INTERNSHIP REPORT

Towards smart hospitals

Examining the use of Industry 4.0 in hospitals and the associated benefits: An international perspective

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Executive summary

Introduction. Hospitals are experiencing an increased burden due to ageing societies and demanding patients, which requires enhanced efficiency in inpatient services, resource utilization, and clinical outcomes. Digitization in healthcare has been proven to have positive effects on alleviating the pressure on hospitals, reinforced by the Electronic Health Record (EHR) and medical apps that have created a new wave of data. With the use of emerging technologies such as the Internet of Things (IoT), big data analytics, and robotics, the current trend of Industry 4.0 builds on digitization with cyber-physical systems (CPS) to leverage connectivity between and integration of processes. Industry 4.0 originated in the manufacturing industry in order to improve production processes and create smart factories. Its value in such industries is well understood; however, to date, the Industry 4.0 environment in hospitals remains underexplored. Therefore, in order to examine the value of Industry 4.0 for hospitals, this study aims to explore how hospitals can use Industry 4.0 to become a smart hospital, and reap the benefits of this transformation.

Theory. The Sustainable Industry 4.0 Framework by Kamble et al. (2018) and the Business Benefits Framework by Shang and Seddon (2000) were integrated to develop the conceptual framework of this study and examine the Industry 4.0 environment in hospitals, resulting in a process framework with the concepts "Industry 4.0 technologies," "process integration" and potential "hospital benefits."

Methods. A qualitative research design was chosen for this study due to the explorative nature of the research topic. Using purposive and snowball sampling, 16 in-depth interviews were conducted face-to-face and over phone with top- and middle-management executives from hospitals in six different countries: the Netherlands (N=7), the United Kingdom (N=3), South Korea (N=2), the United States of America (N=2), Canada (N=1) and Australia (N=1). Interviews were transcribed verbatim and content was analysed iteratively with the conceptual framework using open, axial, and selective coding.

Results. Emerging technologies such as IoT, big data analytics, and robotics have a high potential to integrate hospital processes when a proper IT infrastructure is established, including interoperability of systems and consideration of data quality and analytics capabilities. It was identified that smart assistance tools are able to integrate hospitals processes using integral information and communication systems, wayfinding, and asset tracking. Associated benefits of successful smart hospital transformation were identified—both those experienced as well as those envisioned. The primary benefits identified were increased care quality and safety, (clinical) decision-making support, improved IT capabilities, and a new vision of data sharing.

Discussion. Hospitals in different countries included in the study demonstrate different stages of smart transformation, which has resulted in divided smart hospital maturity. The existing literature

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demonstrates that the readiness for smart hospital transformation generally is doubtful for most hospitals; a digital strategy is needed that considers the priorities of hospitals in their transformation process. An addition to the conceptual framework is proposed to include hospitals' readiness to transform into a smart hospital. The international nature of the study has been demonstrated as an important strength of this study, which outweighs the possible limitations of phone interviews.

Conclusion. It has been revealed that Industry 4.0 has a high potential to create value for hospitals and offer benefits related to improved operations, management, IT infrastructure, and organizational vision. As hospitals are divided in their readiness for the smart hospital transformation process, it is recommended that hospitals prioritise their digital strategy and act accordingly. This way, hospitals will more likely fully harvest the potential of Industry 4.0 and transform into a smart hospital.

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