Web-based Smart Anti-counterfeit Branding System – a Practical Approach

B. Chowdhury, N. Sultana and T. Ahmed

Abstract **-** Brands mature over time and are developed carefully to capture an important position in the minds of consumers. But, many successful brands become victims of the worldwide phenomenon of counterfeiting, where cheap impersonations of the brands are distributed by the counterfeiters. Nowadays, the brand counterfeiting context is increasingly dominated by the unconstrained presence of fake brands. Gray markets are created by illicit trade in counterfeit goods - already grasp both developed and developing countries successfully through counterfeited, pirated and copycat products that lead to a serious economic, social, and political problem. These problems often threaten the lives of unsuspecting consumers, wreak economic havoc, and weaken consumer confidence in branded products. The counterfeiters have been linked to terrorism, the international drug trade, sweatshop conditions and child labour in both domestic and international settings. As the extent of counterfeiting is increasing in almost every industry, it becomes critical to develop measures that can help to prevent buying and selling of counterfeit products. In this paper, we propose a theoretical framework that attempts to capture an emerging technology such as RFID (Radio Frequency Identification) based solutions. RFID can be employed to reduce counterfeit branding and also to facilitate the automatic streamlining of their detection and monitoring processes in an individual industry. It can assist retailers and vendors with fast and accurate detection of their brands. We also outline the design and development of a real-time Web-based RFID-enabled Anti-counterfeit Branding (RACB) application to curb counterfeiting.

Keywords **-** Counterfeit Branding, Complex Adaptive Systems, RFID, and RACB.

I. INTRODUCTION

Brands have always been commercial agents and brand managers take pride in their ability to meet the needs of their target market. Due to counterfeiting these two desires are in problem and always trying to cope with the direction. Over the past two decades, innumerable articles and books have emerged addressing this topic. Counterfeiting is a significant and growing problem worldwide, occurring both in less and well developed countries. Counterfeiting refers to the unauthorized production of goods protected by trademarks, copyrights, or patents. Considering the countries worldwide, almost five percent of all products are counterfeited [1], [2]. It is likely that counterfeiting will increase globally because of the high margins achieved through counterfeiting by manufacturers and the demand for trade name goods at value prices by consumers [3]. The problem of counterfeiting is further magnified because of the opening of huge new economies in Eastern Europe and Asia [4].

In the past, counterfeit goods were easy to identify because these products typically represented luxury goods made with shoddy materials and sold in limited venues such as open-air markets in large, cosmopolitan cities as New York and Los Angeles. Today, however, counterfeiting impacts virtually every product category: from fake foods, beverages and everyday household products to pharmaceuticals, auto parts and consumer electronics [5]. This high level of unauthorised production can be attributed to a number of factors: i) advances in technology; ii) increased international trade, emerging markets; and iii) increased share of products that are attractive to copy, such as branded clothing and software. Due to the technological advancements in materials and processing techniques, many counterfeit goods have found their way to legitimate bricks-and-mortar retail stores, such as Walmart, and Target, in both developed and developing countries. Many successful brands also become victims of the worldwide phenomenon of counterfeiting, where cheap impersonations of the brands are distributed by the counterfeiters. Nowadays, the brand counterfeiting context is increasingly dominated by the unconstrained presence of fake brands [6]. Therefore, this topic has generated a substantial body of scholarly discussion, research and thought [7].

The majority of the research on counterfeiting has focused attention on the demand side of counterfeiting [8], [9], [10] that is consumer accomplices who engage in aberrant consumer behaviour [11], [12] and deliberately purchase counterfeit goods with scant research addressing the supply side [13]. It can be argued that counterfeiters are good marketers because they have found a need and are finding a way to fulfill it [14]. Despite efforts by some in law enforcement authorities to stem the tide of counterfeiting goods by implementing new anti-piracy laws and ratcheting up enforcement, some members of the global community have either turned a blind eye to the problem or are actually enabling counterfeiters to manufacture and peddle their wares.To develop techniques that effectively combat the problem of counterfeiting, it is necessary to determine and identify the existence of the segment(s) of consumer accomplices who purchase counterfeit goods.

B. Chowdhury is with the IT and Engineering department, Melbourne Institute of Technology (MIT), Melbourne 3000, Australia (phone: +61 3 8600 6700; fax: +61 3 8600 6761 ; e-mail: bchowdhury@mit.edu.au).

N. Sultana is with Frankston Hospital, Vic 3199 Australia (e-mail: nasreendrsultana@gmail.com).

T. Ahmed is with the Marketing Department, La Trobe University, Vic 3183 Australia (e-mail: A.Tanvir@latrobe.edu.au).

However, the economic and social consequences of counterfeiting are enormous. It is estimated that brand holders lose approximately $600 billion of revenue annually due to counterfeiting worldwide [15]. In the USA economy, the cost of counterfeiting is estimated to be up to $200 billion per year [16]. A large majority of these products include clothing, luxury goods, entertainment equipment, medicines and pharmaceutical products, handbags, automotive parts and high tech products. Manufacturers of affected products have a direct loss in sale revenues; this is often directly related to losses in tax revenues, and may also result in job losses. Furthermore, counterfeit goods are everywhere on the Internet and if a brand has revenue generating capability or brand credibility, it will surely be counterfeited and sold online. Online auction sites and business-to-business websites also provide the ideal online medium for counterfeit sales that worth billions of dollars. Michael Danel, the secretary general of the World Customs Organization identified that if terrorism did not exist, counterfeiting would be the most important criminal act of the early 21st century.

The effect of counterfeiting is always greater than the value of the counterfeit product itself. By damaging consumers' perception of the performance, reliability, and safety of branded devices, counterfeiting tarnishes brand image, customer loyalty, and satisfaction. According to OECD 2008 report, 10% of the annual Brazilian pharmaceutical production is either stolen or falsified [17]. Electronic Arts, one of the world's largest entertainment software companies, estimated its business losses at about $300 million. They believe that 95% of the sales in Thailand (with Electronic Arts's name on the box) are pirated. The International Federation of the Photographic Industry recently seized 45,000 CDs from a Moscow wholesaler. They were all pirated. The Software Information Industry Association calculated the 1998 United States loss of software alone to be $2.7 billion. They further submit this was approximately 27% of world losses. They estimate losses in this industry may exceed $16 billion annually over the next few years. The auto manufacturers and suppliers estimated loss was $12 billion in annual revenue in 1998 because of parts counterfeiting. Fortune 500 companies spend, on average, $2 to $4 million per year to fight counterfeiting. For some companies, this expenditure will top $10 million annually. Of all the counterfeit goods seized by U.S. Customs, 38% are from China. That amount is three times as much as is seized from number-two Taiwan and ten times as much as from all of Western Europe.

Counterfeiting also has the following broader negative effects:

1) A certain market destabilization can be seen in areas heavily affected by counterfeiting.
2) Reducing the value of intellectual capital, eroding profitability, and stifling innovation.
3) Manufacturers, both local and global, lose their trust in the market place.
4) An unsound environment that affect the cultural, economic vitality and development of a country.
5) Counterfeiting hurts not only the businesses making the components but also the financial health and ability to invest in future innovation of all businesses across multiple industries
6) The illegal and often criminal environment in which the counterfeiting activities take place where the high profit and the relatively low risk situations are in many cases lead to organized crime.
7) Profits made from illicit activities can be employed to fund other criminal activities.
8) Finally, counterfeits of electronic components and system-level products as well as mechanical products and prescription medications can also affect personal safety and security. The highly dangerous effects on consumers of fake medicines, cosmetics, surgical equipment, food, cigarettes, and alcoholic drinks receive increasingly attention among policy makers in the past years.

Actions to limit counterfeits can arise from both supply and demand side, considering the tactics companies employ to deter counterfeits [16] and the motivations that make a counterfeit an interesting option for some customers [18], [19]. Also, there is no single solution to this problem; anti-counterfeiting strategies should be multifaceted. One of the anti-counterfeiting strategies is possible by the use of mobile/wireless technology to prevent counterfeit branding. The application of these principles can be facilitated by the use of the wireless technology such as RFID [20]. Today's advanced technology is capable of uniting brand tags (RFID) and data processing into a single integrated system [21].

A Web-based RACB System can be used to automate and streamline safe and accurate brand identification (ID) uniquely in real-time by product marketing managers and to protect consumers from counterfeited products. By placing brand tags (RFID tags) on brand products at the point of manufacture, manufacturers can trace products throughout the supply chain. The retail industry can use an online application, such as RACB at the point of sale to document the authenticity of their brand products in real-time. The brand tags can store the unique product IDs and the other information can be stored in an associated (i.e., manufacturers) database. If the brand is not properly tagged or the brand tag is not associated (i.e., the product information is missing) with the database, then the retailers know the product is counterfeit. Additionally, by placing brand tags at the point of manufacture, not only can brands be traced throughout the supply chain, but it can also prevent counterfeit brands from entering into the supply chain.

These RFID-based systems can collect and organize data exponentially faster and more accurately. The unique ID number on standard RFID tags (e.g., passive) can be used to verify the authenticity of the products to which they are attached. As in the distribution chain, RFID-based systems in retail can greatly aid in reducing the cost of keeping accurate inventory data. With minimum staff and less time, retailers can keep accurate inventories. They can spend more time providing service to customers rather than counting product. In addition, the accuracy of the real time inventory data enables product marketing managers to ensure that hot selling items

are properly stocked and to ensure replenishment order for these items are placed as quickly as possible.

The paper is structured as follows: Section II demonstrates the types of research stream on counterfeit brands. Section III illustrates the conceptual model for counterfeit branding. Section IV outlines the RFID model used for developing anti-counterfeit branding systems. Section V outlines the RACB architecture. Section VI illustrates the application of a real-time RACB system. Section VII demonstrates the implementation of RACB systems. Section VIII concludes the paper.

II. TYPES OF RESEARCH STREAMS ON COUNTERFEIT BRANDS

Counterfeiting has rarely been considered as a worldwide problem. Although some studies have applied theories such as "reasoned action" [22], "planned behavior" [23], "expected utility" [24], and "ethical decision making" [25] to consumers' counterfeit purchasing behaviour, a thorough explanation is still lacking. Thus, it is necessary for researchers to develop more comprehensive theoretical frameworks by expanding and integrating current explanations of counterfeit production, selling, and purchasing. The following Table 1 shows three different types of research streams - demand side, legal and policy issues and supply side are considered for this research. Demand-side factors include product attributes, consumer characteristics, and institutional and cultural factors; supply-side factors include market potential, production, distribution and technology, and institutional and cultural factors.

Table 1 types of research streams on Counterfeit Branding

First Stream		Second Stream	Third Stream	
Demand Side		**Legal and Policy Issues**	**Supply Side**	
Product Attributes		**Regulatory Framework**	**Market Characteristics**	
Price	Product Involvement	Risk of Discovery	Profitability	Market size
Quality	Image	Access and availability of products	Brand power, recognition, and popularity	Investment cost
Appearance	Accessibility		Technology requirements	Simple and cheap logistics
			Distribution channel	Easy to deceive consumers
Socio-demographic Factors		**Penalties and Sanctions**	**Brand Owners and Technologies**	
Income	Education	Risk of prosecutions	Efforts to support anti-counterfeiting strategies	Techniques to curb counterfeits
Age	Gender	Government endowments		
Social pressure	Brand personality	Enforcement		
Consumer attitude	Product knowledge			
Materialism	values			
		Enforcement - laws	**Cultural factors – attitude & values**	

The majority of the research on counterfeiting has focused attention on the demand side [26] with scant research addressing the supply side of counterfeiting and regulations [27] at a national and supranational level. In previous studies a large range of anti-counterfeiting strategies have been recommended to target distribution channels, international organizations, pirates, and companies themselves with company-based initiatives. This research proposes a system level (e.g., RACB) of analysis to address the interrelationships among the drivers/ stakeholders that maintain this market behaviour. Systems analysis is closely related to operations research and helps, through explicit formal enquiry carried out, to identify a better decision.

III. CONCEPTUAL MODEL FOR COUNTERFEIT BRANDING

It is necessary to develop a complete model which analyse reasons for counterfeit branding properly and helps to deter it.

System theory can explain this problem and exhibit the stages properly in this regard. Systems theory is a transdisciplinary approach that abstracts and considers a system as a set of independent and interacting parts. The main goal is to research the general principles of systems functioning, so that they can be applied to all types of systems, and in all fields of research [28]. In order to choose a model that clearly explains the counterfeit branding on system theory, Complex Adaptive System (CAS) is the ideal one. CAS is a dynamic network of many agents (which may represent cells, species, individuals, industries, nations) acting in parallel, constantly acting and

reacting to what the other agents are doing. Despite the fact that CAS was introduced over 30 years ago, there is little research on their use for solving business problems. The overall behaviour of the system is the result of a huge number of decisions made every moment by many individual agents.

If we consider the participants of demand and supply side are the two agents and legal policy gap as the stimulator, then the complex adaptive model for counterfeit branding will look like as in Figure 1.

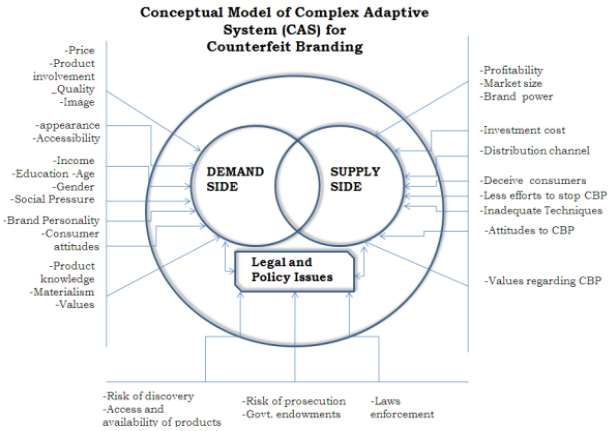

Fig. 1 conceptual model of CAS for counterfeit branding

The interactions between two agents (demand and supply side) are logically responsible for the illicit trade. We cannot blame one individually as it paves the path for other. While the gap in legal and policy issues support these two agents to ameliorate counterfeit branding.

Many studies have explored a variety of practices involved in the production and trade of counterfeit goods. No study has fully discussed counterfeiting and piracy in terms of supply, demand, and institutional and cultural factors at both individual and aggregation levels. Counterfeiting is a complex individual and social phenomenon. Previous research has suggested various factors that directly or indirectly influence the production and purchase of counterfeit goods. In addition, public policy should facilitate the development of new technologies to curb counterfeiting [29].

IV. RFID MODEL FOR ANTI-COUNTERFEIT BRANDING

Unlike previous identification techniques such as barcodes, RFID technologies do not need line of sight and the RFID brand tag can be read without actually seeing it. Also, RFID brand tags are able to store much larger amounts of data easily and more rapidly than a barcode system. They are very effective in being read through a variety of substances and conditions such as extreme temperature, soil, dust and dirt, snow, fog, ice, paint, creased surfaces, and other visually and environmentally challenging conditions, where barcodes technologies would be useless [19].

RFID is an advanced emerging technology that elegantly provides a solution to leading global brands in multiple industries including retail, pharmaceuticals, electronics, entertainment, aviation, IT and many more. RACB represent one of the most promising approaches to curb counterfeit branding. RACB systems are mainly consisting of smart brand tags, a RFID Reader and retailer's IT system. It can be embedded into the retailer's web portal (i.e., dashboard) to identify the authenticity of the brand tags. Each unique brand tag can be passive, semi-passive or active [30]. Passive tags can be used for both reading/writing capabilities by the mobile device based RFID reader and do not need an internal power (i.e., battery). They get energized by the reader device and have a read range from 10 mm to almost 10 meters [20]. Passive tags are cheap, ranging from $0.25c to $0.40c each and life expectancy is unlimited. Thereby, we suggest the use of passive brand tags (13.56 MHz ISO 15693 tag) with the read range of one meter attached to each brand at the point of manufacture. The main components of the RACB system are shown in Figure 2.

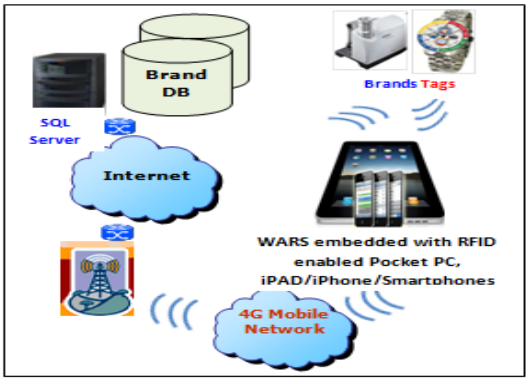

Fig. 2 main components of web-based RACB system

The passive brand tag antenna picks up radio-waves or electromagnetic energy beamed at it from an RFID reader attached to mobile devices (e.g., iPad, iPhone or smart phone) and enables the chip to transmit the brand's unique ID and other information to the reader device, allowing the product to be remotely identified [20]. A mobile web-based RACB can automatically log into an integrated database server (e.g., SQL server) wirelessly to check a brand identity. The RFID reader can also request any additional information from the brand tag that is encoded on it [31]. The reader converts the radio waves reflected back from the brand tag into digital information [32] then passed onto RACB system (embedded in a smart phone/iPhone) for processing. The brand database can also link with other databases (e.g., manufacturer) through Internet for retrieving specific brand information.

V. MULTI-LAYER RACB ARCHITECTURE

As the retail industry currently faces counterfeit branding issues, multi-layer RFID architecture can establish an infrastructure to address such a challenge, to automate and simplify the functionality for tracking and detecting brands wirelessly. Figure 3 shows the multi-layers (i.e., six layers) of RFID-based RACB architecture, namely, physical layer,

middleware layer, IT infrastructure management layer, brand data layer, application security layer and graphical user interface layer [30].

The physical device layer consists of the actual RFID hardware components (such as brand tag, and mobile device-based RFID reader) that integrate with RACB for capturing brand data automatically.

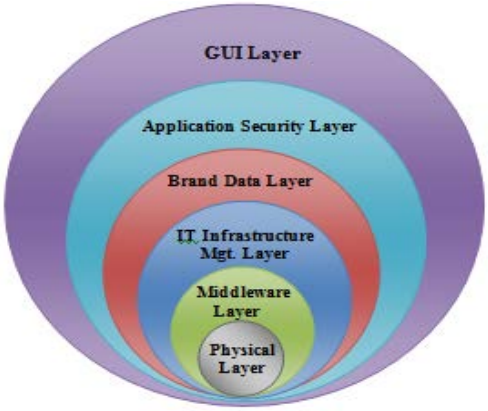

Fig. 3 multi-layer architecture for anti-counterfeit RFID systems

The middleware layer acts as the standard mechanism for getting rapid connectivity between brand tags and mobile device-based RACB. The IT infrastructure management layer is responsible for managing and controlling the local retailer's IT components such as computers, back-end servers, networks, and printers. The brand data layer interacts with a back-end database (SQL server) and includes a data query/loading approach using SQL (structured query Language). The application security layer ensures a reliable, proper security measures such as Cryptosystems. Finally, the GUI layer is responsible for coordinating and displaying the brand data.

VI. RFID-BASED ANTI-COUNTERFEIT BRANDING APPLICATION IN RETAIL SECTOR

Figure 4 shows a retailer's mobile-based web portal (i.e., dashboard) integrated with web-based RACB systems. By clicking '**Brand Check'** tab on the dashboard will activate RACB systems.

Fig. 4 retailer's mobile-based web portal (dashboard)

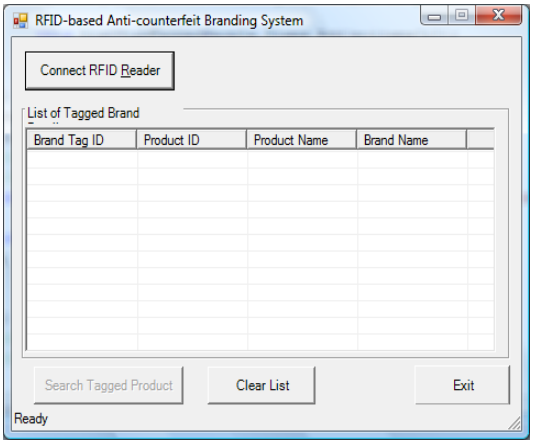

Fig. 5 RACB system main interface

Figure 5 shows the windows based RFID-enabled RACB system application developed using C# in the Microsoft Visual Studio.net 2008 environment. This application can be embedded with a mobile device for capturing brand information (e.g., product ID, product name, or brand name) automatically and wirelessly. The web-based RACB application identifies every product uniquely with a brand ID embedded in brands through RFID-enabled mobile devices. A brand tag only contains a unique ID and perhaps other information (e.g. brand name), which a RACB application uses to retrieve a product's record stored in the retailer or manufacturer branding database (e.g., SQL server).

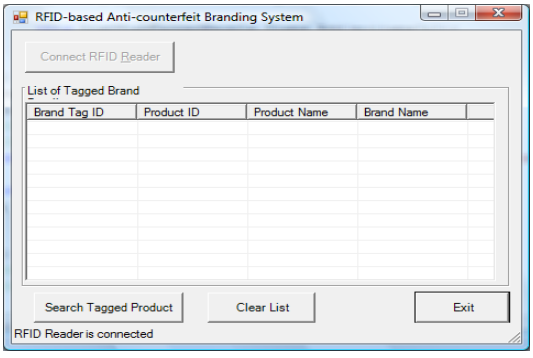

Fig. 6 connect RFID reader with RACB application

To check counterfeit branding, a retailer or vendor can use a smart phone based RACB system for detecting and determining the authenticity of brands. After running the RACB application, the retailer or vendor needs to connect RFID reader first by clicking "*Connect RFID Reader*" button as shown in Figure 6. Then detect brand product(s) by clicking "*Search Tagged Product*" button.

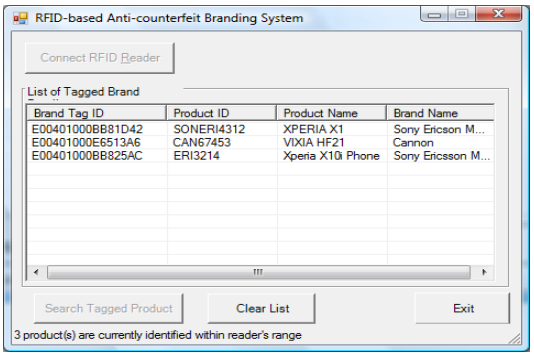

Fig. 7 automatic brand product detection system

When the required brand products are in the mobile device-based RFID readers energizing field, the web-based RACB application beeps, indicating that the identified product is not counterfeited and displays the brand information (e.g., tag ID, product name, and brand name) in real-time in the list box as shown in Figure 7. In case of counterfeit brand, the RACB system pop-up an error message, "*Brand information is not found*".

VII. PRACTICAL IMPLICATIONS OF WEB-BASED RACB SYSTEMS

A drawback of existing anti-counterfeiting measures (such as barcodes) is the low achievable degree of automation when checking the originality of a brand. With existing schemes, large-scale checks, for example required in retail warehouses, are not feasible. RFID-based system helps retailers or vendors to address this problem, and provides the possibility to implement extensible, secure protection mechanisms in the retail supply chain management (SCM). Additionally, a secured real-time automatic web-based RACB system can be implemented in any SCM for better management of its retail and wholesale services. The RFID-based systems also enable the product marketing managers to identify slow moving items quickly and to take corrective action to goose demand through promotional or advertising activity before a 'fire sale' is needed. Thus RFID systems help managers to maintain their margins. These systems are a significant aid in deterring theft in retail environments, where brand tags trigger alarms when they are removed from the store without a due process.

VIII. CONCLUSION AND FUTURE WORK

This paper provides a comprehensive overview of the growing problems that counterfeiting imposes to industry world-wide. It is estimated that trade in counterfeit goods is now worth more than 5 per cent of world trade. Moreover, it may have a devastating impact on society as a whole. Both clear empirical evidence and satisfactory policy solutions to global counterfeiting remain lacking. Many controversial issues still remain unresolved. More valid measurement of the degree of counterfeit activities is necessary, along with more research to identify the relative importance of various determinants of counterfeiting and its effects on individuals and the economy as a whole. No estimates have been made of the total magnitude of counterfeiting and piracy worldwide. The most widely cited aggregate figure on infringements relies on international trade. However, there is no consensus on the validity of the sources of the estimates and the techniques used to create them. Because of the problems of measurement, adequate scientific data are lacking on the scale and nature of counterfeiting and piracy and the welfare and economic losses that they cause.

In this paper, we have proposed a real-time web-based real-time RACB system to curb counterfeit branding. We have designed, developed, and shown the application and implementation of such a system. Using the RACB system, retail and other industries have the opportunity to track a counterfeit brand quickly and accurately at the point of sale without human intervention. This system also helps these industries to enhance cost savings and improve security which plays a vital management role.

While RFID-based system provides promising benefits such as retails or other business process automation, some significant challenges (e.g., security and privacy concerns, and managing RFID data) need to be addressed before these benefits can be realized. To overcome this challenge, sophisticated security measures will be an important direction for future research.

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Belal Chowdhuryhas a multi-disciplinary background in management and computer science. Currently, he is a Lecturer in the school of IT and Engineering at Melbourne Institute of Technology, Melbourne, Australia. Belal has obtained a Master of Computer Science degree from Victoria University, Australia in 1998 and Doctor of Philosophy (PhD) in Australian healthcare area at La Trobe University, Melbourne, Australia in 2011.

His research focus is Intelligent Healthcare Management Systems using emerging technologies (e.g., RFID and sensor). Before joining academia, Belal worked as a Software Engineer/Developer for number of years in different IT disciplines with several multinationals (e.g., IBM GSA,Westinghouse Signal, Mitek Australia, and so on) in the Engineering sector. He has extensive experience in Object Oriented Programming using C++, Java, VB and VisualStudio.net in client/server environments. Belal has published 24 refereed journal, book chapter and conference papers. He has chaired a conference and reviewed many reputed international journals