2016 International Conference on Computing, Analytics and Security Trends (CAST)
College of Engineering Pune, India. Dec 19-21, 2016

Baggage Tracing and Handling System using RFID and IoT for Airports

Ashwini Singh[1], Sakshi Meshram[2], Tanvi Gujar[3], *Student Member, IEEE*, P. R. Wankhede[4], *Member, IEEE*
[1,2,3]Student, Department of Electronics and Telecommunication Engineering
[4]Assistant Professor, Department of Electronics and Telecommunication Engineering
Shri Sant Gajanan Maharaj College of Engineering, Shegaon
Dist-Buldhana-444203, Maharashtra, India
[1]ashwini.indai97@gmail.com ,[2]meshramsakshi1@gmail.com, [3]tanvigujar97@gmail.com, [4]pravin.india1@gmail.com

***Abstract*— Aviation industry is one of the areas which have a strong potential to benefit from Radio Frequency Identification (RFID) and the Internet of Things (IoT). The most common loopholes experienced in Aviation industry for Baggage Handling are mislaid baggage, lost baggage and damage to belongings. So for providing a better and secure system to the passengers, we have proposed a design of baggage tracing and handling system using smart RFID tags and IoT which is based on cloud server. We have designed a prototype at two locations having both check-in and check-out processes. A more secured algorithm is used for generating tags that are attached to printed baggage label with the details of passenger and airline stored in it. RFID readers in the check-out areas facilitate step tracking of baggage which prevents baggage loss. The baggage's real time position is tracked and stored in a cloud using IoT and unique ID can be retrieved by the passengers wherever and whenever necessary. The same ID can be used while collecting bag at check-out counters. The system provided ensures less consumption of time, security for baggage and is economical hence provides customer satisfaction.**

Keywords*— *RFID, internet of things, baggage tracing*, *object identification, air transport

I. INTRODUCTION

Airport being the most important means of international transport, it is observed that each year more than 31 Million passengers and 34 Million bags are influenced by baggage mishandling which resulted in loss of $3,300 Million to aviation industry. A passenger wastes around 1.7 days of his vacation or business trip waiting for the mishandled bag [1]. In the recent years, RFID has proven to be a boon for object tracing purpose and is one of the most promising areas for research. The RFID is a very effective, feasible and cost-effective technology for object identification. The fundamental RFID system consists of three components: Tag, Reader, and Backend Application. The tag consists of a microchip and antenna which is assigned a unique serial number to identify the object and can also store information such as including the name of the Airlines, flight number, bag nature and mobile number of the passenger. The tag is passive and receives both information and energy to operate from RF signal [4]. The tag specification is operated in the UHF range because UHF works well in the dry non-metallic environment and is usually used in aviation baggage application. RFID have its place in a group of technologies referred to as Automatic Identification and Data Capture (AIDC). AIDC methods automatically identify objects, collect data about them, and write those data directly into computer systems with little or no human intrusion. RFID methods utilize radio waves to accomplish this. Some tags are even featured with certain computing capability to detect simple data cryptograph and access control. The reader consists of the RF module, control unit, and coupling element to interrogate tags via RF communication. It has a secondary interface to communicate with backend systems for the transmission of the information stored in tags. The backend applications not only aggregate, filter, and calculate the data gathered by readers but can process the dynamic product data (e.g. location, history and current analysis). The RFID virtually creates a remote database which travels with the item by making use of RF communication to exchange data between tags and backend applications [15].

The RFID technology is being promising not only in supply chain management but also in the aviation logistics industry. It provides a significant improvement in efficiency and security over the barcode that is used in most airports around the world. International Air Transport Association (IATA) has developed the plan for the adoption of RFID in the aviation industry (e.g. baggage tag, baggage track, boarding pass, and employee pass).When RFID technology is implemented, losses in aviation industry will decrease by 10% which include mislaid baggage, lost baggage and damaged [2] [3]. RFID collects information wirelessly as the tags are read by the reader, the received data is to be processed and controlled remotely and this is where IoT comes into play. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure [13], creating opportunities for more direct integration of the physical world into computer-based systems [6][12] which helps reducing manpower involved and reduces the complexity. IoT is one of the emerging technologies for future because it has wide application and spin-off [4]. In system processors by 2020 IoT will be the third industrial revolution and second digital revolution behind the Internet.

978-1-5090-1338-8/16/$31.00 ©2016 IEEE

Many companies and organizations are providing IoT services using different sensors. Therefore by combining the IoT and RFID, perfect application is being designed for the Aviation Industry. In reference to other papers in this direction people tried their best to make the baggage handling system more effective using many different technologies. One such method made use of Boarding Pass and the long Baggage Tag (Bag Tag) with a barcode at the departure control system (DCS) [8]. Presently it is done for domestic airlines considerations. They used it for writing data along with RFID and barcode which then led to high costing. Other example is use of cameras so as to have perfect tracking of each and every bag [10]. Similar projects were also implemented on few airports but it used only RFID for regular passengers [9]. However the use of RFID brought good results hardly 1 out of 1000 bags were misplaced due to improper input data, but along with these advantages RFID has some problems such as weak safety function and risk via device/tag damage. This is why Airports are using RFID for custom clearance or terminal only, some airlines are using RFID for their domestic flights. This paper proposes an IoT based air-baggage tracking system for cost reducing and improving convenience.

II. METHODOLOGY

RFID supplies a real time and accurate view of the baggage along the transportation and enormously enhances the ability for baggage sorting, baggage matching and baggage tracking. The RFID tags are attached to the baggage after security checks. The baggage information such as the owner, the origin, the destination and the airline number is stored in the tag the same information is stored in the server at the airport. All the servers at different airports are connected to a central server which facilitates the sharing of specific information of the passenger details. Readers have wired or wireless Gigabit Ethernet over which they report their RFID data to a server. All readers run custom software that processes RFID data before sending it to the central server. This software continuously checks the reader hardware for newly detected RFID tags and generates one tag-read event per tag with the format (tag ID, time). For example, if tag A is detected, then the custom reader software will generate and send the following information to the server: (tag A, t). When the baggage is loaded in the airplane it will pass through a checkpoint where the reader will read information and will promptly send the message to the local Server. The information about the baggage on RFID labels is shared with the destination airports through IoT cloud. When the baggage arrives at the destination it will be sent to different counters from the conveyer belt following certain sorting criteria. The baggage by passing through a gate of the RFID readers will read the information and through server and SMS Gateway will send a message to the passenger that the baggage is arrived. Now, the passenger will have to enter the unique identification number on the keyboard located at the counter gate. The entered code on the keyboard will verify the same code in RFID tag that was saved previously at location 1. Once the identification number is matched, the bags of that code will be sorted out on that counter.

A. Process on arrival at the Airport.

This RFID and IoT system at Airports uses UHF RFID passive tags for storing information and identifing baggage.

1) Input and Registration of Information: When passengers arrive at the Airport they first head to the check-in section to deliver their luggage. At check-in section, the information of each and every passenger is taken and stored in information bank (server). The information bank consists of four important items including the name of the Airline, flight number, bag nature and mobile number of the passenger along with the identification number which is peculiar to each person. This identification number is stored in the memory of the RFID tag along with the other details of the passenger for any further investigation and referral to the information about the person and their luggage. The same identification number is sent to the passenger through SMS in order to keep it personal. After completing all the security protocols the baggage is headed to the conveyor belt for further handling.

2) Control System of Baggege Handling (CSBH): After the making of tags and sticking them on baggage, it is passed through a gate including four RFID readers. In the case of the specifications related to the baggage not confirmed in the system, such baggage is returned to the previous stage and its tag is studied and a new tag is stuck to it if necessary. All the baggage is passed through EDS (Electronic Data System) to observe their content and sort them according to their flight number. The baggage is then loaded to the respective flights and for conforming that the baggage is being loaded on the flight, baggage is again passed through RFID readers at the time of loading and the information is stored at the local server.

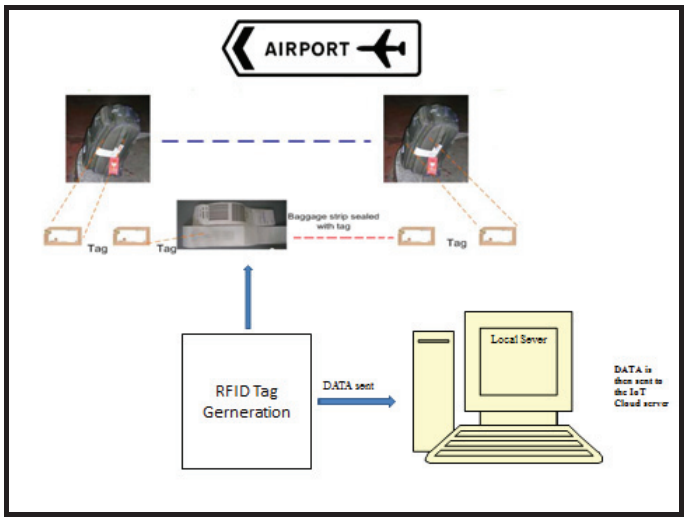

Fig.1. Process at the time of check-in at Airports

B. The process at the Destination Airport.

1) Baggage Sorting: After the passengers arrive at their destination and the baggage is ready for offloading they are passed through the RFID readers, the Identification number of

the MR6011 tags read by the readers are stored in the local Server of Destination Airport, which confirms the offloading of baggage at the destination Airport. The baggage is passed through a gate including four RFID readers on the conveyer belt and simultaneously will inform the passenger that the baggage is arrived at the airport through SMS.

2) Conforming Baggage and handing it over to Passenger using IoT: When the passenger reaches the counter he will have to enter the unique identification number received by him on his mobile on the keyboard installed at the counter gate. Now, the identification number is read by the reader they will try to match the information related to the Identification number on the RFID tag and entered by the passenger , which was already uploaded on the main cloud server by the Arrival Airport. Further the process of sorting will occur. As soon as the entered identification number is read by the reader the push mechanism will sort the bag to the required counter by opening the gate controlled by servo motor and the confirmation message about passenger receving the baggage will send the message to the Server.

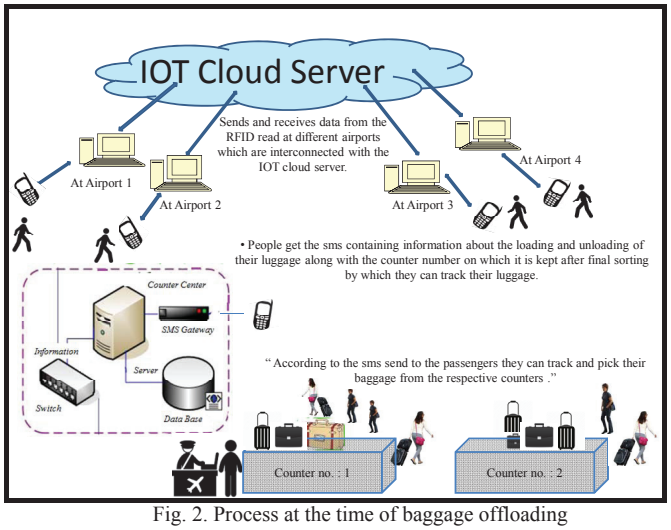

Fig. 2. Process at the time of baggage offloading

III. Implementation and Results

We have implemented the prototype at two locations for the performance analysis of the proposed system, some people with their baggage checked in at one location. Since our main focus is on tag generation at check in and reading ID and checking on the data on cloud during check out we have discussed the following stages in more detail.

A. Design for Check-In

When the passengers arrived at the location 1 their basic information like number of bags, their mobile number, the serial number (s) of RFID attached at each bag, destination, identification code was stored on a local sever. The passengers were provided with a unique identification code under which the details of all their bags was stored and which they needed to claim all their baggage once they reach the destination(or else they can also use the SMS containing Identification number).

The information about passengers was stored on local server and was uploaded to a cloud in which the server's of location 2 is connected with the help of IoT. When the baggage was ready to be loaded on airplane it was passed through RFID readers, the readers read that particular serial number and sent it to the Raspberry Pi via Ethernet; Raspberry Pi sends it to local server which will note that the baggage was loaded. If the serial number was not read by the readers then the baggage was sent back to the starting point and checked for any problems.

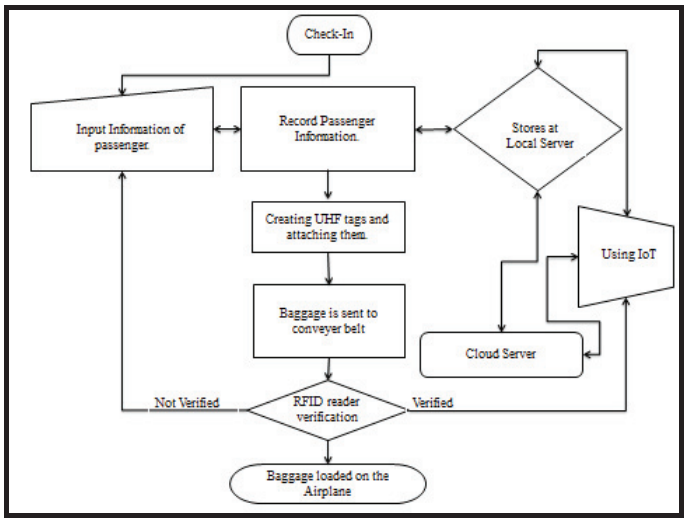

Fig. 3. Design flow for check-in process

B. Design for Check-Out

After the passengers arrived at their destination (location 2) their baggage was loaded on the conveyer belt, which will keep on rotating the baggage until someone calls for it. The passengers will receive a unique identification code when they give their luggage during boarding which will be sent in the form of SMS. The conveyer belt is given four gates (counters) for collecting the baggage. The passengers went at one of the gates and entered the identification code given to them on the keypad installed on the gate.

An independent reader is installed on each gate, as soon as the passenger enters his identification code the identification code will go to server where it will check the number of baggage and their serial number under that particular identification number entered by passenger, the serial number (s) will then be sent to the reader and the reader will sort out the bags of that particular serial numbers accordingly. When the serial number(s) of the baggage is detected by reader the servo motor opens the gate and a push mechanism installed on conveyer belt pushes the baggage out of the gate, this functioning will be achieved with the help of Raspberry Pi. The baggage of a passenger is thus separated from the other baggage on the conveyer belt. In this way the passenger get greater convenience to retrieve his baggage as he will have to enter only one code on the keypad.

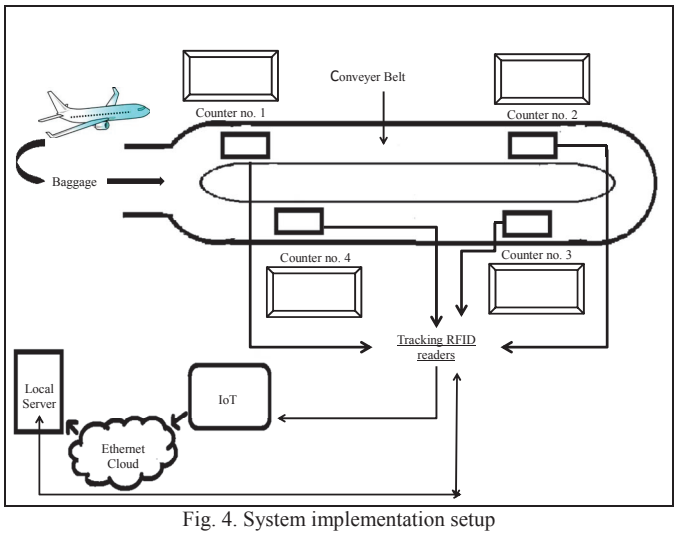

Fig. 4. System implementation setup

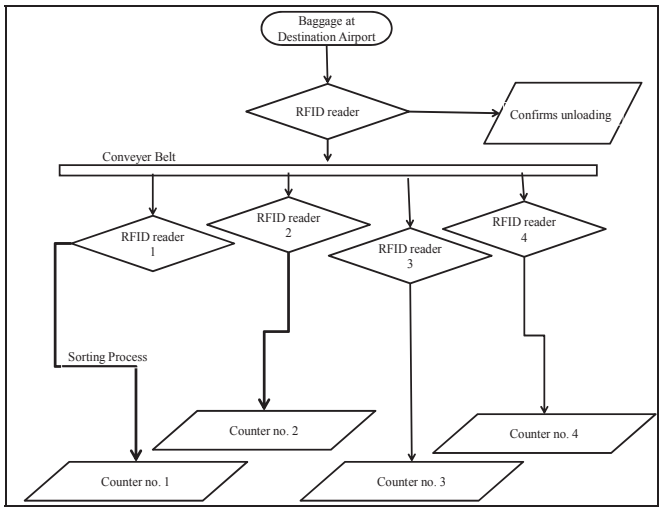

Fig. 5. Design flow for check-out.

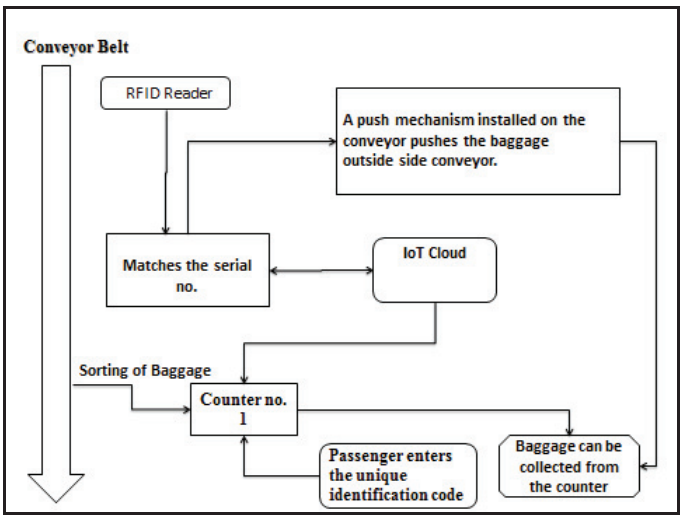

Fig. 6. Use of IoT for sorting baggage

C. *Experimental Review:*

We included 100 people in our Experiment and allowed them to check-in at location 1 with their baggage. We entered their information at the local server and allotted them the unique identification number and then uploaded the Information on the Cloud server created, also attached the UHF RFID passive tags MR6011 to the baggage. Then the baggage was sent to location 2.

When our passengers reached to the location 2 (which was their destination) and their baggage was ready to be offloaded, the baggage were passed through RFID reader which was connected to the cloud server and the destination Server through IoT. When the reader read the tags they searched information related to the tag on the cloud server and stored the information on the destination's local server. Now the baggages were sent to the conveyer belt. The conveyer belt is installed with four RFID readers in front of which there were counter for picking up the baggage.

The passengers entered the Identification number sent to them, on the keyboard which was installed at the counter gate itself. The opening and closing of the Counter gate was controlled by a servo motor. Once the identification number was entered the RFID reader searched the information related to number of bags, the serial number of tag(s) attached to it, on the server and after collecting information it send the tag(s) serial number to the same reader from which it took the input. When the bag(s) tag number matched to the serial number present in the memory of the reader it read it and gave information to the servo motor to open the gate and a push mechanism pushed it out of the conveyer belt and again closed the gate this was done with the help of RaspberryPi 3 model b.

	A	B	C	D	E	F
1	Information at Location 1					
2	Passenger's Information					
3	Name	Contact Number	Identificatio no	Time	Flight Number	Destination
4	Vinita Agrawal	7875375733	ab457ff	13:11	DL2972	Detroit(DTW)
5	Sushank Tidke	8625062166	reh233r	13:14	DL2030	Las Vegas (LAS)
6	Darshan Dhande	7058203535	hfk8jvb	13:17	DL2460	Fort Lauderadle (FLL)
7	Nikita Mankar	705837028	ldsp04g	13:20	DL1237	Denver (DEN)
8	Atul Lambate	8421480697	mngs90	13:23	DL2030	Detroit(DTW)
9	Pranav Lengule	8983279994	4kjg0jg	13:27	DL2972	Las Vegas (LAS)
10	Akshay wangal	7798163281	ddhiy8	13:30	DL1996	Orlando (MCO)
11	Pooja Dhote	9403601128	nbv071	13:33	DL3345	Atlanta (ATL)
12	Nikita Aware	8275772256	qwhy56	13:36	DL3324	San Antonio (SAT)
13	Abhishek Meshram	9403601128	sl0k72	13:39	DL3345	San Antonio (SAT)
14	Ojaswi Nagpure	7385894889	560bdjp	13:42	DL2460	Atlanta (ATL)

Fig. 7. Baggage information system at source airport

	A	B	C	D	E	F
1	Baggage Arrival Confirmation					
2	Serial no of tags	Name	Baggage Arrival Time	Baggage Status	Message Status	Baggage Recieved
3	DU53253625	Vinita Agrawal	18:21	Arrived	sent	Yes
4	DU53253626	Sushank Tidke	18:24	Arrived	sent	Yes
5	DU53253627	Darshan Dhande	18:27	Arrived	sent	Yes
6	DU53253628	Nikita Mankar	18:30	Arrived	sent	Yes
7	DU53253629	Atul Lambate	18:33	Arrived	sent	Yes
8	DU53253630	Pranav Lengule	18:36	Arrived	sent	Yes
9	DU53253631	Akshay wangal	18:39	Arrived	sent	Yes
10	DU53253632	Pooja Dhote	18:42	Arrived	sent	Yes
11	DU53253633	Nikita Aware	18:45	Arrived	sent	Yes
12	DU53253634	Abhishek Meshram	18:48	Arrived	sent	Yes
13	DU53253635	Ojaswi Nagpure	18:51	Arrived	sent	Yes

Fig. 8. baggage information system at destination airport

In our experiment passenger could get better security, none of the baggage was misplaced and every baggage was delivered on time. And because of the counters created passengers got distributed into groups which also decreased the time consumed at check-out.

IV. Discussion and Conclusion

With the aim of providing reliable and efficient services with world class facilities to passengers the introduction of integrated RFID tags along with IoT in the aviation industry will prove to be a boon for baggage handling and tracking. The average read-rate accuracy of the airport's baggage-handling system is increased from an average of 80% for bar-code tags to 97% for the assimilated RFID tags [11]. This gain in efficiency will enable the system to process approximately 5% more bags. As the number of bags being processed by automation, the average time required to process each piece of luggage will decrease, which is necessary in easing baggage loads during rush hours [11]. Today 357 millions of bags are lost and a total 35.7 billion US dollars loss is incurred by the airline industry. On an average the people travelling by air is 3.5 billion today and is expected to increase by 5% per year i.e. it will be 7 billion after 20 years [8,9] so to avoid such huge losses; RFID and IoT technology application will prove to be very efficient. Unlike reading barcodes, the reading of tags is not influenced even when they are dirty, partially folded, concealed or blocked. This characteristic, which is suitable for belt conveyors and container type sorters, effectively changes operation flow and dramatically reduces the manual processing speed and time.

A. Conclusion

In this 21st century, the high security of luggage is of big concern in aviation industry due to repeated loosing, delay and stolen baggage of passengers. The proposed research work focuses on research to develop a working model of a baggage handling system using RFID tag and IoT which will track bags, assist in locating bags, alert staff if baggage not loaded correctly, identify a bag for security personnel to track, and change the flight itinerary on the tag. The main advantage of the system is that it consumes less time as the passengers don't have to wait for their baggage to turn up on the conveyer belt instead they are routed to different counters and ensures high security due to the unique identification number. It is following the current trend as it is environment friendly, as it is paperless, no printing and paper are needed which is a very important issue currently in the aviation industry. With this design we tend to make the air travel more customers friendly, less time consuming, hassle free, with less queuing and greater security of the passenger. The economic benefits and customer satisfaction results achieved by extensive deployment of RFID in baggage handling are furnished.

References

[1] Tanvir Ahmed, *A Data Warehouse Solution for Analyzing RFID-Based Baggage Tracking Data*, IEEE 14th International Conference on Mobile Data Management 2013, Page: 283-292

[2] L. Riley. *IATA Introduces RFID Standard for Baggage Tags Annual Industry Savings* Projected at US$760Million.[Online]. Available: http://www.iata.org

[3] International Air Transport Association, *RFID Business Case for Baggag Tagging*, 2007, [Online] Available: http://www.iata.org

[4] IRS Global*.: Overall Analysis for 2015 Creative Economy for Trying to New Bussiness Stratergy related IoT*, In: Market Report 2014-9(2014)

[5] EPCglobal, *EPC™ Radio-Frequency Identity Protocols Class-1 Generation-2 UHF RFID Protocol for Communications at 860 MHz 960 MHz Version 1.0.9,* [Online] Available : https://www.epcglobalinc.org/standards/uhfc1g2/uhfc1g2_1_0_9-standard-20050126.pdf.

[6] Gerald Santucci: *The Internet of Things: Between the Revolution of the Internet and Metamorphasis of Objects*, Page: 4-23.

[7] Mostafa Tavassoli, Abolfazl Rajabi, Mehrdad Javadi, SasanMohammadi, *Baggage Traffic Control in Airports making use of RFID Technology*, International Journal of Soft Computing and Engineering, Volume-2, Issue-5, November 2012, page: 111-116.

[8] Katalin Emese Bite*, Improving on Passenger and Baggage Processes at Airports with RFID*, Page: 121-138.

[9] Longest Chance, *Longest Chance presents Hand to Hand RFID Baggage Tracking System "HHRBTS" for Airlines and Airports:* [Online] Available: www.longestchance.com.

[10] Farid Abedan Kondori,Shahrouz Yousefi, *Smart Baggage in Aviation*, Proc. of Int Conf on iThings/CPSCom, 2011, Page 620-623

[11] Claire Swedberg , *Hong kong airport says it now uses only RFID baggage tags,*RFID journal: http://www.rfidjournal.com/articles/view?4885/2 .

[12] Cisco*, Introduction to IoT,* [Online] Available: http://www.cisco.com/web/solutions/trends/iot/introduction_to_ IoT_November.pdf

[13] Harvard Business Review Analytic Services, *internet of things: science fiction or businessfact,* [Online] Available: :https://hbr.org/reources/pdfs/comm/verzon/18980_HBR_Version_IoT_ Nov_14.pdf .

[14] Lee Ye-Won, Choi Yong-Lak, *Proposal for Air-Baggage Tracking System Based on IoT*, IEEE 9th International Conference on Future Generation Communication and Networking, 2015, Page: 25-28.

[15] E. C. Ozelkan, Y. Sireli, M. P. Munoz, and S. Mahadevan, *A Decision Model to Analyze Costs and Benefits of RFID for Superior Supply Chain Performance*, Technology Management for the Global Future, 2006, Istanbul, Turkey, July 2006, Page: 610-617.