

Improving Baggage Tracking, Security and Customer Services with RFID in the Airline Industry

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Abstract: Radio frequency identification (RFID) has been identified as one of the ten greatest contributory technologies of the 21st Century. This technology has found a rapidly growing market, and an increasing variety of enterprises are employing RFID to improve the efficiency of their operations and to gain competitive advantage. In the aviation industry, major airports/airlines have been looking for the opportunity to adopt RFID in the area of baggage handling for a long time. Many pilot tests have been done at numerous U.S., European, and Hong Kong airports. RFID tags were found to be far more accurate than bar codes, and their performance was also measured to be well above that of bar codes. This paper presents the state of RFID adoption planning, architecture and implementation at a major airline, with a special focus on improved services due to improved baggage handling, on increased airport/airline security and on frequent flier program services. This is accomplished by integrating RFID technology together with networking and database technologies.

Keywords: Radio Frequency Identification; RFID; baggage handling/tracking; airline industry; customer-service

1 Introduction

Developments in logistics have been changing the world faster than ever [1]. Radio frequency identification (RFID) is an emerging technology that is increasingly being used in business and industry. RFID systems have three main components as shown in Figure 1.

- The tag: RFID tags are chips embedded in items which store and transmit information about these items. Most RFID tags store data that identifies a specific item.

- The reader: RFID readers are radio frequency transmitters and receivers that communicates with the tags. Readers, using an attached antenna, receive data from the tag and then pass it to a computer system for processing.
- The computer system: The computer system receives the data from the RFID reader through a cable or wireless connection for storage, interpretation and action.

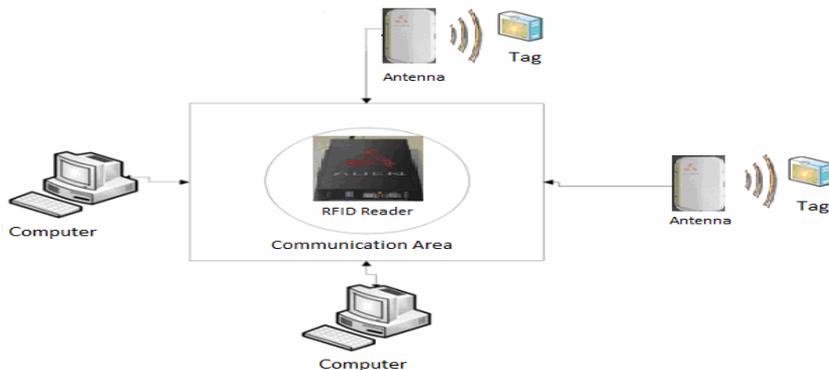


Figure 1
A Simplified View of an RFID system

Owing to its “MOST” (mobility, organizational, systems and technologies) characteristics, RFID has received considerable attention and is considered to be the next wave of the IT revolution [2]. RFID can allow any tagged item to be mobile and intelligent and to communicate with an organization’s overall information infrastructure [3]. The main applications of RFID are in aviation, retailing, the food industry, hospitals, libraries, animal detection, building management, waste management, museums, etc.

The global business environment is changing very quickly [4]. The new, global economy is the economy of knowledge and ideas, where innovative ideas and technologies fully integrated in services and products became a key to a generation of new working positions and higher living standards [4].

The aviation industry is just one of many industries that could benefit from RFID technology. In the travel industry, the pressure to provide better customer service has never been greater. Yet the pressure to reduce operating costs is equally strong. This is an industry which operates on average profit margins of less than 4%. RFID is a technology that could help revitalise the airline industry and could be the impetus for the change it needs [5].

"In 2005, the industry lost in the region of \$2.5 billion on mishandled baggage, when you take into account the costs involved in reuniting the delayed baggage with its owner, which, happily, is the case over 99% of the time. This year we will

reach the two billion passenger landmark, which on current trends will translate into 30 million pieces of mishandled baggage" [6]. The IATA surveyed airlines on their understanding of the reasons for and proportions of bags being mishandled. Among the main reasons, the airlines identified two areas where RFID can fix the issues [7]:

- Barcode reading problems cause 9.7% of all mishandled baggage and
- failures to receive a baggage status message contribute to a further 11% of mishandled baggage.

Many airlines have run RFID trials over the past few years to prove the efficacy of the systems employed in the air transport environment. RFID benefits over bar code tags, as shown in Table 1, are:

- High reading speed: a considerably higher baggage identification rate than with barcode readers for minimized manual intervention and high savings in terms of time and costs.
- Higher accuracy in reading: Tests have shown first-read rates of over 99% with RFID tags compared to less than 90% for bar code-only tags.
- The writing option opens up the potential for new applications: the data stored on the bag tags can be updated at any time for additional security. Example: inline screening results can be written onto the bag tag.
- Flexible bag-tag choice: the system can read and write on all IATA-specified bag tags from a large range of different manufacturers.
- Efficient baggage reconciliation processes (flight makeup) through simple bag tag reading.
- Robust and easy to integrate: the industrial-design system is based on standard components proven in day-to-day use all over the world.
- Cost Savings [8]:
 - US\$760 million per year in industry savings when fully implemented (based on US\$ 0.10 per tag cost).
 - Out of 2 billion plus pieces of luggage handled per year, just over 1% are mishandled.
 - Each baggage mishandling costs on average US\$90.

Table 1
Comparison of Barcode and RFID Tags (Source: IATA [7])

ATTRIBUTE	BARCODE TAGS	RFID TAGS
FLEXIBILITY Line of sight reading	Required	Not required
ABILITY Number of simultaneous scan	One	Multiple, and can distinguish bags from other items
ACCURACY	Read rate highly variable	Fully automated & accurate Read rate > 99%
DURABILITY	Can be damaged easily	More durable, withstand handling
DATA SUPPORT	No write capability	Possible to update data
MAINTENANCE	High Maintenance	Low Maintenance
COST	Cheap tags but expensive readers	Expensive tags but cheap readers

Both academics and practitioners are keenly aware of how organizations can extract business value from RFID [9], [3]. The main question here is how RFID can be used to reduce costs or whether the investment required in the RFID project can be returned. The cost of investment is apparently the primary reason the airline industry has not yet implemented RFID baggage tagging. Also, such tags end up being disposable and are currently not cheap enough to use, as they cut into already small profits. However, weighed against the fact that airlines lose track of about 100,000 bags each day and must therefore compensate passengers, baggage tagging costs begin to look more attractive for RFID implementation. The prediction is that, as more airlines start to implement radio frequency technology for baggage tagging, the cost of tags and readers will drop, which in turn will likely encourage more airlines to follow suit.

Other issues that need to be worked out, beyond the tag costs, are the infrastructure and the tags themselves. It is unclear who will pay for installing RFID systems because the responsibility for baggage handling varies around the world. Experts recommend that it will be more beneficial if the airports rather than the individual airlines adopt the system [10]. This case study reports that RFID implementation will ensure the effective management of baggage tracking/delivery and will provide customized and personalized services to premium customers. There have been reports of airlines and airports abandoning RFID system implementations and pilot tests due to the lack of demonstrable return on investment, but here tangible and intangible benefits such as efficient baggage handling and improved services to premium customers will outweigh the costs. To the best of our knowledge, this case is the first one which reports improved services to premium customers as an added feature of RFID implementation in the aviation industry.

The paper is structured as follows: Section 2 addresses the literature review of the topic. Section 3 presents the real-life RFID adoption planning and implementation as a case study. Finally, Section 4 concludes with discussions.

2 Literature Review

In the aviation industry, major airports have been looking for opportunities in the baggage handling area since 1999 [11]. Many pilot tests of RFID have been done at numerous U.S. and European airports [11]. In U.S. tests, RFID tags were far more accurate than bar codes when applied to baggage handling operations [11]. Nath et al. [12] advocate embedding RFID tags in luggage labels, as it could eliminate the need for manual inspection and routing by baggage handlers. A network of readers placed along conveyor belts could read the tags' routing information and provide feedback to a system that could then direct the bags onto the correct path [12]. Automatic routing could reduce the number of misrouted bags, lowering costs and improving customer satisfaction [12]. Al-Ali et al. [13] described the design and implementation of a prototype system for baggage handling in airports to enhance the management and tracking of passengers' luggage while, as a side effect, improving airport security. Wyld et al. [14] showed by specifically focusing on Delta Airlines how RFID technology can improve customer service through better operational efficiency in baggage handling, which has been demonstrated to be an integral component of an airline's customer service rating.

Even though the value of RFID-enabled technologies in handling passenger bags is generally accepted in the industry, the adoption of these technologies is hindered by concerns relating to their inadequate return on investment [15]. The reason most of the projects failed to demonstrate the needed financial return was because they focused primarily on increased labour productivity in the baggage scanning process, instead of considering other more valuable applications of RFID-enabled technologies, such as the savings in time, money and effort from the avoidance of costly baggage handling exceptions [15]. Viswanadham et al. [15] attempted to address this issue by highlighting scenarios in the baggage handling process where RFID-enabled technologies may be uniquely positioned to create value.

Sample et al. [16] focused on the use of RFID technology in the US department of Transportation's (DOT) international airport security initiative in Nigeria. One of the uses of RFID baggage tags, in conjunction with RF handheld readers and boarding pass readers, is to verify passenger boarding versus luggage loading for positive passenger baggage matching on flights departing for the U.S. and other international locations [16].

The need for matching passengers with checked luggage has been at the forefront of anti-terrorism concerns ever since the in-flights bombings in the 1980s that took down a Pan American 747 over Lockerbie, Scotland and an Air India jumbo jet over the Atlantic [17]. Out of this concern, airlines must routinely remove bags from the aircraft when a passenger fails to board [18]. Often, this is a time-intensive, laborious process, which can delay flight departures indefinitely, costing the airline countless amounts of goodwill amongst the passengers, even if such measures are done precisely to safeguard their transit and their very lives [17]. A bag with an RFID tag could be pinpointed accurately in a unit loading device or individual aircraft hold, greatly facilitating offloading if necessary.

Wong *et al.* [19] discussed workers' safety concern due to radiation emissions from a recently installed 900 MHz RFID baggage handling system at Hong Kong International Airport. They concluded that the operation of the RFID system is considered a safe system, as the E-field levels recorded for the whole system is well below the ICNIRP (International Commission on Non-Ionizing Radiation Protection) restricted level.

RFID technology provides enormous economic benefits for both business and consumers, while simultaneously potentially constituting one of the most invasive surveillance technologies threatening consumer privacy [20]. Kelly and Erickson [20] recommended that the use of RFID technology should be legally regulated. Manufacturers and retailers should notify purchasers that RFID tags are being used, and these tags should be automatically disabled at checkout. Also, government authorities should be required to obtain a court order in order to be able to access RFID tags [20]. Juels *et al.* [21] proposed the use of selective blocking by blocker tags as a way of protecting consumers from unwanted scanning of RFID tags attached to items they may be carrying or wearing.

Generally, the case study method is a preferred strategy when “how” and “why” questions are being posed, and when the researcher has little control over events [22]. The case study method, a qualitative and descriptive research method, looks intensely at an individual participant or a small group of participants, drawing conclusions only about the participants or group and only in a specific context [22]. The case study method is an ideal methodology when a holistic, in-depth investigation is required [23]. Case studies are often conducted in order to gain a rich understanding of a phenomenon and, in information systems research, the intensive nature, the richness of a case study description and the complexity of the phenomenon are frequently stressed in case study reports [24].

3 Case Study

This is a case-study of an airline which is a member of Star Alliance group. The airline needs to maintain high levels of flexibility to face new challenges from competitors around the world, and to identify and create new services to improve customer satisfaction and reduce costs.

The increase in passenger and baggage volumes, plus the development of global alliances and dual transfer flights, all create big challenges for airlines and airports. This is especially true for an airline handling over 2 billion passengers per year. This puts an extra load on the existing baggage handling system, which relies on an aging Barcode system. The airline, therefore, requires a highly efficient method to handle the increasing passengers and baggage volumes, and RFID technology has drawn the attention of the airline.

The strategic importance of RFID applications cannot be underestimated and the advancement of RFID creates opportunities for new and innovative services provided through the RFID infrastructure [2]. RFID is expected to drastically impact the organization's strategic management [3]. One of the key priorities for the airline is to offer excellent services to its clientele and, in addition, the airline company appears to target mainly the premium segment of the market. The major advantage of targeting the top end segment of the market is that it gives the airlines the opportunity to maximize revenue and profit generation, a key factor in the highly competitive and not very profitable airline industry. Recently the company started an RFID project with two main objectives:

- To ensure better services, especially in terms of service delivery. Improvement in baggage tracking and baggage delivery has been identified as key business driver.
- To initiate a new Frequent Flyer Program (FFP) experimental project for premium members based on RFID technology, with the main aim of providing customized and personalized services.

By focusing a firm's RFID strategy on customer-facing activities, a firm can use the technology to change its basis of competition from an efficiency oriented strategy to one where RFID has more strategic implications, such as in providing the foundation for new products or services, or by providing the infrastructure to enhance customers' value perceptions in order to strengthen customer loyalty [25].

The additional functionality of RFID allows information to be changed at different points in the airline system. This makes it possible to hold bags for security checking and release them for loading when checked, provided the RFID system is linked to the baggage reconciliation systems. Similarly, RFID will be used to track passenger progress through airports, reducing the number of passengers arriving late at the gate, and in doing so ensuring that planes leave on time.

Business process reengineering (BPR) is described as a fundamental rethinking and radical redesign of business processes in order to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed [26]. Research in electronic data interchange (EDI) usage has shown that integrating EDI with process redesign results in more benefits than EDI alone [27], [28]. RFID will provide the foundation for a thorough rethinking of vital business processes [29]. RFID will require considerable process redesign at all stages in the value chain where the technology is applied [30]. Some key systems that need to be changed to accommodate RFID functionality:

- check-in systems,
- belt and tray conveyors,
- sorting systems,
- baggage screening,
- baggage reclaim,
- IT control and instrumentation technology.

Three official surveys were written and published before the design process for three different classes of target groups: passengers, managers and stakeholders. Additionally interviews were conducted with these target groups. The following issues and requirements were found to be necessary from user's perspective:

- Security / Privacy policy,
- Scalability, Reliability, Availability,
- System performance and speed,
- Mobility of hardware parts,
- Initial Price and total ownership cost,
- Self managed system, Automatic failover,
- Using contactless cards which work remotely,
- ISO-18000 compliant.

Keeping the above facts in mind, the design of the system was made. The company chose the system which follows the 'EPC global UHF Gen 2' standard protocol, the most reliable and accepted standard in implementing RFID projects. The specifications of the system are explained in three sections: Architecture, Hardware, and Software. Users were indirectly involved in the system architecture design process, from surveys and initial interviews, as well as directly via interviews and meetings throughout the design process. However, due to the nature of other parts like hardware and software specifications, users were not directly involved in these parts. However, the selected technologies were chosen based on the requirements mentioned by users as well as on compatibility with the other parts of airlines IT infrastructure and on cost implications.

3.1 System Architecture

The system is made up of a RFID passive card which transmits radio frequency data collected by an RFID wired reader, which in turns transmits data to a filtering system. This filtering system filters data based on business rules and transmits that to the appropriate application, which is connected to a host of database, via the network. The database processes the data and sends it back to the appropriate application. This process works in the same way for baggage tags as well as for frequent flyer tags. While it informs airport staff of the presence of a premium member via the frequent flyer tags, it also ensures that the bag is directed to the correct belt by the baggage tag.

The main critical point of the system is the sophisticated filtering algorithm which improves the performance of the system and makes it highly scalable as well. In other words, the system works with paralleling ability, and if the number of bags or passengers increases, there will only be a need for adding another filtering system, without any drastic change in the system architecture. While the tags on the baggage will be for a single use only, the cards for the members should theoretically be long lasting.

Just to focus on how the RFID chips for Frequent flyer members are programmed, the system will not be confused by different RFID cards because the system will respond based on the data written in a card which is the username and user id (which is the frequent flyer number) and response will be based on a set of clearly laid out business rules.

3.2 Hardware Specification

In this phase, surveys were used for making decisions regarding the special consideration as to “Price / Total cost of ownership”, and being ISO-18000 compliant.

RFID tags: The tags are based on the IATA standard of RP1740c and use 850 MHz to 950 MHz frequency, also known as UHF, which is licensed by different countries at different bands and powers. The air interface protocol employed is ISO-18000-6-C, which is an open standard that defines the way in which the reader talks to the tag and the way the tag responds.

RFID cards: The cards are the same size of Visa cards. They follow ISO-7813 with “Tag Model: 116501 GAO”, which follows the ISO-18000 6-C (the IATA accepted standard). It is very light in weight and is contactless, with the ability of 5-500 tag reads per second. For the non-technical design of the card, such as colour and images, customer opinions were widely used. The tag is passive, thus it follows the security and privacy policy regulation.

The RFID reader: Fixed readers were selected due to the fact that they are used mainly for monitoring. The reader chip is ‘Intel® UHF RFID Transceiver R1000,

which meets the EPCglobal Gen 2 and ISO 18000-6C specifications (the IATA mandatory standard) and is appropriate for the purpose of the project (Intel® UHF RFID Transceiver R1000 is Intel's newest RFID reader, which has a reasonable price and can read UHF RFID tags). Readers come in a wide range of sizes, offer different features and start at \$500. They can be affixed in a stationary position, integrated into a mobile computer that is used for scanning bar codes, or even embedded in electronic equipment, such as label printers [31].

The Network: It is a high speed wired fibre optic LAN. The reasons for choosing this are network area, resistance to noise, high security and resistance to security breaches, high performance and very high speed. Though this technology is expensive, the advantages outweigh the costs. Due to security concerns, all parts of the network have been wired and all the transmitted messages are encrypted. The network is segmented and separated with firewalls, which makes the system robust against security breaches.

Servers: The servers are comprised of Intel Xeon 2.8 GHz processors and Intel Xeon 3.4 GHz processors with minimum 2 GB RAM and required hard disk volume based on the volume of data. These servers have been used for hosting database, application server and load balancing purposes.

3.3 Software Specification

Oracle application servers are used along with an Oracle sensor edge Server as the middleware between the Oracle Database and the application. The main reason for using this technology is that the product has the proven ability to filter the data from sensor based technologies such as RFID, which collect unstructured data from the environment. One of the main factors for selecting Oracle products is that the airline is already using many Oracle products such as the Oracle ERP system e-business suite; therefore the new system is compatible with the existing ones. The operating system is Oracle Enterprise Linux 4 which is free, open source and highly compatible with Oracle products.

3.4 Implementation

Based on the nature of the project and company requirements, the project will be implemented in phases based on the functionalities and logistics issues as shown in Table 2.

Table 2
Outline of Implementation

Phase	Baggage Tags	Passengers Tags
One	Will be implemented between the airport where the airline is based and key airports which already have RFID capability.	Will be implemented for premium passengers using the Premium Terminal at the airport where the airline is based, to provide more personalized service in the lounge.
Two	Will be implemented between airport where the airline is based and high value/volume destinations.	Will be used for the Decision Support System (DSS) for analysing customer behaviours, travel trends and the booking /travelling habits of customers for better Customer Relationship Management (CRM).
Three	Will be implemented for all destinations in the airline's network.	Will be implemented for all the airline's frequent flyer members at all stations in the network.

3.5 Testing

Testing has been done at all three levels:

- **Unit Testing:** The system has been tested to ensure that it is error-free. This test has been done by the system creator and his/her related team. In this stage, each part of the system is tested separately; for example, RFID readers have been tested to ensure that they work properly in a real environment. The other parts of the system have been tested by following the same approach.
- **System Testing:** In this stage, the system has been tested as an integrated unit (testing the system as a whole). The main concept of this test is to check whether all parts of the system are compatible and work in harmony with each other. This test has been performed by a special team of system inventors. Penetration test has been done in this stage to check the system scalability, performance and the maximum workload at which the system can operate without problems.
- **Acceptance Testing:** This has been final test and as suggested by its name, stakeholders, managers and passengers play main roles in this stage. The main question which needs to be answered in this stage is if the system fulfils all the needs of the target groups. This has been a broad, precise test and has a documented test plan which is written by system creator and his/her clients.

For the airport tests, the focus has been on system durability, user friendliness (stakeholders are able to work with applications easily) and whether the system users can manage other related tasks without any additional work load. Another focus has also been to check if there are any bugs which still exist in the system.

4 Discussion and Conclusion

As it is among the top 50 airlines world-wide, this airline needs to stay competitive by offering the highest quality passenger services and service levels. One of the key priorities for the airline is to offer excellent service to its clientele and to differentiate itself by implementing RFID technology not only to tag the passenger's baggage but also the passengers themselves.

The objectives of the RFID business case study were cost savings and other benefits such as enhanced safety and quality control, increased customer satisfaction, etc. The adoption of the RFID technology for the sorting and handling of baggage along the global supply chain provides a Win-Win-Win for the three main stakeholders, the airlines, the airports and the passengers [7].

According to the survey performed by the IATA [7], the RFID project is expected to offer a 9.7% savings opportunity. While barcode reading problems attribute 9.7% of the total baggage mishandlings to the airline, airports deal with a much larger baggage volume. An airport requires manual interaction to ensure that the baggage makes the intended flight. If RFID technology is put into use, it allows the airport to increase efficiency in the baggage handling operation. It is estimated a 12.5% savings opportunity, based upon analysis of airport baggage statistics. Another factor contributing to baggage mishandling is the failure to receive a baggage status message. The airline's survey results state that this factor alone will contribute to savings of around 11% [7].

While cost savings is the key business driver, there are other benefits that the RFID project can create. By implementing the latest RFID technology, it can improve the overall passenger service level by improving the tracking of mishandled baggage. The RFID technology tracks and records the baggage location when it is delivered to the wrong terminal or flight. This will make for more responsive and faster delivery of mishandled baggage.

On top of these benefits, the new technology will also enhance the speed and accuracy of baggage handling, especially when dual flight transfer is required. Passengers will be better informed, and the baggage delivery status can be tracked easily. All these functions will set passengers' mind at ease and in return increase the passengers' satisfaction toward the airline.

With the increasing transparency of the baggage handling process and a reduced baggage claims record, the RFID project will help the airline to build a strong brand image and set new standards of passenger service.

In addition, the baggage tagging initiative is also expected to reduce the overall operating cost, beyond the savings associated with baggage claims. With improved efficiency in baggage handling and tracking, the reduced number of baggage claims will free up customer service resources to carry out higher impact activities like customized services for frequent travelers. Enhanced baggage

handling will improve the resource planning capability and strengthen the decision making capabilities of the airline. The quick tracking function of the RFID system will help the airline to identify areas of failure, and can help to identify the problem caused by other carriers or airports. By feeding the information into IT tools like dashboards, it can help the airline to manage its global productivity and performance, and allow it to make necessary changes and decisions efficiently and effectively.

The result and logging of performance can contribute to a key service level measurement. It can assist the airline in planning for the resource allocation on one hand and become a key reference for negotiating contracts with Ground Handlers on the other.

The RFID project can improve the security management of the airline and airport. After the 9/11 incident, the Federal Aviation Administration (FAA) put great pressure on the airlines to ensure proper baggage-to-passenger matching. This in return increased the requirements for the tracking and visibility of all bags. Airlines can add different security levels into the baggage tag, and this together with the tracking mechanism can immediately identify and locate any misplaced bag. The system and information logged could become key references for security audits. The overall transparency of information can help both airlines and airports to enhance and optimize the baggage handling process. In this way, RFID can be instrumental in helping airports and airlines deal with security issues. Thus in an effort to increase safety standards, airports can get financial support from management and authorities.

After the successful implementation of the RFID baggage tagging system, the next phase of the project will be to extend the system to passenger tagging. By tracking the location of passengers with the RFID cards, customized services can be offered to boost the customer satisfaction and create a positive impact on the sales turnover. Via the information on the RFID embedded card of the premium passengers, they can be greeted in the language they prefer, and they can be offered their favourite newspaper and drinks once they enter the premium passenger lounge. This RFID card can also be a tracking device to help the airline better understand its passengers' profiles. By tracking which duty free shops passengers visit, which restaurant they go to, etc. the cards can be a source of information for the Customer Relationship Management system (CRM), which in turn can allow for custom-made programs to enhance business performance and improve customer loyalty.

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References

- [1] Koczor Z., Takács A., “Engineering Evaluation about the Role of Innovation in a Globalized Economy, *Acta Polytechnica Hungarica*, Vol. 5, No. 3, 2008, pp. 65-73
- [2] Tzeng Shiou-Fen, Chen Wun-Hwa, Pai Fan-Yun (2008) Evaluating the Business Value of RFID: Evidence from Five Case Studies, *International Journal of Production Economics*, Volume 112, Issue 2, April 2008, pp. 601-613
- [3] Curtin, J., Kauffman, R. J., Riggins, F. J. (2007) Making the “MOST” out of RFID Technology: A Research Agenda for the Study of the Adoption, Usage, and Impact of RFID, *Information Technology and Management*, 8 (2), pp. 87-110
- [4] Lesakova L., “Innovations in Small and Medium Enterprises in Slovakia”, *Acta Polytechnica Hungarica*, Vol. 6, No. 3, 2009, pp. 23-34
- [5] Collins, J. (2004) Delta Plans US-Wide RFID System: the Airline Carrier will Spend up to \$25 Million during the Next Two Years to Roll out an RFID Baggage-Handling System at Every US Airport it Serves. *RFID Journal*, 2 July, available at: www.rfidjournal.com/article/articleview/1013/1/1
- [6] SITA (2006) Mishandled Baggage Costs Air Travel Industry \$2.5 Billion a Year. *WIRELESS NEWS*, 10Meters, <http://www.10meters.com>
- [7] IATA (2007) RFID Business Case for Baggage Tagging. available at <http://www.iata.org/NR/rdonlyres/99091491-CB49-4913-BAB4-EA578CA814CC/0/RFIDforbaggagebusinesscase21.pdf>
- [8] IATA (2008) Fact sheet: Radio Frequency Identification (RFID) for aviation. available at http://www.iata.org/pressroom/facts_figures/fact_sheets/RFID.htm
- [9] Weinstein, D. (2005) RFID: A Technical Overview and its Application to the Enterprise, *IT Professional*, Vol. 7(3) pp. 27–33
- [10] DeVries, Peter D. (2008) The State of RFID for Effective Baggage Tracking in the Airline Industry, *International Journal of Mobile Communications*, Vol. 6, No. 2, pp. 151-164
- [11] Chang, Y. S., Oh, C. H., Whang, Y. S., Lee, J. J., Kwon, J. A., Kang, M. S., Park, J. S., Ung, Y. P. (2006) Development of RFID Enabled Aircraft Maintenance System. *Industrial Informatics*, 2006 IEEE International Conference on, Aug. 16-18, 2006, pp. 224-229
- [12] Nath, B., Reynolds, F., Want, R. (2006) RFID Technology and Applications, *IEEE Pervasive Computing* 5, 1 (Jan. 2006) 22

-
- [13] Al-Ali, A. S. A., Sajwani, F., Al-Muhairi, A., Shahenn, E. (2007) Assessing the Feasibility of Using RFID Technology in Airports. *RFID Eurasia*, 2007 1st Annual, Sept. 5-6, 2007, pp. 1-5
- [14] Wyld, David C., Jones, Michael A., Totten, Jeffrey W. (2005a) Where is my Suitcase? RFID and Airline Customer Service, *Marketing Intelligence & Planning*, 2005, Volume 23, Issue 4, pp. 382-394
- [15] Viswanadham, N., Prakasam, A., Gaonkar, R. (2006) Decision Support System for Exception Management in RFID Enabled Airline Baggage Handling Process. *Automation Science and Engineering*, 2006. IEEE International Conference on, CASE '06, Oct. 8-10, 2006, pp. 351-356
- [16] Sample, K. B., Taylor, D. K., Rao, E. (2004) High Tech Aviation Security Program in Africa - a Model for Technology Transfer. *Security Technology*, 38th Annual International Carnahan Conference on, Oct. 11-14, 2004, pp. 270- 277
- [17] Wyld, David C., Jones, Michael A., Totten, Jeffrey W. (2005b) I'm on Beale Street, but my Luggage is in Memphis ... Egypt?: Deploying RFID-enabled Baggage Tracking Systems to Improve Airline Customer Service, *Academy of Marketing Studies Journal*, Vol. 9, Number 1, Jan-July, 2005
- [18] AIM Global (2004) Flying high, RFID Connections. January 2004 from www.aimglobal.org/technologies/rfid/resources/articles/jan04/0401-bagtag.htm
- [19] Wong, Y. F., Wu, P. W. K., Wong, D. M. H., Chan, D. Y. K., Fung, L. C., Leung, S. W., (2006) RFI Assessment on Human Safety of RFID System at Hong Kong International Airport. *Electromagnetic Compatibility*, 2006, EMC-Zurich 2006, 17th International Zurich Symposium on, Feb. 27-March 3, 2006, pp. 108-111
- [20] Kelly, Eileen P., Erickson, G. Scott (2005) RFID Tags: Commercial Applications v. Privacy Rights, *Industrial Management & Data Systems*, Vol. 105, Issue 6, pp. 703-713
- [21] Juels, A., Rivest, R. L., Szydlo, M. (2003) The Blocker Tag: Selective Blocking of RFID Tags for Consumer Privacy. In V. Atluri, ed. 8th ACM Conference on Computer and Communications Security, pp. 103-111, ACM Pres 2003
- [22] Yin, R. K. (2003) *Case Study Research: Design and Methods*, 3rd Edition, Sage Publications, Thousands Oaks, CA
- [23] Feagin, J., Orum, A., Sjoberg, G. (Eds.) (1991) *A Case for Case Study*, University of North Carolina Press, Chapel Hill, NC
- [24] Van Der Blonk, H. (2003) Writing Case Studies in Information Systems Research, *Journal of Information Technology*, 18, pp. 45-52

- [25] Lee, L. S., Fiedler, K. D., Smith, J. S. (2008) Radio Frequency Identification (RFID) Implementation in the Service Sector: A Customer-Facing Diffusion Model, *International Journal of Production Economics*, Vol. 112(2), pp. 587-600
- [26] Hammer, M., Stanton, S. (1999) How Process Enterprises Really Work. *Harvard Business Review*, 77 (6), pp. 52-57
- [27] Clark, T. H., Stoddard, D. B. (1996) Interorganizational Business Process Redesign: Merging Technological and Process Innovation, *Journal of Management Information Systems*, 13 (2), pp. 9-28
- [28] Riggins, F. J., Mukhopadhyay, T. (1994) Interdependent Benefits from Interorganizational Systems: Opportunities for Business Partner Reengineering, *Journal of Management Information Systems*, 11 (2), pp. 37-57
- [29] Chao, C. C., Jen, W. Y., Chi, Y. P., Lin, B. (2007) Improving Patient Safety with RFID and Mobile Technology. *International Journal of Electronic Healthcare*, Volume 3, Number 2, pp. 175-192
- [30] Chuang, Y. W. (2005) An Exploration of Application of Radio Frequency Identification Technology in Hospitals. Working Paper, National Taiwan University
- [31] Homs, C. (2004) Exposing the Myth of the 5-Cent RFID Tag. Forrester Research Inc., Cambridge, MA