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Healthcare 4.0: Technological innovation in healthcare

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ABSTRACT
Data processing is a very important topic in all professional sectors, which is also valid for the global health system, which has been suffering from the exponential increase in demand for its services, on the other hand, investments are stagnant and do not follow the natural evolution of processes. Thus, aiming to achieve the sustainability of its system, an ally proved to be extremely important in this search, Industry 4.0 and its artifices. The use of disruptive technologies arising from Industry 4.0 seeks to promote the health system, making it more efficient, safer, and more sustainable in several spheres. The concepts of healthcare 4.0 and Lean Healthcare emerged. With the objective of patient well-being and safety, the use of these technologies promises to make health lean, reducing unnecessary expenses, streamlining the process as a whole and mitigating possible errors, from the storage and transfer of data to the execution of intra and extra-hospital processes, in addition to facilitating access and reducing distances. with telemedicine, for example.

Keywords: Healthcare 4.0, Lean Healthcare, Agile methodologies, Information security, Sustainability.

INTRODUCTION

The search for continuous improvement in strategic sectors leads us to think about the concept of Industry 4.0, also known as "The fourth industrial revolution" (SCHWAB, 2018). This reality is already known by many who belong to the industry sector, as well as in other areas that are looking for an update to new trends, that is, that follow this evolution. When it comes to the health area, the concept of Healthcare 4.0 emerges, bringing the incorporation and adaptation to the disruptive technologies of Industry 4.0 to the environment of care, prevention, promotion and health care. Healthcare 4.0 is an ideology whose main ideal is to find and propose solutions that automate and simplify tasks, based on technologies, in order to reduce errors in the processes of health institutions, in addition to optimizing all phases of the line of care and data storage and access to health, through technological subsidies and other advances. In line with the aforementioned concept, another model also proposes significant improvements within the health system, Lean Healthcare, whose definition reinforces and highlights the search for waste reduction, making processes leaner and, consequently, also more sustainable (SCAVARDA et al., 2019b).

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Health institutions at their various levels of care have been suffering from increased expenses and every day there is an exponential increase in patient demand, with higher costs, making care expensive and, on the other hand, the investment in optimization in agility in the area does not grow in the same proportion. This results in unsatisfactory care for most patients.

In addition to the patients' perception of the satisfaction of the process, the equally important view of the health professionals, directly involved, deal daily with the impact in various proportions, whether in the time involved in the actions, in the recording of data, in the effective communication with the patient, in the verification of possible errors, among other issues.

One of the key features involved in this process is based on data management. Currently, there is a large amount and diversity of data being generated and extracted in an increasingly qualified way and being presented in the form of reports. These reports, in turn, bring information with great potential to generate value in asset management, and are even considered as the main ones of an institution.

The culture of the evolution of Healthcare is a theme whose origin goes back a long way and to this day it is still developing.

In the nineteenth century, there was a great loss of life due to a series of epidemics, due to various reasons, such as the lack of basic sanitation, the lack of medicines, and the difficulty of disseminating information. Subsequently, other countries also adopted this practice, generating worldwide repercussions in the eradication of diseases. Another major achievement was the development and availability of vaccines, which was fundamental for the control of epidemics. At that time, the first industrial revolution (mid-eighteenth and early nineteenth centuries) was taking place, also known as industry 1.0. In healthcare, the term is known as Healthcare 1.0.

The second industrial revolution (industry 2.0) emerged in the mid to late nineteenth century and ended in the twentieth century, during the second world war. The concept of mass production line was inaugurated in industries, where products were produced on a large scale and consequently made it possible to reduce their cost. The health area followed the same line of evolution and introduced the concept of Healthcare 2.0, taking advantage of the benefits brought in this new era, such as feasibility and wide distribution of various medicines, such as antibiotics, which began to be produced on a large scale, which resulted in greater access to the population as a whole. The medical field expanded a lot in this period, there was a significant increase in hospitals and professionals in the area received incentives and greater training to deal more deeply with various diseases.

Evolution continued to work intensively and at the end of the twentieth century, more precisely in the 1980s, microcontrollers appeared, allowing the manufacture of the first affordable, smaller computers (before microcontrollers, the few devices that existed were huge, occupying large rooms, making access unfeasible for the general population). With the use of computers more comprehensively, it was possible

to accelerate the evolution of health, then called Healthcare 3.0. In this way, it was possible to apply technology in favor of health, enabling optimization in several sectors, such as some exams that started to be extracted by digital images, diseases could be diagnosed in advance, ease of storage and transfer of information, which resulted in agility in the process of patient care.

Healthcare 4.0, also known as the era of intelligent medicine, emerged in the 21st century, along with the fourth industrial revolution, where the focal point is the use of cutting-edge technology, which has had an extremely significant and very fast advance, compared to previous revolutions. Health 4.0 has a range of technologies in its favor, a theme that will be addressed and deepened throughout this study (CHEN, et al., 2020).

OBJECTIVE

This study aims to analyze how the use of Industry 4.0 technologies and their resources can make the health system more efficient, safe and sustainable. A review of the literature on Lean Healthcare, Healthcare 4.0 and Agile methodologies in supply chain management was carried out and the impact that the use of technologies can add to the health system was evaluated.

METHODOLOGY

The methodological proposal was based on an exploratory case study, of a qualitative nature, integrating the literature review. The following guiding question will apply: How can technology interfere with the functioning of a health institution?

For the literature review, search equations were constructed based on keywords and connected to the theme. The Portal of Journals of the Coordination for the Improvement of Higher Education Personnel (CAPES) was the database for the search for articles. This research methodology was chosen with the intention of facilitating the identification of the technologies used and what can be improved, generating information that can guide the implementation of new technological resources.

DEVELOPMENT

Currently, with the growth in demand for high-performance health services, it is becoming increasingly essential to invest in innovative technologies in health institutions. In this scenario, the new digital tools have the power to act in several points, such as they can avoid human errors, to which every professional is subject, whether with protocols, process and people managers, adjustment of steps to be followed or even avoid the use of manually written documents, which would bring possible confusion of readability, thus ensuring that patients receive adequate and agile treatment and care, regardless of the stage of the process.

In addition to what has already been mentioned, high-performance services require subsidies so that health professionals can have their processes facilitated and optimized, allowing the main focus on care, as well as speed in the execution of tasks, prescriptions, understanding of commands, management of specific protocols for applicable diagnoses and treatments. This contribution is mainly at the level of the use of its resources to focus on a more humanized service during contact with the patient, without losing proximity and agility. In this sense, the use of technology in medical areas is a growing competitive advantage in the world, aiming to automate what is feasible, as well as to facilitate the understanding and application of processes in health care and promotion, as well as to allow longitudinality in care, with information properly recorded in an effective and intuitive electronic medical record.

The search for increased quality in the health system is a global challenge, whether in the public sector or in the private service. Health institutions need investments and every day the situation tends to follow the same path of decline. The increase in requests for medical services is remarkable, but investments in this area do not keep up with demand.

The use of technology in favor of health is the starting point to achieve the concepts that funnel into the same goal, which is to transform it into sustainable health. The concepts of Healthcare 4.0 and Lean Healthcare demonstrate that it is possible for the healthcare system to become sustainable (SCAVARDA et al., 2019a). With the use of technological methodologies from Healthcare 4.0, which refers to Industry 4.0, health care follows the same perspective and, consequently, the trend of increasingly incorporating health into the digital sphere, since the benefits are broad and directly and indirectly applicable in daily life.

Technologies based on Artificial Intelligence can, in the long term, transform the way surgeries are performed, and may one day even bring remote surgeries, for example. It is possible to see one of these advances being applied, through the use of robotic technology in surgeries, making the process faster, more ergonomic and safer for the surgeon, in addition to reducing complications, postoperative pain and peace of mind for the patient, exemplifying how the technology has already been implemented and directly impacts the execution in health, perceived by the professional and the patient.

Decision-making can be exponentially streamlined, mitigating possible and varied human errors, in addition to the use of technological redundancy, which ensures accessibility and stability in access in case of equipment failure. When a failure occurs, other equipment takes over the process in a natural way, avoiding bottlenecks that could cause errors and/or slowdowns in the process as a whole. Facing the severe crisis of the COVID-19 pandemic, for example, showed how essential and valuable it was for digital data to be available when requested (VILELA JUNIOR; PASSOS, 2021).

In this sense, technology assumes importance in the context of effective and organized data storage and availability, in addition to systematizing notifications, facilitating epidemiological data collection and,

mainly, adjusting protocols that allow rechecking of requests, prescriptions, and medications, with the objective of minimizing specific human errors.

Another example is the concept of the "new normal" left by the COVID-19 pandemic, where many tasks could be performed remotely, excluding the obligation to be physically in the same place. This was rethought and analyzed so that these tasks could be performed efficiently, whether in the healthcare setting or not. Remote health care, which made it possible not to eliminate, but to reduce overcrowding in hospitals, consequently also reduced the contagion of diseases transmitted within the hospitals themselves. There was the possibility of increasing productivity and the level of care in general, reducing costs that currently overload hospital management and make sustainability in the health system unfeasible. In addition, it also allowed and facilitated access to health care, allowing a patient to be evaluated, as far as possible, at a distance, without having to expose themselves to possible contagions or even transmission, as well as speeding up access to health.

It is known that the beginning of this process, as already mentioned, was mainly motivated by the COVID 19 pandemic, however, it represented a step that continues to be applied and improved, in order to allow quick and safe access to those who, for some reason, cannot physically attend the health unit, regardless of the reason.

On the one hand, this thinking has extended to all areas and some companies have adopted the home office model, where the employee works from their own home, avoiding waste of time with traffic, unnecessary agglomerations and bringing cost reduction to companies. In addition, it can significantly increase production. On the other hand, not all services can be performed remotely, especially when it comes to the health service, in which there is often a need for an adequate physical examination for complete guidance. From the combination of these two ways of working, the hybrid and multidisciplinary scenario emerges, with face-to-face and/or remote care, where each case must be analyzed in a unique and individual way, in order to extract the best possible conduct for each patient.

Lean Healthcare can add value to the study, enabling a sustainable process for the health system, as it shows, through technological resources, how to reduce waste that constantly occurs in health institutions, whether they are materials, such as paper, for example, or non-physical resources, but which end up wasting time, unnecessary exams, among other factors. This waste ranges from fixing errors in the supply chain to excellent patient care (DAÚ et al., 2019). Sustainability represents a topic of significant importance, since human beings have been producing more and more content and have not always thought about how to reduce or improve production, in order to avoid waste.

FINAL THOUGHTS

Healthcare 4.0 can propose solutions that automate tasks, mitigating errors in processes, in addition to reducing waste costs, which can be difficult to map without technological support (SOUZA, 2015).

The use of technologies in favor of health has been highlighted worldwide. Big Data exponentially increases data processing capacity (MARQUESONE, 2016), while Business Intelligence extracts and transforms data into extremely valuable reports, both are very powerful tools, among others that also have prominence in this sphere.

A healthcare institution that is a reference in Healthcare 4.0 involves the use of specific technologies that streamline medical work, minimize errors in hospital processes and, at the same time, focus on the well-being and safety of patients. The new management methodologies will also work together with the new software and hardware (NETTO; NÓVOA, 2019). This is the case of Lean Healthcare, a strategy inspired by Lean Manufacturing, used in the industrial area, which involves organizing processes so that there is a gain in productivity in health teams, increased patient safety and reduced waste of resources and time.

The results demonstrate the benefits that health institutions now have by becoming a reference in Healthcare 4.0, making use of specific technological solutions. Such solutions contribute to the automation, simplification and streamlining of medical and nursing tasks, reducing costs and mitigating errors in hospital processes. At the same time, they seek the well-being and safety of patients, adding value not only to institutions, but also to the social environment as a whole.

This study has a positive and multidisciplinary impact, integrating professionals and students from different areas, which aims to carry out revolutionary research in the field of Healthcare 4.0, since it covers a large area within the suggested scope, focusing on innovation and the use of technologies in the health area, involving several areas of global interest for the proposed theme.

REFERENCES

Ulbrich, H. C. (2004). Universidade H4CK3R. São Paulo: Universo dos Livros.

Carmona, T. (2002). Universo H4CK3R. São Paulo: Digerati Books.

Lakatos, E. M., & Marconi, M. A. (2001). Metodologia do trabalho científico: Procedimentos básicos, pesquisa bibliográfica, projeto e relatório, publicações e trabalhos científicos (6th ed.). São Paulo: Atlas.

Sosinsky, B. (2011). Cloud Computing Bible (1st ed.). Wiley.

Hugos, M., & Hulitzky, D. (2010). Business in the Cloud (1st ed.). Wiley.

Rhodes-Ousley, M. (2013). Information Security the Complete Reference (2nd ed.). McGraw-Hill.

Bosworth, S., & Kabay, M. E. (Eds.). (2014). Computer Security Handbook (6th ed.). Wiley.

Mather, T., Kumaraswamy, S., & Latif, S. (2009). Cloud Computing and Privacy (1st ed.). O'Reilly Media.

Tulloch, M., & MSFT. (2014). Network Virtualization and Cloud Computing (1st ed.). Microsoft Press.

Daú, G. L., Scavarda, A., Scavarda, L. F., & Portugal, V. J. T. (2019). The Healthcare Sustainable Supply Chain 4.0: The Circular Economy Transition Conceptual Framework with the Corporate Social Responsibility Mirror. Retrieved from https://www.mdpi.com/2071-1050/11/12/3259

Magrani, E. (2018). A Internet das Coisas (1st ed.). Rio de Janeiro: Editora FGV.

Marquesone, R. (2016). Big Data: Técnicas e tecnologias para extração de valor dos dados (1st ed.). São Paulo: Editora Casa do Código.

Mataric, M. J. (2014). Introdução à Robótica (1st ed.). São Paulo: Editora Blucher.

Netto, A. V., Berton, L., & Takahata, A. K. (2022). Ciência de dados e a inteligência artificial na área da saúde (1st ed.). São Paulo: Editora dos Editores.

Netto, A. V., & Novoa, C. (2019). Fundamentos em gestão e informática em saúde (1st ed.). São Paulo: UNIFESP.

Scavarda, A., Daú, G. L., Scavarda, L. F., & Korzenowski, A. L. (2019a). A proposed healthcare supply chain management framework in the emerging economies with the sustainable lenses: The theory, the practice, and the policy. Resources, Conservation & Recycling, 141, 418-430. https://doi.org/10.1016/j.resconrec.2018.10.027

Scavarda, A., Daú, G. L., Scavarda, L. F., & Caiado, R. G. G. (2019b). An Analysis of Corporate Social Responsibility and Industry 4.0 with Focus on the Youth Generation: A Sustainable Human Resource Management Framework. Retrieved from https://www.mdpi.com/2071-1050/11/18/5130

Chen, C., Loh, E., Kuo, K. N., & Tam, K. (2020). The Times They Are a-Changin' – Healthcare 4.0 Is Coming! Journal of Medical Systems, 44(40). https://doi.org/10.1007/s10916-019-1513-0

Schwab, K. (2018). A Quarta Revolução Industrial (1st ed.). São Paulo: Edipro.

Souza, T. A. (2015). Lean Healthcare: Aplicação dos Conceitos de Gestão de Operações em Centros Cirúrgicos. Retrieved from http://www.repositorio.jesuita.org.br/handle/UNISINOS/5157

Stender, G. H. C. (2016). Lean Healthcare: Modelo de Implantação da Ferramenta Kanban a um Almoxarifado de um Hospital Federal no Rio de Janeiro. Retrieved from pppro.cefet-rj.br/T/376_Gustavo Henrique Cordeiro Stender.pdf

Vilela Junior, G. de B., & Passos, R. P. (2021). Inteligência Artificial nas Ciências da Saúde (2nd ed.). Campinas: CPAQV.