurring challenge in the daily life of professionals. In Group X, an electricity distribution company located in the Brazilian Northeast, fleet management is one of the priorities. This study compares the use of two tools to measure fleet idleness, RFID Antennas and electronic fences created from the Telemetry system. The process and cost of installation, scope, maintenance costs and results obtained were compared between the two tools. This comparison was used to analyze the feasibility of expanding the tools in Group X for newly acquired companies. Based on the results, it was concluded that the Telemetry system was economically and operationally the best option for Group X.**

Keywords*: Fleet Monitoring, Vehicle Idling, RFID, Telemetry, Logistics, Transportation, Fleet.*

1. Introduction

"Radio Frequency Identification" (RFID) means a term that describes any identification system in which an electronic device that uses variations of radio frequency or magnetic field to communicate is attached to an item. The two components of the RFID system are the label, which is the identification device attached to the item that will be tracked, and the reader, which is a device that can recognize the presence of RFID tags and read the information stored in them [1]. The beginning of RFID was during World War II, when the British used it to identify if the aircraft belonged to the "friend or enemy" [2]. After it, RFID applications, for example, are used in cattle tracking, forgery prevention, supply chain management, security to differentiate copies of pirated videos, access control to buildings, and so many other applications [3].

Telemetry is a technological monitoring system, used to command, measure or track something at a distance, through wireless communication (radio or satellite signals). This technology is used at geographically remote or constantly moving points (such as automobiles), collecting its information and transmitting it to a control center, which has the function of monitoring and decoding this data. Currently, telemetry is applied in many branches, such as agriculture, meteorology, water and sewage treatment, energy monitoring and others. The advanced use of vehicle telemetry is a trend, a tool that aggregates much more information and allows better control of the fleet, with great opportunities to increase productivity, among other benefits. This tracking and monitoring system allows the creation of Electronic Fences that act as a traffic limiter on the map, allowing the establishment of an area that should not be exceeded by drivers.

These technological monitoring systems, RFID antennas and electronic fences have been used, for example, in the measurement of idleness of vehicles in any company.

This article brings to the knowledge of the academic society the experiments and tests developed by the Planning and Monitoring team (P&M) of an Electric Energy distributor, located in the Northeast of Brazil, which will be referred to in this work as Group X. This team is responsible for the logistic budget of the entire

International Journal of Supply Chain Management
IJSCM, ISSN: 2050-7399 (Online), 2051-3771 (Print)

group, which includes costs of maintenance and operation of the fleet, acquisition of new vehicles, replacement of old vehicles, and travel expenses. In addition, it has analysts responsible for monitoring the fleet and seeking innovations with the potential to generate cost savings without losing quality in service level agreements.

Initially, the P & M team used RFID antennas to measure fleet idleness in the Group X distributor's yards, which at that time met expectations for control and idle reduction. However, according to [4], there was a high value of installation of equipment, maintenance and TAGs (electronic labels positioned in vehicles) and the RFID tool was not able to measure a large number of vehicles, since there were only antennas in the large yards of the distributors.

Grupo X, on the other hand, already used Telemetry technology in a large part of its fleet, but with the approval of the board of directors to expand this technology to 100% of the group's vehicles, even with the initial intention, which was having a greater management on the way of how drivers conduct the company´s vehicles, and cost reduce with fuel and vehicle components, a window of opportunity was opened to initiate the control of idleness of the vehicles using a tool, available on the vendor's web platform, which were the Electronic Fences, and with that would have the possibility of expanding the number of patios monitored.

Based on the foregoing, this study aimed to compare the RFID tools and Electronic Fences and the results achieved, considering the analysis of financial and structural feasibility to expand these tools in Group X.

The organization of this report is guided by the protocol proposed by [5]: The first section is aimed at introducing the report and the subject matter. The second section seeks to describe the methodological path of the report focusing initially on Telemetry and RFID technologies, their operational and technical principles and how it was used on the Group X. Next, results obtained in the tests and in the fourth and last part we discuss more about the conclusions and final considerations of this article as well as its limitations and future possibilities.

2. Methodology

This article was elaborated in two stages, starting from the professional experience of the researchers, who elaborated the first version through the use of participant direct observation and the analysis of documents related to the implementation and management of RFID in the monitoring of idle vehicles - Final Report of the Patio Monitoring Project [6]; Presentation/System Utilization Training/PMF [7]; Electronic messages of instruction and evaluation of the system [8]; and Vehicle Optimization Suggestion [9]. In addition, were used the documents related to the implementation of the pilot project of Telemetry - Final Report of the Pilot Project of Telemetry [10]; Comparative Report of Idleness Tools [11]; and Idleness of the 2016 Fleet [12]. In the second stage of the work, it was possible, based on the interaction with the P & M team, to analyze the data generated by each tool and its practical applications for the day to day operation. The approach was predominantly qualitative, although the use of reports and secondary data used in the process management was relevant for the projection of the results obtained.

The analytical categories proposed were strategic alignment [13] [14]; knowledge management [13]; and, the decrease of the idleness of vehicles. The data analysis was guided by the qualitative model proposed by [15], through data condensation and visualization, followed by the elaboration and verification of conclusions, which were used iteratively and simultaneously. The data were condensed in first and second level, allowing open and interpretive coding with the support of the families of codes proposed deductively from the theoretical reference of this research and from those that emerged in an inductive form.

2.1 Installing and Using Tools

Grupo X created in 2012 a corporate unit linked to the company's Supply and Logistics director, which was called Planning and Monitoring (P & M), with the objective of finding ways to optimize resources related to the company's fleet. Initially, two work fronts were formed, the first to carry out a pilot project to install Telemetry in vehicles to monitor drivers, limit vehicle speeds and reduce misuse of the fleet. This tool proved feasible after months of analysis of the pilot project, in which it was verified and established that using the tool and monitoring the drivers of the company would have a cost reduction of around 6% in the fuel sub-account, 3% in the maintenance sub-account and 4% in the sub-account rolled kilometers. The second work front was aimed at measuring and reducing vehicles with higher indices of idleness in the courtyards through the tool of RFID Antennas.

2.2 Antennas RFID

In the installation of these antennas there was a feasibility study of installation by patio, and as in the implantation of the antennas there was a high cost involved, referring to the construction of the antennas next to the entrance and

exit gates, hardware installation, labor of specialized technicians, TAG purchases for vehicles, among other expenses, would only become viable if the yard had a significant number of vehicles to be monitored. So, the tool was only approved for 5 yards, where they had at least 40 vehicles.

Once the tool was installed and running 100% of the fleet, the P&M team monitored the idle of the vehicles, considering the commercial hours of the day, in which the vehicles should be running. In addition to this assessment, the tool could be integrated to the vehicle request software of the *Pool* (Sector of the company that works as a car rental company, where all can make reservations through the system, marking day and time of use), and with this integration the *Pool* management team had immediate access to know in real time whether the vehicles were inside corporate yards.

With the resources coming from the supplier's system and the integration made, the P&M team analyzed the extracted data generating synthetic reports, analytics and rankings of vehicles less used in each department. This flow of information generates knowledge of the real situation for the directors and managers of the group and seeks to promote better use, reallocation between departments or even the alienation of automobiles.

The RFID antenna installation project in the 5 largest courtyards of the Group, was budgeted at R$ 286.006.00, but was able to be realized with a savings of approximately R$ 9.924.00, due to the reuse of computer equipment, such as computers, peripherals and etc. The value of the project included expenses with Hardware, Licenses of Use, Services, TAGs, Extended Warranty, Civil Works, Infra TI and trips of the company consultants [6].

2.3 Telemetry

The pilot project of Telemetry was carried out initially using 4 suppliers; each vendor installed 4 pieces of equipment, and the team analyzed characteristics of the monitoring platforms, investment value, reliability of the data generated, quality and format of the reports available, and the ability of companies to perform necessary integrations and customizations. After choosing the supplier, a larger number of vehicles received the tracking equipment to be matched the performance gain; this study lasted approximately 6 months, and the financial gains accrued by the tool proved feasible to expand for the all fleet. The P&M team checked the infraction events on a daily basis, and a monthly report of all infractions was sent to directors and managers, informing the largest offenders by department.

As some integrations were made between the Telemetry supplier and Group X, it was realized that electronic fences could be created directly from the system and thus monitor all the movements and measure the idleness of the system.

The electronic fences (Figure 1) are areas delimited by the user which have parameterizable rules that may differ from other events followed by the client. Different speed limits, log entries and exits, email alerts, or reports can be created. In addition, the system allows a large number of fencing per user.

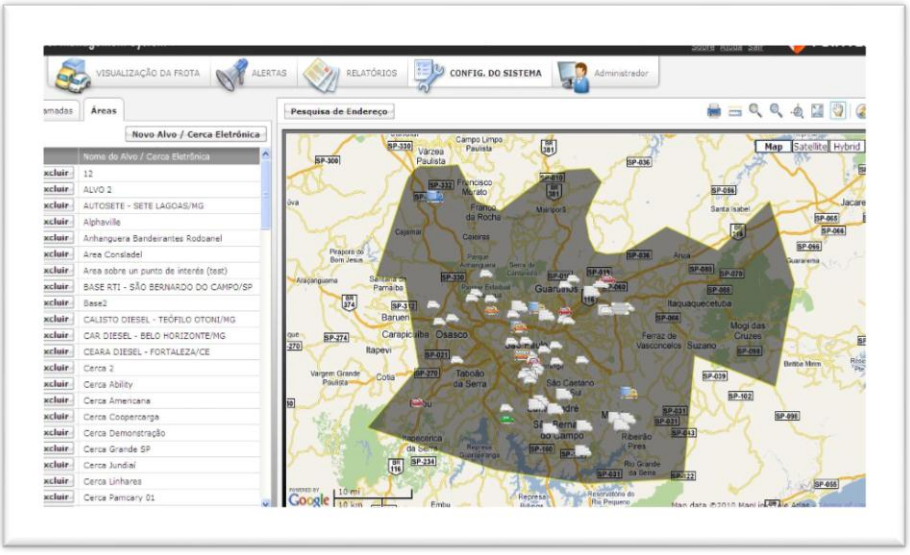

Figure 1. Electronics Fence created in the Web Platform

After the creation of the electronic fences in the main yards, an audit was performed comparing the efficiency and accuracy of the tools. The results were determined using the electronic fence data, the RFID data and a manual entry and exit record made by the concierge officer. The electronic fences had 98% of the entries and exits registered correctly, giving the P&M team and its board of directors the opportunity to adopt the tool to control the idle fleet.

A few months after Group X performed these tests, the group acquired two more companies in different states, and the P & M team was asked to make a financial feasibility analysis on the tools considering an investment period of five years.

In the preparation of the feasibility study the team had to define some premises for the calculations [11], they were:

- Expected savings through the use of Telemetry (Table 1).

Table 1. Percentage of savings found in the pilot project, by category

Category	% savings
Performance Improvement	4%
Maintenance	3%
Km reduction	6%

- Savings values have been projected by vehicle class according to the budget history of the last 3 years.
- Number of vehicles in the two companies: 318.
- WACC discount rate for return analysis: 11.6% (amount indicated by the financial department of Group X).

3. Results Obtained

The financial feasibility analysis was calculated by projecting expenditures over 5 years, taking into account the installation of RFID Antennas in 7 yards (considering the minimum number of vehicles per yard for deployment) versus the telemetry installation analysis in 100% of the fleet of the companies acquired, using the financial gains resulting from the installation of the tool, which were obtained in the pilot project.

According to the data presented in Table 2, it can be observed how much Group X would need to pay to install and maintain the RFID antennas in 7 new companies' yards. The investment brought to Net Present Value (NPV) would mean an amount of R$ 858.585,00. In this scenario it was decided not to consider the gains, since it was understood that the gains generated with the idle control would also occur in the Telemetry tool, so the two would cancel out as a financial advantage in this analysis. However, even if this comparison were considered, the Telemetry tool would have a wide advantage due to the possibility of creating numerous fences, which would increase the number of vehicles and yards monitored.

Table 2. Financial feasibility analysis of installation of RFID antennas in 7 courtyards. [11]

VALUES REGARDING THE PURCHASE OF RFID EQUIPMENT					
	Year 1	Year 2	Year 3	Year 4	Year 5
Initial Costs	**R$ (416.600)**	**R$ -**			
Hardwares	R$ (240.010)	R$ -			
GTI MID Licenses	R$ (28.045)	R$ -			
Services	R$ (82.373)	R$ -			
Tags	R$ (13.252)	R$ -			
Extended Warranty	R$ (52.921)	R$ -			
Monthly payment	**R$ (76.754)**	**R$ (76.754)**	**R$ (76.754)**	**R$ (76.754)**	**R$ (76.753)**
Infrastructure	**R$ (130.176)**				
Civil works	R$ (71.701)				
Infra TI	R$ (24.500)				
Reservation Tags	R$ (3.975)				
Travels	R$ (30.000)				
TOTAL FLOW	**R$ (623.530)**	**R$ (76.754)**	**R$ (76.754)**	**R$ (76.754)**	**R$ (76.753)**
ACCUMULATED FLOW	**R$ (623.530)**	**R$ (700.283)**	**R$ (777.037)**	**R$ (853.791)**	**R$ (930.543)**
WACC	11,6%				
VPL:	R$ (858.585)				

The installation and maintenance expenses (monthly payments), and the financial gains calculated on the basis of expenses per vehicle and the average km run are shown in Table 3. It can be observed that the installation of Telemetry, over 5 years, besides bringing a financial return on the NPV result of R $ 1.483.980.00, still adds a greater management on the behavior of the drivers of the group, bringing intangible gains as an increase in productivity, reduction of accidents and mainly greater operational control by managers.

Table 3. Financial viability analysis of Telemetry installation in 318 vehicles of the fleet. [11]

VALUES CONCERNING THE INSTALLATION OF TELEMETRY WITH GAINS					
	Year 1	Year 2	Year 3	Year 4	Year 5
Expenses	**R$ (259.806)**	**R$ (213.696)**	**R$ (213.696)**	**R$ (213.696)**	**R$ (213.696)**
Monthly payment	R$ (213.696)	R$ (213.696)	R$ (213.696)	R$ (213.696)	R$ (213.696)
Installation:	R$ (38.160)	R$ -	R$ -	R$ -	R$ -
Buttons:	R$ (7.950)				
Gains	R$ 590.337	R$ 590.337	R$ 590.337	R$ 590.337	R$ 590.337
Km Wheeled	R$ 375.011	R$ 375.011	R$ 375.011	R$ 375.011	R$ 375.011
Fuel	R$ 133.782	R$ 133.782	R$ 133.782	R$ 133.782	R$ 133.782
(parts + serv.)	R$ 81.543	R$ 81.543	R$ 81.543	R$ 81.543	R$ 81.543
TOTAL FLOW	R$ 330.531	R$ 376.641	R$ 376.641	R$ 376.641	R$ 376.641
ACCUMULATED FLOW	**R$ 330.531**	**R$ 707.171**	**R$ 1.083.812**	**R$ 1.460.452**	**R$ 1.837.093**
WACC	11,6%				
VPL:	R$ 1.483.980				

In addition to the financial comparison presented in the tables above, the P & M team created a comparative table considering other aspects of the tools, which made even clearer the operational advantage in the choice of Telemetry (Table 4).

Table 4. Comparison of different aspects of the tools studied.

COMPARATIVE BETWEEN TOOLS		
	RFID	**Telemetry**
Patios	7 patios with at least 40 vehicles	n patios without minimum number of vehicles
Maintenance	All patio information is lost	Only vehicle information on maintenance is lost
Technicians	Own technician, care takes weeks to accur	Network accredited throughout Brazil, immediate care
Integration	Restriction and development of time-consuming and expensive integrations	Great team of integration and customization, fast and free
Other Gains	---	Great team of integration and customization, fast and free

This comparison can help companies that have large fleets to compare different tools before implementing them, taking into account all the positive and negative aspects of each system, avoiding wrong and poorly planned investments, which is usually a traumatic

process in organizations, and end up getting an obsolete tool due to the error in the process of choosing.

4. Conclusions and Final Considerations

Therefore, based on the financial results and the operational comparison presented in the sections above, we were able to achieve the general objective of this article, which was defined as: compare the RFID tools and Electronic Fences and the results achieved, considering the analysis of financial and structural feasibility to expand these tools in Group X. It was concluded that to achieve the purpose of controlling idleness in the patios both tools delivered satisfactory results, but the Telemetry system was the ideal tools for Group X not only economically but also operationally.

Among the future practical aspects, it is necessary to mention the possibilities of extending the perspective of idleness to a more general view of efficiency. In this context, dynamic fleet management should be considered [16], which offers more suitable possibilities to Group X. The P&M team is seeking to integrate the Telemetry platform with the service dispatch system to have greater traceability and routing among teams, which should generate gains in field team control, increased productivity and routine predictability and services.

The limitation of this report is related to the lack of concrete results of fleet reduction based on the comparison between the two tools. In an improvement of the study, the historical results of the use of the tools could be included for the reader to have a real notion of the impact of each system.

REFERENCES

[1] Glover, B., Bhatt, H. *RFID essentials: theory in practice. Sebastopol: O'Reilly & Associates*, 2006.

[2] Want, R. *An Introduction to RFID Technology*. IEEE Communications Society, v.5, n.1, p. 25-33, 2006.

[3] Ahuja, S., Potti, P. *An Introduction to RFID Technology*. Communications and Network, v. 2, p. 183-186, 2010.

[4] Chaves, A.G., Bittencourt, J.P., Siqueira, F.J.Q., Chaves, G.G., Lima, D.L.C., Oliveira, H.R. *Monitoramento de veículos ociosos em uma distribuidora de Energia Elétrica utilizando antenas de Rfid*. In: EMPRAD: Encontro de Mestrados Profissionais em Administração, São Paulo. Anais do III Emprad. Sao Paulo: FEA-USP, v. 1. p. 1-14, 2016.

[5] Biancolino, C.A., Kniess, C. T., Maccari, E. A., Rabechini Jr. R. *Protocolo para Elaboração de Relatos de Produção Técnica*. Revista Gestão e Projetos, 3(2), 294-307, 2012.

[6] Companhia de Distribuição de Energia Elétrica – Grupo X (2013a) *Relatório final do Projeto de Monitoramento do Pátio*. RelatórioInterno. João Pessoa, Brazil.

[7] Companhia de Distribuição de Energia Elétrica – Grupo X (2013b) *Apresentação/Treinamento de utilização do Sistema/PMF*. João Pessoa, Brazil.

[8] Companhia de Distribuição de Energia Elétrica – Grupo X (2013c) *Mensagens eletrônicas de instrução e avaliação do sistema.* Relatório Interno. João Pessoa, Brazil.

[9] Companhia de Distribuição de Energia Elétrica – Grupo X (2013d) *Sugestão de Otimização de Veículos*. Relatório Interno. João Pessoa, Brazil.

[10] Companhia de Distribuição de Energia Elétrica – Grupo X (2013e*) Relatório final do Projeto Piloto de Telemetria*. Relatório Interno. João Pessoa, Brazil.

[11] Companhia de Distribuição de Energia Elétrica – Grupo X (2013f) *Relatório de Comparativo das Ferramentas de Ociosidade*. Relatório Interno. João Pessoa, Brazil.

[12] Companhia de Distribuição de Energia Elétrica – Grupo X (2013g) *Ociosidade da Frota 2016.* Relatório Interno. João Pessoa, Brazil.

[13] Pessoa, C.R.M., Jamil, G.L., Gonçalves, D.M.R., Souza, R.O. *Gestão estratégica do conhecimento em produção: uso da tecnologia de Rfid (Radio-Frequency Identification) para controle de equipamentos ativos em ambientes industriais.* Anais da *10th International Conference on Information Systems and Technology Management – CONTECSI*, São Paulo, Brasil, 2013.

[14] Davenport, T. H. *Information Ecology*. (2ed.) Sao Paulo: Futura, 2010.

[15] Miles, M. B., Huberman, M. Saldaña, J. *Qualitative data analysis: a methods sourcebook*. (3rd ed.) Thousand Oaks, CA: SAGE Publications, Inc. 2014.

[16] Zeimpekis, V.S., Tarantilis, C.D., Giaglis, G.M., Minis, I.E. *Dynamic fleet management: concepts, systems, algorithms & case studies* (v. 38). Springer Science & Business Media, New York, 2007.