Health 4.0: How Digitisation Drives Innovation in the Healthcare Sector

Bahar Khayamian Esfahani[1*], Melania Bause[1], Dirk Schaefer[1]

University of Liverpool, School of Engineering, Division of Industrial Design

[1]melania.bause@liverpool.ac.uk, [1]b.khayamian-esfahani@liverpool.ac.uk, [1]dirk.schaefer@liverpool.ac.uk

Abstract

Driven by networked Electronic Health Record systems, Artificial Intelligence, real-time data from wearable devices with an overlay of invisible user interfaces and improved analytics, a revolution is afoot in the healthcare industry. Over the next few years, it is likely to fundamentally change how healthcare is delivered and how the outcomes are measured. The focus on collaboration, coherence, and convergence will make healthcare more predictive and personalised. This revolution is called Health 4.0. Data portability allows patients and their physicians to access it anytime anywhere and enhanced analytics allows for differential diagnosis and medical responses that can be predictive, timely, and innovative. Health 4.0 allows the value of data more consistently and effectively. It can pinpoint areas of improvement and enable decisions that are more informed. What it also does is help move the entire healthcare industry from a system that is reactive and focused on fee-for-service to a system that is value-based, which measures outcomes and ensures proactive prevention (Thuemmler, Bai, 2017). In this paper, the authors discuss how digitisation is paving the way for data-driven innovation in the healthcare systems. They elaborate on the opportunities and challenges for all stakeholders involved and discuss how emerging technologies can help overcome the inherent rigidity of today's healthcare ecosystem. Following on from this, the authors explain the importance of research on the actual design of smart healthcare products and product service systems of the future and the challenges faced from the viewpoint of design practice.

Keywords: design research, health 4.0, health services, innovation, digitisation

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1. Introduction

A growing ageing population and the rise in the number of people living with long-term conditions are leading to an increasing demand for resources to support healthcare (Bause et al. 2019). According to the UK National Statistics (2018), the worldwide population is ageing at a significant rate. In 2015 there were around 901 million people over 60 years of age which is 12.3% of the world population and further statistics show that by 2030 there will be an increase of 1.4 billion or 16.4% and by 2050 increase of 2.1 billion or 21.3%. It is therefore increasingly important to provide an equal and equitable healthcare system for the most vulnerable in our society including the elderly and those in remote areas who have limited access to regular healthcare provision. In the last few years, however, "healthcare organisations have been facing several critical issues, such as patient safety, quality of service, financial constraints and budget reductions." (Merone et. al., 2018). Studies have shown that "a significant number of patients are harmed during health care, either resulting in permanent injury, increased length of stay in health care facilities, or even death." (WHO, 2018). Furthermore, as Stuckler et al. (2018) have discovered, a political agenda of austerity, like those many countries in the EU, are adopting, has led to significant job losses in healthcare (Stuckler et al., 2018). This, in turn, has resulted in a "reduced quality of service" and further implications of declining health such as an increase in suicides and homelessness (Stuckler et al., 2018). There is therefore great evidence to suggest that new approaches and solutions to healthcare are required (Bause et al. 2019). Recent technological advancements in Information and Communication Technologies (ICT) are now extending to healthcare (including AI, VR, AR, MIoT, big data), which brings about a so-called Health 4.0 revolution. As Bause et al. (2019) discussed the paradigm shift in healthcare is shifting towards technology-enabled care services (TECS). This shift benefits both patients and physicians (NHS, 2018) and its benefit are being recognised with the UK government planning to significantly increase TEC solutions by 2020 (Great Britain. Department of Health & Social Care, 2014). The plan is to empower patients to access health data and track their information for preventive care, support and treatment (Great Britain. Department of Health & Social Care, 2014). The empowerment of patients, however, is only one facet of Health 4.0 and the technologies it encompasses in several fields.

The aim of this paper is to explore innovation in the healthcare sector through the digitisation of the healthcare system and its data-driven innovation. It draws on the Health 4.0 opportunities and challenges and has opened the next stage of the research which is concerned with investigating, understanding and assessing the full spectrum customer requirements from the perspectives of all

stakeholders involved. This opens new avenues for further research on the design of smart healthcare products and product service systems of the future from the viewpoint of design practice

2. Digitisation in Healthcare

The process of converting physical information onto a digital platform has initiated to transform the healthcare system since industry 4.0. Adopting technologies such as AI (Artificial Intelligence) for the means of collecting valuable data has revolutionised the healthcare sector today and for the future. Bause et al. (2019), defined health 4.0 as "a strategic concept for the health domain derived from the Industry 4.0 concept" The term is often used synonymously with digital health, m-health, e-health and smart health (Thuemmler and Bai, 2017). The virtualisation in healthcare results in personalisation for patients, professionals and other stakeholders as well as the overall improvement of the health industry with digital technologies. Briefly, Health 4.0 can be described as a phenomenon to improve healthcare service and improve connectivity between health care stakeholders using such technologies. According to a recent case study by Forbes magazine, the following five are game-changing technologies in the healthcare of the future: AI, AR (Augmented Reality), Big Data, Blockchain and wearables (Forbes, 2019). With this in mind, innovation in healthcare is mainly driven by adopting state of the art technology and applying it to the rigid and traditional system.

The economist J. Schumpeter (Topol, 2012) popularized the term "creative destruction" to denote transformation that accompanies radical innovation, some have adopted the term and name it the creative destruction of medicine. And the aforementioned five game-changing technologies are in the process of disrupting the system in beneficial terms as well as in challenging ones. For instance, Wearable Health Devices (WHD) such as smartwatches, wristbands, smart glasses, mobile ECG's, mobile glucose monitor etc., are increasingly receiving attention and being gradually certified as medical devices by legislative authorities such as FDA in the U.S. or EMA in Europe. These technologies generate an abundant amount of data, hence the term big data accumulated from numerous sources including "electronic health records (EHRs), medical imaging, genomic sequencing, customer records, pharmaceutical research, wearables, and medical devices, to name a few." (NEJM Catalyst, 2018). Big data in healthcare separates itself from conventional databases due to its complexity and diversity in format, type and context they are difficult to merge. But then again it offers a significant advancement in treating patients and lowering costs through "the wealth of information that healthcare data analytics provides, caregivers and administrators can now make better medical and financial decisions while still delivering an ever-increasing quality of patient care." (NEJM Catalyst, 2018).

3. Digitisation in Healthcare: Design

To move on from the preceding section, this next part will take a closer look into the role of design in an era of digitising healthcare. Although there has been an enormous investment in innovation over the past decade, the magnitude of opportunities for innovators has yet to be discovered. Vink et al. (2018), suggest integrating research on service design and institutional work in order to change the institutional arrangements with innovative models. According to Vink et al. (2018): "Service design is a collaborative and creative approach focused on imagining and enabling new forms of value co-creation between actors" and where, "simply put, institutions are the enduring, underlying "rules of the game" (Vink et al., 2018). The authors suggest service design practices as an enabler of institutional work and suggest that these practices can contribute to the development of more adaptive healthcare systems.

Bause et al. (2019), discussed the key role of design in the transformation of smart healthcare systems and how healthcare is delivered with increasing effectiveness and efficiency. An integral role of design, in improving smart healthcare systems, starts with understanding and influencing the experience of patients for the best possible outcome (Cooper & Tsekleves, 2017). One of the identified current challenges in smart healthcare solutions is that they are often technology-driven without the involvement of the end user (Taylor, 2015). A further challenge remains, therefore, in the enhancement of the patients' participation and engagement in their own health. The incorporation of human-centred design has the potential to reduce risk and ensure patient safety which is of the greatest importance. Human-centred design (HCD) is a creative approach to problem-solving that prioritises understanding human needs in order to develop products, services, and systems that are understandable, usable and desirable for people (Norman, 2013). And as the trend moves towards empowerment of patients and personalised medicine, the HCD priorities play a key role in the process. Major companies such as Apple and Google have already joined the platform for innovation in healthcare and since the launch of the activity tracker, Fitbit back in 2007, apps and wearables have been exploding the market. Although, most of these devices and technologies are wellness and fitness oriented and not approved legitimately as health monitoring devices. This recent emerging focus on personalised healthcare has optimised the value of human-centred design to enhance the development of healthcare centred on patients' experience. This has also raised the contribution of the current global design firms such as IDEO to create innovatively personalised and patient-centred healthcare services (IDEO, 2018). The next section will continue with identifying potential benefits in the development of a digital healthcare system.

The majority of research content found on digital health, innovation and design in healthcare maintain a balance between beneficial and non-beneficial outcomes. As for design research; "design is becoming a recognized activity within the context of health care, with an increase in the use of design methods and approaches in development and research." (Partridge. 2017). As it is primarily

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intended, the digitisation in healthcare will lead to greater advantages for patients and their practising physicians. "As a trillion dollar industry spread over hospital care, clinical services, dental care, nursing homes, home healthcare, medications, and research and development, healthcare can greatly benefit from digitization. In fact, it already uses technology to ensure better patient management and care." (Harrison. 2018).

4. Opportunities and Challenges

There have been identified opportunities within the development of digitising healthcare. This revolution operates on the collection of data, big data is at the benefit of all stakeholders involved from patients and healthcare providers to designer and technology companies. Which opens up the challenging side of the transition, the social aspect of gathering and storing personal information has its own regulations. As Prof Hofmann says: "Innovation cycles relevant to society are not possible without an ethical, legal and political overview". (TUM, 2019)

However, research in design is the essence of a successful product, as well as it is in satisfying peoples' desirability. In designing for healthcare the greater challenge would be the gathering of qualitative and quantitative data, but with new technology, there is a path for collaboration. Design research is operating on a gigantic platform of information, gathered through the internet, remote video chat studies, connection base around the globe. At the same time, these options make the world smaller and a more accessible place. However, the practice of learning about people's behaviour and cultural understanding will not diminish through -new technology- from the traditional way design research is conducted. Therefore, we need a framework to guide companies with standards to consider all these aspects for designing smart healthcare systems. What mostly has been noticed from the information for this paper is a unified notion amongst authors in regards to technology assisting human lives, a form of coexistence.

5. Conclusion

This paper draws on innovation in health 4.0 mainly enabled through digitisation. It reviews the potential impact of technology advances for the means of transforming patients experience and enhancing the service in healthcare.

The potential impact will allow interconnectivity between healthcare stakeholders, technicians and designers. All in conjunction to provide healthcare services, systems and devices in order to carry out preventative health and treat acute and chronic conditions. However, there are challenges regarding data security, big data storage and the experience between patient-physician, which need to be re-innovated and newly formatted.

Challenges faced from the viewpoint of design practice are for example the inclusion of all demographics, from the active fitness group to elder generations. Designs need to clarify the language of the device and systems created and make it accessible for all users and stakeholders involved.   Further research is required to address and overcome these challenges and to develop a framework to guide stakeholders and designers which can contribute and make an impact in designing for healthcare. In this paper, the authors have gathered information on healthcare in the digital age and vice versa. The information stated draws from a large pool of research in the field of digital health (health 4.0), design research and innovation in healthcare. But most written evidence and case studies published meet one notion, to use technology for the means of transforming patients experience and enhancing people's health/wellbeing.

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