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Improving the lean logistic operations management in transportation by introducing the RFID system

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Abstract: *Radio Frequency Identification Device (RFID) gained a lot of attention lately, due to the technology revolution, namely the IoT of things, which allowed a wide range of applications in the manufacturing and service sectors. The research reflects the importance of using the RFID tracking system in the supplier's distributions operations, by reducing the level of inventories' movement, increasing accuracy in depicting in a timely manner the shipping freight, with no paperwork inaccuracies. In this regard, the methodology is based on a semi-structured interview with managers of transportation companies who have provided information of the transportation performance in both cases of use or not use of the RFID technology. The paperwork mistakes and shipping delay were the indicators registered. In this matter, SPSS quantitative methods, Pearson correlation and linear regressions have been applied. The tables reveal the strong bivariate correlation between the RFID systems, paperwork mistakes and shipment delays. The regression analysis underlines the positive strong correlation between paperwork inaccuracies and shipment delays which means that an increase in document mistakes will lead to a certain amount of time increase in shipping processes.*

Keywords: RFID system, shipment delays, paperwork inaccuracies, tracking system, transport efficiency, improvement inventory operations, warehouse management.

Introduction

The transportation industry has been facing lately with huge amount of data processed from all kind of sources indicating movement of inventory, freight and vehicles location, delays and road congestions, increasing the level of transparency and creating conditions for prevention measures.

Radio Frequency Identification Device gained a lot of attention lately, due to the technology revolution, particularly to the IoT of things, which allowed a wide range of applications in the manufacturing and service sectors. (Sheng et al. 2011) "Big data analytics" including the implementation of RFID system along with other cloud based network communication infer the significance of reframing the lean concept of the transportation industry, by redefining the criteria of performance from the new perspective. Previous research conducted by Doan (2017) on 100 American logistics and 3PL companies, reveals important results and improvement of the transportation performance indicators starting with faster freight movement, routing optimization, improved customer satisfaction, better prediction on transit schedules, reduced number of delays and rejection situations.

The purpose of the present article is to further exploit and understand the current benefits of RFID technology in transportation and logistics activities, how its applications and use being reflected in important transportation issues such as route optimization, paperwork inaccuracies and shipment delays. The research is carried out by collecting data

from a semi- structured survey questionnaire and interviews with transportation managers from different American carriers involved by long contracts with large shippers.

The research is structured as follows:

The literature review provides insights of the RFID technology, its components and applications in various fields and industries, the value-added brought compared with the old barcode system, and the last but not the least, specific implementation issues and challenges. The research methodology includes the semi-structured interview, revealing the number of participants, the quantitative and qualitative methods used for establishing the level of correlation between RFID use as an independent variable and some of the transportation KPIs, as dependent variables. The following section explains the data gathered from the interview, centralized in results obtained from the regression tables. The conclusions draw important arguments related to the motivations and benefits of RFID implementation in creating reliable partnerships between transportation and logistics companies and important manufacturing enterprises who already implemented the RFID technology.

Literature review

The definition of the RFID system

In many studies and research articles the RFID technology has been associated with the new trend in the global Supply Chain, namely "The Internet of Things" which emphasizes the importance of extracting valuable information about a certain product or freight whereabouts, using the database entry of a certain radio frequency device. Giving a short definition, RFID is a device that uses radio waves to identify and to capture information of an object in the form of a certain serial number, proving tracking and tracing capabilities along the entire Supply Chain. (Wamba, Anand and Carter, 2013) There is a clear difference between RFID and old barcodes used especially in manufacturing, the first having the power of recognizing more rapidly many objects simultaneously and retracting more information than the traditional way. Another inconvenience of the old barcode system was referring to issues related to extra-use of labor force in case of sequencing errors, requiring manual labor for carrying the barcode reader where the products were stored, like trailers or storage boxes. In this matter, the RFID has reduced considerably the unnecessary movement of workers, speeding the identification and collection processes from distance, along with various and more data storage. The use of RFID scanning system does not imply certain orientation or training sessions like barcodes. (Kang, Kim and Lee, 2017, Michael and McCathie, 2005)

The most important parts of the RFID consist in a tag which usually is being attached to a product, a reader with antennas in direct connection with the tag and a computer program for selecting and managing DATA aligned to other information management systems such as ERP (enterprise resource planning), WMS (warehouse management system) and TMS (transportation management system). (Herschel and Rafferty, 2012) The RFID system can be implemented using The EPC (Electronic Produce Code) global network, designed to be able to inquire history and product information, the present location and condition, sharing the collected data with the interested parts. The actual global framework refers to three basic information services: EPCIS (EPC Information Services), a capture interface entitled to store the RFID data information between stakeholders, the ONS (Object

Naming Services) which contains one or more resource identifiers, providing information regarding product name or manufacturing date, and DS (Discovery Services) which stores and shares the products' information transfer to different sites. (Kang, Kim and Lee, 2017)

The EPC represents one of the most important challenges when it comes to RFID implementation. Leung et al. (2014) reveal many privacy issues concerning implementation of the RFID tags in the Supply Chain Management such as security, adoption costs, and lack of standardization, or potential benefits. In consideration to those issues, the research was oriented through 2 main directions: the mindlessness adopters following new trends without fully consideration of the specific of the sector and the mindfulness adopters, manifesting reluctant behavior and thorough analysis of the objective Supply Chain conditions. In this regard, 2 streams of research were underlined, depending on the management type of companies analyzed: the ones who adopt agile strategies based on volatile market and lean practices based on predictable market. Early lean adopters such as Wal- Mart, Target, Albertsons, US Department of Defense and Metro Group have reported soon after implementation certain functioning barriers like data synchronization, integration, transformation, poor communication or lack of standards. Although the technology incompatibilities have been resolved, private and security issues still arise in the form of unauthorized share of product information which create uncertainty and sometimes jeopardize the companies' competitive advantage. Other types of risks associated to RFID implementation refer to integrity and authenticity, affecting in the same time the production processes (lower rhythm, disruptions, illegal disclosures) and also the logistic functions (order and delivery issues, poor tracking updates, double brokerage) (Brandel, 2003; Bremer and Sloan, 1999; Dong et al., 2008) Despite the existing risks associated with RFID implementation, the tag proves great quality, even in heavy conditions of various temperatures from -40 degrees to +200 degrees C, resisting to any type of acid.

Therefore, many specialists in lean management and Supply Chain Management infer that RFID system is a revolutionary technology having a great impact on reducing the real time data collection, speeding the process of sharing data among stakeholders, rethinking the lean business models and practices, enabling the "build-to order" supply chain, enhancing the "smart processes" of launching transactions with no human factor. (Mall and Mishra, 2012, Wamba, Anand and Carter, 2013)

Strong body of literature is dedicated to revealing important results of RFID technology in certain industries and domains of activity. Lots of articles and research on RFID use and efficiency support their statements based on different theoretical approach, from technological acceptance model, game theory, coordination theory, expectancy theory, push and pull theory or grey theory, with high percentage of case study methodology (41.3%). Other studies were based on data analysis (10.3%), survey (17.2%), conceptual (6.8%) and literature review (13.8%). (Wamba, Anand and Carter, 2013)

RFID technology and supply chain performance

The continuous expand of global Supply Chain operations require lean planning and coordination processes in order to reach the customers' needs and requests in a timely manner. Disruptions and gaps caused by poor data capturing, lack of items traceability, no integration systems between companies lead to waste of resources (excess of inventories, theft, safety issues, not enough stocks, affected sales), activities (slow production, delayed shipments and transportation) and human capital (loss of interest and motivation, loss of

customer loyalty). Therefore, the study of Brenner and Sloan (1999) concede that RFID system is an intelligent tracking mechanism to improve and to support the logistic functions in the Supply Chain Management.

The research of Jansen and Krabs (1999) and later on by Karkkainen (2003) support the idea of introducing the RFID tracking devices in the reverse logistic management, revealing the importance of monitoring the shelf life products.

Many scholars have dedicated impressive amount of time and effort to conclude the importance and benefits of introducing the RFID system, especially in the Supply Chain. According to Ferrer et al. (2010), there is a body of literature describing the evolving process of RFID system, the level of improvement in the inventory operations, evaluating the benefits in tracking the movement of fleet in the automotive plants. Continuing the idea, Kim et al. (2008) offer certain results over customers' satisfaction improvement, decrease in lead time and labor costs, reduced inaccuracies in the paperwork, ensuring a continuous flow of materials, transportation and information movement. In a recent study of Kang, Kim and Lee (2018), the RFID system introduced in the manufacturing sector had proved certain benefits in the prevention of sequencing errors, prevention of shortages of different parts and also reduction in the labor costs.

Kirch, Poenicke and Richter (2016) identify the demand for automation in the automotive industry, creating the smart logistics concept, as the key approach to more efficient flow of information across international transportation and supply chain processes. The paper describes how smart logistics areas are being created by introducing RFID tagging. The purpose of the case study was to prove the utility of introduction the radio frequency devices on the prototype parts in the automotive industry, decreasing the level of uncertainty, volatility and unpredictability along the Supply Chain network. (Kirch, Poenicke and Richter, 2016)

Veeramani et al. (2008) emphasizes the importance of using the RFID tracking system in the supplier's distributions operations, by reducing the level of inventories and warehouse costs, increasing accuracy in depicting in a timely manner the defective products. Introducing the RFID tags, De Kok et al. (2008) brought evidence of the impact in reducing the level of shortages caused by theft or other unethical practices. (Sheng et al. 2011) It was also developed a thorough study estimating a proper price for RFID tags, taking into consideration the level of shortage before and after the system's implementation. Studies developed by Dong-Her et al. (2008) have clearly demonstrated improved efficiency in manufacturing and logistic' operations quite after introducing the RFID tags. The research conducted by Rekik (2008) claims the necessity of RFID introduction in the purpose of reducing the mistakes and errors in the inventory management system. According to Roberti (2008), Lin& Wadhaw (2008), the RFID system implementation has a great impact on reducing the Supply Chain costs, increasing the quality of inventory management system by reducing the product' shortages, contributing with 1-2% increase in sales due to reduced cases of theft or out-of-stock situations. The term of "smart shelves" is commonly used to define RFID inventory systems, were products are properly stored, located, by name, features and history. The EPC network send detailed information to SCM systems, in the moment of product theft or disappearance, providing prevention measures in case of shoplifting.

However, despite of its benefits, the rate of RFID adoption is slower compared to the barcode implementation, due to the difficulty of general adoption in case of an open Supply

Chain, where all the suppliers must align at the new system imposed, requiring higher costs and having the same OEM system, requiring higher costs and the same OEM system, with long- term return on investment, implying technical risks and privacy issues. (Kang, Kim and Lee, 2018)

RFID technology was adopted by large retailers from the USA, starting with Wal-Mart, who introduced the RFID at pallet level and case-level tracking system, decreasing the shortages and inaccuracies with 20% and with 10% in the manual orders. In the retail sector, the out-of-stock products were replenished three times faster than the ones using the regular barcode system. Shortly after introducing the new technology 100 Wal-Mart suppliers were asked to align with the new tracking system. (Fan et al. 2015)

Important results in retail sector were brought by Heese (2007) who made a comparative analysis of the Supply Chain performance in centralized management versus decentralized system. Many deficiencies, inventories errors were found in the decentralized Supply Chain management system. The research was continued by Fan et al. (2015), offering a mathematical model for calculating the improvements of RFID tags in centralized and decentralized retail sector, referring to misplacement and shrinkage. RFID readers concern security issues, therefore, Gandino et al. focused on their research in proposing a probabilistic distributed color system (PDCS) for developing a reader-to reader collision problem. (Sheng et al. 2011)

RFID and Transportation Management System

In the vision of Evangelista (2008), logistics and transportation innovation is concentrated in two directions: incremental innovation by reducing the non-value activities of existing processes and disruptive innovation by introducing new technologies and practices. Reconfiguration of the business management from an asset-based philosophy to value-added processes and information technology is the turning-point of positioning the companies into a valuable differentiated business scale of performance. (Sauvage, 2003)

The new advanced technologies refer to use of big data or the expansion of the IoT concept or block chain automation system. Cloud-based technologies will be adopted by 80% of the manufacturers in the next 3-4 years. (Speranza, 2016)

The differences between big data and regular data consist in variety, volume and velocity. The use of various applications entitles companies to access and deliver information few times easier than a decade ago. (McAfee and Brynjolfsson, 2012)

In the USA transportation business environment, the big challenges are related to the on-going phenomenon of drivers' shortages, the mandatory system of the new electronic device and HOS (hours of regulations) rules, leading to a continuous increase in transportation demand and supply crisis. The latest study of ATA (American Trucking Associations) anticipates a constant annually growth of 3.4% of the freight hauled for the next 5-6 years which entitle the large shippers to reconsider their business models and policies toward a "carrier friendly attitudes", being more proactive and playing the shipper-carrier partnership cards. (Peerless Research Group, 2017)

The concept of "shipper of choice" imply the increase negotiation power of carriers in creating the strategic alliances based on certain criteria such as: the possibility of reaching the highest truck utilization score based on shipping volume, lean loading and unloading processes using shipping "windows" instead of specific appointment time and latest technologies used in monitoring the freight with minimum documents' processing

time with no shipping inaccuracies, and not the least, payments made in a timely manner with no redundant invoices and documents. A survey realized by Convoy in 2017 on 89 shipping and logistics managers from different companies reveals many weak points, especially in the innovative sector of WMS (warehouse management system) or TMS (transportation management system), only 20% declaring the company as an "early adopter" of new technologies and smart applications. Other freight operations issues refer to poor systems compatibilities between carriers and shippers (40% of the shippers), lack of in-transit visibility, in terms of no tracking and traceability devices (36% of the managers surveyed) and timeliness forecasts (31% of the shippers) affecting the carriers' transportation planning processes. (Peerless Research Group, 2017) In order to ensure improved communication and lean process improvement, one-third of the freight managers interviewed admit the importance of creating more efficient loading/ unloading procedures, increasing the level of visibility of the shipments by introducing the RFID systems and other related IoT technologies. (www.convoy.com)

The RFID system is very useful in transportation and warehouse management, covering important needs such as identifying the products, locating and tracking the freight and temperature capabilities in case of temperature control loads.

According to Ferrer et al. (2010), the RFID use reflects its benefits over the important lean strategies' objectives such as quality, speed, flexibility and cost. Identifying the right product, the customer satisfaction will be high referring to conformance, features and reliability of the service provided. Increasing the tracking capabilities means preventing distribution and transportation delays, by proper location and rerouting in a timely manner. Reducing the product cycle-time of a product means increase in speed and volume, obtaining larger revenues with less cost.

Research methodology

The objectives of the research

RFID technology represents an important instrument in data collecting and visibility along the Supply Chain with great impact over the logistics and transportation performance and efficiency. Therefore, the objectives of the research are described as follows: O1- to determine if there is any correlation between the RFID technology and the most important transportation KPIs referring to shipment delays and paperwork inaccuracies; O2- to determine the extent to which RFID influences paperwork inaccuracies; O3- to determine how paperwork inaccuracies influence the shipment delays and performance.

Research tools and data

In order to demonstrate the importance of RFID technology on the transportation management performance, I conducted a semi-structured interview referring to the impact of important shippers who use or not the reader system over the transportation companies who fulfill transportation services within contracts. Initially, 26 companies were asked to respond to the interview, from which only 15 carriers were chosen. The companies selected are small and medium carriers (up to 100 trucks) who usually operate on the spot market by direct biding of movement rates. The transportation companies have provided the most important customers (some of them involved in automotive industry and other in hauling perishable products) who haul for, the numbers of shipment delays specifying the delay

time in minutes, divided in 2 situations: the ones using the RFID tags and the ones with no RFID technology implemented. The study reveals the regressions correlations between the RFID systems, paperwork inaccuracies which lead to shipment delays. In this matter, SPSS quantitative methods, Pearson correlation, and linear regression have been applied.

Research findings

Variables description

The customers and their operations were integrated in Table 1, containing the following information: use of RFID, the total number of loads analyzed, the number of loads with shipment delays, the average delay time (in minutes) due to prolonged time of paperwork, the default average performance in % no. of loads with shipment delays/ total no of loads. The average performance column reflects the root cause of use or not of RFID applications and was considered an independent variable. The regression model uses three important variables: the RFID, using numerical denoting as the use of RFID with 2 and not use of the technology with 1; the documents mistakes as numerical values of delayed registered out of total number of shipments and minutes delay as numerical value expressed in minutes.

Table 1. – Data Collected

Company Name	RFID System	Number of loads hauled	No. of shipment delayed	Delay time/min	Avg. performance
Rossini Suspensions	No	40	26	30	65
Penske	No	192	138	180	71.8
Mann+ Hummel USA, Inc	No	24	10	30	41
Lydal Thermal Acoustical	No	79	33	60	41.7
Material Global OPT	Yes	18	4	48	22.2
Magna Cosma International	yes	10	1	20	10
HEB	Yes	144	34	20	23.6
Autoliv ASP, Inc	Yes	12	1	5	8.3
Drive Automotive Industry	Yes	29	2	10	6.8
Meyer	Yes	36	4	30	11
Walmart	Yes	180	21	10	11.6

Source: Author's own research

Regression results

The analysis depicts huge differences in performance regarding the RFID system, starting with the average sample means of performance in case of use, compared to not RFID use of customers. For the companies who have already introduced the readers' technology the average means of shipment delays due to documents inaccuracies is 24.5 minutes, compared with the others with no reader technology, where the average delay time extended to an average of 84.7 minutes, which is 3.4 times higher.

Table2. - RFID (predictor) and documents mistakes (dependent variable) - model summary
Source: Author's own research

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.901[a]	.811	.790	10.66230

a. Predictors: (Constant), RFID

The first regression has been applied having as predictor the RFID applications and document mistakes as the dependent variable. Table 2 reveals strong correlation and significance between RFID use and paperwork mistakes, the value of R square (.811) explaining that 81.1% variance in documents mistakes depends on the applications of RFID system.

Table3. - RFID (predictor) and documents mistakes (dependent variable) - ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4393.724	1	4393.724	38.648	.000[b]
	Residual	1023.162	9	113.685		
	Total	5416.885	10			

a. Dependent Variable: documents

b. Predictors: (Constant), RFID

Source: Author's own research

The ANOVA results (Table 3) shows strong significance of the correlation between the two variables (RFID technology and documents mistakes), indicated by the p value of 0 which is lower than the reference value of 0.05.

Table4. – Correlation coefficients between RFID system and documents mistakes
Source: Author's own research

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	96.421	11.398		8.459	.000
	RFID	-41.546	6.683	-.901	-6.217	.000

a. Dependent Variable: documents

The coefficients table (Table 4) clearly indicates a significant negative correlation between RFID use and documents mistakes (beta coefficient= -.901, significance 0<0.05), which explains the importance of implementation the radio frequency in reducing the number of documents mistakes.

Table5. -Documents mistakes (predictor) and minutes delay (dependent variable)
Source: Author's own research

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-3.314	17.516		-.189	.854
	documents	1.532	.485	.725	3.155	.012

a. Dependent Variable: delay

The second regression has been developed with the clear purpose of determining the correlation between documents mistakes (as sole predictor) and the minutes delay as the dependent variable. The results collected from Table 5 reveal the strong positive correlation between the two variables (sig. = 0.012< 0.05, beta coefficient of 0.725, B coefficient= 1.532) which means that an increase with 1 minute of documents mistakes will lead to an increase by 1.532 of the minutes delay indicator and implicitly of the shipping process.

Table6. - Pearson correlation- documents mistakes and shipment delay
Source: Author's own research

Correlations

		minutes delay	documents
minutes delay	Pearson Correlation	1	.725*
	Sig. (2-tailed)		.012
	N	11	11
documents	Pearson Correlation	.725*	1
	Sig. (2-tailed)	.012	
	N	11	11

*. Correlation is significant at the 0.05 level (2-tailed).

By applying the Pearson correlation, using the same variable, the results gathered from tables 6, 8 and 9 prove a positive correlation between the documents inaccuracies and shipment delays (0.012< 0.05, R= 0.725, R square= 0.525) confirming that 52.5% from minutes delay variable is explained by the paperwork mistakes.

Table7. - Pearson correlation- RFID, documents mistakes and minutes delay
Source: Author's own research

Correlations

		minutes delay	documents	RFID use
minutes delay	Pearson Correlation	1	.725*	-.560
	Sig. (2-tailed)		.012	.073
	N	11	11	11
documents	Pearson Correlation	.725*	1	-.900**
	Sig. (2-tailed)	.012		.000
	N	11	11	11
RFID use	Pearson Correlation	-.560	-.900**	1
	Sig. (2-tailed)	.073	.000	
	N	11	11	11

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation has been applied using the variables mentioned. As Table 7 shows, there is a bivariate correlation between the use of RFID technology, documents mistakes and minutes delay, determined by a strong negative correlation between RFID and documents mistakes (R= -0.900, significance 0< 0.05) and less significant correlation

between RFID use and minutes delay (R= -0.560, significance 0.073>0.05), limited by the scarce data.

Table8. - Regression model documents mistakes (predictor) and minutes delay (dependent)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.725[a]	.525	.472	35.72079	2.828

a. Predictors: (Constant), documents

b. Dependent Variable: minutes delay

Source: Author's own research

Table9. - ANOVA documents mistakes documents and minutes delay

Source: Author's own research

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12704.405	1	12704.405	9.957	.012[b]
	Residual	11483.776	9	1275.975		
	Total	24188.182	10			

a. Dependent Variable: minutes delay

b. Predictors: (Constant), documents

The regression tables depict direct negative correlation between the radio frequency system and documents mistakes, in which use of the new technology will decrease the time allocated to invoice processing by 20 minutes at least, and indirect negative correlation between the RFID variable and the shipment delay as the dependent variable. Significant positive correlation appears between the two variables, namely minutes delay and inaccuracies in paperwork (1minutes document mistakes will determine an increase by 1.532 minutes in the whole shipping process; 20 minutes of documents' delay will lead to 30.6 minutes shipment postpone). The model proposed has clearly fulfilled the objectives aforementioned, showing the negative correlation between RFID use, documents mistakes and minutes delay (the use of the radio frequency technology will decrease the number of shipping situations with invoice inaccuracies and will lower the loading time) and also the strong positive correlation between documents mistakes variable and minutes delay (1 minute of delay in paperwork will determine the increase in shipping time by 1.532 minutes). The R square coefficients have determined the strong influence of the RFID technology on the variance of documents mistakes (81.1%) and also the reflection of the paperwork mistakes in the minutes delay variable (52.5%). There is a clear limitation in the present research model restricted by the low number of respondents.

The future research and analysis will be dedicated to the importance of RFID in the truck utilization, delivery delays indicators and drivers' retention using the factor analysis methodology.

Conclusions

The purpose of the paper was to give a better view of the RFID influence on the important transportation performance indicators, namely paperwork mistakes and shipment delays.

The conclusions confirm other scholars' opinions who clearly demonstrated that implementation of the RFID system lead to the elimination of manual verification of the products, reducing process of transferring the right information and freight by 49%. Hence, the shipping time was reduced considerably. (Nikolicic et al, 2015, Doan, 2017)

It is very important for the carrier to make a clear selection of the load opportunities, by choosing "shippers of choice" who use the RFID barcoding system of monitoring the freight, decreasing the time allocated to loading and processing the documents. Big Data and IoT techniques such as RFID or SaaS (software- as-a- service) system increase the visibility and reliability of resource planning, allowing transportation providers to optimize the process of matching the transportation fleet and resources with the transportation demand. (Doan, 2017) In the past two years, new start-ups had launched their transportation businesses based on the "Last mile philosophy", creating a holistic business model by using "just- in –time" technologies that provide quick access to the supply chain data with high level of penetration on the brokerage market. (Trebilcock, 2018)

The results obtained will frame the objectives of broader research of the RFID system, revealing the direct positive changes in the following performance factors:

- Flow of labor force
- Reduced labor and shipping time
- Increased number of shipments per day
- Better prediction of on- time deliveries, avoidance of delivery windows reschedules
- Reduced pallets handling assigned to a certain time
- Reduced situations of paperwork mistakes
- Increased truck utilization score
- Reduced dispatch time
- Rejected products
- Drivers' retention

Further research will include also the cost/benefit analysis on each type of transportation activities, biased by the reduced number of articles dedicated to RFID return on investment reports. The research will expand the application of lean practices proposed, enlarging the number of the participants in the questionnaire, giving a better image of the strategies within companies. It will be necessary also dividing the research in three important components analyzed at different levels, referring to the complexity and scope of the transportation activities concerns: 3PL companies, freight logistics brokers and freight carriers.

References

Attaran, M. (2007). RFID an enabler Supply Chain Operations, *Supply Chain Management: An International Journal*, 12 (4), pp. 249-257.

Brandel, M. (2003). Smart Tags, high costs, Computer World, December 15th

Bremer, A., & Sloan, N. (1999). Intelligent tracking in manufacturing, *Journal of Intelligent Manufacturing*, Vol. 10. pp. 245-250.

Doan, B. (2017), Radio frequency identification (RFID) and its impacts on logistics activities, *International Business*.

Dong-Her, S., Yuh-Wen, C., She-l, C., & Yen, D.C. (2008). An empirical study of factors affecting RFID adoption in Taiwan*, Journal of Global Information Management*, 6(20), pp. 55-80.
Ferrer, G. Dew, N., & Apte, U. (2010). When is RFID right for your service? *International Journal of Production Economics*, 124 (2), pp. 414-425
Herschel, R., & Rafferty, P.D. (2012). Understanding RFID technology within Business Intelligence Framework, *Intelligent Management*, 4, pp. 407-414.
Jansen, R., & Krabs, A. (1999). Automatic Identification in Packing: Radio Frequency Identification in Multi-Way System, *Packing Technology and Science*, 12 (5), pp. 229-234.
Kamala Devi, B. (2010). RFID: The best technology in SCM, *Advances in Management*, 3 (2), pp. 198-204.
Karkkainen, M. (2003). Increasing efficiency in the SC for short shelf life goods using RFID tagging, *International Journal of Retail and Distribution Management*, 31 (10), pp. 529-536.
Kirch M., Poenickle, O., & Richter, K. (2016). RFID in logistics and production- applications, research and visions for Smart Logistics Zones, 16th *Conference on Reliability and Statistics in Transportation and Communication*, RelStat, 19-22 October, Riga, Latvia.
Kosasi, S., S.E., M.M., Kom, M., & Saragih, H. (2014). How RFID technology boosts Wal-Mart's Supply Chain Management, *International Journal of Information Technology and Business Management*, 24 (1).
Maurno, D.A. (2005). The real story on RFID: 5 questions for 6 experts, http://www.Inboundlogistics.com.
Michaela, K., & McCathie, L. (2005), The pros and cons of RFID, in Supply Chain Management*, Proceedings of the International Conference on Mobile Business*, pp. 623-629.
Nikolicic, S., Kilibarda, M., Atanaskovic, &P., Ivanisevic, A. (2015). Impact of RFID technology on logistic process efficiency in retail supply chains, *Promet-Traffic & Transportation,* 27 (2), pp. 137-146.
Rekik, E., Sahin, E., Dallery, J. (2008). Analysis of the impact of the RFID technology on reducing product misplacement errors at retail stores, *International Journal of Production Economics*, 112 (1), pp. 264-275.
Roberti, M. (2003). Analysis: RFID Wal-Mart's network effect, http://www.doinsight.com.
Sheng, Q.Z., Zeadally, S., Mitrokotsa, A., & Maamar, Z. (2011). RFID technology, systems, and applications. *Journal of Network and Computer Applications*, 34 (3)
Vijayaraman, B., & Osyk, B.A. (2006). An empirical study of RFID implementation in the warehousing industry, *The International Journal of Logistics Management*, 17 (1), pp. 6-20.
Wamba, S.F., Anand, A., & Carter, L. (2013). RFID Applications, issues, methods and theory: a review of the AIS basket of top journals, *Proudio Technology*, (2013), 9, pp.421-430.
Zaragoza, S. (2005). Tandy using RFID on Wal-Mart shipments *Dallas Business Journal,* February 11th.
Zhekan, L., Gadh, R., & Prabhu, B.S. (2004). Applications of RFID technology and smart parts in manufacturing, *Computers and Information Engineering Conference*, Sep. 28 – Oct. 2, Salt Lake City, UT.