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USE OF RFID TECHNOLOGY FOR MEASUREMENT OF QUALITY OF TRANSPORT OF POSTAL PARCELS

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Abstract: *RFID technology offers a number of features that are very useful in transport of goods and for records making for different shipments. This technology began to be successfully used in transportation of mail. The number of RFID solutions that are applied in the post traffic slowly grows. The paper presents possibilities of application of RFID technology in measurement of the quality of postal services, primarily the quality of delivery of unregistered shipments. Here are presented the basics of the RFID solution for automatic measurement of quality that is now used in 52 countries. Special attention is given to the analysis of the quality of international postal services. Here are also shown the results of measurement of quality of the transfer of postal parcels in departure and arrival in five international routes from and to Serbia. At the end, some conclusions about the future application of RFID technology for the postal needs are given.*

Key words: *RFID, quality of services, post, QSM,"J+5" standard*

INTRODUCTION

The postal sector is the largest distribution network in the world, and it presents the necessary infrastructure for the global economy. Post offices worldwide employ more than 5 million people, annually deliver 435 billion letters, 6 billion packages, and offer an array of electronic and financial services. Nevertheless, there are opinions that the post's core business has no perspective. Those statements compare the post office with the dinosaurs, alluding to the extinction of the old traditional monopolistic activities.

Figure 1 RFID post tag for the postal test letters (IPC 2011)

Such predictions are nothing new for the post offices, because they come up each time when something new appears in the telecommunications or in the computer technologies (telegraph, telephone, fax, personal computer, and now the Internet, e-mail and mobile telephony).

In today's society, the society of modern information technologies, traditional postal services still keep their place and their meaning. Although commissioned by telecommunications (Internet), purchased products must be delivered to customers in the physical form, and a postal infrastructure network is the necessity. Bearing in mind the above, the conventional postal services should not be regarded as "services at sunset." On the contrary, they will continue to have a large share of the world economy, enabling the receiving shipments from anywhere, as well as sending them to anywhere in the world.

However, one can see that something certainly has changed from the previous times - the expectations of the users of postal services. They require all the better, i.e. all the faster service. In reaction to such requests, posts of the world have responded by raising the quality of transportation and delivery of shipments. This immediately raised the question of monitoring and measuring of the achieved quality. There appeared a need to find an effective system that could determine the quality of services in international postal services, from admission in the country of origin to delivery to the destination country. To detect such the most appropriate system, International Postal Corporation (International Post Corporation - IPC) in the year 1994 began collaboration with the winner of an international tender, the Danish company Lyngsoe Systems, to develop solutions to deal with the measurement of quality - Automatic Mail Quality Measurement (AMQM) based on radio waves (RFID). Today, IPC is the exclusive supplier of postal industry with AMQM RFID equipment. Lyngsoe Systems manufactures, sells, distributes and introduces AMQM solution in favor of IPC.

RFID SOLUTIONS FOR TRANSPORT QUALITY MEASUREMENT

RFID solution for automatic measurement of quality is now used in 52 countries. Test letters, which contain RFID tags, are sent aiming to record time of their passage through the processing centers. Reader's antennas in processing centers are placed at locations through which all parcels must pass, so the pass time of each test letter can be recorded, the reception time and the sending time. Antennas must be strong enough to record answer of each tag, even if the tag is in the metal box or in a container. This way, it is possible to collect information about letters' transport through the post system. This is important for identification of bottlenecks in processing and delivery. This solution is primarily used in the Exchange Post Offices, for the measurement of quality at international level, but, also, it is increasingly used to measure quality at the national level.

The next level is the use of RFID technology within the processing centers during the processing of postal parcels. Carts or containers fitted with tags are used to transport the parcels that are directed to delivery, to the exact exit, to the exact vehicle. Reader antennas are located above each exit and detect any cart that has a tag. Tag contains information on which exit parcel is sent, and if an error occurs and cart comes to the wrong exit, the alarm will be switched on with the primary aim to prevent overshoot. This is a simplified presentation of applied solutions in the processing centers, where the carts or containers move by rail to a specified exit, but the solutions very often use a combination of the new RFID and older bar-code technology.

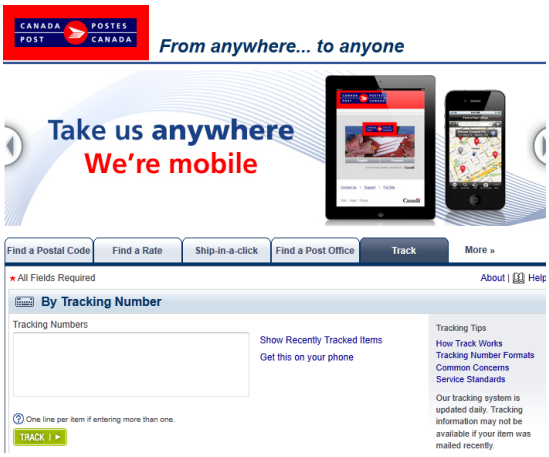

Figure 2 Tracking of the parcel by tracking number (CAP 2011)

RFID solutions are also used in cases where the 100% visibility of shipments is required. For this kind of parcels, when it is necessary to know at any moment where the parcel is, Canada Post has started a pilot project "Secure Tracking Pilot". The essence the idea is that any parcel gets its own RFID tag. On the way to the delivery address, when it finds in the premises of the Canadian post, this RFID tag returns signal to any reader that sends the signal. Thus, the system records the time of getting returned signal from the tag and one can see the path of the parcel from the initial location to the end point (end-to-end).

The application of such a solution requires an extensive AMQM network in domestic postal traffic, but that investment is high payable because provides full visibility to users of postal services of their shipments in the system, reducing the possibility of loss of shipment and overruns, and thus damages costs, raise service quality and act positively on the company's image.

QSM (Quality of Service Monitor) applications are an ideal means for RFID tag readings converting into information that enables continuous improvement of postal and logistics chains.

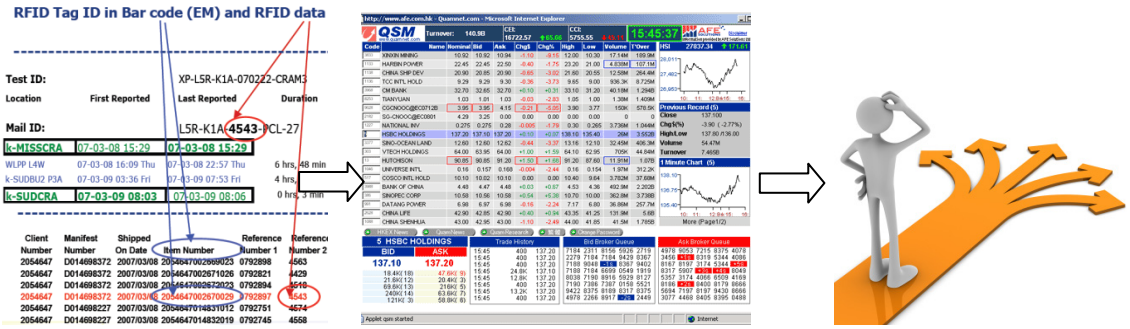

Figure 3 RFID data are transformed into information by the QSM applications that help managers in decisions making (Figure composed of pictures from (CRA 2008) (Lipoff, Funderstanding 2011) (Lipoff 2011))

Why diagnostic monitoring and what is the use of it?

- Identifies the weak links;
- Gives objective information for the responsible managers;
- Allows benchmarking;
- Gives trends and analysis;
- Optimizes the process time;
- Optimizes procedures;
- Allows financial savings;
- Controls parcels and property;
- Improves quality of services;
- Improves customer services

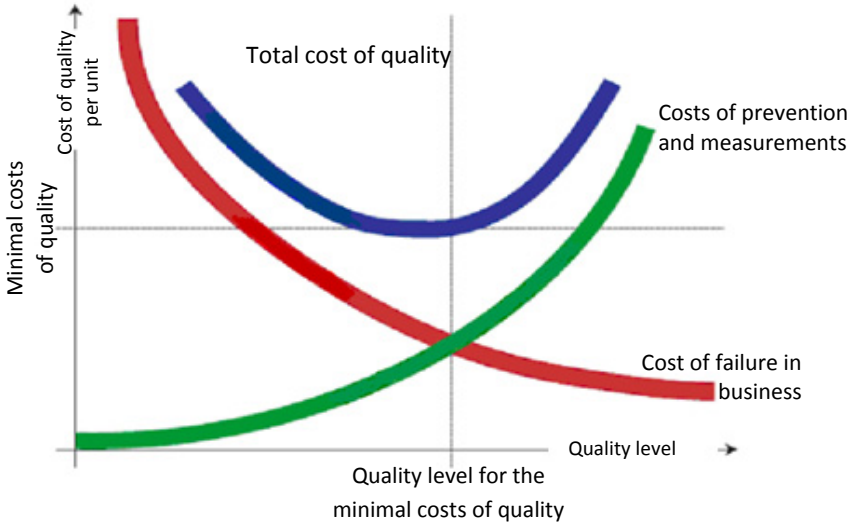

Figure 4 Graphical representation of quality costs in relation to the level of quality

RFID systems provide tremendous cost savings and competitive advantage while improving the quality of operations. Figure 4 shows the relationship between quality costs and quality level. As they, the costs of prevention and measure grow, the cost of failure in business decrease (payment of fees for exceeding the transportation dead line and/or loss of shipments). Optimum of total cost of quality is located at the intersection of these two curves.

The number of RFID solutions that are applied in the post traffic slowly grows. Wasel project, implemented by the Saudi Post, in an attempt to transform and improve its services before privatization, provides the use of smart mailboxes equipped with RFID chips, that should inform the deliverer, who has the mobile RFID reader, that he found right address. Also, the idea is that this project could eliminate the necessity that users have to go to the post office when sending packages. Users can through electronic mail boxes also send their parcels.

Delivery with E-stamp is the service of having excellent mail or registered mail delivered to your Wasel Box rather than having to go to the Post Office to sign for and pick up your mail. An electronic RFID device in the Wasel Box "electronically signs" to say that the item has been delivered to the correct address. (Saudi Post 2010)

According to research firm IDTechEx (Research and Analysis of printed electronics, RFID technology and energy saving), stamps in the future could contain microchips. RFID technology has a great number of advantages compared to the bar-code technology (Čekerevac, et al. 2010), and electronic postage stamps with RFID chips will likely replace bar codes printed on letters and packages, which are used for sorting and processing mail.

Figure 5 RFID chips that can be integrated into the postage stamp

According to the prognosis of *IDTechEx* in its report "RFID for the Postal and Courier Service", the global market for RFID systems, including tags, in this sector will grow extremely rapidly to be $2.5 billion in 2018. It could be much bigger if current efforts to tag individual items gain widespread acceptance. In due course, over one trillion postal items will be tagged yearly, making this the second largest application of RFID in the world after the retail supply chain. (Harrop and Das 2010)

ANALYSIS OF THE QUALITY OF INTERNATIONAL POSTAL SERVICES

Post of Serbia participates in the Project of continuous testing of the Universal Postal Union, bearing in mind the importance of cooperation with other public postal operators, as well as the importance of rapid, timely and quality services. The project involves recording of the time of test parcels transportation using the letters equipped with transponders, with the help of RFID equipment.

Parcel tracking the "door to door" (E2E) implies that non-registered mail parcels are put into the mailboxes and then delivered to the project participants, to their home address.

The UPU Congress in Bucharest in 2004 adopted the norm of 65% of standard "J +5" by 2008 year. This means that mail parcel received in any part of the world, have to be delivered within 5 (five) days from the "J" anywhere in the world. Date of receipt of the shipment in international traffic is marked with the mark "J" (for domestic services the symbol "D" is used). In the five days the days of national holidays are not counted, as well as Saturday and Sunday (calculation method 5/7). Post of Serbia, in cooperation with its partners in this project, public postal operators of Slovenia (SI), Croatia (HR), Bosnia and Herzegovina (BA), FYR Macedonia (MK), and Denmark (DK) achieved significant improvements in the year 2009 compared to the results achieved in the first quarter of 2007 and 2008 year, as it can be seen in the table.

Table 1 The quality of the transfer of postal parcels in departure and arrival in five international routes[1]

Period		**January - Jun 2007**		**Januar- Jun 2008**		**Januar- Jun 2009**	
		J+5 (%)	everage	J+5 (%)	everage	J+5 (%)	everage
Serbia	Denmark	**88**	3,9	**84,6**	4,1	**97,8**	2,6
Serbia	Croatia	**70,6**	5,2	**68,9**	4,9	**84,9**	4,1
Serbia	FYR Macedonia	**86,6**	4	**82,7**	4,4	**92,9**	3,6
Serbia	Slovenia	**93,6**	3,3	**96,3**	2,9	**96,2**	2,7
Serbia	B&H	**89,2**	3,7	**92,4**	3,6	**94,9**	3,2
Denmark	Serbia	**56,7**	5,5	**55,6**	5,9	**83,6**	4,2
Croatia	Serbia	**82,8**	4	**83,3**	3,8	**97,9**	2,5
FYR Macedonia	Serbia	**79,9**	4,4	**56,7**	5,8	**85,6**	4,1
Slovenia	Serbia	**91,5**	3,5	**82,6**	3,8	**98,4**	2,8
B&H	Serbia	**87,6**	3,9	**81,3**	4,5	**97,3**	3,3

[1] Source: Reports of expert services Public Company PTT "Serbia"

The table presents the results of measuring of the quality of the transfer of shipments for the first six months of the years 2007, 2008, and 2009, in the departure and arrival in all 5 international routes through the percentage of shipments delivered within "J +5" and the average number of days required for the transfer and delivery. Average number of days reduces in proportion to the increase in the percentage of delivery on time. Measured lines, which were of high quality, remained at that level, while those of lower quality became significantly improved.

It may be noted that the goal of 65%, set by the Universal Postal Union, was achieved and significantly exceeded in each of the lines on which measurements were carried out. It was also noted that the measured results on the lines on which the mail parcels were carried by airline were better than the lines on which the transfer of postal parcels were carried by road (for example, Serbia - Croatia).

Because it is not possible to determine precisely where delays in delivery of postal items appear (MPC or mail delivery post offices), expanding of existing AMQM system to the domestic mail traffic, it will be possible to define bottle necks and improve the quality of international postal services, both in arriving and in departure.

CONCLUSIONS

RFID systems, because of their diversity and flexibility, provide opportunities to improve all areas of human endeavor. Accelerating and efficiency increasing receipt and delivery of shipments, facilitating their monitoring during transport, eliminating the need for manual recording of data, they all are abilities that provide a safe penetration of RFID systems in the transfer of postal shipments.

This is helped by improved standardization, the ability to use between different sectors, further research on the development of the Internet and the like, are just some of the possibilities for the bright future of RFID.

Bearing in mind the requirements of the postal sector, in the international postal relations, between the terminal costs (international calculation between postal administrations for the costs arising from the delivery of shipments) are associated with the quality (speed) of delivery of parcels to the destination postal administration, systems based on RFID technology are only able to provide a fully automatic tracking without the need that postal employees enter any data manually. Therefore, it is a system that provides impartial monitoring of the quality and relevance. EU member states (UNEX) officially accepted only the measurement results obtained with this system. The acceptance of these results as the only authoritative information on the achieved quality for the purposes of calculation is in procedure at the Universal Postal Union.

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ИЗПОЛЗВАНЕ НА ТЕХНОЛОГИЯТА ЗА РАДИОЧЕСТОТНА ИДЕНТИФИКАЦИЯ ЗА ИЗМЕРВАНЕ НА КАЧЕСТВОТО ПРИ ТРАНСПОРТИРАНЕ НА ПОЩЕНСКИ КОЛЕТИ

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Ключови думи: *RFID, качество на услугите, поща, стандарт QSM, "J +5".*

Резюме: *Технологията за радиочестотно идентифициране RFID предлага редица функции, които са много полезни при транспортирането на стоки и за записите, което за различни пратки. Тази технология започва да се използва успешно в транспортирането на пощата. Броят на решения за RFID, които се прилагат в пощенския трафик, бавно нараства. Докладът представя възможностите за прилагане на технологията за радиочестотна идентификация за измерване качеството на пощенските услуги, преди всичко на качеството на доставката на нерегистрирани пратки. Тук са представени основите на RFID решение за автоматично измерване на качеството, което сега се използва в 52 страни. Специално внимание е отделено на анализа на качеството на международните пощенски услуги. Показани са също резултатите от измерването на качеството на трансфера на пощенски колети при заминаване и пристигане по пет международни маршрута от и до Сърбия. Накрая са дадени някои заключения за бъдещото прилагане на технологията за радиочестотна идентификация за потребностите на пощите.*