# APPLICATION OF TRACKING TECHNOLOGIES IN THE POSTAL SYSTEM

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**Abstract:** This paper presents the possibilities of tracking technologies application in the postal systems. There could be the postal items, vehicles, production tools and employees tracked in the postal system. Based on the tracking object and the way the collected data are used, these technologies could lead to a corresponding efficiency control of the business process and higher quality achievements in the postal company. For the tracking purposes it is possible to use various technologies. In this paper the implementation of Radio Frequency Identification (RFID) is illustrated.

**Keywords**: tracking, postal technology, efficiency control, RFID.

## 1. Introduction

The postal network makes a biggest logistic system globally. The traditional postal services have a significant role in the global economy even in the modern society characterized by information technologies. For example, when people communicate and buy through the Internet, goods must be delivered to the purchaser in physical form where a corresponding postal infrastructure is certainly necessary. In this case postal service could be seen as a connection between virtual and physical world.

For decades, national postal operators were the only providers of postal services by keeping a monopoly in this area. However, today's postal market is rapidly transforming to adapt to the modern world market characterized by liberalization, deregulation, globalization and technological progress. In the postal industry, these developments bring increased competition, changed customer behavior as well as a possible reduction in the volumes of shipments. In parallel with these market changes, a substitution by other communication media should be mentioned, as well as increased efficiency standards and requirements for improved performance at all stages of the postal process.

A possible solutions for these challenges is the use of modern technologies in the postal process. One of the mentioned is RFID (Radio Frequency Identification). The introduction of RFID systems in the postal sector can bring significant savings and competitive advantages while enhancing the quality of operations. It is very important to notice that while the costs of prevention and measurements grow then the costs of failure in business or the payment of fees for exceeding the time limits or shipment losses decrease.

Harrop and Holland (2008) in their report estimate that the global market for RFID systems, including tags, in the postal sector will 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.

In this paper we analyze the possible points in the postal process where RFID technology could bring the higher efficiency and quality. In the second section we first explain the basic concept of RFID technology. Then in the third section we scrutinize the possibilities of RFID implementation in the postal system. These possibilities could be divided in groups depending on what is tracked. In this paper we make the following groups: tracking of postal vehicles, production tools, employees and postal items. Finally, we conclude with the benefits expected by the implementation of RFID technology.

## 2. RFID technology

Automatic identification, or auto ID for short, is the broad term given to a host of technologies that are used to help machines identify objects. Auto identification is often coupled with automatic data capture. That is, companies want to identify items, capture information about them and somehow get the data into a computer without having employees type it in. The aim of most auto-ID systems is to increase efficiency, reduce data entry errors and free up staff to perform more value-added functions, such as providing customer service. There are a host of technologies that fall under the auto-ID umbrella. These include bar codes, smart cards, voice recognition, some biometric technologies, optical character recognition and radio frequency identification (RFID).

Radio Frequency Identification (RFID) is a generic term for technologies that use radio waves to automatically identify people or objects. There are several methods of identification, but the most common is to store a serial number that identifies a person or object, and perhaps other information, on a microchip that is attached to an antenna (the chip and the antenna together are called an RFID transponder or an RFID tag). The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves reflected back from the RFID tag into digital information that can then be passed on to computers that can make use of it.

RFID system consists of a tag, which is made up of a microchip with an antenna and an interrogator or reader with an antenna. The reader sends out electromagnetic waves. The tag antenna is tuned to receive these waves. A passive RFID tag draws power from field created by the reader and uses it to power the microchip's circuits. The chip then modulates the waves that the tag sends back to the reader and the reader converts the new waves into digital data.

The most common applications of RFID technology are tracking goods in the supply chain, reusable containers, high value tools and other assets and parts moving to a manufacturing production line. RFID is also used for security (including controlling access to buildings and networks) and payment systems that let customers pay for items without using cash. The application in the postal industry is significant as well.

According to research conducted in 2015, the total RFID market is worth $10.1 billion, up from $9.5 billion in 2014 and $8.8 billion in 2013. This includes tags, readers and software/services for RFID cards, labels, fobs and all other form factors, for both passive and active RFID. Forecast predicts rise to $13.2 billion in 2020.

## 3. RFID in the Postal Sector

It all started with active tags being put in a random sample of postal packages, including letters, from many countries to assess the level of service so cross charges between the postal services of different countries could be equitable. This is still done to this day. However, RFID is now used by postal and courier services for many other purposes.

The potential market for RFID in the postal and courier service is second only to that for the retail supply chain as shown below (Figure 1).

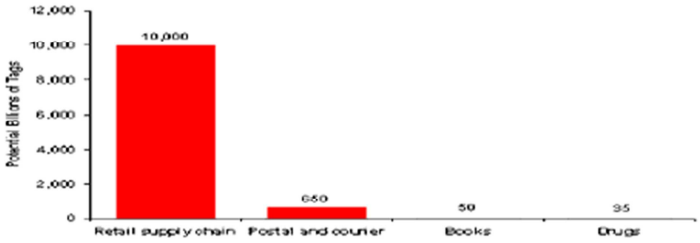


**Fig. 1.**
*Potential global market in billions of RFID tags yearly*
*(Source: Das and Harrop, 2015)*

RFID can facilitate the perfect product recall and postal companies are fitting RFID labels on cases and pallets of consumer packaged goods at retailers, because it increases availability and thus sales and reduces costs, valued at billions of dollars yearly for that industry. RFID is so crucial to the future of courier and postal services that UPS (United Parcel Service) has invested in four RFID companies just to be first to see the future.

The global market for RFID systems, including tags, in this sector will grow extremely rapidly to be $3 billion in 2016 (Figure 2).

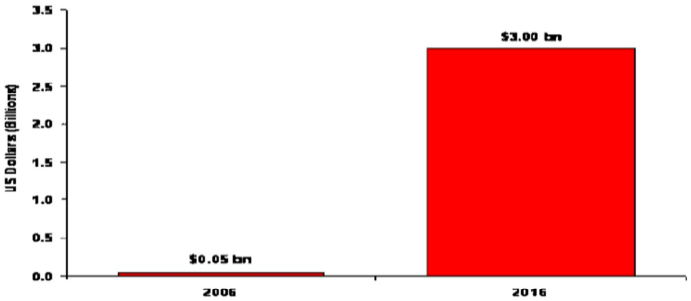


**Fig. 2.** *The global market for RFID systems*
*(Source: Das and Harrop, 2015)*

Today, the percentage of tags by value that are active (i.e. with a battery to increase range or manage sensors or encryption) is around 20%. In the postal and courier service the percentage by value is higher because most of the initial work is done on vehicles, trailers and conveyances but that will change. As the really high volume tagging of postal items commences, the percentage of spend on active tags in the postal and courier service will drop to a figure below the average for all RFID. Indeed, the new passive tags with enhanced performance, notably improved range, will take market share from active tags in existing applications. Nonetheless, the market for active tags in the postal and courier service will continue to rise. It will remain a worthwhile and profitable activity for suppliers (Das and Harrop, 2015). The global market for RFID systems, including tags, in this sector will grow extremely rapidly to be $2.5 billion in 2021. 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. Detailed ten year forecasts are given plus a full explanation of the technologies. In detail, there are over 40 new case studies of RFID in action in the postal and courier service in North America, Europe, the Middle East and East Asia. The major breakthroughs that will provide future success are discussed. Postal services ignoring this accelerating change will become uncompetitive and suppliers missing out will regret it. RFID is an idea whose time has come in postal, courier and high volume light logistics. In the past, RFID has been used for little more than the evaluation of postal performance, using tags in a

small percentage of letters, and the tracking of a small number of conveyances and vehicles. From the International Postal Corporation now monitoring mail flow with RFID in over 50 countries to Saudi Post tagging postal boxes, the big innovations are now happening. Saudi Post and the electronics giants in Korea are among the great innovators in this area. Within Deutsche Post, another RFID innovator, DHL has done successful trials of RFID labelling individual items to improve service and reduce cost and has tested market prices against the possibility of tagging all its one billion items yearly. This is the stuff of competitive advantage.

### 3.1. Vehicle tracking system

As we mentioned, postal vehicles, as a part of the postal infrastructure, can be covered by tracking technologies. In that sense, an efficient vehicle tracking system is designed and implemented for tracking the movement of any equipped postal vehicle from any location at any time. Purpose of the vehicle tracking system is multiple. The emphasis is on monitoring the characteristics of vehicles which are important for the smooth running of postal flows. Some of these features are vehicle tracking, vehicle's access control and inventory.

***Vehicle tracking*** - in the case of vehicles movement between predetermined and fixed destinations it is possible to automate the monitoring of vehicle's movement without human influence. On each vehicle is fixed tag. In the moment of arrival and departure on the destination the reader on a given point writing to tag data of arrival and departure time. When the vehicle is returned to the destination point these data is automatically removed during the passing of the vehicle through the entrance of the building, through the antenna and the reader.

***Vehicle's access control*** - means control such as access to a reloading point, access to parking, vehicle identification in the process of refueling, vehicle identification during transport and so on. In the case of controlling parking, RFID tag is placed on the vehicle or on the driver and reader is located at the entrance of the parking space. Arrival of the vehicle causes reading information located in the transponder, processing this information and providing of appropriate command.

***Inventory*** - reliable and accurate data on the status, condition and tire positions are one of the most important factors for successful management of operational fleet costs at post offices. The usual situation is that the tires indicate by incision or marks with waterproof markers. Keeping records of each tire, including the place where it is set, date of purchase, date of retreading, amortized cost, etc., is done by manually collecting, typing in the document and the manual data processing. This process is susceptible to errors and possible manipulations. A system for keeping records of tires based on RFID technology consists of the following components:

- Miniature radio frequency tag that has pre-registered the unique ID code of twenty characters. There is no possibility to find the two tags with the same ID code. The tag is fixed to the outer tire, on the side of the tire. Fixing is done by simply pasting flakes over the tag. In this way, each tire is uniquely defined by the ID code. Basic characteristics of the tag is light weight, work in extreme conditions and communication wirelessly with the handheld reader for updating data,
- Handheld reader for automatic collection and storage of data on each tire. ID code from the tag is wirelessly transmitted to a database that is in the handheld reader. For all the tires on one vehicle process takes a few minutes. In addition to the tire's ID codes, there are entered and vehicle's information, driver's information and so on. In the same way collects data of the tires in the warehouse and workshop. Data from the handheld reader is transmitted via the communication to a computer for further processing,

- A computer that enables further processing of data on tires obtained from the handheld reader,
- Software that is installed on computer and uses for the collection, analysis and reporting.

### 3.2. Production tools monitoring

***Controlled delivery and collection of postal items from post boxes*** - using the RFID system it is possible to automate the process of monitoring collection of items from post boxes. On each mailbox a tag with clearly inscribed ID code is placed. Bags for collection are equipped with micro-reader with a memory sufficient for registration and storage of alleged ID codes from tags on the post boxes. A reading of contents from the micro-reader is performed at the place where the items are collected. In this way, automatically is recorded the ID of each post box which was read during the collection of items.

The Wasel project, implemented by the Saudi Post, in an attempt to transform and improve business before privatization and provides the use of smart mailboxes equipped with RFID chip. The role of the chip is to report to the courier equipped with handheld reader whether address is appropriate. Also, the idea of this project is the possibility of elimination of users need to go to the post office when sending items. Instead of that, aim is to perform dispatch through electronic (smart) mailboxes.

After participating in the first phases of an ongoing project using active RFID tags to monitor the performance of Saudi Arabia's postal service, Saudi Post is rolling out RFID based mailboxes for citizens across the kingdom. This rollout is part of an overall IT and service upgrade that includes an active RFID based system to monitor quality at the nation's mail sorting centers.

Each of the 10 million mailboxes that will be installed at homes in Saudi Arabia is fitted with a passive ultrahigh frequency (UHF) EPC Gen 2 RFID tag that uniquely identifies it. Postal carriers employ handheld reader to identify the mailboxes before slipping letters into them (Figure 3). After a letter is inserted into a mailbox, the tag is read once more so that Saudi Post's system can verify when mail was delivered to that particular home. The handhelds, containing GPS and wireless data communication modules, are used to provide real time updates to managers regarding postal carriers' locations and activities.

**Fig. 3.**
*Saudi postal carriers with handheld reader*

Before the RFID based mailboxes were installed, Saudi citizens picked up their mail at post offices, where they could also take care of banking, the payment of utility bills and other tasks. Homes did not have mailboxes at all, and the country lacked a single, unified addressing system. That limitation has resulted in various entities, such as electric companies or private logistics firms, creating their own grids and zones and utilizing different addressing

systems for the same location and, thus, causing confusion and delays for the delivery of packages and mail. To rectify this problem, the government run Saudi Post implemented uniform addresses simultaneous with the planning of the RFID based mailbox project.

To date, millions of steel government owned mailboxes bearing RFID tags have been installed across multiple cities, as part of the so called Wasel project (*wasel* is the Arabic word for "reachable"). The mailboxes, which resemble those widely used in Europe, are attached to the exterior walls of homes and buildings (Figure 4).

**Fig. 4.**
*Saudi Post mailbox with an embedded EPC Gen 2RFID tag*

The tags which have 96 bits of programmable memory and function at 915 MHz are embedded in a plastic housing attached to the steel mailbox, manufactured by a local company. The housing keeps the metal from interfering with the tag, and also protects the tags from Saudi Arabia's sand, as well as windstorms and other harsh weather. In addition to providing the intelligent mailboxes at homes, Saudi Post is continuing to offer post office boxes to its citizens. The postal carrier is leaving it up to each individual to decide if he or she wants to use both systems, or to switch completely to home based delivery.

Saudi Post is planning a pilot to use the RFID mailboxes together with bar coded ID numbers printed on mailed items, in order to monitor the performance of the country's mail sorting centers. The monitoring system currently features semi-active RFID tags attached to regular mail test letters.

The letters are mailed from random locations and are tracked at key postal sorting centers. Saudi Post also has three mobile reading systems that can be set up in any facility in which it wants to track mail for quality measurement. Each mobile system contains a special computer that operates as a controller, as well as an interrogator and two units for exciting the tags. The units connect to Saudi Post's main servers via a GSM connection and the carrier moves them around as needed to conduct quality tests.

In the new pilot Saudi Post is utilizing the infrastructure already set up to track a total of 500 bags of secure government mail carrying semi-active tags. The entire system and the tags are provided by Lyngsoe Systems. Each piece of government mail in the sack is printed with a unique ID number in bar code form, enabling Saudi Post to know which items are in a particular bag. As part of the pilot, the mail carrier plans to expand the reader infrastructure to three additional postal sorting centers.

Once the government mail is delivered to the RFID based mailboxes, and after a letter carrier has scanned the mailbox tag, the information will serve as an electronic proof of delivery receipt. The system's main benefits are its ability to ensure that the correct mail is delivered to the proper mailbox, and to serve as proof of delivery for registered and official government mail. If the test of semi-active tags on sacks of mail becomes an ongoing project

and is used together with the RFID based mailbox system, Saudi Post will also be able to track the time required for express home deliveries.

***RFID control over roll containers*** - more than 600 RFID portals have been mounted in Swiss Post's postal and logistic centers to give the post complete control over their 70,000 roll container assets and their flow.

**Fig. 5.**
*RFID tag for roll containers*

Apart from the RFID tags on the containers, the fully integrated solution also utilizes barcodes and interfaces to other IT systems to provide end-to-end, track-and-trace of containers as well as onboard mail trays. Destination barcodes on mail trays are registered as consignments within individual containers using a unique automated nesting solution.

Swiss Post has a strategic goal of consistently meeting its own ambitious targets for customer satisfaction. Efficiency is the key, making heavy use of container and tray-based automated logistics, to handle:

- 2.4 billion letters,
- 100 million parcels,
- 70,000 roll containers.

Swiss Post has defined its own core values as "reliable", "value-enhancing" and "sustainable." To minimize operational costs, eliminate manual process, improve quality and logistics, it wanted to be able to identify and track all its containers and the items they contain.

Lyngsoe Systems won a tender to provide a new material management solution to provide Swiss Post with a complete inventory and flow overview system. The solution installed is advanced, fully automated and RFID-based comprising over 600 Quick Mount RFID portals at 47 sorting centers around the country, able to read passive EPC global Gen2 RFID tags attached to roll containers. The system also uses barcodes on mail trays that interface with other IT systems to provide end-to-end track and trace. Swiss Post achieved the following benefits:

- 100% visibility for roll container flow,
- Real-time track and trace data,
- Substantially reduced costs.

***Tote boxes*** - UPS is a follower in RFID. The company began a series of pilot tests in 2004 on both its package delivery business and its supply chain solutions business, which serve many customers who must comply with upcoming RFID mandates. In one trial passive RFID

tags are replacing bar codes on reusable fibreboard tote boxes used to shuttle packages through UPS's automated facilities. The objective is to extend the life of the tote boxes and to reduce the readfailure rates of the barcodes, which tend to wear off over time. In another pilot, RFID tags have been attached to UPS trucks in an effort to monitor cost-effectively vehicle activity moving on and off the property at three different locations.

***Locking valuable bag*** - postal bags are often tagged with active or passive RFID tags to keep track of them. The Italian Postal Service has been a leader in this and other uses of RFID in the postal service. The problem of insurance of valuable bags can be enhanced by using the RFID system. On the inside of the bag is placed mechanical lock. Since such a mechanical lock can be easily robbed, RFID system provides complete mechanical and electronic coded protection of the possible ways of unauthorized unlocking. Unlocking is performed by mechanical key with a miniature radio frequency tag. The device inside the bag recognize ID code and unblock the mechanical lock and allows unlocking. Tag can include numerous combinations which the reader recognizes and on the basis of which allows the unblocking or blocking of a mechanical lock. One of the most important feature of this system, thanks to the technology of encryption, is that code in the tag changes dynamically every time when the key with tag brings closer to lock. At the same time provides a method of blocking and unblocking (Harrop, 2005).

Also, money transfer and insurance of deposit transactions can be raised to a higher level using the RFID system. Each bag of money contains a fixed tag, which reads on the depository machine. When the ID code from the tag is authorized, unlocks the space for the money. The client puts a bag with money in the slot and again starts ID code reading. If the ID code is correct client gets printed receipt.

### 3.3. RFID personnel and people monitoring

People access control, monitoring and attendance tracking belong to most demanded RFID applications. RFID based access control and monitoring systems are typically used for granting access or control the people attendance to office, enterprise, work place, car park, school, library, hotels, events and exhibition areas as well as for tracking employee time for payroll, safety, production and maintenance needs.

RFID based access control system can provide an easy and efficient solution for enabling access to only authorized employees. RFID embedded cards are being used for identification of authorized person to allow or deny access to restricted area.

Access control points can be doors, turnstiles, parking gates, elevator or other physical barriers with embedded RFID readers and antennas. The typical RFID tag can be a contactless smartcard, key fob, wristband or smart phone with NFC UHF sticker. The ID of a tag is verified against the access control list and the IDs access rights. RFID solution at work places is ideal for a wide range of industries and businesses where hourly and salaried employee time is tracked, including manufacturing, warehouse and distribution, healthcare, retail, professional and medical offices, government, and educational agencies. RFID could be very useful in control over lost time and productivity, which can have a significant impact on the company’s profitability.

Data collected can be further used for work efficiency improvements and work flow optimization. The workers performance can be evaluated and compared, e.g. how many products a worker created within given time. This information can be used for work flow and methods optimization, evaluation, experience sharing and staff motivation. RFID time and attendance systems automate employee time and attendance tracking improve productivity and eliminate costly payroll errors and thus reduce the time required to process employee time and attendance. Tracking employee time and attendance can be fast and simple with the RFID. Each employee is provided with a unique RFID badge. As the employee passes the

RFID badge near the RFID reader/RFID gate, the RFID reader records the time of entry or exit. Data is downloaded on a scheduled or periodic basis, automatically delivering accurate time and attendance records (Roth, 2006).

Working hours recording terminal device provides accurate records of employees arrivals and departures from the company. Abuse by the employees can be reduced to the minimum by placing the network video camera to surrvey the spot arround the RFID readers. Video camera provides snap-shot of employees checking in or out. Employees check in when arriving to the work and check out when departuring by placing their ID card in front of the appropriate terminal device reader (CHECK IN or CHECK OUT). While checking in or out, employee can hold his/her card in protective foil or wallet. The card doesn't have to be taken out in order to be detected by the RFID reader.


**Fig. 6.**
*Terminal device reader (CHECK IN or CHECK OUT)*

ID card usually contains printed company's trade mark, owner's basic data and his/her photo, so the card provides not only electronic but also visual identification of the employee. ID card is equipped with re-writable memory which can be used for additional functions system provides (for example paying in company's restaurant). Employee's departure from the company during working hours can be managed in different ways. We suggest that employee reports to his/her superior which then decides whether employee can leave the company. Depending on the decision, superior then issues electronic approval, using his/her PC. Employee checks out when leaving and checks in on the return.

Turnstiles are placed on the gates for access control and passage records. They allow single person passage only. They can be equipped with RFID card readers, bar code readers, or both, as well as the coins and tokens acceptor. The turnstiles can be managed by external controller. Existence of separate reading devices for arrival and departure recording and turnstiles on the entering gate enables anti-pass back protection.

**Fig. 7.**
*Turnstil*

There are several different technologies used for card-based access control systems. Magnetic stripe cards store secure information encoded on a magnetic strip. By sliding the card through a special reader, an employee can gain entry to specific buildings and designated areas. Another highly popular method utilizes proximity (or RFID) card technology. With proximity cards, the information is embedded in the card, and the cardholder must simply waive the card within range of a card reader. The system can be designed so that specific workers are able to gain access to certain buildings and areas that require authorization. When it comes to controlling access to computers and networks, smart cards are an excellent option. Typically, these cards contain information on a smart chip embedded into the card. The employee inserts the card into the computer in order to log in and gain access to the company network. Such technology is often used for companies and corporations where workers must log in remotely. This allows employees from various locations to access the same network (FlexiRay, 2016).

Besides cards, very interesting solution is RFID chip implanted under one's skin (Fig. 8). The first reported experiments with an RFID implant were carried out in 1998 by the British scientist Kevin Warwick. His implant was used to open doors, switch on lights, and cause verbal output within a building. After nine days the implant was removed and has since been held in the Science Museum (London). This kind of human identification is further developing even today, despite a possible moral dilemmas about this process.

**Fig. 8.**
*FRID tag under the human's skin*
*(Source: "Michael" Journal, 2016)*

### 3.4. Shipment tracking

Shipment tracking is the process of localizing shipping containers, letters and parcels at different points of time during sorting, warehousing and delivery to verify their provenance and to predict and aid delivery.

Shipment tracking developed historically because it provided customers information about the route of a shipment and the anticipated date and time of delivery. Mail tracking is made possible through certified mail and registered mail, additional postal services which require the identification of a piece of mail to be recorded during various points of delivery, so that the sender can obtain a proof of delivery and the receiver can predict the time of delivery.

By using the service of tracking the item, a customer may get the information on date, time, place and status of their item from the moment of its entering the system. Each item in the system has its own identification (reception) number received upon posting.

#### 3.4.1. RFID Postage Stamp

RFID technology is the future in improving the mail delivery. It is obvious that this technology will be the standard in marking parcels, especially as this technology has an increasing decline in the cost price tags (chips) and accompanying infrastructure equipment for RFID recording. The model of RFID Postage Stamp aims to initiate the implementation of the RFID technology on the basis of the symbiosis of traditional postage stamp and RFID tag which should mark the shipment and provide its complete Trace&Track service.

High-tech stamps containing radio frequency identification (RFID) chips are likely to replace the barcodes printed on letters and packages to sort and process mail. 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. That may occur already around the year 2020. Postal services and shipping companies are already using RFID to grant access to secure areas, measure mail delivery performance and track vehicles.

In terms of programmable RFID postage stamps user can attach a stamp without a predetermined postage to an article to be mailed. The stamp has a top layer having a visual display, middle layer having an electronics layer, and a bottom layer having an adhesive layer. The stamp is encoded such that the visual display of the stamp is altered to indicate a state of the stamp. Postage of the item is determined by a postal authority worker and payment is authorized using the unique identifier. This eliminates the need for the sender to have any personal interaction with a postal worker to ship an article and eliminating the need for the

sender to estimate postal cost prior to the article being received at the postal office. Altering the adhesive layer provides safe removal of the affixed stamp which can then be reused.

A system and method for postage payment utilizes passive RFID tags as postage “stamps”, with the amount of the postage automatically billed to a previously established customer account. The tags are stored in a separate stamp database and are “enabled” by linking the individual tag to a customer account. The use of the RFID stamps eliminates the need for the customer to know the proper postage beforehand. The existence of a customer account with a proper return address reduces the likelihood of a dead letter. Also, a special category of stamps may be used for automatic reply mail. By virtue of using an RFID tag, the mailed item's progress through the postal delivery system may be tracked from dispatch to delivery.

### 3.4.2. Measuring letter performance with RFID tags

RFID (Radio Frequency Identification) is an alternative technology to barcodes for the identification of items. The main difference is that barcode information is captured by optical means (a barcode scanner) whereas the RFID information is captured via a radio signal. The captured information for the purpose of letter performance measurement is the same but the means are different. The main advantage of RFID technology is that it is easy to automate the data capture process compared to barcodes. Scanning barcodes is typically a manual process which makes it more labor intensive. The absence of unique identifiers requires the implementation of a sampling methodology, where test letters are mailed according to a statistical model. The posting and delivery dates are recorded by trained people. This data only provides information about the time the test letter takes to complete its journey.

The inclusion of an RFID transponder or tag in the test letter makes it possible to track the item at specific locations, typically where mail changes responsibility from the sending post to the receiving post. RFID equipment at specific entrance or exit doors records the passage of these tags without interfering with the operational process. The time and location is associated with the item details. This information undisputedly marks the ownership of the mail item that is necessary for measuring the letter performance of the postal operator responsible for processing the mail. Posts have extended the technology in their facilities to gain a better understanding of their processes and make performance improvements where necessary. RFID is the enabling technology for measuring the performance of items that do not have a barcode such as letter mail. It largely avoids the problems of human error and cost of disorientation, obscuration and needing to read many barcodes at a time, phosphor dots, print issues, etc. This is why RFID is already used in the postal and courier service for secure access by people to vehicles and secure areas, secure access of vehicles to yards, location of parcels, conveyances, trailers and much more besides. RFID monitors the performance of the letter post, matches letters to postal boxes to prevent errors and records when and how much a sensitive package has been overheated in transit. In Sweden it is the basis of smart packages that record time of tampering and theft and leads to arrests.

The Universal Postal Union has been using passive ultrahigh-frequency (UHF) RFID tags based on the EPC Gen 2 airinterface protocol standard for monitoring the delivery times of letters in member countries, but there are no official standards for the use of RFID in the postal service. In general, most national postal agencies are utilizing passive UHF transponders to track parcels, bins, sacks and other assets used in their operations. For example, Correos, Spain's postal service, employs passive UHF RFID technology to pinpoint inefficiencies in its mail-handling processes. When it was installed in 2006, the system utilized 340 readers and 2,000 antennas installed across its 16 automated processing centers throughout the country, as well as four bulk mail-handling centers. Correos worked with a third party that uses a pool of 5,000 passive Gen 2 RFID labels to monitor the movements of

letters through the mail delivery systems. By tracking the tagged mail's movements, the agency identified mail-handling procedures that it must improve to make speedy deliveries more consistent.

Radio Frequency Identification chips have been already deployed by postal companies in around 50 countries across the world to measure the quality of their services. The tags are attached to sample items. Their delivery process is monitored and is used to assess the efficiency of a postal service. But as costs drop and tags become smaller, RFID could be used for item-level tracking. Item-level tracking implies a massive deployment of RFID, potentially involving all the items sent. This would result in a close-to-zero risk of failed delivery. To make this possible, RFID chips would have to be cheap, tiny, easily available and based on common standards. High tech companies, like Hitachi or Motorola, are currently working to make chips more affordable and functional. The size has already decreased so much that now experts do not talk of chips, but of “smart dust”. But interoperability remains a key concern. The European Commission launched a two-year project called GRIFS to build a global RFID standards forum. All stakeholders agree on the need of talking and finding common grounds.

There is even a postal RFID system that completely automates the whole process of mail delivery from accepting the package to classification and dispatching. It has been successfully tested in Korea. The new RFID system, developed by ETRI of Korea, aims to reduce costs, errors and tedious human intervention. It will provide a comprehensive electronic postal system with the potential to maximize mail package process capabilities while minimizing logistics cost. It is difficult to estimate when RFID tagging of most of the courier and letter post will occur; however RFID labeled parcels, conveyances, vehicles and trailers are now very usual, with multiple benefits often being enjoyed. RFID is enhancing security and safety and removing tedious operations. Swedish Post has a parcel that detects and records tampering using RFID and other innovations abound, including RFID cards controlling driver access to postal vehicles and RFID enabled postal sorting equipment.

### 3.4.3. AMQM system for postal service quality measurement

The Universal Postal Union has paid special attention to traffic measurements and stimulates the postal operators by various measures to introduce advanced systems of measuring quality in providing postal services. Many postal operators have undertaken significant steps to increase the percentage of postal item delivery within a defined period of time, to reduce the terminal costs and to respond to the increased users' requirements. These authorities were the first to introduce the quality measurement system - AMQM (Automatic Mail Quality Measurement).

This system allows tracking of postal items "from start to end", i. e. from sender to receiver, and provide the postal authorities with the necessary activity with the aim of identifying and then also of eliminating bottlenecks in the phases of transfer and processing. The AMQM system records the difference between the actual and expected transfer speed of postal items in particular parts of the transfer process. This information is the basis for constant process of increasing the quality of providing postal services (Spajić and Sapina, 2007).

The basic elements of the AMQM system for quality measurement include:

1. Transponders,
2. Stations for reading/low-frequency antennas, uhf antenna grid and reading unit,
3. Local system for collecting data ldsc,
4. Central control system.

Post Norway is Norway's national postal service, covering the entire country and its islands. Norway's postal service needed to ramp up its technology-based systems to meet the need for visibility and real-time information on shipments. Its forward-looking policy has meant constant investment in an RFID based hardware and software infrastructure over the last 20 years, designed to support the best in customer services. Investment in an advanced RFID data capture infrastructure achieved the following:

- Real-time data on location and expected delivery of shipments,
- Full track and trace,
- Competitive advantage over other carriers,
- An increase in business measurable on the top line.

The geography and demographics of Norway pose special problems in terms of logistics. Recognizing the need to arrest falling revenues whilst increasing value, Post Norway began to implement an advanced portal infrastructure to generate data on the movements of items at a very early stage. Lyngsoe Systems has supported the carrier every step of the way to measure its domestic and international Quality of Service levels. The most recent significant investment was the installation of active/passive RFID portals across the country at no less than 340 locations (Lyngose Systems, 2016). Post Norway's policy is to utilize Lyngsoe Systems' Automatic Mail Quality Measurements (AMQM) RFID hardware and Quality of Service Monitor (QSM™) software to take the provision of customer data to the next level. Benefits include:

- Top line business growth,
- Cost reductions,
- High quality of service,
- Improved logistics,
- Real-time data and visibility for customer shipments.

Post Norway is able to offer complete Track and Trace to B2B, B2C and private customers thanks to Lyngsoe Systems' RFID portal infrastructure, track large load containers for carrying parcels and measure Quality of Service for domestic and international services. Lyngsoe Systems has provided a complete range of services from planning and design, through consultancy to installation over more than 20 years.

Post of Serbia is the winner of the award for AMQM – Enlargement of the system for automatic quality measurement as the best implemented project financed by the Fund for the quality of the Universal Postal Union since 2007. Transit time of the test-letter which included the transponder, is recorded through RFID equipment and Post of Serbia in an absolute leader of this segment in the region. The following chart presents the results of AMQM measurement system in the Post of Serbia for the year 2012 (Fig. 9).

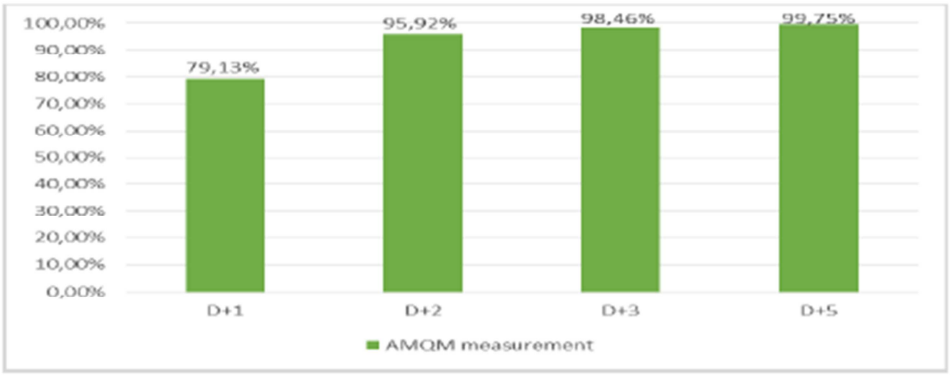


**Fig. 9.**
*Quality level measured by AMQM system in 2012*

The following graph shows a relationship between the level of quality specified by the regulatory body of Republic of Serbia (RATEL) and quality level measured by AMQM system (Fig. 10).

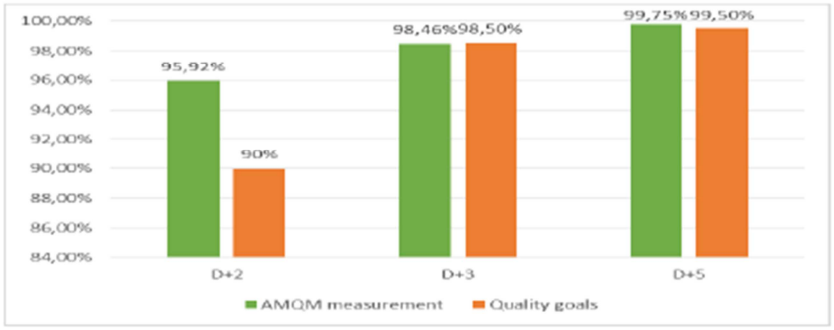


**Fig. 10.**
*The relationship between required minimum level of quality and quality level measured by AMQM system for 2012*

Looking at the results in the previous chart it is noted that the achieved results have exceeded goals set by RATEL, except for D+3 transit time.

## 4. Conclusion

The new material management system allows to always know where a mail is located, its destination and to identify bottlenecks in production or transport. It helps improve the level of quality of service and meet strategic targets including customer satisfaction.

Due to its diversity and flexibility RFID technology provides opportunities for improvement in all areas of human activity. It brings to accelerating and increasing of production efficiency, facilitating of monitoring in transport, eliminating the need for manual inventorying of warehouses and shops, control of pets and patients in hospitals and many other benefits in all fields where the identification and sharing of data is required.

The possibilities of using RFID technology are practically limitless. The information gathered by RFID technology provides making correct and timely decisions, and also, it can be expected that the application of RFID improve and optimize the engagement of the workforce, increase the efficiency of the supply system and reduce human errors and frauds and finally what is most important, it could bring to significant savings.

The development of new technologies many analysts saw as a threat to the postal sector; however, in practice it shows just the opposite. They create a fertile ground for the development of new postal services, quality and efficiency improvements. In this paper we precisely address these issues by illustrating the possibilities of RFID implementation in the postal company. We pointed out these possibilities in the following segments: vehicle tracking, production tools monitoring, personnel monitoring and shipment tracking.


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