INTERNET OF THINGS WILL CONTRIBUTE TO SHIFT HEALTHCARE SERVICES DELIVERY

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Managing rapidly increasing aging population, individuals with chronic conditions or frequent outburst of disease epidemics are putting the capabilities of healthcare and social systems from most of the world's regions to the test [1]. To cope this challenges, the next evolution in healthcare, that will be experienced during the 20's decade, will move services delivery from a clinic-centric to patient-centric treatment where each healthcare agent (hospital, patient or services) is seamlessly connected to each other [2]. The current technological revolution will ease this transition by supporting all aspects of patient's life such as vital signs monitoring, emergency situations management, rehabilitation strategies, and medication management. In particular, the tremendous growth in mobile devices, sensors, wearables and applications able to monitor physiological signs; the wide availability of wireless connectivity; the increasing knowledge-based capital; and the rise of digital economy are becoming Internet of Things (IoT) a main pillar of smart-healthcare solutions to provide patients with a more comprehensive and personalized care. IoT allows to handle heterogeneous communications and information flows that involve multiple healthcare providers and hence improving the cost-efficiency, reliability, quality and timeliness of healthcare services delivery. Consequently, IoT appears as technology to develop consistent, suitable, safe, flexible and energy-efficient solution that healthcare services demand [3].

The Internet of Things (IoT) is an ecosystem of interconnected persons and things (physical objects, software and hardware) that interact at anytime and anywhere to enrich and make our lives easier. IoT is a "new evolution of the Internet" [4] and it is forecasted than in 2020, 25 billion things will be connected to the Internet [2]. In particular, Internet of Medical Things (IoMT) is the interconnection between not only numerous personal medical devices but also between devices and healthcare providers [5]. IoMT combines both the reliability and safety of traditional medical devices and dynamicity, genericity and scalability capabilities of traditional IoT [5]. To implement those personal connected things, IoT systems are developed over a particular layered-architecture composed, from bottom to top, of: a *sensing layer*, where on-body and on-object devices collect respectively personal and environmental signals ; *network layer* responsible of transferring signal and data captured; *processing layer* that allows raw signal analysis, storage, classification/clustering data techniques, semantic interpretation of information; and *application layer* aimed at enabling the interaction with users [6]. Nowadays, a new "cloud of things" [2] is emerging by combining the increasingly important cloud computing concept with IoT to bring new capabilities of storage, analysis, networking, security and real-time processing to smart-healthcare applications.

The catalogue of IoT applications in healthcare is broad and extensive and abundant solutions can be classified in multiple areas as: mHealth for remote monitoring and personalized treatment; Ambient Assisted Living for supporting aging and individuals with disabilities; medication and treatment adherence control; monitoring falls or other emergency situations; patient surveillance in hospital premises; chronic disease early diagnosis and management; functional rehabilitation; teleconsultations; sleep and daily habits control; smart medical implants; early detection of patient's deterioration or health anomalies; population health management; hospital resources management [1], [4] [2].

Thus, IoT through numerous and cost-effective wearables and applications might promote for instance a healthier lifestyle for elderly people and reduce the onset of functional decline and chronic diseases. Among other benefits that IoT could bring to healthcare are increasing patient empowerment and satisfaction; better health self-management and awareness thanks to real-time feedback; higher user acceptance, availability and comfort due remote monitoring by low cost and portable devices; and health improvements by tailored recommendations based on patient historical data. From a healthcare system perspective, IoT could provide better efficiencies in resource management and enable reducing admission rates and costs in healthcare, improving chronic disease care and hence increasing population health level. The economic and business opportunity of IoT in healthcare cannot be underestimated because it is expected to grow to a global market size of $300 billion by 2022 [3] covering medical devices, systems, software, and services.

However, IoT implementation is not exempt of challenges to achieve a successful integration in healthcare centers and hospitals as well as in the uncontrolled user's living environment. Special attention must be paid in security vulnerabilities about medical data accessing and sharing, hardware devices functioning, as well as patient data privacy and confidentiality. Therefore, robustness, resilience and security requirements must be considered as early as possible in the design process of IoT systems. Moreover, the growth of heterogeneous IoT platforms might imply a lack of interoperability between devices and applications carrying low service reuse and end-user dissatisfaction, worsening sometimes by a lack of adoption of medical data interoperability standards. Besides, heterogeneity of data sources and devices, and also the medical context itself might lead to confidentiality, long-term reliability and transparency issues. Other technical devices' features as memory and battery life can also alter such usability. On the other hand, high level of reasoning in IoT applications must be guaranteed to suggest patients with appropriate advice messages about health outcomes since it can affect usability experienced when using IoT technology. Thus, fulfilling the user requirement is the main factor affecting the wide adoption of IoT, and always the patient's safety must be protected at the same time quality-of-service is ensured.

Pedro A. Moreno Sánchez
RDI Expert/ Researcher
PhD, PMP®
Seinäjoki University of Applied Sciences
School of Health Care and Social Work

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