DISSERTATION TITLE

The Implications of Immersive Technologies in the Healthcare Sector and its Built Environment

ACADEMIC RATIONALE

1. Introduction

The COVID-19 pandemic has accelerated disruptive innovation in the healthcare sector to come up with new ways of delivering healthcare services and futureproofing them in the post-pandemic era. Extended Reality (XR), an umbrella term for immersive technologies including Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR), can offer both physical and psychological experience by merging the virtual and real worlds (Marr, 2019). The AR healthcare market is expected to generate £7.6bn in revenues, with the VR healthcare market reaching £1bn in 2024. An early adoption of XR in public health services ais the most impactful use cases, addressing some of the biggest global challenges from COVID-19 (Kilkelly *et al*., 2021). Incorporating immersive technologies into the healthcare built environment presents a full range of opportunities in six key areas: (i) promoting mental health and wellbeing; (ii) assisting physiotherapy and rehabilitation; (iii) enhancing surgical procedures and pain management; (iv) training healthcare professionals and educating patients; (v) diagnosing or treating disorders and pathologies; and (vi) advancing design and construction of healthcare facilities (Piatkowski, 2020; Mousavi, 2021; NHS, 2021).

Figure 1. Immersive Technologies in Healthcare (Adobe Stock, 2022)

Such opportunities do not simply mean the transition of healthcare resources from real-world to virtual space, because healthcare premises must evolve accordingly to them. Consequently, a built environment professional should play a significant role in creating a long-standing value chain in which the virtual reality becomes an integral part of the healthcare industry. In addition, the implementation of immersive technologies can reinforce the sociological characteristics of healthcare facilities as it can alleviate health inequities by increasing access to healthcare services during public health crises (Marr, 2021). In this context, this research aims to examine the implications of immersive technologies in the healthcare sector and its built environment through the systemic review of extant literature and the synthesis of empirical evidence from cross-national cast studies.

2. Literature Review

Staff Relaxation and Retention

In 2020, NHS Health Education England's Technology Enhanced Learning (TEL) published "a national vision for the role of simulation and immersive learning technologies in healthcare for enhancing education, clinical practice, and staff wellbeing" (NHS, 2020a&b). Rest and recuperation of healthcare staff should not just be seen as a short-term response to the pressure of working through backlogs, but as a long-term commitment of mitigating a global workforce crisis in healthcare industry. Harnessing digital technologies enables us to reimagine new models of care and levels of workforce agility (NHS Providers 2017; Britnell, 2019; Charles and Ewbank, 2021; RCN, 2021) and immersive technologies have been supporting the mental health and wellbeing of frontline healthcare staff during the COVID-19 pandemic (Pizzoli *et al.*, 2019; Putrino *et al.*, 2020; Riches *et al.*, 2021). For example, Mount Sinai in the US transformed underused areas into nature-inspired '*Recharge Rooms'* for hospital's staff. Cardiff University in the UK provided staff and wider teams with AR/VR devices with the choice of contents, ranging from a football match to a guided journey through a rain forest (Smallman, 2020; Mayberg, 2021). Spanish company Broomx Technologies (2021) described a multi-sensory environment for the wellness therapies of healthcare staff as the *'Humanization of Hospital Spaces'*.

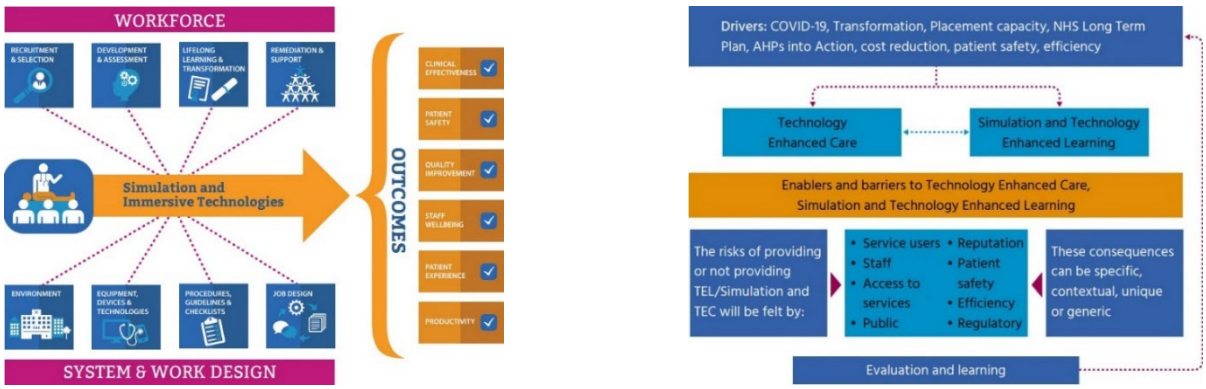

Figure 2. TEL Framework for Immersive Technologies in Healthcare (NHS HEE, 2020)

Interoperable Medicines and Clinical Governance

VR combined with robotics and artificial intelligence can assist surgical procedures and virtual training courses. For instance, the XR navigation helps surgeons by reducing operation time, blood loss, and adverse event (Sugimoto, 2020). Cambridge NHS Foundation Trust and GigXR co-create evidence-based holographic acute care simulations for multi-professional training (IVRHA, 2022). Northumbria NHS Trust allows patients to wear VR headsets to reduce the needs of general anesthetic or heavy sedation for limb surgery. AR/VR sessions help patients in physiotherapy and rehabilitation face real-life challenges in a safe and controlled way (Ticho, 2020; NHS, 2020). Also, the reminiscence therapy for dementia patients can incorporate VR technology (Saredakis *et al*., 2021; Tominari *et al*., 2021).

To foster a '*Risk-free XR*' in the UK healthcare industry, Kilkelly *et al*. (2021) suggests the establishment of the Centres of Excellence, facilitating collaborative R&D to exchange knowledge; global digital exemplars; product development; regulation and quality assurance; procurement frameworks; and distribution through virtual pharmacies.

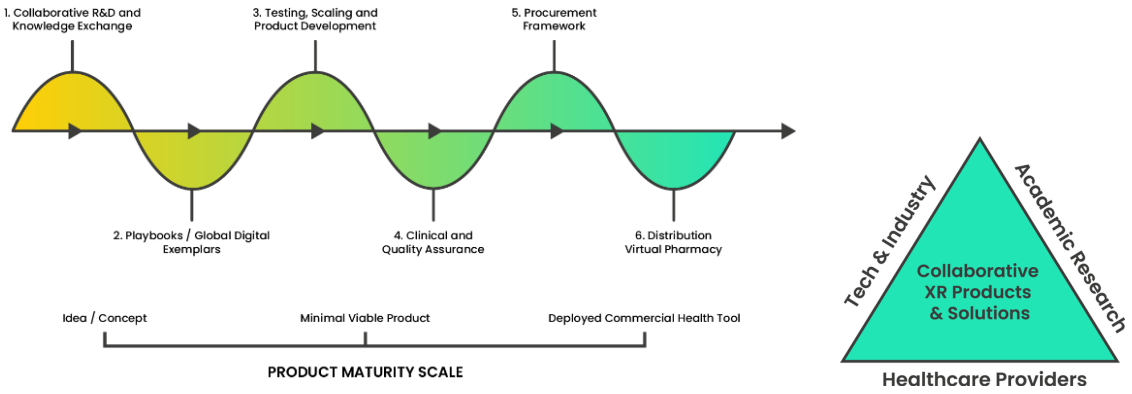

Figure 3. Mapping out Risk-free XR in Healthcare (Kilkelly *et al*., 2021)

Interdependence between Virtual Hospital and Built Environment

According to the 2021 Q4 Emerging Technology Sentiment Analysis, XR overtakes artificial intelligence as the most disruptive technology. As an open platform for virtual collaboration and real-time interaction, the rise of metaverse in healthcare can contribute to the advancement of population health and wellbeing (Ameen, 2022; Orr, 2022). Although the arbitrary scarcity of virtual property is a subject of ongoing debate (Baketon, 2022; Canales, 2022), there will be interaction between virtual and real-world healthcare premises. For instance, Seoul National University Hospital gave lung cancer surgery training through a metaverse platform in a smart operating room (Song, 2021). Also, the new forms of real estate value (Edkins, 2018; Edkins *et al*., 2021) will be generated through the new models of care, which involves three major technological trends: telepresence, digital twinning, and blockchain (Marr, 2022). The physical healthcare platforms integrating immersive technologies, as the next phase of telemedicine and telesurgery, will result in "better prevention and quicker responses to health crises at scale" by enhancing one-on-one personal care through therapeutic medical settings if we can tackle some challenges: greenhouse gas emissions by massive electricity usage; cybersecurity and protection for health data; and ethical implications (ARUP, 2020; Kilkelly *et al*., 2021; Rosenberg, 2022).

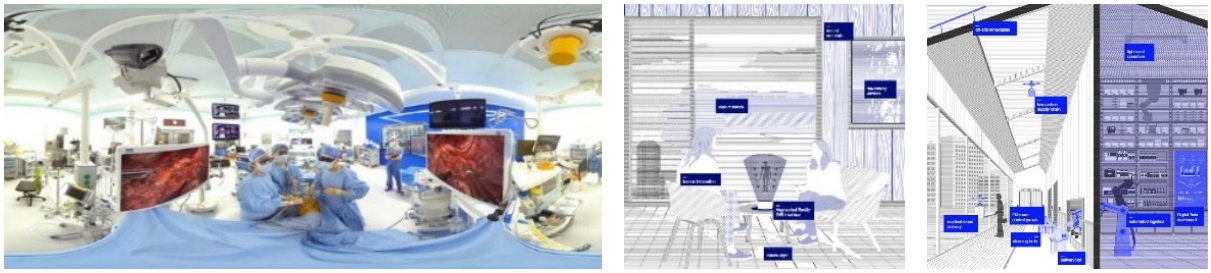

Figure 4. Smart Operating Room with Metaverse Platform (Song, 2021); Future Healthcare Ecosystems (Arup, 2020)

3. Research Questions

Three critical research questions arise as to,

i. How the immersive technologies contribute to the advancement of healthcare services to improve population health and wellbeing in the post-pandemic era?

ii. What are the risks/challenges that hamper a further development and a wider spread of XR applications for clinical purposes?

iii. What are the roles of built environment professionals in creating a long-standing value chain of healthcare premises undergoing transformation by immersive technologies?

4. Methodology

This research uses three methods:

i. A series of direct interviews using emails or video conferences with industry leaders or academic scholars who understand the latest trends of immersive technologies in healthcare industry.

ii. A systemic literature review of monographs and articles in academic journals to understand an agreed body of knowledge or different accounts/approaches of immersive technologies used for medical purposes.

iii. A systemic literature review of governmental reports, private sector research and surveys to synthesise empirical evidence from cross-national case studies of comparing the applications of immersive technologies in healthcare sector.

STATEMENT OF FUND USAGE

Above all, personal guidance and support from a mento practitioner will be a great help to make sure the quality of MSc dissertation dealing with a relatively new area of research. The awarded funds will be used only for costs directly related to the research and will not be used for personal or other non-research expenses. The original copies of receipts, invoices or bills will be exhibited as adequate evidence to verify all expense claims. The lists of possible expense claims are as follows.

- Books or pay-to-download research papers that are essential for the research

- Professional or scholarly journal subscriptions
- Computer software, if necessary
- Registration fees to attend conferences on immersive technologies
- Clerical and administrative help including library fees
- Membership in professional organisations relating to immersive technologies
- Costs to visit any XR-related events (e.g. Dopamine Land London)
- Transportation costs to conferences, libraries, or research sites

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