Implementation of RFID in Retail Outlet

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Abstract:

 The adoption of radio frequency identification (RFID) will create a revolutionary change in the management of a supply chain, particularly in the retail sector. The aim of this paper is to study the benefits/applications of RFID on retailers and in turn, to formulate the cost benefit analysis model which helps in adopting this technology. The findings show that RFID could be implemented in the retailing in the logistics and inventory management etc. Improved operational efficiency and effectiveness, and increased sales and profits, are the major perceived benefits, while implementation cost, compatibility with current systems, top management attitude, and staff acceptance are the key challenges. The results give retailers a better understanding of the potential benefits and challenges of adopting RFID. The retailers will, therefore, be able to make more informed decisions in operational planning and resource allocation. Moreover, the results may inspire more retailers to use this technology. By integrating the views of the potential users, the RFID-based business value-added framework and qualitative models supposed by different researchers agenda for further investigation of the use of RFID in commercial sectors and contributes to the understanding of technology transfer in a less technologically advanced retailing industry.

Keywords: Radio Frequency Identification (RFID), Cost Benefit Analysis, Inventory management, Operational efficiency

Introduction:
RFID is a rapidly evolving Technology for automatic identification data capture of products. RFID is in today's perspective changing the way of companies in supply chain system which track, trace and manage assets easily. This will have major impact upon the whole supply chain. Radio Frequency Identification (RFID) is a term used to explicate technologies that use radio waves for "identifying and tracking objects automatically". This RFID system can store signals below the detectable light with frequencies called "bands" by intonation of electromagnetic waves.

Unlike Internet and wireless technologies, RFIDs started off with humble beginnings and have taken much longer periods for implementing them commercially. Radio-frequency identification (RFID) can provide cost effective solutions to improve organizational efficiency. In the context of supply chain management (SCM), the technology has been considered as 'the next revolution' since it allows the tracking of each object or product in real time in the supply chain (SC).
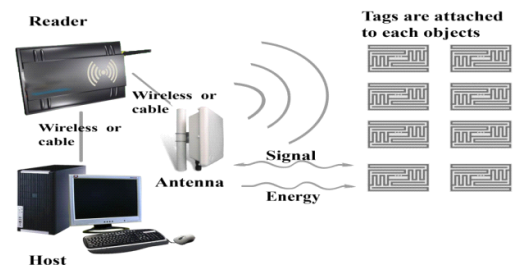

Fig1: RFID Process [3]

Previous research on justifying RFID investment decisions predominantly focused on cost benefit analysis or using discounted cash flow technique but after some criticism wu proposed a better way to deal with RFID uncertainty, risk and reflect the actual value of the investment process real option for RFID project investment evaluation for pharmaceutical supply chain.

- Wu and yue consider for pharmaceutical supply chain and we consider for retail supply chain that what benefits are achieving after implementation of RFID .We consider in this processes such as receiving, inspection and handling of inventory at backroom and also shrinkage cost yearly. Generally many larger retail outlets considering their shrinkage cost by default more than 0.7.In this model point of sale data with consideration of human error with barcoding so these possibilities are discusses here as:

- When range of products for scanning is more than the products are to be scanned by the clerk than there are chances of mistakes i.e. by getting one product of

biscuit he got multiple products so on the data sheet the particular segment or product to be sale out but actually it will not happened.

- Many time scanning due to rushes at the pick time than clerks due to their regular practices doing fast scanning and due to which some products are misplaced or some products scanning is not taken place i.e. not counting properly in the bill so that is come in loss.

- There are mismatching of the products are held at point of sale which also considered as loss. The initial value of the underlying assets is the present value of investment projects. In order to determine initial value of the underlying asset. on the basis of wu and yue paper on pharmaceutical supply chain we offer a cost benefit analysis on retail sector analyzes RFID cost and benefit quantitatively, and offer corresponding formulas .finally propose the present value of the project i.e. RFID installation is feasible or not.

II. Literature Review

RFID application in retail industry is increasing now a days .most of the RFID application mainly concentrated in supply chain. But the current scenario shows that the retail sector in order to strengthen retail supply chain efficiency and safety has urged retail supply chain to apply RFID. On the basis of wu's model we apply same quantitative model based on RFID by considering many factors which are related to the retail industry. RFID technology including the design of tags and frequency/distance ranges in which the readers operate have been described in many articles [2]. Applications of rfid tags for many industries including retailing, healthcare, and IBM and a. T. Kearney's report prepared for grocery manufacturers of America (gma) presents research on rfid implementations in the consumer products industry [3]. A report prepared by a. T. Kearney and k. Salmon, associates for gma, discusses how implementation of epcs can benefit each partner in the supply chain. However, as implementations and ex- tended processes are examined, gma has also found that the benefits of rfid may be more substantial in some product categories and supply chain partners than others [2].Mit center have demonstrated rfid applications that result in substantial gain in efficiency and effectiveness of logistic processes[10], but have also identified situations. Where the technology needs to advance to provide more than marginal benefits. Clarke and kipp discuss the technical details of how tag readers obtain data from the RFID tags [2].RFID transactions based on service levels restaurants industries have been discussed [4].however ,no research has been reported on the cost benefit models for RFID implementations. In section III, we discuss RFID transactions generated at different locations which are accomplished in retail outlet and the starting point is from receives goods based on the order, while the end point is customer purchase that product at point of sale so the business processes of before and after RFID application can be shown in As shown in fig.1 we can compare the differences before and after RFID application scenario, which is shown in table1.Many time decision makers can not decided the company policies on time in the competitive environment because daily updated selling data send to the corporate office from which companies most profitable decisions takes place that is beneficial from companies point of view.

"AS- IS"
1. Receive goods
1.1 Truck entered through the designated entry
1.2 The forklift is ready to pick
1.3 Discharge goods from trucks
1.4 forklifts fully loaded to outlet
1.5scan barcode on pallet
1.6forklifts fully loaded to area to be transported
1.7discharges the pallets
2. Put away
2.1 note the cargo in the area to be transported
2.2 forklift to the area to be transported
2.3 read the storage list and select the pallet
2.4 scan barcode on the pallet, and specified to the shelf
2.5 complete outlet on specified shelf

2.6scan barcode on the shelf
2.7 confirm
2.8generate the outlet report on ERP
3. Inventory checking
3.1check the inventory manually

"TO –BE"
1. Receive goods
1.1Accept ASN in ERP
1.2Trucks enters through the designated entry and scan
1.3Ready to pick
1.4Read tag information with portal RFID reader
1.5check the efficiency and accuracy of the reader
1.6Dicharge
2. Put away

2.1Generate storage list byERP
2.2Discharge goods
2.3confirm accepts goods in ERP
2.4complete outlet on specified shelf
2.5check information by scanning tag on shelf
2.6Generate outlet report in ERP
3. Inventory checking
3.1check the inventory with portal RFID reader and do with ERP

Table 1. Process of Receiving, put-away and inventory checking at "retailer-Distribution Center"

Sector	Process	"As is"	"To be"
Retailer	Receive goods	Unload cargo from the truck	Automatically check ASN information
	Put away/backroom stocking	Firstly place goods to the area to be transported Forklift transport the goods Confirm whether the goods on the right shelf manually	Automatically scan the shelf to check the goods whether on the correct shelf
	Inventory checking storage in	Manually similar with supplier	RFID automatically scans the tag similar with supplier

Table 2: Differences of processes between As-is and To-be

III. COST BENEFIT ANALYSIS OF RFID
A. Modeling
For RFID in retail sector ensures its high efficiency and security through talking the advantages of high data accuracy, fast transmission, an anticounterfieting and so on. We take the RFID application in retail sector, only considering the process to the retail outlet from the supplier.
Suppose a retail sector is composed of a supplier, a distributor centre and a retailer and the goods information is accurate and then all logistics receives the goods, no reverse logistics. The paper is based on business processes, the starting point is the supplier business processes picks and sends goods based on order, while the end point is the retailer receives the goods on the shelves. So business processes of before and after RFID application can be shown in table1.

As shown in table1, we can compare the difference before and after RFID application scenario, which has shown in table2:

B. Qualitative Analysis on cost and benefit
Firstly, we analyze RFID cost i.e. the constituents of RFID are given as:
- Hardware: RFID hardware cost mainly includes: RFDI infrastructure (tags, readers,

antennas) and other RFID device infrastructure for supporting.

- Software: RFDI software cost mainly includes: middleware software upgrade and integration with other software such as ERP, WMS and so on.
- Service: RFID service cost mainly includes: RFID infrastructure and the corresponding software installation, staff training, system maintenance and business process reengineering costs after RFID application.

Secondly, we analyze RFID benefit:

- Process: RFID can solve warehouse handling processing and tracking problems, ensure that the information is accurate and reliable and reduce the misplacement, theft damage and losses caused by shipping errors. RFID reader can read the information automatically to check the mistake. While portable data terminals and radio communications are able to grasp the real time tracking in transit goods with GPS.
- Resources: RFID can tag every player in the supply chain to carry out unified management. While the production efficiency can be collected in the terms of materials. Equipment and other assets of the final product are marked by RFID to strengthen materials monitoring and reduce the loss and damage, while combining with the EPC, the information can be shared by supply chain members to improve efficiency.

An overall RFID benefit in retail supply chain includes the following aspects:

- The cost reduction: labour reduction, inventory costs, operating time reduction, process automation, efficiency improvement and so on.
- New values RFID create: increase revenue, improve customer satisfaction, prevent out of stock, reduce loss, and prevent counterfeiting and so on.
- Decision analysis, perfect forecasting, accurate information delivers to floor clerk, real time visibility, information and so on.

IV. MODEL OF COST BENEFIT ANALYSIS:

Development of model for cost benefit analysis of a Retail Outlet:

A. Quantitative Analysis on Cost

1. Tag cost (T_{ct}): At the retailer distribution centre tag the pallet received from supplier, the quantity of pallet tagged Q_p per year, and the cost of tag C_t. [1] so:

$$T_{ct} = C_t * Q_p \quad \text{-----(1) [5]}$$

Where,

C_t= Quantity of pallet tagged per year
Q_p= cost of tag in Rs.

2. Reader cost (T_{cr}): For outlets ,2 fixed readers are needed to control the goods in and out the outlet and portal reader is needed to scanning, picking, inventory checking. Suppose the cost of portal reader as C_{pr}, the quantity as Q_{pr} ; the cost of fixed reader as C_{sr}, the quantity as Q_{sr}. So. [2]

$$T_{cr} = C_{pr} * Q_{pr} + C_{sr} * Q_{sr} \quad \text{---(2) [5]}$$

Where,

C_{pr}= cost of portal reader
Q_{pr}=quantity of portal readers
C_{sr}=cost of fixed readers
Q_s=quantity of portal readers

3. Antenna cost: There are 2 antennas in every reader. Suppose the cost of the antenna as CA, and the quantity in every reader as C. So: [2]

$$T_{ca} = C_a * C * (Q_{pr} + Q_{sr}) \quad \text{-------(3) [5]}$$

Where,

C_a= cost of anteena
Q_{pr}=quantity of portal readers
Q_{sr}=quantity of fixed reader
C= antennas quantity in every reader

4. If infrastructure cost (T_c) ----(4) [5]
5. Other cost: There are costs including software C_s),training cost (C_t),RFID installation cost(C_i), system maintenance cost(C_{st}) for yearly. [2] -- (5)[5] ------(5)

$$TC = T_{ct} + T_{cr} + T_{ca} + T_{ci} + C_s + C_t + C_i + C_{st} \quad \text{------(6)}$$

There are inventory checking is very important task Which are checked by outlets in a particular time period but this process is too much time Consuming which can takes place 2-3 months so due to knowing all the expected terms so the outlets saving cost of inventory checking incorporated RFID reduces time for inventory checking.

- Picking
$$DSC_P = T_S * RQ_D * RQ_{DP} * AS_L / (T * T_L) \quad \text{----(c) [5]} \quad \text{--(3)}$$
- Storage out
$$DSC_O = T_S * DQ_T * DQTP * AS_L / (T * T_L) \quad \text{---(d) [5]}$$
- Asset management ----(6) [5]

Modification : Enterprise asset management is the business processes and enabling information systems that support management of an organization's assets, both physical (such as buildings, equipment, Infrastructure etc.)Asset management including in this a cost of stationary paper work etc., cost of inventory and other things, and cost of labour.
So the benefit in asset management is including.
So the total benefit of DC is shown as follow:
$$B_D = (DSC_I + DSC_{IC} + DSC_P + DSC_O) * YD + BA_D$$
Since the benefits of a retail outlet are as follows which are different from pharmaceutical supply Chain as:

We examine the formula for receiving quantity from the truck with due respect of time. So receiving quantity is given as,

Modification I: The Quantitative formula is incorporated which sets necessary position viewing from the side of retail outlets.

A. Receiving Quantity in respect of time: [4]
Receiving time= $T_A+T_U+T_C$
Where,
T_A=time to accept the truck
T_U=time to unload the truck
T_C=time to control
T_C =time to identify the pallet+ time to check the information matched on standard operating procedure+time in counting+ time to control case* no. of cases check*no. of cases per pallet load+time for terms of trade.
T_R=Receiving time*l_c/ (T*T_S)-----(1)
Where,
l_c=labour cost per hour
T=total time duration in hrs
T_S=seconds in per hour
There are receiving section has very important which required particular whole day so retailers gets benefits by RFID ,they can save their time as well as Customers point of view.

Modification III :There are need of less time taking Place in backroom so the given formula incorporated the given formula as:

B. Backroom stocking (B_S):
$B_S=I_H* T_{SRFID}* l_c$/ (T*T_S)   --------(3)
Where,
I_H=total inventory handling per day
T_{SRFID}= saving time due to RFID
l_c= labour cost per hour
There are much time taken place in backroom in inventory handling so due to RFID exact location and time saving taken place which shown above.

Modification IV:There are cost saving made at point of sale point which shown in the given formula as:

C. Point of sale data: [4]
The total POS load rate at the central location is the sum of POS reading load and reordering load. So the total POS load rate at the central location.
POS$_{ti}$=(Fij^{POS}*Tj^{POS}+Rj*tj)*h   ------(4)
where,
Fij=frequency of tag reads of item j in location i
Tj=processing time required for reading of item j at point of sale
Rj=reorder placement rate at the central location for item j
Tj=processing time for reordering from central location for item j
Rj=demand rate of item j/order quantity

h=human error in respect of bar coding [8]

There are much time consuming at point of sale in peak hours so there are chances of errors made by the clerk so how tackle this problem is incorporated in above formula by enabling RFID.

Modification V: There are considering all extra Costs which coming in the category of shrinkage Cost which are shown as :

D. Shrinkage cost (S_C): [6]

$S_C =A_{ty}+A_{ied}+A_{stopl}+A_{damage}+A_{discontinuous\ item}$

$S_C =A_{ty}+A_{ied}+A_{unsalable}$ -----(5)
where,
A_{ty}=amount of theft per year
A_{ied}=amount of items per year reaching the expiry date

$A_{unsalable}$=amount of unsalable products
There are considering whole shrinkage cost in which including theft cost ,shoplifting cost ,unsalable products costs etc so with the help of RFID the shrinkage cost will be reduced.

Cost Benefit Analysis of Retail Outlet is given by:
So from equation (1) to equation (6), final equation of total benefit comes as:
T= (A+B+C)*365+D+E+F ,i.e.
T=(T_R+ I_C+ B_S)*365 + S_C+ POS$_{ti}$+ A_M---(7)

VI. Illustration :
We have tried to implement the above quantitative model in retail outlet X from which necessary information/data are collected and takes benefits from the particular retail outlet. Now we take an analysis of retail outlet X i.e. for the tag cost from equation (1), the quantity of pallet tags is to be 500000 per year and the cost of tag is $0.05 i.e. given as: [Assuming 1$=Rs 50/-]
T_{ct} =C_t*Q_p
    =500000*2.5= Rs.1250000/-
and the retail outlet 2 fixed readers are needed to control the goods in and out the outlet and 50 readers are fixed inside the retail outlet needed to scanning,picking,inventory checking .one reader cost is to be $15000 so by putting values in equation (2) we get, 15000*50+15000*2= $780000 and from equation (3) we have , two antennas are attached in particular reader whose cost is to be estimated $2500 so values from equation (3) is given as:
2500*2*(50+2)= $ 260000
On the basis of wu's research paper infrastructure cost is takes place as T_c $ 120000 and other costs including software cost (Cs),training cost (C_t),RFID installation cost(C_i),system maintenance cost(C_{st})

about 300000 dollar totally.

So, the investment cost of RFID project in the first year (TC)is about after putting the values in equation (6) we have,

$TC=T_{ct}+T_{cr}+T_{ca}+T_{ci}+C_s+C_t+C_i+C_{st}$

25000+780000+260000+120000+300000

= \$1485000 /- (Rs.7,42,50,000/-)

So the cost of RFID installation and other including comes as Rs.74250000/-.

take an analysis of retail outlet X i.e. where time to accept the truck loading is up to 1800 sec. and time in unloading is up to 5400 sec. and time for Controlling the whole processed to be 800800 sec. So receiving time is given as:

T_R=808000*18.2/ (3600*9) =Rs 453.87/-

In inventory checking there are 30000 items are in whole sales stock checking made only one time in a month labour charges are to 18.2 per hour and time saving due to RFID is up to 200 sec. then we have,

I_C=30000*200*1*18.2/ (9*3600*30) =Rs 112.34/-

In backroom stocking daily inventory handling is to be700 then saving cost in backroom stocking is given as: B_S=700*200*18.2/ (9*3600) =Rs 78.64/-

If there are 1200 products scanned in 3600 sec. means in one hour duration, reordering time is to be 500 sec. and At point of sale assuming saving as in percentage of human error is up to 0.0000001 than saving cost at point of sale is given as:

POS_{ti}=1296500*0.0000001*10*18.2*9

212.36*30=6371.00*12=Rs. 76452.012/-

There are shrinkage can be taken as 3% of total sales per year there are Rs 206341339.2/- total sales than saving value of shrinkage is given as:

S_C=Rs.6190240.2/-

and the benefit of asset management value is considered as Rs.18,53,00,000/-a cost of stationary paper work etc .is to be Rs 500000/-and cost of inventory and other things is to be Rs.180000000 /-and cost of labour is to be Rs.4800000/- yearly so cost including asset management is given as:

A_M =Rs 18, 53, 00,000. /-

Cost benefit analysis at retail outlet is given as:

18,53,00,000+6190240.176+ 76452.012+235370.25

=Rs.19,18,02,062.4/-

Than benefit at outlet in the first year is Rs. 19,18,02,062.4/-.Assuming outlet operates in good condition, expected benefit of the second year is grown by 65%.so the benefit of the second year is 19,18,02,062.4 *165% =316473403/-

Assuming the enterprise invest RFID and discount rate K=12% after risk adjusted .assuming the cash flow in the next two year is given by:

PV=19, 18, 02,062.4 / (1+12%) +316473403/ $(1+12\%)^2$=Rs.423622976.2 /-

If taken NPV as the investment evaluation method, NPV=423622976.2-74250000

= Rs.34, 93, 72,976.2>0,

therefore, investment is to be feasible.

So the value of RFID project is so important.

VII. Conclusion:

RFID gives the very good sign in retail industry, due to which many benefits can be achieved by the Retailers.

The contribution of the paper is shown as follows :

(1)The paper constructs the scenario and compares the differences before and after RFID application,

(2) Based on the scenario the paper carries out cost benefit analysis qualitatively and quantitatively.

VIII. References:

1. R. Clarke, R. , and T. Kipp, "Matching radio frequency tags to readers,"Smart Packaging J., no. 12,
2. T. Kearney, IBM, Washington, DC, "Grocery manufacturers of America (GMA)" 2005. [Online]. Available:http://www.gmabrands.com/publications/docs/2005/Balance Perspective .pdf.
3. www.iot-online.com/RFID/xinwen/2011/083011134. html,
4. Thorsten Staake, Frédéric Thiesse "Extending the EPC Network – The Potential of RFID in Anti-Counterfeiting", Report No. 27 20.10.2004.
5. Dianmin Yue, Xiaodan Wu,Mengyuan Hao, Junbo Bai "A Cost-Benefit Analysis for Applying RFID to Pharmaceutical Supply Chain".
6. Giovanni Miragliotta,Alessandro Perego,Angela Tumino Politecnico di Milano" An Activity-Based model to assess the costs and the benefits stemming from an RFID application in the Fast Moving Consumer Goods supply chain". Jayavel Sounderpandian, Rajendra V. Boppana, Senior Member, IEEE, Suresh Chalasani, , SeniorMember, IEEE, and Asad M. Madni, Fellow,"Models for Cost-Benefit Analysis of RFIDImplementations in Retail Stores".
7. Rodney Schmidt CAP Companion Meeting at USCAP 2010 Quality and Patient Safety in Anatomic Pathology: Practical Solution Barcoding for Specimen Identity .
8. Indan Retail Industry:challenges, opportunities, and outlook-insight at retail.net/issues.asp.htm
9. Christian Tellkamp "A Dissertion The impact of Auto-ID.technology on process performance – RFID in the FMCG supply chain".

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