PROBLEMS IN EXISTING RFID SYSTEMS: USER-CENTERED DESIGN METHODS

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Abstract-*RFID (Radio Frequency Identification) is an emerging identification technology having greater capability than bar codes. But, the use of these systems is being discouraged by certain practical problems associated with them. Such as, high costs, tag reader sensitivity, limited transmission distances etc. End users participation and designers expertise when combined, form the key ingredients of igniting improvements and innovation in any system. This paper proposes some user-centered approaches for the improvement in the existing RFID systems.*

Keywords-*Participatory, Design, RFID, Conceptual Mapping.*

I INTRODUCTION

The magic of RFID is everywhere. The pace with which this technology is expanding its wings, as of now, it may sound futuristic but within next 10 years, we might witness fully automated homes, offices and markets and so on. Radio Frequency Identification (RFID) is an automated identification technology with greater identification capabilities than bar codes. This technology offers promising advantages like: (1) Read through obstacles (2) Read in hostile environment (3) Read in real-time by the RFID Reader [1]. Due to this attractive package, this technology is making its way into the bodies of consumers [4], and even introducing itself to the newly born ones by tagging mothers and their new borne babies to prevent mismatching later [3]. In the past, there have been several obstacles that have kept RFID from gaining full acceptance in consumer applications as well as in enterprises. Some of these obstacles included tag reader sensitivity, RF transmission distance, and the high cost of implementing RFID. It was observed that the end users feedback played an extremely important role in finding these obstacles and to some extent removing them [5]. Conceptual mapping is a structured conceptualization technique used to stimulate the generation of ideas. More often concept maps are used to communicate complex ideas. For example, it combines group processes with a sequence of multivariate statistical analysis in multidisciplinary research teams (Maize, Soya beans and Swine) investigating market opportunities within the Global food system [2].

II USER PARTICIPATION IN RFID SYSTEMS

User participation becomes obvious in a world where day to day objects like garments, food and home appliances and so on carry RFID tags. By exploiting RFID tags, home appliances could operate in more sophisticated ways [6]. Some of these ways are very much suggested by users of these products like your refrigerator might warn you when a particular item in it has been expired and so on. Thus user needs may lead to creative innovations and of course may lead to improvements in the existing system. Hence user centered design demands for user engagement in the various design processes, ranging across the wide spectrum of requirement analysis to the working model with desired functionalities.

RFID are mostly used at Wall Mart Stores and Department of Defense. They demand from the supplier that goods should be attached with RFID tags so that they can uniquely identify and trace the goods when required. If some problem occurs with the quality then they can easily trace out the batch number, supplier and even the precise assembly line which held that flaw. The problems of tag reader sensitivity, RF transmission distances, high cost etc. discourages both customers and suppliers to adopt the RFID technology to a larger extent in spite of lucrative offers provided by the technology. The main focus of the paper is on describing these problems from the user's perspective and proposing their corresponding solutions. Since a picture is worth thousand words, concept maps have been used to communicate the idea.

II PROBLEMS AND SOLUTIONS

(a) Problem 1: Tag Reader Sensitivity

The RFID tag has no fixed location for pasting it on goods package. Hence a problem in determining where the tag is located relative to the RFID reader device. So if the RFID tag is not present in the main lobe of the Tag reader, then it can not be sensed by the reader or vice-versa. This problem is known as reader sensitivity. This is due to the fact that the antenna of tag reader or RFID tag itself comes in the dead zone. Also, since the RFID signal is not in the visible range of the user, the problem becomes more critical. The temporary solution suggested by the user is to rotate the goods, so that both the antennas should come out of the dead zone. But this leads to the inconvenience faced by the user in rotating the goods and especially the heavy ones. For example, when a user purchases a heavy item like a 20 kg floor packet and the RFID tag reader antenna comes in the dead zone of the RFID tag antenna, then it is not readable by the RFID Reader. Then it becomes difficult for the user to rotate the packet, so that it gets scanned by the RFID reader. Similarly the situations may become worse when we talk of more heavy and unmanageable items.

Solution: These reader sensitivity issues can be resolved by using a dual dipole antenna in the RFID Tag. These antenna are placed such that one signal transmitted by one antenna will overcome the dead zone for the other antenna. It will enhance the use of RFID for a broader range of applications making life of the user a little more convenient. The idea is being illustrated with the help of the concept map.
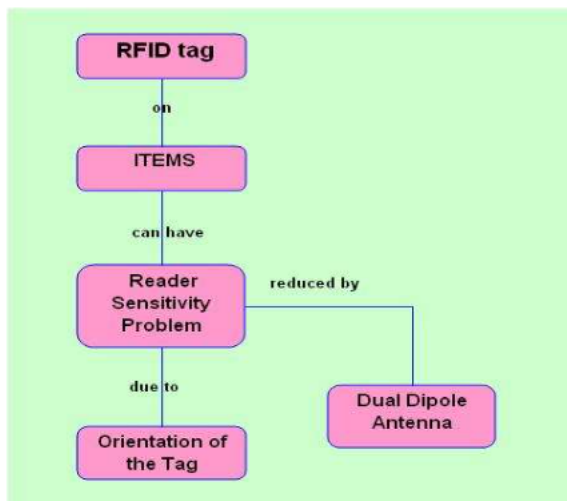

Figure 1: RFID Tag Reader Sensitivity Resolving Model

(b) Problem 2: RF Transmission Distance

There are two types of RFID tags Active and Passive. The problem associated with the users of both kinds of tags is with their transmission range. Their transmission ranges are very small. Mostly EPC class 4 type tags are used which have a very small transmission range capability [8]. The problems associated with it are many. For example, consider a big mall or showroom where each of the items is RFID Tagged and the customer wants to trace the goods with the help of sales person and sales person does not know the exact location of that product. Then he comes near to the tag reader, sends query signals to all RFID tags, receives acknowledgement and tries to find the location. But due to limited range capability of the RFID tag, he fails to locate it. One solution of the above problem is that he should have mobile tag reader, so that he walks and try to find the location of the product.

This problem of tracking goods which are kept at long distances is enhanced when a user of RFID wants to track a valuable entity like car, etc. For example, suppose user handed over the car to the parking staff to park the car in a highly crowded parking lot spreaded in big area. By the time user wants to get back to the car, then parking staff takes a lot of time to search it. Now, if the car were holding an RFID tag of higher range transmission capability, then it can be easily located with RFID Reader. When a user is interested in tracking mobile items, with existing RFID tag then the problem becomes even worse due to its limited range capability. A recent study says that 30% cars, laptops and mobiles are stolen every year. In most of the cases they are not traced at all and even if traced then also it becomes difficult for the police to find the actual owner of that item.

Solution: Noticing the above problem it is concluded that there is requirement of the RFID tag with the various range capabilities. The one solution is that we should have RFID tag with having a varying range capability. The designing of such RFID tags is highly complex and uneconomical. Another approach is that we can have separate RFID tags for the various range capability, so according to the need user can select it. For short range communication between RFID tag and RFID reader, RFID tags with HF waves are used. For medium range communication, RFID tags with UHF wave are required. Similarly for long distance (in few kilometers) communication, microwave can be used and more than that SAW can be used. The advantage of using SAW is that its signal does not deteriorate with the

environmental changes. This quality of the RFID tags with SAW can be utilized in the seizing the gray market, because missed or stolen things can be easily located by the owner or police even over long distances.

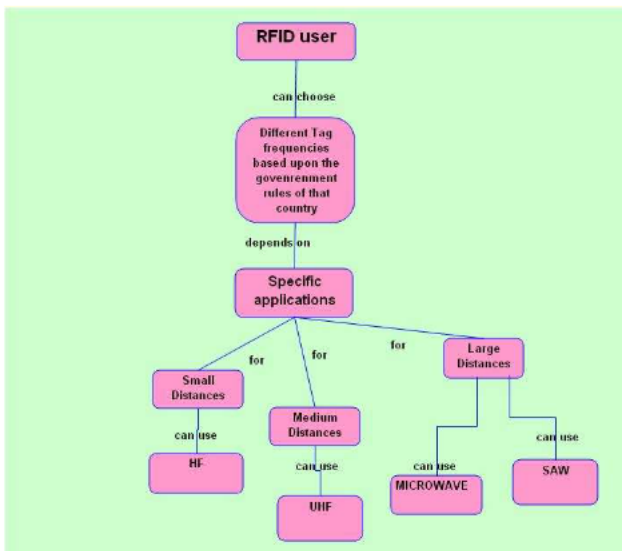The proposed idea is illustrated with the help of concept map.

Figure 2: RFID Long Transmission Distance Model

(c) Problem 3: High RFID Cost

A recent study shows that the biggest users of RFID technology Wal-mart Stores and department of defense feel that the RFID cost is still a primary reason that RFID hasn't become common place [7]. A solution to this is to increase the manufacturing of the number of tags so that the cost should come down. But it further leads to upgrading the existing infrastructure to support RFID such as storage devices, new methods for searching database etc. To be precise, an RFID infrastructure needs a number of elements apart from the RFID Tag and Reader which includes additional servers, databases, middleware and applications. Further, the middleware and application layers need to support number of critical components such as device management, data collection data management and integration with the back–end system, collaboration with partners and customers and integration with data synchronization networks. And a result of doing all this will further increase cost and Risk.

Solution: The proposed solution is inspired by those products which are a part of daily needs of consumers,

precisely, with small life span and disposable packets (with pasted RFID Tags) such as milk carton. After selling such products there is no need to store information for a long time in the RFID database, since it leads to unnecessary overloading of the information in the database, causing a penalty in terms of searching time for other items. Therefore, one of the possible solutions to reduce the cost factor in RFID systems is Tag recycling which includes reprogramming of the RFID chip and updating the database entries. This should be implemented with proper instructions being issued to the customers and if special bonus schemes are incorporated, this idea can work wonders. The empty goods packet containing RFID Tags should be collected by the customers and sold to RFID street vendors (to be introduced in the system) which further are sent for reuse. The advantage of this idea is that there will be no need to increase in the production rate of the tags and existing RFID infrastructure. Hence, this can bring cost of RFID tags considerably down without inducing risky complexities in the RFID systems.
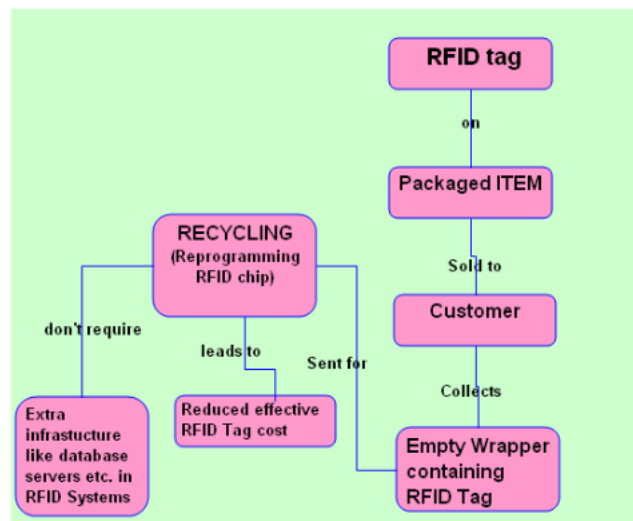

Figure 3: RFID Cost Reduction Model

III   CONCLUSION

Recent research shows that user-centered design approach leads to great innovations in the existing systems. In the case of RFID systems also it has been observed that problem faced by the user works as catalyst in incorporating improvements. The advantage of using concept maps made the design procedure simple to illustrate and cost effective.

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