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Information and Knowledge in Internet of Things

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Preface

Internet of Things (IoT) is currently one of the most challenging areas of the Internet, enabling communication and ubiquitous computing between global citizens, networked machines, and physical objects, providing a promising vision of the future integrating the real world of knowledge agents and things with the virtual world of information. IoT is seen as a network of trillions of agents and machines that communicate with each other, being a profound technological revolution, which is the current reality and the future of computing and communications, supported by a dynamical technological evolution in many fields, from wireless sensors and wireless sensor networks to nanotechnology. Due to its broad impact in many fields, it has rapidly gained global attention from academia, governments, industry, and the citizenry. This change in the network of agency profoundly modifies the landscape of human activity, particularly as regards to knowledge acquisition and production, offering new possibilities but also challenges that need to be explored and assessed.

This book contains a selection of chapters accepted for publication in the book *Information and Knowledge in Internet of Things*, belonging to EAI/Springer Innovations in Communication and Computing series.

The program committee was composed of a multidisciplinary group of more than 90 experts from 30 countries, with the responsibility for evaluating, in a “double-blind review” process, the chapters received for each of the main themes proposed for the book: Decision Support Systems in IoT; IoT Knowledge Management; IoT Sensing Technology and Applications; Security and Privacy; and Smart Environments.

We received 55 contributions from 14 countries around the world. The acceptance rate was 38%.

The accepted chapters are published by EAI/Springer Innovations in Communication and Computing series, and will be submitted for indexing in Scopus, Ei Compendex, and zbMATH.

We acknowledge all of those who contributed to this book: authors, program committee, and editors. We deeply appreciate their involvement and support that were crucial for the success of this book *Information and Knowledge in Internet of Things*.

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Teresa Guarda, Maria Fernanda Augusto, Isabel Lopes, and Luis Mazon

19.1 Introduction

With the technological advances of the last decades, its impact on the environmental level is increasingly notorious, which causes sources of contamination that affect health and personal performance. Technology changes our daily habits every day, giving the feeling that technological advances will solve many of our problems, without thinking about the possible prejudicial impacts of that.

Due to the constant technological innovation and its decentralized diffusion, these are essential for environmental sustainability, despite the existing anti-technical and reductionist attitudes.

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Environmentalism, among other contemporary sectors, must capture the innovation of large corporations and government agencies and disseminate it to all social groups, creating conditions for the establishment of plural and efficient environments. Technological innovation may be the solution; the logic of risk and precaution cannot prevent constant experimentation and the search for technological efficiency, as long as they are combined with the imperatives of democracy and sustainability.

Despite the fact that technology is increasingly present in our daily lives, it is even used to manage large urban centers. In this sense, the concept of smart cities has become popular, which can be defined as systems of individuals that interact and use energy, services, materials, and financing in order to promote quality of life.

The interactions that occur between citizens and the technology used in cities are considered intelligent because they are strategically used in the advances in infrastructure and services from information and communication technologies, which is made possible through urban management planning, which purpose is increasing the efficiency of local operations, in order to meet the needs of the city.

In this sense, the massive use of mobile devices, together with the growing worldwide adoption of social media sites by its users, allowing them to be connected, and share data, anytime and anywhere, leads us to the concept of participative sensing. In this context users act as voluntarily sensors, capturing and providing data of their day-to-day life. The huge volume of social data available can be used to support the decision-making processes of different entities.

This chapter aims to discuss the research challenges, opportunities, and concerns in the field of participative sensing, using participative sensing networks that provide the data, which have a very comprehensive scale and can be easier to obtain than other sources, as they rely on the collaboration of users in data collection, presenting an overview of different applications, like the case of healthcare in the context of urban environment that allow a more sustainable environmental management.

19.2 Remote Sensing

Remote sensing (RS) can be defined in a simple way as the technique of obtaining data about an object without touching it. In this sense, the definition will include satellites, airplanes, and weather radars, because they all capture information from a specific target, without any contact between them [1].

In more detail, we can define remote sensing as the set of techniques and technological procedures that aim at the representation and collection of data from the Earth's surface without the need for direct contact [2]. Therefore, all information is obtained through sensors and instruments in general. Such process is linked to the treatment, storage, and analysis of such data in order to better understand the phenomena that appear on the surface [3].

The use of this type of technique is of fundamental importance in the current context of societies, as it is capable of revealing many geographical and even historical data concerning urban, social, and natural spaces.

In the past, remote sensing was performed based on data from cameras, dependent on the existence of photographic films [4]. Around the middle of the twentieth century, with the advent of artificial satellites, sensor technology was developed, which did not depend on photographic films and could have a greater number of spectral bands [5].

While the technology of cameras can be called panchromatic, the technology of sensors corresponds to multispectral [6]. In the mid-1980s, an evolution of multispectral technology emerged, enabling imagers that could obtain images in hundreds of narrow bands, the so-called hyperspectral sensors [7].

Currently, technological advances already allow us to foresee the next advance in the area of sensors, which will be called ultra-spectral and will be able to collect data in thousands of spectral bands.

19.3 Urban Sensing

The sensing architecture in smart cities is divided into seven areas: smart surveillance, smart electricity and water distribution, smart buildings, smart healthcare, smart services, smart transportation, and smart infrastructures (see Fig. 19.1) [8].

Smart surveillance is comprised of monitoring and security technologies, mainly through camera systems. Smart surveillance applications can assist in the detection of violent actions and also in the identification of the people involved. The sensing in this area allows to contribute in the aid of the monitoring and security with the objective of assisting in supposed investigations that involve violent actions [9]. Therefore, sensing in smart cities in this area is extremely important.

Advanced sensing applications for smart electricity and water distribution allow for more accurate measurement and prediction compared to traditional techniques.

In smart buildings, sensing techniques are developed to help reduce resource consumption. Sensing plays a fundamental role in this task, and for that it is necessary to accurately assess current consumption.

In the case of smart healthcare, all technologies that assist management in hospitals or clinics are considered. Sensing in the smart healthcare area uses technologies that assist in hospital management through remote monitoring, in order to detect problems that can compromise the health of a patient in real time, through sensors interconnected in different parts of the body. In this area, we highlight the wireless body area networks, which consist of interconnected sensors located in different parts of the body. These sensor networks allow remote monitoring of the patient's vital signs, as well as the storage and transmission of information in real time [10].

Fig. 19.1 Sensing in smart city

Technologies are used in smart services. The sensing in this area can be applied to several services, for example, it can be applied in the detection of fires, since any signal emitted by the sensor can activate the devices, thus allowing rescue teams to be present to fight fires and enabling improvements in the service provided.

In smart transportation, technologies for monitoring and managing vehicle traffic in the smart transport area are addressed. Applications such as GPS navigation systems allow drivers to choose more efficient routes to get around the city, thereby reducing travel time to destination and traffic in major cities [11].

In the smart infrastructure area, technologies for sensing are used in public infrastructures such as buildings, bridges, and roads, thus allowing, based on the data collected, a more efficient maintenance and use of resources.

19.4 Participative Sensing

The sensing carried out through mobile devices causes costs to obtain data from large areas to be mitigated, as it would be much more costly to manually deploy a large number of sensors to cover them. Systems that use data from this type of sensing are called participative sensing.

Users are the central element of a participative sensing network (PSN), sensing their daily environment. In this context, people participate as social sensors, voluntarily providing data about a certain aspect of a location that implicitly captures their daily life experiences, with the help of sensing devices, such as sensors incorporated in smartphones accelerometer, barometer, gyroscope, GPS, pedometer, iris and fingerprint reader, magnetometer, light sensor, proximity sensor, heart rate sensor.

The urban population has been growing in recent years. The increase in population density in large urban centers and the aging of the population brought the need to allocate resources, such as health, energy, transport, security, and economy, in a more efficient way.

Cities are crucial to a region's socioeconomic development. The term smart city refers to the use of information and communication technologies for this purpose. Thus, through the participatory sensing paradigm, which combines information and communication technologies and smartphone users, it is possible to understand characteristics of the dynamics of a city and the urgencies of the citizens who live in it.

Participatory sensing in smart cities allows participants to send event records about the city, through a smartphone application. These events can be related to health, safety, infrastructure, and city mobility, among others.

19.4.1 Smart City Participative Sensing

The participation of the population is important for smart city solutions. Some of the services need users to monitor the urban environment, the case of the participative sensing services [12]. These services can be exchanging photos and comments with other users or with the responsible entities. Participatory sensing collects data from the environment and makes it possible to obtain relevant information from society, analyzing the data collected with appropriate techniques.

Participative sensing is a distributed process of collecting personal data and covering different aspects of the city [13]. For this, participation of activated people is necessary to voluntarily share the detected data and contextual information; in other words the user manually determines how, when, what, and where to sample. Thus, through participative sensing, it is possible to monitor aspects of the city, and also the collective behavior in real time, of people connected to the Internet. Participative sensing is also known as urban sensing.

Another concept that can be related to participative sensing is that of collective intelligence, starting from the principle that nobody knows everything, but everyone knows something.

The functionality of the systems that use it derives from the decomposition of a problem by specialists and the integration of solutions provided by ordinary people. The diversity of people and independence between them can cause results for several problems to be found more optimally than by an expert.

In participative sensing, several people collect data that will be used by researchers or companies that will carry out the desired analyses.

To better characterize the data collected through participative sensing, it is necessary to know who (the data has an associated user), what (the sensed values), when (date and time of the data collected), and where (spatial coordinate of the location). The data can be structured or not. Structured data has a value that already presents relevant information, while unstructured data has a set of values that generate information. This information can be shared voluntarily or not, by sending it to one or more servers, thus making it accessible to other users. Information shared by the same user can be used by others in whole or in part [8].

19.4.2 Participative Sensing Systems

Systems that use data from this form of sensing are called participative sensing systems (PSS). The data in a PSS is not restricted to that obtained by devices, but derivatives of human sensors are also included, like sight, taste, hearing, touch, and smell. PSS with these characteristics can be termed as ubiquitous crowdsourcing sources in which data is obtained by various users, manually or automatically, from any location, with the aim, for example, of being used to offer services to citizens [14]. That integration of technology into people's habits refers to the ubiquitous computing.

Another concept related to PSS is that of collective intelligence, based on the fact that nobody knows everything, but everyone knows something [15]. The functionality of the systems that use it derives from the decomposition of a problem by specialists and the integration of solutions provided by ordinary people.

The diversity of people and independence between them can allow results for different problems to be found more optimally than by an expert. This is how PSS works: several people collect data that will be used by researchers or companies that will carry out the desired analyses.

The PSS can be analyzed together in a model called layers, where each PSS is a layer, that is, each represents a system with its activities of collection, processing, and distribution of data. Since mobile devices can contain multiple PSS, a node can be in several layers simultaneously. When the layers are unified, they form a work plan that can bring useful information to users.

Although they are already part of people's daily lives, assisting them in several aspects, the PSS present several challenges. The PSS are dependent on the people who carry their devices for data to be provided; it is necessary promote the incentive to participation, to establish policies that aim to keep collaboration at a minimum, acceptable level in order to maintain the functionality of the system [3].

Ensuring quality is another challenge. In addition to the amount of data, it is necessary that they represent the veracity of the monitored items, in order that the participants are obtaining realistic data. Maintaining data quality, that is, when they conflict with reality, is also a concern in participatory sensing. If inconsistent values are transmitted, the reliability of the system is affected.

Users' private information must be preserved; only sensed data should be available to participants [4]. The participant's privacy information must be prevented from leaking.

19.4.3 Participative Sensing Networks

Participative sensing networks offer unprecedented opportunities for accessing large-scale sensing data. This large amount of data facilitates obtaining information that is not readily available with the same practically global scope and can be used to improve the decision-making processes of different entities, from the people level to the groups, organizations, services, and even applications [16].

The central element of a participative sensing network are the users capable of sensing the city using their smart devices and collaborating as sensors as social sensors in a voluntarily way, collecting and providing data about a certain aspect of a location, which captures daily life experiences. This data can be obtained with the help of sensors incorporated in smartphones or other smart devices, such as the case of GPS, accelerometer, gyroscope, and microphone, among others.

Sensing by mobile devices allows sensing data to be collected through the sensors of smartphones and other mobile devices. More and more of these devices are becoming the main computing device in people's lives, and this further increases their potential for sensing applications.

Sensing applications can be classified into three categories: personal sensing, group sensing, and community sensing. Personal sensing applications are designed for a single individual and are focused on data collection and analysis. Personal sensing applications generate data for the sole and exclusive benefit of the user who collected it and are not shared with any other user. Group sensing applications are designed for a group of individuals to share sensing data freely or with privacy protection in order to achieve a common goal. In the case of community sensing, they use applications, which represent large-scale data collection, analysis, and sharing for the common good of a community. This type of application implies the cooperation of people who do not necessarily have a trusting relationship with each other and consequently requires a higher degree of privacy protection as well as a low level of commitment from users.

19.5 Healthcare Participative Sensing

Participative sensing helps people to optimize their health. In 2019, 38.2 million children under the age of 5 years were overweight or obese [17]. Analyzing the worldwide distribution by age, 38.9% of adults are overweight, in the adolescents 17.3%, and in children 26.5% (preschool age 5.9% and school age 20.6%).

There are several factors contributing to this condition, such as poor-quality sleep, stress, inadequate nutrition, and lack of physical activity, among others (Fig. 19.2).

Mobile health (mHealth) is a subdivision of eHealth and refers to tools and practices performed on mobile, wireless devices that emerged not only to facilitate the patient's life, helping to monitor treatments and patients' vital signs and medication consumption, but also to optimize healthcare services.

The spread of the mobile Internet has contributed to new possibilities for transmitting information, transforming the patient-health professional relationship and allowing the exchange of diagnostic parameters remotely and in real time.

The possibility of obtaining information on clinical data in a reliable way, available at any time and place, and designing customized therapeutic interventions has changed the ways in which some health services are offered [21]. Mobile health opens new perspectives for the collection of environmental, biological, behavioral, and emotional data, including patient monitoring and therapeutic interventions.

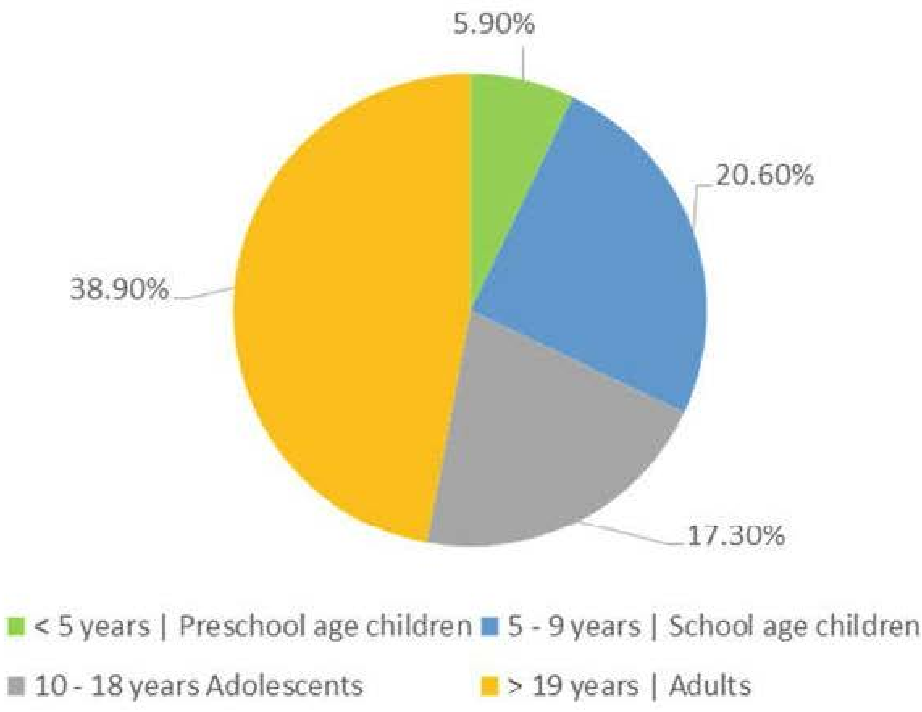

Fig. 19.2 Year 2019 people with overweight worldwide. (Adapted from [18])

mHealth creates conditions for the continuous assessment of health parameters, sets up a new scenario to encourage healthy behaviors, and assists self-management of chronic conditions, among other aspects of application.

Monitoring patients' behavior and analyzing health conditions can help in the development of services for recommending physical activities and remote diagnosis [19]. Monitoring service at distance, such monitoring variables as blood pressure, heart rate and blood sugar levels, acting if the sensors report readings of limits close to the abnormal limits [20].

The fast explosion of personal eHealth, premising self-management and data collection of health conditions, is changing the way to deliver and collect healthcare information.

Organizations have already identified and started working on projects to address issues related to security, scalability, data collection, and interoperability [21].

Although the mobile devices make our lives easier and allow a constant connection to the world around us, they carry some security risks. Computer threats to mobile devices, especially smartphones, have become very common, and attack strategies are increasingly effective. More and more vulnerabilities have emerged, taken advantage of by malware installation schemes, which not only corrupt devices but also result in data and money losses.

Fraud can take many forms, and some types of fraud are perpetrated through mobile devices. Fraud involves social engineering, services, and spam, which leads the victim to reveal confidential information, both personal data and the services they consume, without realizing that they have compromised their own security.

It is important to highlight that, whatever the security solution adopted, regardless of the devices used, people remain the most vulnerable element, due to behaviors and psychological traits that can make them susceptible to social engineering attacks. The path to invasion can be in very common situations, such as the desire to be useful, the search for new friends, and persuasion.

Social engineering, in the context of information technology, refers to techniques for manipulating people in order to overcome security barriers. They are ways of obtaining information in which the target rarely realizes this type of action. Among the most used forms, we have phishing, SMiShing, QRishing, and vishing [23].

Phishing is the most used technique in social engineering; the objective is to steal private information: user authentication data, bank details, sensitive information, and social network data, among others. This technique can also be used to install malicious software on the target equipment. For this, the attacker pretends to be a trusted person or entity and tries to persuade the victim. The attack uses emails and messages via social networks as its main vehicle, requesting some urgent action, so when continuing the process, the victim is directed to a phishing site, which looks familiar, or downloads an attachment with malicious content [23, 24].

In 2020, the country with the most users attacked by phishing was Mongolia with 15.54%, followed by Israel with 15.24, France with 12.54%, and the last place in the top 10 which is Ecuador with 9.52% (Fig. 19.3). Analyzing by continent, the majority of attacks occurred on the Asian continent, with Africa being the least

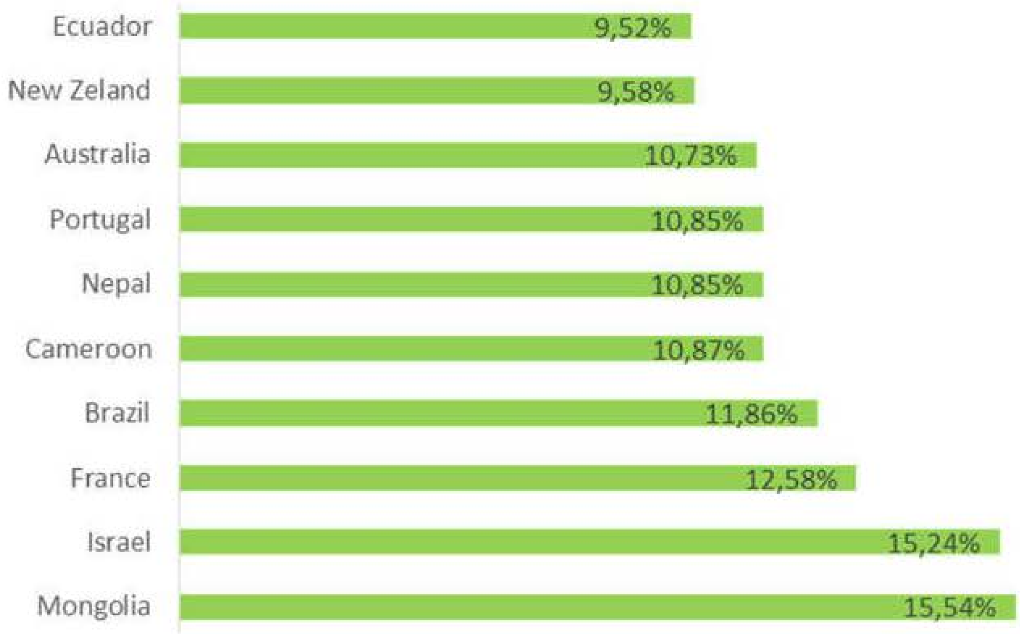

Fig. 19.3 2020 countries most targeted by phishing ([25])

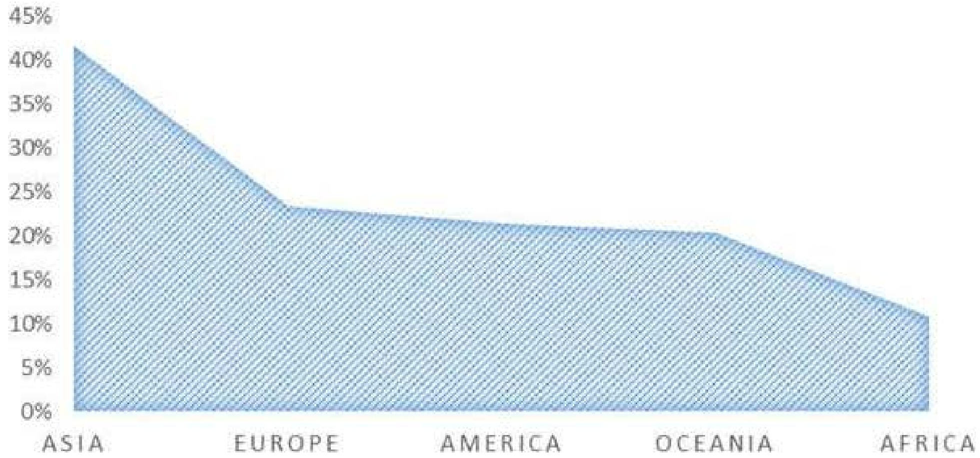

Fig. 19.4 2020 phishing impact of phishing attacks

affected the continent. The difference between the other continents is not relevant (Fig. 19.4).

In the case of SMiShing, this approach is carried out by sending SMS messages or other messaging applications for smartphones, usually containing a link that directs the victim to a form, requesting some answers that may vary, such as updating a registration and redemption of premiums, among others. This technique has as main objective the collection of personal information such as credit card data, bank access passwords, access credentials to social networks, and e-mail events.

QRishing is another approach through QR codes that are very present in our daily lives; through a reader we can access a wide range of information and services. The problem being that the maliciously modified QR code appears in public places where legitimate codes normally exist. When the QR code is scanned, you are redirected to a fake website that puts the user's safety at risk.

Vishing is defined as the practice of obtaining information or trying to influence actions over the phone. The purpose of this method is to obtain valuable data that can contribute to the direct commitment of an organization or individual, exploring people's willingness to help. During a vishing attack, the attacker impersonates someone who can build a bond of trust with the victim, such as a customer service or support employee [23, 25].

Social engineering is a field of study of greater relevance in that all people and organizations have data, information, and knowledge that should not or cannot be shared and that, in a totally digital world, specific care is increasingly needed to keep data private.

Privacy is another problem, since most mobile applications have access to huge amount of data and store it in the cloud.

The use of healthcare participative sensing for delivery of healthcare to citizens raises new challenges at security and privacy levels.

There are still a lot of confusion about the legal status of the data collected from mobile devices, and it's not clear the level of authority that agencies have over the smart devices of citizens and organizations.

The European Union has established laws and guarantees of personal privacy that affect data collected or transmitted to devices based in Europe, which has created some stir, since the laws must affect transactional negotiations with non-European countries [22].

In the case of the United States, the Federal Trade Commission is providing information and supply to the users with doubts and questions about mobile data practices.

19.6 Conclusion

The ubiquity of modern technologies allows for constant monitoring of the daily activities of citizens, making communication technologies the bridge between the real world and the virtual world, by promoting digital interactions and transactions.

Sensing applications for smart healthcare area use technologies that assist in hospital management through remote monitoring, in order to detect problems that can compromise the health of a patient in real time, through sensors interconnected in different parts of the body. Then the sensor networks allow remote monitoring of the patient's vital signs, as well as the storage and transmission of information in real time.

Data, and the exchange of sensitive information between people, between objects and between people and objects in wireless medical sensor networks make data security a priority issue. Communications must be protected, guaranteeing authentication, access control, confidentiality, integrity, availability, and irreversibility.

Although the wireless sensor network devices facilitate the control and monitoring of functions and devices, inevitably they can also cause the vulnerability of devices and network [23]. These devices handle highly personal health data, some of which have life support functions; security attacks on connected health devices can put the patient at risk for life.

The privacy and security of health information is a particularly delicate matter; it is essential to keep people's data safe. Constant innovation in this area is critical for eHealth systems to remain relevant. Data security and the adoption of secure privacy measures will evolve along with intelligent healthcare systems.

The new perspectives for the provision of health services and the popularization of these mobile devices can contribute to the reduction of health expenditures, minimization of medical errors, prevention of unnecessary hospitalizations, and expansion of the possibilities for interaction between patients and health professionals.

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