

# **AN EMPIRICAL STUDY OF SMARTPHONE BASED TRACKING DEVICES AND ANALYSIS OF ITS DEMAND & MARKET**

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## Abstract

*The issue of misplaced and lost items is one that at least everybody had to face at some point in their life. People more often not tend to lose or misplace common home appliances and personal effects ranging from phones, hand-held devices such as PDAs and keys. In an attempt to solve this difficulty of locating and tracking commonly misplaced items, the last decade has witnessed the emergence of tracking devices for such items. With time the market demand for these devices that operate with smart phones has been burgeoning in the recent past. This trend of a sudden increase in the market demand for such devices may be explained by reference to the various benefits and advantages. The random sampling technique used to evaluate the consumer preferences, 1000 smartphone users was targeted to describe the misplaced items issue and their views on tracking solutions. Our study explored the extensive demand of smartphone based tracking devices and it shows the strong desire of tracking devices should be part of basic cell phone package. Based upon our findings we suggest that the Bluetooth based items tracking technology provides an excellent means of Location-based Services (LBS) to meet the consumer requirements. The system, which is versatile and multi-faceted, helps in tracking lost and misplaced items. In the end of paper, managerial implications and research limitations are presented*

*Keywords: Tracking Devices, Smartphone, Anti-Loses, Misplaced and Lost Items*

## INTRODUCTION

Advances in information and communication technology have led to the development of various handheld and pocket telecommunication devices, whose importance is directly embedded in contemporary living. Almost every member of the family has a mobile communication device, which have become integral parts of daily lives. Genuine loss or theft of items including such devices is so common that tracking devices have been designed and incorporated in these communication devices to assist in retrieving a lost device. Currently tracking technologies such as triangulation, multilateration, trilateration including Time Difference of Arrival, beam forming, angle of arrival, received signal strength indication, among others have been integrated in the development of a smartphone (Aghasi, Hashemi & Hossein, 2012). Importantly, Radio-Frequency Identification and Bluetooth technologies are especially useful as tracking devices in smartphones, as is Wi-Fi, Global System for Mobile Communications, and Global Positioning Systems (Iskander, Yun & Zhang, 2001). Different tracking technologies are bound to encompass different advantages and disadvantages, and this article explores the attached

benefits and disadvantages together with the needs of customers to use the technologies. Additionally, this paper explores the investment potential of companies that engage in the design and development of tracking device technologies and their target markets.

### **Need For Tracking Device Technology**

The number of lost items including pets, misplaced households, keys, wallets, including mobile communication devices such as cellular phones is very high (Nielsen, 2009). Retrieval of misplaced and/or lost items is a rampant problem that requires being addressed. According to a 2012 survey in United Kingdom cited by Ahmad, Rouyu & Hussain, (2014), over 200,000 items have been lost or misplaced by the adult population in UK, of which the items prone to misplacement or loss include mobile communication devices, car and house keys, and wallets. In the contemporary society, the majority of adults, especially the working class, have made smartphones a part of their daily life. Advances in ICT have transformed the initially simple cellular phone to a smartphone, an interactive device that is redefining user's daily life in terms of available applications in the device including data storage, information media and sharing, entertainment, finance as well as payment of utility bills, among other applications. As stipulated in a 2013 Flurry Analytics Report cited by Ahmad et al. (2014), the number of smartphone users is increasing day by day with approximately 230 million and 256 million users in the United States and China, respectively. Considering the role of smartphones in the daily life, their loss shuts down some major life needs, and therefore necessitates the need for tracking devices to assist in their retrieval.

### **Technological Solutions**

The increased use of wireless communication technology has led to the design of different tracking devices that integrate its use especially in smartphones as the most adept tracking platform. Considering their role in contemporary life as resource facilitators and managers, integrating the tracking technology in smartphones can be indispensable in tracking lost mobile communication devices, car or house keys, persons, wallets, and documents among other things. In this regard, the design and tracking device technology has been embedded on the application, usability and the environment including GSM, GPS, and Wi-Fi (Ash, Kyperountas, Hero, Moses & Correal, 2005; Tranter, Bose & Ratchaneekorn, 2010).

Tracking devices are built upon diverse principles all of which depend on connectivity infrastructure as well as host platforms. Triangulation, trilateration and multilateration are tracking technologies that engage the use of GPS and LPS, which track signals from many

interconnected transmitters to enhance the signal while computing the location of the lost item (Furey, Curran & Kevitt, 2012; Zhou, Law, Guan & Chin, 2011). The use of radio waves is the main drawback considering that the receiver may not directly compute the direction of the transmitter in weak signal strengths (Ash & Potter, 2007; Miguel, Labrador & Yejas, 2014). Multilateration entails calculating the dissimilarities between the time periods of flight of two waves received by a receiver from two coordinated transmitters. The advantage is that via this technology, no instant signals are required by the antenna while the receiver and transmitter do not have to be synchronized.

The associated tracking technologies include doppler measurement, which encompass satellite tracking by estimating the distance between a satellite and a receiver following the shortest path and time (Moses, Krishnamurthy & Patterson, 2002; Sallai, Völgyesi & Lédeczi, 2011). With RSSI, intermediate frequency phase is applied prior to IF amplification. On the other hand, beam forming technology is a modification of 4 by 4 Multiple Input Multiple Output technologies, which augments the wireless interconnection facet of the device. When integrated in a smartphone, beam forming upgrades Wi-Fi connectivity. Of importance is the radio-frequency Identification technology, which utilizes wireless communication systems of non-contact electromagnetic radio frequencies to disseminate signals.

Several miscellaneous tracking technologies have been designed for outdoor tracking including outdoor tracking technology for tracking lost children and older adults, and include anti-lost alarms, outdoor portable locator tracking gadget, child GPS tracker, SOS emergency, GPS, SMS positioning, tracking playback, remote listening and sensing, etc (Carr & Hippisley, 2012; Zhen, 2012). Antitheft devices have been designed to prevent unaided or unintended and unauthorized use of items that include biometric recognition, first-lock solutions, and anti-robbery systems.

Bluetooth device technology is another important tracking technology that utilizes wireless communication between mobile communication devices. This technology is principally affordable, and uses very little electrical power. Bluetooth device design incorporates a RF transmitter, baseband and a protocol, which facilitates transmission and reception of different types of data (Sun, Chen, Guo & Liu, 2005). This technology is secure allowing safe electronic transfers between mobile communication devices with a data rate conveyance of 150ft and 50ft radii outside and within a room respectively (Chang, Rashidzadeh & Ahmadi, 2010). Bluetooth technology is considered optimal considering its varied application allowing for customization by the user to tailor sensitivity of Bluetooth alarm devices.

### **Customer Requirement for the Tracking Device Technology**

The most viable customer requirement is the need to perform either continuous active or passive divide tracking, which can be either indoor or outdoor. Considering smartphones, they are currently owned by virtually every adult, it is requisite for customers to own a smartphone to act as a platform to install the tracking device. Some tracking devices are not freeware, and therefore, there is a need to pay for the tracking services rendered. Important considerations are required to be made when deciding an optimal tracking device. Bluetooth technology is the most affordable technology considering its volatility, and flexibility, such that it can be attached to diverse types of items that are prone to loss or misplacement including keys. Customers require having access to obligatory infrastructures such as GSM and Wi-Fi, as well as GPS for device connectivity. It is notable that although over 92% of people with smartphones would like to install a mobile tracking device on their phone (Ahmad, Rouyu & Hussain, 2014), only a small proportion, about 38%, would accept the requisite to change their smartphone with only 61% of the remaining population that concur to pay for tracking service charges (Ahmad, Rouyu & Hussain, 2014).

Moreover, although several types of tracking device technologies are available in the market, their utility and application is dependent on GSM, GPS, and/or Wi-Fi availability and are dependent on other platforms such as cellular towers, satellites, crickets, and access points for Wi-Fi connectivity (Chen, 2007; Terry & Cleary, 2008). These applications are direct customer requirements, which are needed to use the tracking device technology efficiently. With respect to the use of Bluetooth tracking devices, the customer will be required to tag the misplaced item with a Bluetooth tag used for tracking using a Bluetooth-based application installed in the smartphone. Lastly, the customer requires that the tracking device be host independent such that it is able to function in indoor and outdoor environment, energy efficient and cost effective, and features characteristics of the use of Bluetooth technologies.

### **Consumer Demand**

The most important aspect for a customer when purchasing a smart phone is to be at a position of tacking it in case if it is misplaced or stolen. This helps in easing the customers from losing a lot of money if their smart phones are stolen and not at a position of tracking them (Fling, 2010). A customer may require his or her smartphone to have Media Access Control which is usually instated during manufacturing. This helps a consumer to track a phone with ease because when a smart phone is turned on, there are signals that are always emitted which allows Bluetooth connectivity. This allows for identification of the person carrying the phone and the location of

the phone is identified. This plays a great role in tracking of smart phones because the location of the phone will be identified thus the person carrying it will be followed electronically.

Some customers may demand for smart phones which have probe pocket signal which helps in tracking regardless of whether the owner is connected to any Wi-Fi network. This would be very beneficial to the customer because they could track their smart phone regardless of whether Wi-Fi connections are available or not. If these tracking systems are available in a smart phone, many customers may prefer it since it would meet their demands in being able to track their device.

### **Available Tracking Schemes**

Most mobile telecommunication companies have realized the market niche that exists out there for mobile tracking devices. As a consequence, there are several tracking devices that different companies offer to find misplaced items. These devices are readily available and offer a variety of tracking services. However, they vary in terms of the range within which their overall tracking effect can be felt.. Apart from commercial Bluetooth tracking devices and location facility from a phone, (Cheung KC,IntilleSS and Larson K, 2006) have modeled and established other Bluetooth tracking schemes. In addition, as Fernandes (2013) notes, some of them are capable of providing an indoor accuracy of 1.5m. Bekkelien (2012) also supports this view and observation by Fernandes. Other Bluetooth localization proficiencies cover the Bluetooth-Wi-Fi conjunction used in Proximity Marketing or Location Based Mobile Marketing (Ace Marketing & Promotions, Obliquity Networks 2013). Here customers are popped up commercial adverts or information related to their proximity to a shop or mall. In the recent past, Nokia Research aims at integrating indoor localization using Bluetooth technology (Deng Z, Xue T, Cao H, 2008). However, the only limitation of most of them, as indicated earlier, is that they rely mainly on technologies like Wi-Fi, GMS and GPS, which in most cases require internet domains or sources to function effectively. The invention of a Smartphone-based tracking technology has, therefore, been a breakthrough of this century. An example would be the NLocator tracking device which operates on Smartphone and gives results of the tracking in meters.

### **Customer Preference for In-built Features in Tracking Devices for Phones**

In most cases, consumers show special attention to some features in the Bluetooth tracking devices. Such customer taste and penchant has driven most smartphone manufacturing companies like Samsung and Apple to design and tailor their products accordingly to meet these growing demand and preferences. This is in addition to the conventional features

discussed above. The difference is that these features that customers for mobile Bluetooth tracking devices tend to like most are hardware and software features installed by default.

In 2011, Apple released a Bluetooth enabled iPhone with a totally new feature (Bluetooth v4.0) which was expected to enable the new smartphones to wirelessly connect to similar ones to be produced later. In a similar vein, Samsung in 2012 released its new Samsung SIII with powerful Bluetooth tracking power but low power consumption rate. Due to this gorgeous features, the market demand for the two smartphones suddenly short up as consumers went for the improved tracking advantage in them (Dudley,2012). It is these unique tracking features that customers want mostly for their Samsung and iPhone smartphones. According to Dcyre (2007),

### **Features of Effective Tracking Device**

There are some scientifically agreed characteristics that a good mobile tracking device should have. These include, but not limited to the following:

- **Low power consumption**

The tracking device should be able to minimize on power consumption.

- **Low Budget**

The tracking device should be not so costly in buying and also for use

- **Wide coverage**

The device should be able to cover a wide area both indoor and outdoor.

- **Accuracy and efficacy**

The device should be able to monitor effectively and track the lost or misplaced item with desired precision and accuracy.

- **Conformity and Compatibility**

The tracking system should conform to the available Smartphone specifications including hardware and software with ease.

- **Versatility**

One should be able to use the Smartphone for other applications such as internet or calls while at the same time tracking. The Bluetooth system should not overstretch the phone usage beyond the limits.

### **RESEARCH METHODOLOGY**

The main goal of this survey was to establish customer needs for tracking devices. In addition, the investigators required to identify the current tracking solutions, their usability and their impact on users while integrated in their smartphones. A survey has been carried out in

Pakistan, targeting smartphone user's with 1000 sample size. random sampling was employed in Considering the type of identified variables and the amount of data obtained, the apt statistical model identified was the use of descriptive statistical model to determine percentages within the cross-sectional domain of the population that have found use in the stipulated tracking device technologies. Moreover, the statistical estimates and survey weights will facilitate in providing observational inferences within the entire population.

## EMPIRICAL RESULTS

From the survey, it is deducible that all the respondents own or have ever owned a mobile communication device, with 91.7% having owned a smartphone for more than a year. There is highly demand of integrated tracking solutions compatible with smartphone, 92% demand inbuilt tracking hardware in their smartphone. Means the people don't want to carry additional equipment for tracking purpose. These findings are as depicted in the table:1, table:2 below.

Table: 1, Length of Owning a Smartphone

Length of Time of Owning a Smartphone					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 - 1 Year	83	8.3	8.3	8.3
	1 - 3 Years	405	40.5	40.5	48.8
	Over 3 Years	512	51.2	51.2	100.0
	Total	1000	100.0	100.0	

Table: 2, Supporting Integration of Tracking Device in Smartphone

Supporting Integration of Tracking Device in Smartphone Hardware					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	919	91.9	91.9	91.9
	No	81	8.1	8.1	100.0
	Total	1000	100.0	100.0	

Knowledge regarding the use of smartphones to retrieve lost or misplaced items is poor based on the findings showing that only 2.7% respondent have tried to use their smartphones for tracking purposes. Among the different tracking device technologies available in the market, only 1.4% no about Bluetooth based availability or use, RFID, GSM and WIFI tailing almost



people unaware about the tracking schemes. GPRS tracking facility relatively high then other schemes but still in low profile in term of awareness and use 12.6%, the most common tracking Scheme the people are aware and use for different tracking purpose is GPS and almost 69% people are aware about it but not for tracking personal items, most of them use it for tracking places and for Road assistance. Overall 68%people don't know about personal items tracking with their smartphones and just 1.6% people here about Bluetooth tracking facility. Most of the Smartphones user's containing 98% are not familiar about the principle used in tracking schemes so we can say that respondent are unfamiliar with technical issues they just have knowledge about usage. Some users identified CDMA as an additional tracking technology that is not so popular, but forms an add-on to the available tracking solutions. Only very few respondents provided a response to other tracking devices that were not listed, which explains the 3.1% of individuals with knowledge on the principle of any of the tracking technologies, which all were mentioning RFID and its use of radio waves to sense and detect lost items.

Fig.1: Priodic Tracking Cost assosted with tracking

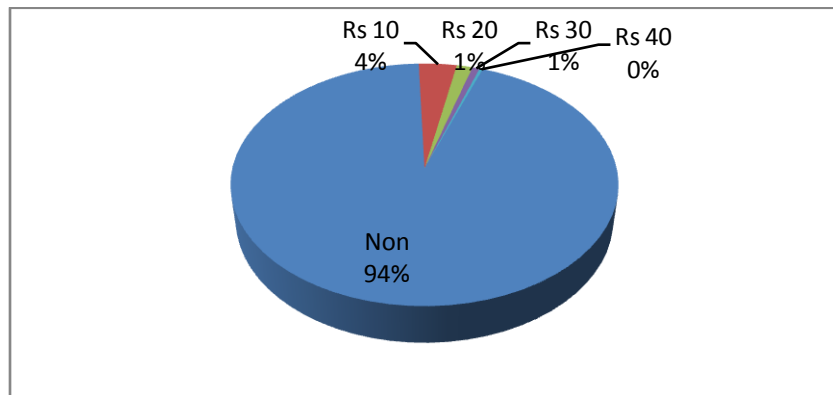
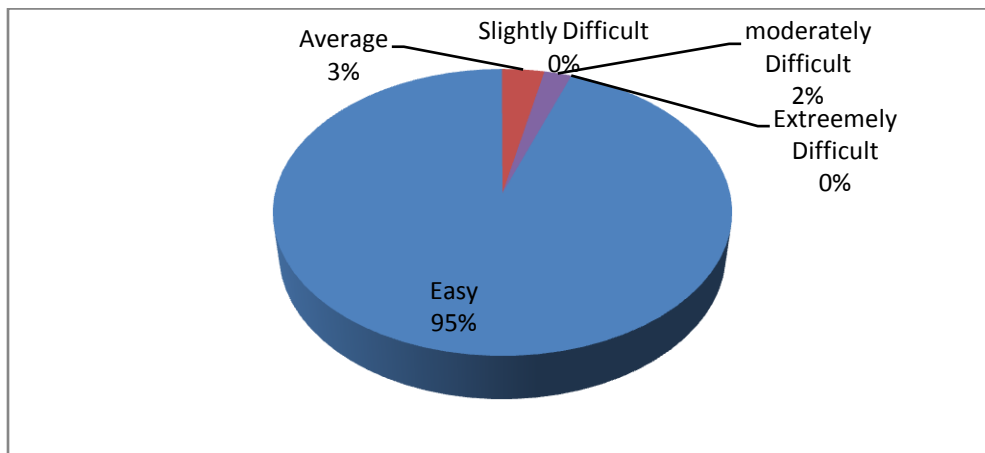


Fig.2: Complexity interm useabilty of tracking devices



The survey results further explained that 94% respondent are not interested in periodic payment for tracking services results shown in Fig.5 and among those 6% who willing to pay 4 % are not willing to pay more than Rs.10 and on the average Rs.15 is most suitable monthly charges according to 6% of target population results are display in Fig.1. according to Fig.2 Tracking Devices must be easy to use just only 5% people can handle the complexity of using the service.

Fig.3 Accuracy of Personal Tracking Devices

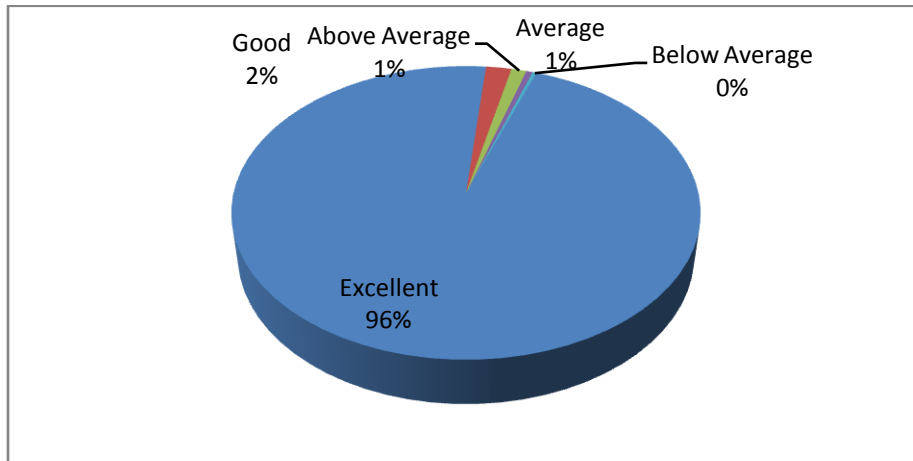
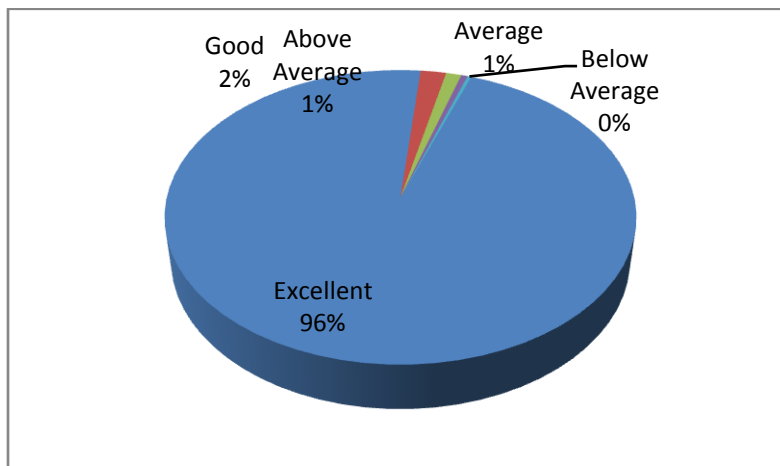


Fig.4 Speed of Personal Tracking Devices



Target audience show no compromise on accuracy and they want to track their misplaced with in no time as the results shown in Fig.3 and fig.4.

As indicated in the fig.5, 100% population segment showed that everyone facing the misplaced or lost item issue in Daily life and they demand from manufacturing companies to incorporating tracking devices in the handset package, either as an integral application or as an

additional package, as is the case with the charger or hands free components. Almost 80% consumer willing to buy tracking devices to solve the problem of lost items, and 75% willing to change the company to avail tracking facility. The fig.6 showing the demand of the customer, the customer demands from handset manufacturer to add the tracking devices with their basic mobile package like microphone and charger. The quantity of tracking devices according to consumer preferences is 5 devices is the most ideal and 3 devices are also acceptable.

Fig.5 Misplaced Issue and Consumer Preferences

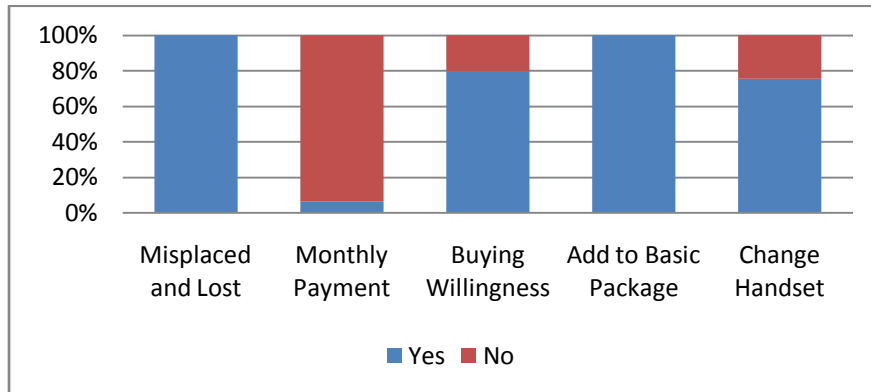
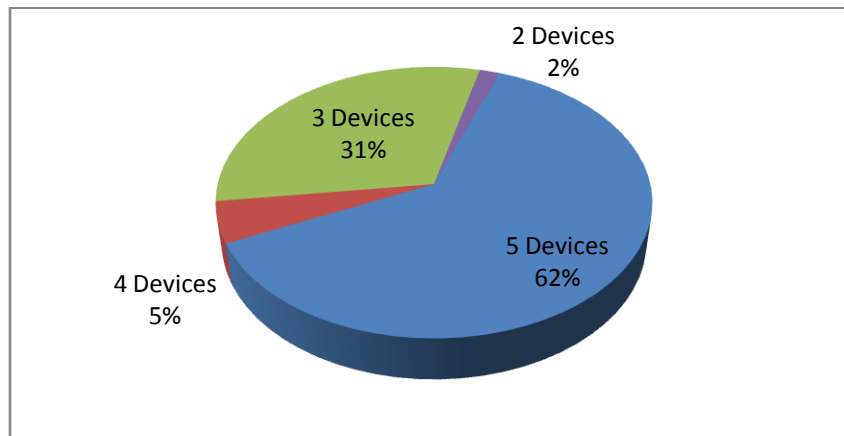


Fig.6 Quantity of Tracking Devices Demand with Basic Package



In summary, misplacing issue is more common in our daily life, there is no common or well-known technological solution available or generally adopted. There is highly demand of tracking Devices operating with smartphones, consumer are willing to pay at once for the solution but don't prefer to pay on monthly or periodically. There is requirement of accurate and speedy tracking system offer with the purchase of mobile phone.

## RECOMMENDATION AND CONCLUSION

The recommendations cited regarding improvements on the tracking device technology include the need of tracking devices integrated into the smartphone or iPhone hardware. This is to ensure safety and durability of the tracking device. In addition, it is to be accompanied by its separate transmitter in different sizes to attach to items prone to misplacement. Majority of the study subjects cited how Bluetooth technologies have tried to incorporate Bluetooth sensors on phones while they have a separate transmitter and receiver. Lastly, they recommended design and integration of tracking devices that are free or affordable, pointing at the expenses related to the use of GSM, GPRS, and GPS in tracking. Manufacturing companies such as Samsung, Nokia, or Apple are advised to reconsider designing and providing such tracking technologies, especially to avert loss of important items and communication devices, considering their crucial role in daily life, extrapolating on increased revenue due to increased volume of sales.

In the contemporary world, it is anticipated that the retrieval of misplaced and/or lost items is easier with the development of many tracking devices. Different users make different choices on tracking devices depending on needs, prevailing environment, and ease of application, power use, and budget effectiveness. Current customer demands require the use of Bluetooth-based tracking devices including the Bluetooth-based location estimator because they are host independent with respect to the use of GSM, towers, GPS, or Wi-Fi routers, can be used in both indoor and outdoor applications, energy efficient and cost effective when installed in smartphones. Conclusively, it is evident that investing in technologies such as Bluetooth in Smartphones, and nLocator in iPhones is an appropriate business venture considering the number of users using this technology as third party software plugins.

This study has several limitations. First, this study is limited to the smartphone users. Secondly, we only focused on smartphones based tracking solution, and also don't highlight the negative aspects of tracking devices applications. Third, Sample of the study has drawn only from Pakistan.

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