

(Re)envisioning the contribution of design to the sustainable transition of healthcare systems

*Original*

(Re)envisioning the contribution of design to the sustainable transition of healthcare systems / Pereno, Amina. - ELETTRONICO. - 2:(2021), pp. 2387-2403. (Intervento presentato al convegno Cumulus Roma 2021 'Design Culture(S)' conference tenutosi a Roma nel 8-11 June 2021).

*Availability:*

This version is available at: 11583/2939335 since: 2021-11-22T13:23:18Z

*Publisher:*

Cumulus the Global Association of Art and Design Education and Research

*Published*

DOI:

*Terms of use:*

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

*Publisher copyright*

(Article begins on next page)

# DESIGN CULTURE(S)

Cumulus Conference Proceedings Roma 2021

Volume #2

ARTIFICIAL ARTIFICIAL  
LANGUAGES LIFE LIFE LIFE  
MAKING MAKING  
NEW NORMAL  
MULTIPLICITY  
PROXIMITY  
RESILIENCE  
REVOLUTION  
THINKING THINKING

**Design Culture(s)  
Cumulus Conference  
Proceedings Roma 2021**

Volume #2

**Editors**

Loredana Di Lucchio  
Lorenzo Imbesi  
Angela Giambattista  
Viktor Malakucz

**Layout and Graphic Design**

Viktor Malakucz  
Concept for Cumulus  
Conference Proceedings  
Series was developed in  
2018 by Jani Pulkka

**Cumulus conference**

*Design Culture(s)*

hosted by

Sapienza University of Rome, Italy  
on June 8-11, 2021.

Conference website:

[www.cumulusroma2020.org](http://www.cumulusroma2020.org)

**Published by Cumulus**

Cumulus the Global Association of  
Art and Design Education and  
Research. Aalto University, School  
of Arts, Design and Architecture  
PO BOX 31000, FI-00076 Aalto  
[www.cumulusassociation.org](http://www.cumulusassociation.org)

**Copyright © 2021**

Sapienza University of Rome,  
Cumulus Association,  
Aalto University.

All content remains the property of  
authors, editors and institutes.

ISBN 978-952-64-9004-5 (PDF)

ISSN 2490-046X

Cumulus Conference Proceedings  
Series, N°7

**Cumulus Conference  
Proceedings Series**

**Editor-in-Chief**

Cumulus President  
Mariana Amatullo

**Publications in the Series**

- 01/17 Kolding,  
REDO
- 02/17 Bengaluru, Letters  
to the Future
- 03/18 Paris, To get there:  
designing together
- 04/18 Wuxi, Diffused Transition  
& Design Opportunities
- 05/19 Rovaniemi, Around the  
Campfire – Resilience  
and Intelligence
- 06/19 Bogotá, The Design  
After
- 07/21 Rome, Design Culture(s)  
Volume #1, Volume #2

# DESIGN CULTURE(S)

Cumulus Conference Proceedings Roma 2021

Volume #2

Cumulus Conference  
Proceedings Series

Cumulus the Global Association  
of Art and Design Education and Research

Rome 2021

DE  
SIGN  
CULT  
URE ( S )

---

ROMA **2021**

---

JUNE 08.09.10.11  
CUMULUS CONFERENCE



DESIGN CULTURE(S) | CUMULUS ROMA 2021  
JUNE 08.09.10.11, SAPIENZA UNIVERSITY OF ROME

# (Re)envisioning the contribution of design to the sustainable transition of healthcare systems

Amina Pereno <sup>a\*</sup>

<sup>a</sup> Politecnico di Torino, Department of Architecture and Design

\*amina.pereno@polito.it

**Abstract** | The health emergency has challenged our health systems, stressing the weakest points but also revealing the strengths to be harnessed. Among these, the concern for the environmental, social and economic aspects of health systems – gathered under the heading of sustainable healthcare – has suffered a temporary setback but will certainly experience strong growth in the post-pandemic era. During 2018 and 2019, a collaborative foresight process on the future of sustainable healthcare was conducted with over 150 healthcare stakeholders. This paper starts from the strategies that emerged from the collaborative foresight to re-read them in light of the impacts of COVID-19 on health systems. A systematic literature review mapped the effects of the pandemic on the sustainable development of health systems and, therefore, on the defined strategies. Hence, the paper defines the connections with design disciplines and the possible contribution of designers in the development of sustainable healthcare in the post-pandemic era.

**KEYWORDS** | SYSTEMIC DESIGN, SUSTAINABLE DESIGN, HEALTHCARE, SYSTEM TRANSITION, SUSTAINABLE DEVELOPMENT

# 1. Introduction

## 1.1 Origins and effects of the sustainability debate in healthcare

In 1996, the U.S. Environmental Protection Agency identified the incineration of medical waste as the main source of dioxin, one of the most powerful carcinogenic gases. For the first time, healthcare organisations realised that environmental protection had a direct link to patient care, and international associations and campaign groups gathered under the banner of the Hippocratic principle *primum non nocere* (first, do not harm). Main organisation, such as Healthcare Without Harm, addressed the substitution of impactful chemicals and pharmaceuticals, endorsed energy efficiency initiatives in health care facilities and, above all, promoted awareness raising programmes on the environmental impact of hospital routines. The results have undoubtedly been positive, but the main limit of ‘do not harm’ is that of a fragmentary vision of the health systems.

During the 2000s, the economic crisis exacerbated the problem of the environmental, social and economic sustainability of the health sector, which has always been a heavy burden on the public budgets of Western societies. New health associations and hospital organisations started addressing the issue, and medical research engaged in the debate on sustainability. Important medical journals published the reflections of health professionals questioning the socio-environmental impact of their medical specialties, as evidenced by the contribution of Sherman and Ryan (2010), among the first to tackling the challenge:

“Only through understanding the connectivity and contribution of modern health care practice to ecological issues can physicians work toward aligning commitment to individual care with public and planetary health” (Sherman & Ryan, 2010, p. 139)

As also recognised by the European Commission (2016), making health systems sustainable means to find new approaches to make them more effective, accessible and resilient. The Hippocratic principle deserves credit for having pushed medical research to question its role towards society and the planet, broadening the concept of health towards a holistic vision of well-being. However, it lacks of systematic methods to investigate sustainable healthcare, and the complexity of the issue requires a step forward to find points of convergence between different disciplines.

## 1.2 Design and medicine towards a co-disciplinary vision

The relationship between Design and Medicine consolidates in the same years of the sustainability debate in healthcare, but it focuses on topics other than the environmental ones.

The literature highlights multiple points of contact between the two disciplines: the attention to a new design of healthcare spaces was one of the first contributions of the design disciplines in the medical field (Golembiewski, 2016). A more recent field is the design

of biomedical devices (Vincent & Blandford, 2017), which involves design in the creation of home and hospital items for rehabilitating patients in their daily routines, or in the design of safer and more usable medical-surgical instruments to support professionals. The ability to understand people and manage complex systems has also found wide application in the emerging eHealth sector (Ekelanda, Bowes, & Flottorp, 2010), which adopts ICTs in the healthcare field to improve the treatment dynamics and foster the prevention and management of diseases at home, especially the chronic ones.

The combination of Medicine and Design has therefore produced interesting results, but the recent addition of the sustainability dimension significantly changes the state of the art. The economic, social and environmental sustainability of health systems goes beyond the product and service dimension and requires a strategic and all-encompassing vision. Design can offer a multi-level perspective to the complex problems of health care and, in particular, Jones (2013) identifies Systemic Design as a design discipline able to focus on the needs of multiple users, while addressing the indeterminate complexity of the system in which they are embedded.

Despite the peculiarity and challenges of the healthcare sector, it is inappropriate to think of "Design for healthcare" as a sub-discipline of Design, this is even more true for "Design for sustainable healthcare", where the inclusion of environmental sustainability leads to a further level of complexity. A single branch of design cannot address the issue of sustainable healthcare. Especially when it comes to environmental sustainability, the risk is to relegate competence and responsibility to a single discipline, as it has happened in the past for eco-design (Toso, Barbero & Tamborini, 2012). Design has a clear disciplinary identity and well-established methodologies to dialogue on equal terms with Medicine. Sustainability comes into play as a transversal topic to both disciplines, and it must be tackled jointly, combining the skills and tools peculiar to Design and Medicine. Only an open and equal collaboration can enable to tackling the challenge of sustainable healthcare, avoiding the risk of making simple improvements to the status quo rather than pursuing real sustainable innovation.

### 1.3 Post-pandemic visions on sustainable healthcare

Today, the COVID-19 pandemic has further highlighted the need for adopting more sustainable approaches to health systems. Indeed, although environmental concerns on healthcare may seem secondary to the health emergency, the protection of our planet plays a crucial role both upstream and downstream in the value chain. First of all, mitigating climate change and reducing the consumption of resources will contribute to improve the economic sustainability of health systems – hence the financial resources for acute illnesses – and to prevent diseases of environmental nature or due to the destruction of natural ecosystems (Marco et al., 2020). Secondly, the linear system on which current supply chains are based has shown its fragility during the pandemic, leading to failures that more dynamic, resilient and local systems could prevent (Jafarnejad et al., 2019).



However, it is undeniable how the pandemic has changed and will change the approach to sustainability in healthcare, questioning the contribution of all disciplines involved. In the two years prior to the COVID-19 outbreak, the author collaborated in a foresight process, coordinated by the Nordic Center for Sustainable Healthcare, which involved several stakeholders in the health sector, particularly in the Nordic region. The process resulted in the definition of macro-strategies aimed at fostering sustainable healthcare. Although the strategies remain valid as an expression of the complexity of a consolidated system, it is clear that the pandemic emergency impacts on them, demanding a review in the light of the COVID-19 experience. It is also important to stress that the strategies were devised from a foresight process mainly involving the Nordic countries, whereas the pandemic phenomenon, as well as the research investigating its sustainability impacts, has a global reach. While, in some respects, this may be a limitation of the analysis of post-COVID strategies, in others the health emergency has exposed common flaws in health systems worldwide and their supply chains, thus highlighting the need to actualise the strategies at a global level. Moreover, the strategies involve different sectors and disciplines, and also strongly involve design. This paper starts from an analysis of design's contribution to sustainable healthcare strategies to envision the new evolution of the strategies themselves, as well as the role of design disciplines in the light of the pandemic experience, proposing possible approaches for a new normal.

## 2. Methodology

### 2.1 Research background

The growing interest in Sustainable healthcare highlights the common perception of the need for change in the sector. To date, different approaches and visions to the topic have not yet agreed on a shared definition but, as Fischer (2015) points out, *“all approaches seem to have in common that a comprehensive approach with a long-term focus and a need to balance economic, social, and ecological interests needs to be used in the discussion of sustainable healthcare systems.”* (p. 298).

This need for a systemic transition towards environmental, social and economic sustainability was the starting point for a foresight process on sustainable healthcare, which engaged – through 5 workshops – 165 selected stakeholders representing the health system: regional and national authorities, universities and research centres, NGOs and healthcare networks, clusters, health industries, health providers, professional consortia. This foresight process has jointly adopted anticipation and systemic design methodologies (Pereno & Eriksson, 2020). The results of the workshops have been elaborated with a double purpose: first, to identify possible future scenarios for sustainable healthcare, building a triple vision of the system in the medium-long term. Second, to define the strategies to concretely foster

a transition towards a desirable future, identifying three main areas of intervention (Table 1).

*Table 1. Strategies for sustainable healthcare (SH). Adapted from Pereno & Eriksson, 2020.*

Strategy	Strategic actions	Time horizon	Scale of action
COLLABORATION: Increasing national collaboration on SH	Establishing a national collective impact initiative for SH	Short	National
	Creating a Green Deal for SH	Medium	National
	Strengthening the cooperation around a shared vision of SH	Short	Local
INNOVATION: Increasing sustainable innovation in healthcare	Developing sustainability assessment models for industries	Medium	National Global
	Providing industry specific guidance	Short-medium	National
	Creating virtual accelerator for SH companies	Medium-long	National Global
	Creating 'publics' as interdisciplinary arenas on SH	Short	Global
	Increasing support for test beds in SH	Medium	Global
INFORMATION: Increasing collective knowledge about SH	Introducing SH into university curricula	Medium	National
	Promoting information campaigns targeted at decision-makers	Short	National Global
	Developing an international communication package on SH	Short	Global

The paper starts from the results of previous research to deepen the specific contribution of design in the strategies developed, to explore the implications that the pandemic has on sustainable healthcare strategies and, especially, on design disciplines in this area.

## 2.2 Research methodology

As pointed out in par. 2.1, the adopted methodology aims to answer the following research question: How does design support the implementation of sustainable healthcare strategies, given the changes triggered by the COVID-19 pandemic?

For this purpose, the research starts from the strategies that emerged within the foresight process completed before the pandemic (Pereno & Eriksson, 2020), and implements a methodology based on three analytical steps.

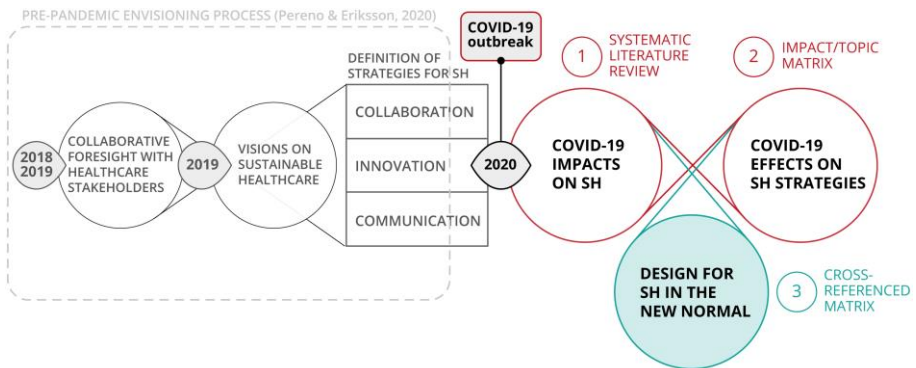


Figure 1. Graphical representation of the methodological process.

Figure 1 visualises the previous research phase in connection to the three research steps followed in the past year:

1. *Systematic literature review of the pandemic impacts on sustainable healthcare.* The first step has carried out a review on the main databases (Scopus, Web of Science, and PubMed) which allowed an overall analysis of the main articles through a categorisation of the authors' keywords and an in-depth analysis of the most relevant publications. This systematically highlighted the main impacts of the pandemic on sustainability in the healthcare sector.
2. *The effects of the pandemic on the strategies for sustainable healthcare.* The strategies presented in par. 2.1 (collaboration, innovation, and communication) have roots in the pre-pandemic era. While in principle they are still valid, it is beyond doubt that the global health emergency calls for re-reading them in the light of the new emerging landscape. Therefore, it has been used a matrix to cross-reference the topics and impacts of the pandemic on the sustainable development of health systems, in order to put them in connection with the sustainable healthcare strategies.
3. *The contribution of design to post-pandemic strategies for sustainable healthcare.* The last step combines the results of the two previous ones to define how strategies have changed due to the pandemic and how the contribution of design disciplines to sustainable healthcare should evolve into the new normal. The previous work (see par. 2.1) adopted a design approach for the analysis of foresight process results; however, the specific contribution of the design disciplines in the implementation of the strategies that emerged was not further investigated. Thus, the final step focuses on highlighting the synergies that design brings into play to contribute to these strategies.

The three-step methodology has enabled the pandemic phenomenon to be analysed by means of qualitative-quantitative databases in order to investigate, from a qualitative perspective, the design synergies in the emerging area of sustainable healthcare, in the post-pandemic era.

### 3. The contribution of design to new healthcare scenarios

#### 3.1 The impact of COVID-19 pandemic on the sustainable development of health systems

A systematic literature review was carried out through the main databases (Scopus, Web of Science, PubMed) to define the impact of the pandemic on the healthcare sector as regards sustainability. Table 2 shows the results obtained through a query that was purposely wide-ranging to include all the topics and disciplines that have dealt, to some extent, with the effects of the pandemic on the sustainable development of health systems. The records obtained from the different databases have been cross-referenced to eliminate any duplicates.

*Table 2. The main impacts of COVID-19 pandemic on sustainable healthcare.*

Query	Database	Records	Final records
("covid-19" OR coronavirus) AND (health OR healthcare OR "health care") AND (sustainability OR "sustainable development") AND (LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020))	Scopus	370	429
	Web of Science	190	
	PubMed	169	

The next step was the analysis of the results collected and their categorisation according to the topics addressed. This has been done in two phases: first, a schematisation of the keywords of the total records that allowed a general analysis of all contributions. Figure 2 visualises authors' keywords in hierarchical order: some macro-topics emerge, both of a general nature (public health, system resilience, policy and strategic management, etc.) and of a more specialised interest (mental health, Personal Protective Equipment, ecosystems protection, etc.). Hence, the keywords analysis enabled to identify nine main topics resulting from the relationship between the pandemic and the sustainable development of the health sector: Health systems, Policy and governance, Environmental aspects, Social aspects, Economical aspects, Technological aspects, Industry, Food production and consumption, Education.



Social aspects	Equity of access to healthcare; pandemic effects in developing countries; models of international collaboration for health emergencies; causes of inequality within the pandemic (migration, low-income, informal economy); causes of social exclusion within the pandemic; information suppression.	Bahn, Cohen, and van der Meulen Rodger, 2020; Wang and Tang, 2020; Armitage and Nellums, 2020; Shadmi et al., 2020.
Economical aspects	Economic risk management strategies; financial sustainability during the pandemic; labour market impacts of the pandemic; innovative welfare strategies; corruption problems.	Kruse and Jeurissen, 2020; van Barneveld et al., 2020; Visconti and Morea, 2020.
Technological aspects	Telehealth/telemedicine; social media and pandemic communication; Healthcare 4.0 and digital innovation in health systems; machine learning; Internet of Medical Things (IoMT) and medical devices.	Fryer et al, 2020; Helou et al., 2020; Smith et al., 2020; Thomas et al., 2020.
Industry	Supply chain management and supply chain disruptions; Personal Protective Equipment (PPE); sustainable manufacturing in the healthcare industry; sustainable transportation.	Ibn-Mohammed et al., 2021; Leite, Lindsay, and Kumar, 2020; Rowan and Laffey, 2020; Tirachini and Cats, 2020.
Food production and consumption	Food security; food safety; production and management of food waste; sustainable and healthy nutrition; sustainable agriculture models.	Galanakis, 2020; Attwood and Haja, 2020; Savary et al. 2020.
Education	Role of higher education in the pandemic; health education; technology and ICTs in education; Learning Management Systems (LMS).	Code, Ralph, and Forde, 2020; Hays, Ramani, and Hassell, 2020; Wahab, Shuib, and Shaik, 2020.

### 3.2 The implications of COVID-19 pandemic on sustainable healthcare strategies

While the sustainable healthcare strategies highlighted by the foresight process (see par. 2.1) show the potentials for action towards new pre-pandemic sustainable scenarios, the categories analysed in the literature (see par. 3.1) revealed the issues most affected by COVID-19, and which will undergo a significant change in the post-pandemic era.

In order to identify the role of design in this transformative scenario, a cross-analysis of these outcomes was carried out. Figure 3 presents the different sub-topics that have been analysed through a matrix that combines the topic specialisation level with its impact scale on individual and collective activities. The three categories of sustainable healthcare strategies are then included in the matrix to identify the scope for future interventions and impacts:

1. *Post-pandemic collaboration.* Collaborative strategies will mainly address general issues that may have specific impacts on individual activities as well as on collective life. Among the issues demanding greater attention in the future are the sector's governance strategies aimed at creating more resilient systems that can collectively address health emergencies and complex challenges, such as those posed by the UN Sustainable Development Goals. The economic and financial crisis has also highlighted socio-economic weaknesses, as in the welfare, that have a far-reaching impact on people's lives and require urgent collaborative strategies.
2. *Post-pandemic innovation.* Innovation strategies will mainly deal with specialised topics impacting on individual but also collective tasks. During the pandemic, manufacturing and agri-food industries have shown the need for greater flexibility, safety and sustainability, particularly some supply chains such as PPEs. Health technologies also need to innovate from a social perspective, addressing a global audience with different needs, especially in developing countries. The efficacy and sustainability of digital health is another social and technological issue that the pandemic has dramatically accelerated, while also highlighting shortcomings in usability and acceptability.
3. *Post-pandemic information.* The prevention and awareness-raising role of the media was already evident before the pandemic, but COVID-19 stressed the need for attention to environmental issues that may cause or accelerate disasters of environmental origin. Waste and supply chain management in emergency situations also require more careful and coherent information strategies. The role of education in such a context is even more striking, as there is a need to train students, professionals and citizens on sustainable healthcare issues that are cross-cutting to care, environment and wellbeing. The results of the literature review (see Table 1) showed that the topic of misinformation or suppressed information is marginal with respect to COVID-19. Although the link between sustainable development of the health sector and information transparency is not one of the core topics of current research, it is undeniable that seeking out reliable channels and modes to communicate with citizens is crucial, especially in relation to sustainable healthcare.

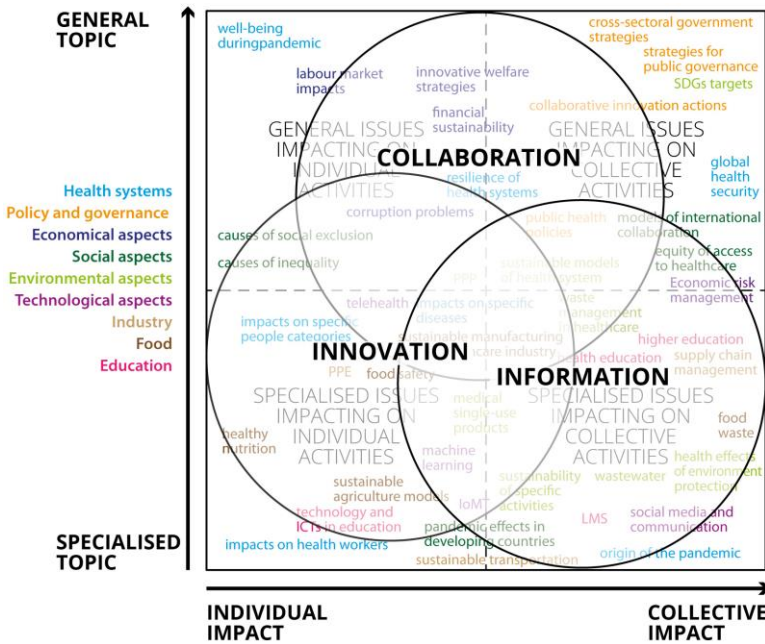


Figure 3. Relationship between the topics and impacts of the pandemic on the sustainable development of health systems, in connection with sustainable healthcare strategies.

### 3.3 The contribution of design to sustainable healthcare strategies in the post-pandemic era

Starting from the matrix shown in Figure 3, the research finally focused on the contribution of design disciplines to sustainable healthcare strategies, considering the new challenges that have emerged.

Figure 4 depicts the design disciplines within the matrix and in connection with sustainable healthcare strategies. The choice of design sub-disciplines is based on the categorisations proposed by Ceschin and Gaziulusoy (2019) and Irwin et al. (2015), as both address the issue of design for sustainability through different levels of action, from product to socio-technical systems. In some cases, the proposed disciplines have points of overlap or inclusion in each other (e.g. Design for sustainability transition includes policy design methods and tools), but the focus was placed on the disciplines themselves rather than on their interdependencies.



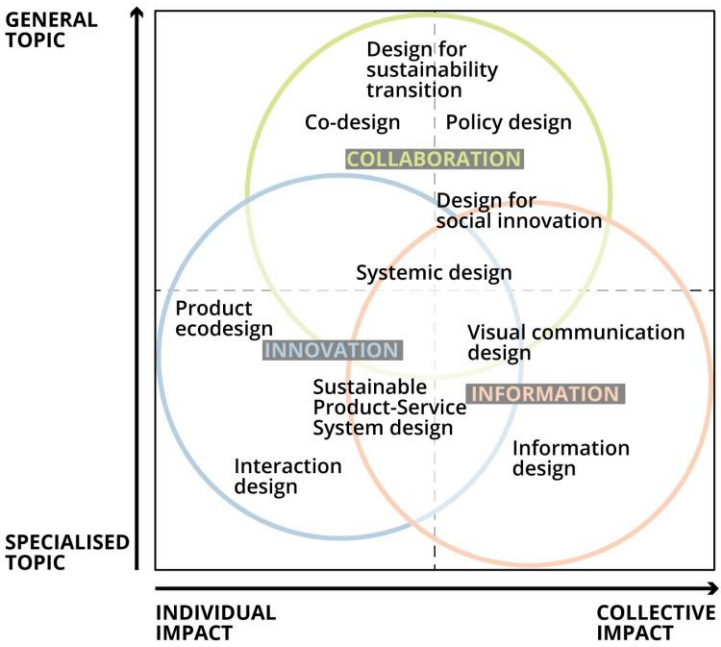


Figure 4. Relationship between main design disciplines and sustainable healthcare strategies.

Overall, the matrix provides support in defining the contribution of design to the three action areas identified as strategic for the development of sustainable healthcare:

1. *Design for collaboration in sustainable healthcare.* As previously highlighted, the governance strategies of the healthcare sector should aim at boosting the resilience of health systems, addressing the socio-economic issues and the need for collaborative actions. The pre-pandemic foresight identified collective impact initiatives and green deals as desirable instruments to enhance collaboration. The COVID-19 has been strengthening this urgency and design disciplines can support the process acceleration. To that end, co-design strategies are crucial: Manzini (2015) defines co-design as a problem-based and solution-oriented design process resulting from the interaction of a variety of disciplines and stakeholders. In this process, design experts have acquired the skills to foster collaboration and guide the process towards achieving solutions that meet actual needs. This ability is applied to the policy field, working on the design of policies for socio-economic systems, as well as to the definition of transition strategies for social and socio-technical systems in the medium and long term. Overall, design for collaboration towards sustainability acts at the level of complex systems, fostering trans-disciplinary and cross-sectoral processes. They support both the engagement of

key stakeholders and the pursuit of clear objectives over multiple time horizons, based on a clear understanding of the underlying system.

2. *Design for innovation in sustainable healthcare.* Whether collaborative actions can foster social innovation, industries from different value chain are called upon to address the demand for sustainable innovation, especially in services and products. The pandemic stressed the need of manufacturing and agri-food industries for greater flexibility, safety and sustainability from a cross-country perspective. Service design methods, and Sustainable Product-Service System design in particular, allow a lateral approach to product design, focusing on a strongly social dimension that enables complex innovations to be pursued. The tools for user engagement in the design and validation phases can also be valuable in the healthcare field, where sustainable healthcare strategies aim to accelerate the testing and introduction of new solutions. As healthcare, compared to other sectors, has a lower environmental concern regarding products, ecodesign skills can act to support recycling and reuse strategies, providing specific guidance to industries. Lastly, digitalisation and information technologies have been accelerated by the pandemic and the shift towards digital services will be confirmed and consolidated in the future. From that perspective, interaction design methods and tools have already been active in the area of eHealth, but they can still play an important role in driving new sustainable behaviours, from resource saving to distributed home care management.
3. *Design for information on sustainable healthcare.* The pandemic has highlighted the urgency of informing and training people and professionals on environmental issues. The environmental origin of COVID-19 strengthens communication strategies, providing new topics to be addressed. At the same time, some aspects of resource and waste management require effective communication even in stressful and emergency situations. In this context, two important design disciplines come into play: information design supports effective and efficient understanding of complex situations and information provided to users. In stressful conditions, this is even more important to enforce environmental guidelines without overburdening healthcare staff. Visual communication design, on the other hand, deals with communication to the general public, helping to define the channels, methods and messages to be conveyed towards creating a fertile ground for sustainable healthcare.

## 4. Discussion and conclusions

The paper addressed the impacts of the COVID-19 pandemic on sustainable healthcare, a trend that was rapidly developing in the pre-pandemic era. This contributed to understand how the phenomenon may be stalled or, conversely, strengthened in the post-pandemic era.

The literature shows very little research in the field of design for sustainable healthcare, and a greater gap exists in investigating how design will contribute to the sustainability of health systems in the future. The paper lays the groundwork to address this research gap, basing its contribution on solid research conducted within co-disciplinary and cross-sectoral arenas.

However, the research presents limitations that should be better addressed in the future. Firstly, the contribution of design is theorised through a deductive path which, although following a consistent methodology, remains in the realm of anticipation. Therefore, further validations are needed in the short- and medium-term to validate the actual contribution of design in a real environment.

The second limit, is related to the problem of assessing the design contribution through real case studies, which are not common in sustainable healthcare. As discussed in the introduction, collaboration between Design and Medicine has historically focused on other research fields – from medical devices to eHealth – other than the environmental issue. The radical change in the post-COVID era will further evolve existing disciplinary relationships and research topics, making it even more challenging to identify or create practical inter-disciplinary projects.

The third limitation relates to the high stress condition in which healthcare professionals are working. Although the pandemic seems to be coming to an end thanks to the new vaccines available, doctors, nurses and health workers will still face stressful working conditions in the coming months. In 2020, this forced the postponement of many projects outside the health emergency, and in the short term, the restarting of cross-sectoral and inter-disciplinary collaborations will take time before finding new spaces in a calmer and normalised situation.

Although not easy to address, these research limits pose important challenges for design disciplines, raising the bar towards broader sustainability goals – such as the link between the well-being of the planet and our societies – and towards new collaborations able to work on a system level rather than on specific products or services.

## References

- Armitage, R., Nellums, L.B. (2020). Considering inequalities in the school closure response to COVID-19. *The Lancet Global Health*, 8(5), e644.
- Attwood, S., & Hajat, C. (2020). How will the COVID-19 pandemic shape the future of meat consumption?. *Public Health Nutrition*, 23(17), 3116-3120.
- Bahn, K., Cohen, J., & van der Meulen Rodgers, Y. (2020). A feminist perspective on COVID-19 and the value of care work globally. *Gender, Work and Organization*, 27(5), 695-699.
- Baxter, D., & Casady, C.B. (2020). Proactive and strategic healthcare public-private partnerships (PPPs) in the coronavirus (Covid-19) epoch. *Sustainability*, 12(12), 5097.
- Ceschin, F., & Gaziulusoy, İ. (2019). *Design for sustainability: A multi-level framework from products to socio-technical systems*. Abingdon, UK: Routledge

- Cheval, S., Adamescu, C.M., Georgiadis, T., Herrnegger, M., Piticar, A., & Legates, D.R. (2020). Observed and potential impacts of the covid-19 pandemic on the environment. *International Journal of Environmental Research and Public Health*, 17(11), 4140.
- Coccia, M. (2020). Factors determining the diffusion of COVID-19 and suggested strategy to prevent future accelerated viral infectivity similar to COVID. *Science of the Total Environment*, 729, 138474.
- Code, J., Ralph, R., & Forde, K. (2020). Pandemic designs for the future: perspectives of technology education teachers during COVID-19. *Information and Learning Science*, 121 (5-6), 409-421.
- DeWit, A., Shaw, R., & Djalante, R. (2020). An integrated approach to sustainable development, National Resilience, and COVID-19 responses: The case of Japan. *International Journal of Disaster Risk Reduction*, 51, 101808.
- Djalante, R., Shaw, R., & DeWit, A. (2020). Building resilience against biological hazards and pandemics: COVID-19 and its implications for the Sendai Framework. *Progress in Disaster Science*, 6, 100080.
- Ekelanda, A.G., Bowes, A., & Flottorp, A. (2010). Effectiveness of telemedicine: A systematic review of reviews. *International journal of medical informatics*, 79:736–771
- European Commission (2016). *Joint Report on Health Care and Long-Term Care Systems & Fiscal Sustainability*. Luxembourg: Publications Office of the European Union.
- Fraher, E.P., Pittman, P., Frogner, B.K., Spetz, J., Moore, J., Beck, A.J., ..., Buerhaus, P.I. (2020). Ensuring and sustaining a pandemic workforce. *New England Journal of Medicine*, 382(23), 2181-2183.
- Fryer, K., Delgado, A., Foti, T., Reid, C.N., Marshall, J. (2020). Implementation of Obstetric Telehealth During COVID-19 and Beyond. *Maternal and Child Health Journal*, 24(9), 1104-1110.
- Galanakis, C.M. (2020). The food systems in the era of the coronavirus (CoVID-19) pandemic crisis. *Foods*, 9(4), 523.
- Golembiewski, J.A. (2016). Salutogenic Architecture in Healthcare Settings. In: M.B. Mittelmark et al. (eds.), *The Handbook of Salutogenesis*. Cham, CH: Springer, ch.26.
- Hays, R.B., Ramani, S., & Hassell, A. (2020). Healthcare systems and the sciences of health professional education. *Advances in Health Sciences Education*, 25(5), 1149-1162.
- Helou, S., El Helou, E., Abou-Khalil, V., Wakim, J., El Helou, J., Daher, A., El Hachem, C. (2020). The effect of the covid-19 pandemic on physicians' use and perception of telehealth: The case of lebanon. *International Journal of Environmental Research and Public Health*, 17(13), 4866.
- Ibn-Mohammed, T., Mustapha, K.B., Godsell, J., Adamu, Z., Babatunde, K.A., Akintade, D.D., Acquaye, A., ..., & Koh, S.C.L. (2021). A critical review of the impacts of COVID-19 on the global economy and ecosystems and opportunities for circular economy strategies. *Resources, Conservation and Recycling*, 164, 105169.
- Irwin, T., Kossoff, G., Tonkinwise, C., & Scupelli, P. (2015). *Transition Design*. Carnegie Mellon School of Design.

- Jafarnejad, A., Momeni, M., Razavi Hajiagha, S. H., & Faridi Khorshidi, M. (2019). A dynamic supply chain resilience model for medical equipment's industry. *Journal of Modelling in Management*, 14(3), 816-840.
- Jones, P.H. (2013). *Design for Care: Innovating Healthcare Experience*. Brooklyn: Rosenfeld Media.
- Kruse, F.M., & Jeurissen, P.P.T. (2020). For-profit hospitals out of business? Financial sustainability during the COVID-19 epidemic emergency response. *International Journal of Health Policy and Management*, 9(10), 423-428.
- La, V.-P., Pham, T.-H., Ho, M.-T., Nguyen, M.-H., Nguyen, K.-L.P., Vuong, T.-T., ..., Vuong, Q.-H. (2020). Policy response, social media and science journalism for the sustainability of the public health system amid the COVID-19 outbreak: The vietnam lessons. *Sustainability (Switzerland)*, 12(7), 2931.
- Leite, H., Lindsay, C., & Kumar, M. (2020 – in press). COVID-19 outbreak: implications on healthcare operations. *TQM Journal*.
- Manzini, E. (2015). Design in the transition phase: a new design culture for the emerging design. *Design Philosophy Papers*, 13(1), 57-62.
- Marco, M.D., Baker, M.L., Daszak, P., de Barro, P., Eskew, E.A., Godde, C.M., ... Ferrier, S. (2020). Sustainable development must account for pandemic risk. *Proceedings of the National Academy of Sciences of the United States of America*, 117(8), 3888-3892.
- Naidoo, R., & Fisher, B. (2020). Reset Sustainable Development Goals for a pandemic world, *Nature*, 583(7815), 198-201.
- Osingada, C.P., & Porta, C.M. (2020). Nursing and Sustainable Development Goals (SDGs) in a COVID-19 world: The state of the science and a call for nursing to lead. *Public Health Nursing*, 37 (5), 799-805.
- Patrício Silva, A.L., Prata, J.C., Walker, T.R., Campos, D., Duarte, A.C., Soares, A.M.V.M., ..., Rocha-Santos, T. (2020). Rethinking and optimising plastic waste management under COVID-19 pandemic: Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment. *Science of the Total Environment*, 742, 140565.
- Pereno, A., & Eriksson, D. (2020). A multi-stakeholder perspective on sustainable healthcare: From 2030 onwards, *Futures*, 122, 102605.
- Rowan, N.J., & Laffey, J.G. (2020). Challenges and solutions for addressing critical shortage of supply chain for personal and protective equipment (PPE) arising from Coronavirus disease (COVID19) pandemic – Case study from the Republic of Ireland. *Science of the Total Environment*, 725, 138532.
- Sarkodie, S.A., & Owusu, P.A. (2020 – in press). Global assessment of environment, health and economic impact of the novel coronavirus (COVID-19). *Environment, Development and Sustainability*.
- Savary, S., Akter, S., Almekinders, C., Harris, J., Korsten, L., Rötter, R., Waddington, S., & Watson, D. (2020). Mapping disruption and resilience mechanisms in food systems. *Food Security*, 12(4), 695-717.

- Seshaiyer, P., McNeely, C.L. (2020). Challenges and Opportunities From COVID-19 for Global Sustainable Development. *World Medical and Health Policy*, 12(4), 443-453.
- Shadmi, E., Chen, Y., Dourado, I., Faran-Perach, I., Furler, J., Hangoma, P., Hanvoravongchai, ..., & Willems, S. (2020). Health equity and COVID-19: Global perspectives. *International Journal for Equity in Health*, 19(1), 104.
- Sherman, J.D., e Ryan, S. (2010). Ecological Responsibility in Anesthesia Practice. *International Anesthesiology Clinics*, 48(3), 139-15.
- Smith, A.C., Thomas, E., Snoswell, C.L., Haydon, H., Mehrotra, A., Clemensen, J., & Caffery, L.J. (2020). Telehealth for global emergencies: Implications for coronavirus disease 2019 (COVID-19). *Journal of Telemedicine and Telecare*, 26 (5), 309-313.
- The Lancet Public Health (2020). Will the COVID-19 pandemic threaten the SDGs? *The Lancet Public Health*, 5(9), e460.
- Thomas, E.E., Haydon, H.M., Mehrotra, A., Caffery, L.J., Snoswell, C.L., Banbury, A., & Smith, A.C. (2020 – in press). Building on the momentum: Sustaining telehealth beyond COVID-19. *Journal of Telemedicine and Telecare*.
- Tirachini, A., & Cats, O. (2020). COVID-19 and public transportation: Current assessment, prospects, and research needs. *Journal of Public Transportation*, 22(1), 1-34.
- Toso, D., Barbero, S., e Tamborrini, P. (2012). Systemic Design: Beyond Ecodesign. *Proceedings of 18th Annual International Sustainable Development Research Conference*.
- Van Barneveld, K., Quinlan, M., Kriesler, P., Junor, A., Baum, F., Chowdhury, A., Junankar, P.N., ..., & Rainnie, A. (2020). The COVID-19 pandemic: Lessons on building more equal and sustainable societies. *Economic and Labour Relations Review*, 31(2), 133-157.
- Vincent, C.J., & Blandford, A. (2017). How do health service professionals consider human factors when purchasing interactive medical devices? A qualitative interview study. *Applied Ergonomics*, 59, 114-122.
- Visconti, R.M., & Morea, D. (2020). Healthcare digitalization and pay-for-performance incentives in smart hospital project financing. *International Journal of Environmental Research and Public Health*, 17(7), 2318.
- Wahab, A.Y.A., Shuib, M., & Shaik, A.R.A.R. (2020). Higher education for the creation of prosperity, sustainability in security and development in times of COVID-19 pandemic: A case study. *Annals of Tropical Medicine and Public Health*, 23(13A), 8199.
- Wang, Z., & Tang, K. (2020). Combating COVID-19: health equity matters. *Nature Medicine*, 26(4), 458.

#### About the Author:

**Amina Pereno, PhD** is concerned with research and education in the field of systemic design applied to socio-technological systems and their sustainable transition. She has been taking part in several international projects on systemic approaches to socio-industrial systems, especially in the framework of circular economy and sustainable healthcare.