

Exploring the Impact of Open Innovation in the Healthcare Sector: A Multiple Case Study Analysis

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Abstract

Open innovation has gained increasing relevance in the healthcare sector as a tool to promote innovation and address emerging challenges. This paper explores the role of open innovation in the context of healthcare, analysing how healthcare organizations adopt and implement this strategy to enhance healthcare delivery and foster collaboration among various stakeholders. Employing a research approach based on a literature review and empirical case analysis, the paper examines the effects of open innovation on innovation capabilities, healthcare quality, and industry efficiency. The results indicate that open innovation stimulates innovation in the healthcare sector by facilitating knowledge sharing, collaboration among diverse actors, and the adoption of new technologies. However, significant challenges remain, such as safeguarding sensitive patient data and managing relationships with industries.

Keywords: Open innovation; Healthcare sector; Innovation capabilities; Collaboration; Industry efficiency; Multiple case study

Introduction

Innovation in the healthcare sector is a crucial necessity to address the increasingly complex and dynamic challenges characterizing the modern healthcare landscape. As the healthcare industry faces growing demands for quality care, cost savings, and personalized solutions for patients, open innovation has emerged as a promising strategy to foster innovation and tackle these emerging needs.

Open innovation is a collaborative approach that breaks traditional organizational barriers and encourages cooperation among various stakeholders, such as companies,

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academic institutions, government bodies, and even patients themselves (Secundo et al., 2019). This concept is based on the idea that organizations can benefit from external sources of knowledge, expertise, and resources, as well as engage a broad network of actors (i.e. ecosystem) to co-create innovative solutions (Chesbrough et al., 2014; Howson & Davies, 2018).

In the healthcare sector, open innovation offers a range of opportunities. Healthcare organizations can benefit from sharing scientific and medical knowledge among experts from different institutions, fostering the discovery of new therapies and treatment approaches. In fact, collaboration with the technology industry can lead to the adoption of cutting-edge technologies to enhance medical practice, diagnosis, and patient data management. Furthermore, open innovation facilitates increased patient participation in decision-making and care planning. This proactive patient engagement can lead to tailored solutions, enhanced care quality, and higher patient satisfaction.

However, the implementation of open innovation in the healthcare sector is not without challenges. Protecting sensitive patient data, compliance with regulations, and ethical considerations are critical aspects to be considered. Additionally, managing relationships among various stakeholders requires striking a balance between knowledge sharing and safeguarding intellectual property rights.

For these reasons, it appears interesting to gain a better understanding of the dynamics concerning open innovation in healthcare. With this aim, the present paper explores the role of open innovation in the healthcare sector, analysing the effects of this strategy on innovation, healthcare quality, and sector efficiency. Through a combination of literature-based research and empirical case analyses, the paper aims to provide an in-depth insight into the benefits and challenges that open innovation can bring to healthcare.

Theoretical background

The term 'open innovation' was coined and defined by Chesbrough (2003) as a "paradigm that assumes that firms can and should make use of external ideas as well as internal ideas, and internal and external paths to market, as they seek to advance their technology". Open innovation (OI) can be categorized into two types: outside-in and inside-out, also referred to as inbound and outbound, respectively (Bogers et al., 2018). The outside-in approach involves opening processes to various forms of external inputs and contributions, whereas the inside-out approach requires organizations to permit underused and unused ideas to depart the organization for exploitation by external entities. The amalgamation of internal and external knowledge results in heightened openness; hence, interpreting the transparency of the innovation process as an opportunity rather than a threat (Dodgson et al., 2006).

Within this framework, open innovation is closely connected to the concept of an ecosystem that integrates resources from various sectors through the active involvement of external stakeholders such as businesses, universities, non-profit

organizations, and incubators, to collaborate and share novel ideas and solutions (Deloitte, 2023). In fact, open innovation strategies find application in various contexts, including the public sector (Kankanhalli et al., 2017; Mergel, 2021), financial services (Schueffel & Vadana, 2015; Fasnacht & Fasnacht, 2018), museums and exhibition spaces aimed at enhancing visitors' experiences (García-Muiña et al., 2019), tourism (Iglesias-Sánchez et al., 2019; Hermawati et al., 2020), as well as the power and energy sector (Greco et al., 2017).

Within the scope of this study, the relevance of open innovation's contribution to the healthcare sector holds significant importance. Salge et al. (2013) developed a project-level contingency model for open innovation within healthcare, suggesting that unless specific boundary conditions are in place, the costs of embracing open search practices could outweigh their benefits. Furthermore, substantial costs and challenges are associated with new product development (NPD) projects, not only during the identification of external knowledge but also in the assimilation and utilization of such information. Moreover, the advantages of search openness during the ideation phase of NPD projects are evident only when these projects are exploratory in nature, guided by experienced leadership, or bolstered by robust workgroup support. Salge et al. (2013) additionally emphasize that the successful implementation of open innovation strategies hinges on the contextual environment in which they are integrated (Grimpe & Sofka, 2009).

Indeed, in alignment with the success of products, Chatterji & Fabrizio (2014) posit that collaborative efforts between medical device firms and physicians significantly impact the introduction of new medical products and devices. Chitour (2014) tackled the declining profits in the pharmaceutical industry by advocating a shift from a "closed model" to a novel "open innovation" approach, predicated on the collaboration of pharmaceutical companies with biotech firms, Contract Research Organizations (CROs), academia, or local pharmaceutical manufacturers. Aakhus et al. (2017) discovered a plethora of hybrid forms characterized by varying degrees of openness within hospital innovation centers, underscoring the potential and necessity for the wider adoption of innovative practices in the healthcare sector.

Moreover, Weng & Huang (2017) expound upon the influence of exploration and exploitation learning on organizational innovativeness within health service organizations, employing an open innovation perspective. Their findings indicate that the breadth and depth of external knowledge acquisition directly impact organizational innovativeness through the realization of absorptive capacity.

About the topic of privacy and security of patients, the subsequent outcomes presented by Herselman & Botha (2017) highlight privacy and security as pivotal value-based considerations in handling health data. Moreover, their results suggest that a specific innovation model should facilitate co-creation and collaboration, enabling users and stakeholders to generate opportunities for leveraging digital health within this ecosystem. Herselman & Botha (2017) assert that opportunities and challenges connected to preventive health innovation encompass shifts in attitudes

and behaviours among diverse stakeholder groups and individuals targeted to engage with preventive health solutions.

Concerning the technological innovation, the advancement of digital health in South Africa is aimed at enhancing the accessibility, availability, and delivery of healthcare services. This initiative also seeks to bolster the nation's strategic capabilities in conceiving, adapting, and implementing innovative digital health solutions across both the public and private sectors (Herselman & Botha, 2017). Davies et al. (2019) delve into the pertinent policy landscape and the evolving portfolio of innovations within AgorIP, investigating the emergence of social commerce innovation in healthcare management. AgorIP exemplifies open innovation as a strategy for orchestrating opportunities emanating from diverse sources and, notably, offers a pathway to address the enduring challenge of absorptive capacity within the core components of the healthcare system (Davies et al., 2019).

Moreover, the study by Park & Maine (2019) examines the formation, mechanisms of open innovation, financing, and value generation among companies specializing in technologies related to personalized medicine. Meanwhile, Shehzad et al. (2021) conducted an exploration of the influence of knowledge-oriented leadership (KOL), knowledge infrastructure capability (KIC), and knowledge process capability (KPC) on open innovation (OI). The research findings affirm that KOL plays a relatively minor role in the inbound OI of the organization, while KIC and KPC significantly impact OI (Shehzad et al., 2021). Lastly, Orlando et al. (2021) delve into the relationship between open innovation and intellectual property, revealing a connection between intellectual property, the level of innovation of European firms, expenditures in open innovation, and governmental expenditure in healthcare.

Therefore, this research focuses on comprehensively understanding the impact of open innovation in the healthcare sector. The study begins with an extensive literature review to establish a solid foundation, covering theoretical frameworks, concepts, findings, and key variables pertinent to open innovation in healthcare. Additionally, a multiple case study approach is employed to deeply examine the outcomes of implementing open innovation strategies within healthcare. The selected cases provide detailed insights, combining those from sources like Web of Science and Elsevier's Scopus with supplementary cases from secondary resources. This synthesis of literature and case studies enables a thorough and insightful analysis of the research topic.

Methodology

The systematic literature review was performed by means of the databases Web of Science (WoS) and Elsevier Scopus, and the extraction of the documents took place on the 17th of July 2023. More specifically, Table 1 summarises the methodology adopted and the results obtained on each database for the keyword string *health AND "open innovation"*. The quotation marks were used in order to not obtain as a result documents containing individual words (e.g. "open", "innovation") distributed randomly; instead, documents containing only the following formula "open

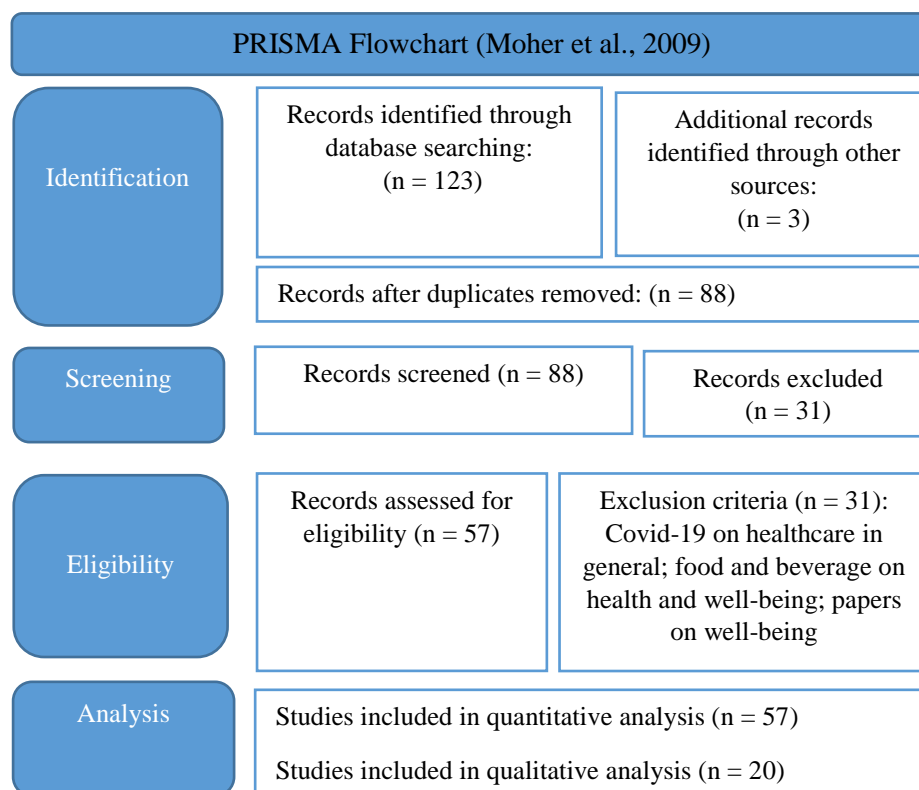
innovation". Furthermore, the Boolean operator AND acts as a logical conjunction between the two prepositions *health* and “*open innovation*”.

Table 1 Search protocol and results (Source: Authors’ elaboration)

Keyword selection	Web of Science	Scopus
Keywords <i>health AND “open innovation”</i> in Title, Abstract and Keywords	136	320
Category filter		
WoS (<i>Management, Business</i>)	48	89
Scopus (<i>Management, Business, Accounting</i>)		
Years 2013-2023	45	78

The PRISMA Flowchart consisting of four phases identified by Moher et al. (2009) will be used as a reference (Table 2). In particular, *Identification* – the initial database search produced n=45 (WoS) and n=78 (Scopus) items while other sources produced n=3 items, hence a total of 126. Duplicates were removed, thus leaving a total of 88 records to screen using the selected inclusion/exclusion criteria. Subsequently, *Screening* - the application of the exclusion criteria (n=31), the remaining records (n=57) were eligible for further assessment.

Table 2 PRISMA Flowchart (Moher et al., 2009)



The third phase *Eligibility* – concerns the inclusion and exclusion criteria. The inclusion criteria represent the elements that studies must possess in order to be considered in the systematic literature review. In this case, the inclusion criteria include the following:

- Studies on open innovation in healthcare;
- Studies on the impact of new technologies in the health industry;
- In particular, studies including case studies on open innovation in the healthcare sector.

The exclusion criteria represent the elements that studies must lack to be excluded from the systematic literature review. In this study, the exclusion criteria are the following:

- Papers that focus on the impact of Covid-19 on the healthcare industry;
- Papers that focus on the role of food and beverage on health and well-being;
- Papers on well-being in general because the aim was to concentrate on the healthcare sector.

The fourth phase *Analysis* – concerns the final stage of the review, hence the quantitative and qualitative analysis of the selected records.

Results

1. Quantitative analysis

The purpose was to observe the following elements in studies containing the keyword string *health AND "open innovation"* and following the inclusion/exclusion criteria:

- The years in which the studies were published;
- The document type.

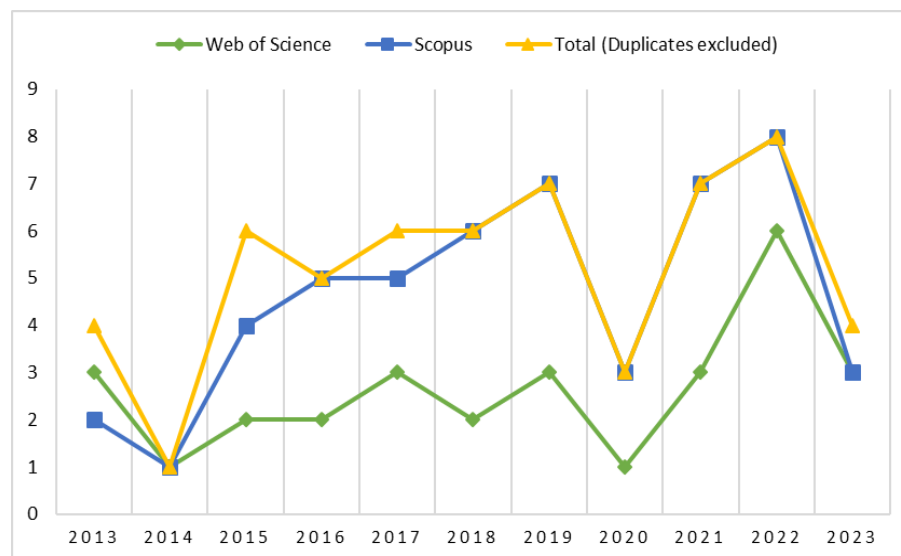


Figure 1 Years (Source: Authors' elaboration)

The analysis of the years is essential in order to gain a clearer view of the results including the course of study of these topics over the years, while the document type to understand the type of contribution.

Figure 1 shows the number of articles achieved using the keyword combination *health AND "open innovation"* and the inclusion/exclusion criteria. In particular, the yellow line (*Total – Duplicates excluded*) in Figure 2 reveals that there has been an increase in the number of studies on the aforementioned topics beginning from 2015 (n=6) onwards until 2019 (n=7) followed by a decrease in 2020 (n=3) and a subsequent increase in 2021 (n=7) up to 2022 (n=8). With regards to the type of contribution, it is possible to observe in Figure 3 the type of publication containing the keyword string *health AND "open innovation"* following inclusion/exclusion criteria.

In Figure 2, the yellow columns show that most of the contributions were articles (n=38), followed by conference papers (n=12), book chapters (n=4) and lastly reviews (n=3).

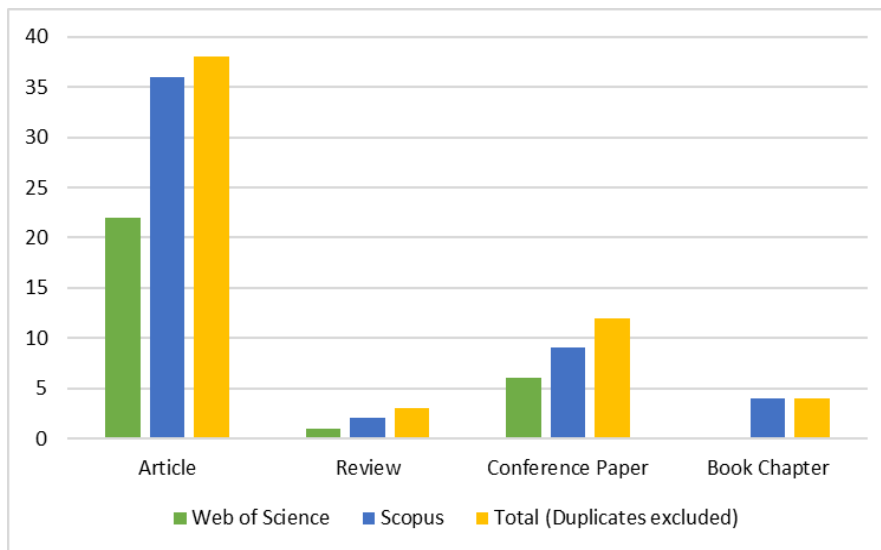


Figure 2 Document type (Source: Authors' elaboration)

2. Qualitative analysis

Category	Case study	Innovation effects	Impact on sector efficiency	Future challenges
Process	A case study of GVK Emergency Management and Research Institute (George et al., 2015)	The authors present a case study on an Indian public-private partnership which successfully brought emergency medical response to remote and urban settings.	The case emphasises the need to innovate organisational design and governance modes to create a new opportunity that combines state actors, private healthcare providers and community at large.	To address organizational and implementation challenges (e.g. the challenge of scale, coordination, and sustainability) to identify best practices, causality, contingencies and boundary conditions of when inclusive innovation occurs and how such innovations can be considered a success to empower the impoverished.
	A case example: Patientrack (Savory & Fortune, 2015)	The Patientrack case presents the elements of OI in knowledge flows between organizations in a network (e.g. ecosystem).	The case illustrates the interaction of a medical technology company, a university, the government and the users of the technology within a teaching hospital. The case emphasizes the importance of knowledge production and the necessary infrastructure to support OI.	Understand how user-driven innovation can fit into the broader strategic requirements of health systems and consider how it can facilitate the building of effective relationships between all four of the quadruple-helix model (centrality of users, firms, citizens, public sector).

	<p>Main agents and sources in the Portuguese case (Fernandes et al., 2017)</p>	<p>Optimisation of internal processes.</p> <p>Results reveal an increasing focus on knowledge and services that have led to greater openness towards innovation.</p>	<p>Addressing new trends and rapid changes</p>	<p>To further investigate the topic using additional datasets to assess changes in terms of innovation agents/sources and scale/scope of application, and ascertain the effectiveness of OI trends</p>
	<p>A healthcare infrastructure case (Dehe et al., 2022)</p>	<p>Benchmarking enabled the organisation to identify and pursue partnerships and best practices to improve its OI mechanisms, while integrating business strategy and the voice of the customer.</p> <p>Benchmarking is the main channel for OI (process, product, incremental and radical), directly influencing the determinants of OI.</p>	<p>Benchmarking appeared to be effective in directly supporting the organisation in managing its OI, learning and knowledge capabilities.</p>	<p>This research adopted a qualitative and qualitative and exploratory approach. Future research could employ a survey to quantitatively test the significance of benchmarking on OI.</p>
<p>Technological</p>	<p>Open Source Drug Discovery (OSDD), (Masum et al., 2013)</p>	<p>OSDD aims to achieve affordable health care through a platform where gifted minds can collectively discover novel therapies, promote openness and collaboration to the drug discovery process, and keep drug costs low.</p>	<p>The platform provides bioinformatics tools, biological information, data on the pathogens, projects for participation in drug discovery, and discussion forums. The purpose of OSDD is to facilitate collaboration and knowledge exchange between participants in terms of ideas, software, articles, IP to solve these</p>	

			issues.	
	School of International Biodesign, India (Gabriel et al., 2017)	HiCARE LIMO is a successful innovation device designed for caregivers working with patients who have suffered traumatic injuries aimed at temporarily immobilising injured limbs in trauma patients for pre-hospital care.	The technology was utilized to treat nearly 30,000 patients in over 16 states in India.	
	The Open Medicine Project, South Africa (TOMPSA) (Gabriel et al., 2017)	TOMPSA refers to the collaboration of healthcare workers, researchers, mobile technology designers and developers in developing smartphone applications to confront problems related to the healthcare sector in the developing world.	TOMPSA developed simple and practical mobile applications covering HIV, tuberculosis, emergency and primary healthcare.	
	A mini-case on commercializing FRESH bioprinting technology (Thakur et al., 2018)	It is crucial to incorporate OI approaches into both new entrants and large entrants business models' entering the 3DBP market considering the interdisciplinary nature of 3DBP (three-dimensional bio-printing).	The OI approach will drive technological development and benefit product design, new market insights, customer contact and business model innovation.	

The Isinnova case (Tani et al., 2022)	The technology can become a valid alternative to traditional supply chain in terms of price and production outcome when combined with an OI approach and when the company is able to harness the power of networks and social media.	The authors explain the potential of 3DP technologies in helping hospitals and other healthcare providers respond to emergencies or unforeseen situations more quickly and adaptively without having to resort to the traditional supply chain channels.	Future research should investigate these aspects using a quantitative approach to comprehend them in order to help managers adopt these technologies when beneficial.
The case of Tunisia (Abbassi et al., 2022)	The case defines an innovation based on 3D printing technologies in order to provide personal protective equipment to healthcare professionals. The authors describe the transition from a local collaborative model to the creation of a national ecosystem which is able to design, produce and respond to the growing needs of the public health system.	The creation of a national ecosystem capable of developing and offering equipment for public hospitals.	To involve less developed, innovative and digitised countries. In addition, multiple case studies will provide a more comprehensive view of the contribution of fostering innovation in time of crisis. To also investigate the role of open-source innovation and the maker movement in combating environmental or social crisis.
Case study: a Finnish Health Innovation Lab (Santarsiero et al., 2023)	Digital transformation (DT) offers new ways to address quality of care, medical practice, management and, in general, value creation for all actors in a healthcare ecosystem.	The implementation of DT in healthcare involves considering both technological, political, social, cultural and economic aspects in innovation and service delivery and the involvement of different actors in the healthcare ecosystem.	

Strategic	Case Study: El Salvador LL (Platz et al., 2016)	The LL (Living Lab) in El contributes to the creation of risk awareness for risk mitigation to optimise the socio-economic, health and environmental situation LL in Southern Africa.	The LL research strategy encourages user-centric, collaborative, open, and multidisciplinary research to foster creative and long-term solutions for community's difficulties.	
	The Brazilian Community Health Agent Programme (Gabriel et al., 2017)	Family Health Teams operating in the São Paulo periphery have used intelligence gathered by community health agents (CHAs) to apprise workshops on different health topics and concentrating on populations that had been identified as being particularly at risk.	The assessments of the Family Health Strategy (FHS) model have revealed great satisfaction among users and it offers better health outcomes (e.g. large reductions in infant mortality, reduced mortality from cardiovascular diseases, improved detection of neglected tropical diseases).	The model has only been applied to local service provision, but it has the potential to contribute to larger-scale research and innovation.
	The NHS Innovation Accelerator (Gabriel et al., 2017)	It's a fellowship programme supporting clinicians, SMEs and academics to advance their innovations within the NHS (i.e. National Health Service) in order to improve health outcomes.	The main focus is to create the culture and conditions to expand innovation.	
Co-creation	Innovation insights from the Welsh Life Sciences and Health Ecosystem	Innovation plays a significant role in overcoming social and economic barriers that hinder the development of the healthcare system, hence improving healthcare for patients and driving economic growth.	Innovation in healthcare comprises an ecosystem that promotes the interaction between actors belonging to both the public and private sector. The transparency of the ecosystem has a major role in encouraging collaborative relationships and in identifying access to	

	(Howson & Davies, 2018)		external knowledge, expertise and resources.	
	InDemand EU project ecosystem (Pikkarainen et al., 2020)	The purpose of InDemand EU project is to develop and test a new needs-driven OI approach where innovation challenges are identified and evaluated by experts. In the project, healthcare organisations and companies innovate and co-create digital health solutions with the business support provided by the intermediate organisations.	Findings demonstrate that the developed OI model can be used to strengthen digital health governance and enhance knowledge transfer and communication between ecosystem actors.	
	A Case Study of Hospitals as Innovation Platforms (Hyrkas et al., 2020)	<p>The project aims to improve the innovation culture of the health sector and to create new businesses and practices.</p> <p>Co-creation enables different professions to work on the same goals, strengthening collaboration within the organisation.</p>	<p>The co-creation model directs healthcare organisations in their collaboration with businesses and other stakeholders to co-create new needs-based healthcare solutions.</p> <p>Co-creation activities have an impact on the hospital's innovation processes and products utilised by healthcare staff on a daily basis.</p>	<p>To focus on how to effectively engage and motivate managers and experts in co-creation processes.</p> <p>To comprehend how the findings fit into the holistic innovation processes of healthcare enterprises.</p>

	A comparative case study on three citizen science projects hosted By Zooniverse (Ciasullo et al., 2022)	The authors investigate OI in healthcare through the citizen science phenomenon, which involves lay people in research initiatives aiming at advancing scientific knowledge.	The development of a strong healthcare ecosystem that depends on the voluntary contributions of lay people is the result of citizen science. Citizen science promotes lay people's education and empowerment by encouraging them to participate actively in service co-production and value co-creation.	To comprehend citizen scientists' participation in projects aimed at democratising scientific knowledge production in healthcare. To evaluate citizen scientists' contributions to scientific knowledge advancement.
Intellectual capital	A case study in telemedicine (Pellegrini et al., 2022)	COVID-19 strained healthcare systems and required the rapid introduction of innovative healthcare technologies. The authors investigate how OI influences the IC to provide effective and timely innovative solutions during crises.	It is shown, by distinguishing between ex-ante and ex-post OI in the COVID-19 outbreak, that ex-post OI can build on the IC reinforced by ex-ante IO and thus enable higher performance needed to combat the pandemic.	
Overcome barriers	Case Studies: Five DemenTalent Initiatives (Ooms & Piepenbrink, 2021)	OI is highly suited to producing and implementing innovative solutions to difficult challenges. The authors created a proximity framework that identifies solutions to better control openness in such a situation.	The authors studied five OI initiatives adopting a particular health service innovation. Results show that variations in proximity between partners are correlated with their ability to overcome OI barriers and their ability to adopt the service innovation despite the complexity of the problem.	

Table 3 Multiple case study (Source: Authors' elaboration)

Conclusion

This paper has provided a comprehensive exploration of open innovation within the healthcare sector. Through a systematic review of the literature, coupled with a detailed analysis of case studies, a multifaceted understanding of the intricacies and implications of open innovation in healthcare has emerged. Specifically, the analysis of each case study has highlighted the effects of innovation, its impact on sector efficiency, and the future challenges associated with each type of innovation (process, technological, strategic, co-creation, intellectual capital, overcome barriers).

Within the specific realm of healthcare, open innovation plays a pivotal role in optimizing internal processes (Fernandes et al., 2017). One such process identified as highly effective is benchmarking, which enables healthcare organizations to effectively manage their OI initiatives while enhancing their capacity for learning and knowledge acquisition (Dehe et al., 2022). In addition, George et al. (2015) prominently underscore the imperative of innovating organizational design and modes to foster the emergence of novel opportunities that support a network of actors. Moreover, the Patientrack case elucidates the significance of interaction and knowledge exchange within a network that delivers mutual benefits and advancements (Savory & Fortune, 2015). Further research is required to address organizational and implementation challenges of when inclusive innovation occurs and how such innovations can be considered a success to empower the impoverished (George et al., 2015). In addition, it is necessary to understand how user-driven innovation can fit into the broader strategic requirements of health systems and how it can facilitate relationships between in an ecosystem (Savory & Fortune, 2015). Moreover, further investigation is required using additional datasets to assess changes in terms of innovation agents/sources and scale/scope of application, and ascertain the effectiveness of OI trends (Fernandes et al., 2017). Finally, Dehe et al. (2022) suggest to adopt a quantitative approach to test the significance of benchmarking on OI.

In the context of technological innovation, it was observed that OI approaches do not only facilitate technological development, but also yield significant benefits in terms of product design, new market insights, customer engagement, and business model innovation (Thakur et al., 2018). By leveraging OI practices in conjunction with advanced 3DP technologies, hospitals and healthcare providers can effectively respond to emergencies or unforeseen circumstances in a timely and adaptive manner (Tani et al., 2022). Moreover, the implementation of digital transformation is vital in the healthcare sector as it yields new ways to address innovation and service delivery together with the involvement of a diverse set of actors in the healthcare ecosystem (Santarsiero et al., 2023). In addition, TOMPSA is related to the development of smartphone applications to confront problems related to the healthcare sector in the developing world, OSDD (i.e. Open Source Drug Discovery) to a platform where gifted minds can collectively discover novel therapies, promote openness and

collaboration to the drug discovery process and HiCARE LIMO is a successful innovation device designed for patients who have suffered traumatic injuries (Gabriel et al., 2017). Lastly, Abbassi et al. (2022) define an innovation based on 3D printing technologies in order to provide personal protective equipment to healthcare professionals. In terms of future studies, Tani et al. (2022) suggest to investigate 3DP technologies using a quantitative approach to comprehend the opportunities they could serve to managers. Abbassi et al. (2022) suggest that further studies should involve less developed, innovative and digitised countries, and in addition to investigate the role of open-source innovation and the maker movement in combating environmental or social crisis.

In the case of strategic impact of OI in the healthcare sector, for instance, the NHS Innovation Accelerator programme aims to create the culture and conditions to expand in order to improve health outcomes while the The Brazilian Community Health Agent Programme's strategy has led to substantial improvements in public health and to better access and satisfaction with services (Gabriel et al., 2017). Gabriel et al. (2017) suggest that the Family Health Strategy (FHS) model has the potential to contribute to larger-scale research and innovation. In addition, the implementation of the LL structure is to create risk awareness to identify and exploit strategies for risk minimization in the area of chronic kidney disease in patients in Central America (Platz et al., 2016).

The multiple case study analysis revealed that OI enhances co-creation in the healthcare sector, like for instance, Pikkarainen et al. (2020) describe the demand-driven OI model that improves global digital health policies, hospital personnel engagement and knowledge transfer between the ecosystem actors to co-create digital health solutions. In addition, Howson & Davies (2016) develop a framework to facilitate the co-creation of health innovation amongst actors from the Quadruple Helix. Also, Hyrkäs et al. (2020) analyse a project concerning co-creation and a collaboration model for healthcare innovations. Lastly, Ciasullo et al. (2022) investigate OI in healthcare through the citizen science phenomenon that enacts the establishment of a strong healthcare ecosystem and promotes lay people's education and empowerment by encouraging them to participate actively in service co-production and value co-creation. In the context of co-creation, future studies should focus on how to effectively engage and motivate managers and experts in co-creation processes (Hyrkas et al., 2020) and to comprehend citizen scientists' participation in projects aimed at democratising scientific knowledge production in healthcare (Ciasullo et al., 2022).

The influence of OI on intellectual capital (IC) to deliver effective and timely inventive solutions during crises is especially noteworthy, as ex-post OI can build on the IC strengthened by ex-ante IO, enabling greater performance needed to combat the pandemic (Pellegrini et al., 2022). Finally, Ooms and Piepenbrink (2021) outline

the role of OI in overcoming challenging difficulties. Their findings reveal that variations in partner proximity are connected to their ability to overcome OI obstacles and to accept service innovation despite the complexity of the situation.

In conclusion, this research sheds light on the pivotal role of open innovation in reshaping patient-centred care, therapy development, and the integration of cutting-edge technologies. As the healthcare landscape continues to evolve, further investigations into these dynamics will be vital in shaping the future trajectory of open innovation's role in revolutionizing healthcare delivery and outcomes.

References

- Aakhus, M., Ågerfalk, P. J., Samra, K., & Ozan, H. (2017). Engaging with Openness Through Common (s) Ground: Healthcare Innovation in the Networked Society. In *Perspectives in Business Informatics Research: 16th International Conference, BIR 2017, Copenhagen, Denmark, August 28–30, 2017, Proceedings 16* (pp. 199-211). Springer International Publishing.
- Abbassi, W., Harmel, A., Belkahla, W., & Ben Rejeb, H. (2022). Maker movement contribution to fighting COVID-19 pandemic: insights from Tunisian FabLabs. *R&D Management*, 52(2), 343-355.
- Bogers, M., Chesbrough, H. & Moedas, C. (2018), Open innovation: research, practices, and policies, *California management review*, 60(2), 5-16.
- Chatterji, A. K., & Fabrizio, K. R. (2014). Using users: When does external knowledge enhance corporate product innovation?. *Strategic Management Journal*, 35(10), 1427-1445.
- Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting From Technology*. Harvard Business School Press: Boston.
- Chesbrough, H., Kim, S. & Agogino, A. (2014). *Chez Panisse: building an open innovation ecosystem*. *California Management Review*, 56, 144–172.
- Chitour, H. L. (2014). Open innovation: An opportunity for Pharmerging countries to close the technology gap?. *Journal on Innovation and Sustainability RISUS*, 5(1), 19-38.
- Ciasullo, M. V., Carli, M., Lim, W. M., & Palumbo, R. (2022). An open innovation approach to co-produce scientific knowledge: An examination of citizen science in the healthcare ecosystem. *European Journal of Innovation Management*, 25(6), 365-392.

Davies, G. H., Roderick, S., & Huxtable-Thomas, L. (2019). Social commerce Open Innovation in healthcare management: an exploration from a novel technology transfer approach. *Journal of Strategic Marketing*, 27(4), 356-367.

Dehe, B., Bamford, D., & Kotcharin, S. (2022). Bespoke benchmarking framework employed as vehicle and platform for open innovation—a healthcare infrastructure case. *Production Planning & Control*, 1-19.

Deloitte (2020), *New roads to the health innovation ecosystems of tomorrow*.

Dodgson, M., Gann, D. & Salter, A. (2006). The role of technology in the shift towards open innovation: the case of Procter and Gamble. *R&D Management*, 36, 3, 333–364.

Fasnacht, D., & Fasnacht, D. (2018). *Open innovation in the financial services* (pp. 97-130). Springer International Publishing.

Fernandes, S., Cesário, M., & Barata, J. M. (2017). Ways to open innovation: Main agents and sources in the Portuguese case. *Technology in Society*, 51, 153-162.

Gabriel, M., Stanley, I., & Saunders, T. (2017). Open innovation in health. *A Guide to Transforming Healthcare through Collaboration*.

García-Muiña, F. E., Fuentes-Moraleda, L., Vacas-Guerrero, T., & Rienda-Gómez, J. J. (2019). Understanding open innovation in small and medium-sized museums and exhibition halls: An analysis model. *International Journal of Contemporary Hospitality Management*, 31(11), 4357-4379.

George, G., Rao-Nicholson, R., Corbishley, C., & Bansal, R. (2015). Institutional entrepreneurship, governance, and poverty: Insights from emergency medical response services in India. *Asia Pacific Journal of Management*, 32, 39-65.

Greco, M., Locatelli, G., & Lisi, S. (2017). Open innovation in the power & energy sector: Bringing together government policies, companies' interests, and academic essence. *Energy Policy*, 104, 316-324.

Grimpe, C., & Sofka, W. (2009). Search patterns and absorptive capacity: Low-and high-technology sectors in European countries. *Research Policy* 38 (3), 495–506.

Hermawati, A., Nurwati, N., Suhana, S., Machmuddah, Z., & Ali, S. (2020). Satisfaction, HR, and open innovation in tourism sector. *Journal of Open Innovation: Technology, Market, and Complexity*, 6(4), 182.

Herselman, M. E., & Botha, A. (2017). The value of co-creation through Design Science Research in developing a Digital Health Innovation Ecosystem for South Africa.

Howson, T., & Davies, G. (2018, September). From mind to market: Innovation insights from the welsh life sciences and health ecosystem. In *International*

Conference on Innovation and Entrepreneurship (pp. 309-XV). Academic Conferences International Limited.

Hyrkäs, P., Haukipuro, L., Väinämö, S., Iivari, M., Sachinopoulou, A., & Majava, J. (2020). Collaborative innovation in healthcare: a case study of hospitals as innovation platforms. *International Journal of Value Chain Management*, 11(1), 24-41.

Iglesias-Sánchez, P. P., Correia, M. B., & Jambrino-Maldonado, C. (2019). Challenges of open innovation in the tourism sector. *Tourism Planning & Development*, 16(1), 22-42.

Kankanhalli, A., Zuiderwijk, A., & Tayi, G. K. (2017). Open innovation in the public sector: A research agenda. *Government Information Quarterly*, 34(1), 84-89.

Masum, H., Schroeder, K., Khan, M., & Daar, A. S. (2013). Open source biotechnology platforms for global health and development: two case studies. *Open development: Networked innovations in international development*, 113-128.

Mergel, I. (2021). Open innovation in the public sector: drivers and barriers for the adoption of Challenge. gov. In *Digital Government and Public Management* (pp. 94-113). Routledge.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G. and The, P.G. (2009), "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement", *PLOS Medicine*, Vol. 6 No. 7, p. e1000097.

Mu, R., & Wang, H. (2022). A systematic literature review of open innovation in the public sector: Comparing barriers and governance strategies of digital and non-digital open innovation. *Public Management Review*, 24(4), 489-511.

Ooms, W., & Piepenbrink, R. (2021). Open innovation for wicked problems Using proximity to overcome barriers. *California Management Review*, 63(2), 62-100.

Orlando, B., Ballestra, L. V., Magni, D., & Ciampi, F. (2021). Open innovation and patenting activity in health care. *Journal of Intellectual Capital*, 22(2), 384-402.

Park, A., & Maine, E. (2019, August). The Emergence of the Personalized Medicine Innovation Ecosystem in British Columbia: Selective Revealing, Strategic Timing and Success. In 2019 Portland International Conference on Management of Engineering and Technology (PICMET) (pp. 1-9). IEEE.

Pellegrini, L., Aloini, D., & Latronico, L. (2022). Open innovation and intellectual capital during emergency: evidence from a case study in telemedicine. *Knowledge Management Research & Practice*, 1-12.

Pikkarainen, M., Hyrkäs, E., & Martin, M. (2020). Success factors of demand-driven open innovation as a policy instrument in the case of the healthcare industry. *Journal of Open Innovation: Technology, Market, and Complexity*, 6(2), 39.

Platz, M., Herselman, M., & Rapp, J. (2016). A living lab for optimising the health, socio-economic and environmental situation in El Salvador. In *Information Technology in Environmental Engineering: Proceedings of the 7th International Conference on Information Technologies in Environmental Engineering (ITEE 2015)* (pp. 125-138). Springer International Publishing.

Salge, T. O., Farchi, T., Barrett, M. I., & Dopson, S. (2013). When does search openness really matter? A contingency study of health-care innovation projects. *Journal of Product Innovation Management*, 30(4), 659-676.

Santarsiero, F., Schiuma, G., Carlucci, D., & Helander, N. (2023). Digital transformation in healthcare organisations: The role of innovation labs. *Technovation*, 122, 102640.

Savory, C., & Fortune, J. (2015). From translational research to open technology innovation systems. *Journal of Health Organization and Management*, 29(2), 200-220.

Schueffel, P. E., & Vadana, I. I. (2015). Open Innovation in the Financial Services Sector-A global literature review. *Journal of innovation management*, 3(1), 25-48.

Secundo, G., Toma, A., Schiuma, G. and Passiante, G. (2019), "Knowledge transfer in open innovation: A classification framework for healthcare ecosystems", *Business Process Management Journal*, Vol. 25 No. 1, pp. 144-163.

Shehzad, M. U., Davis, K., & Shakil Ahmad, M. (2021). Knowledge-oriented leadership and open innovation the mediating role of knowledge process and infrastructure capability.

Tani, M., Troise, C., De Bernardi, P., & Han, T. (2022). Innovating the supply chain in health-related crises: some evidence from ISINNOVA case. *European Journal of Innovation Management*, 25(6), 716-734.

Thakur, P. C., Cabrera, D. D., DeCarolis, N., & Boni, A. A. (2018). Innovation and Commercialization Strategies for Three-Dimensional-Bioprinting Technology: a Lean Business Model Perspective. *Journal of Commercial Biotechnology*, 24(1).

Weng, R. H., & Huang, C. Y. (2017). The impact of exploration and exploitation learning on organisational innovativeness among hospitals: an open innovation view. *Technology Analysis & Strategic Management*, 29(2), 119-132.