

Green Energy and Technology

Stefano Capolongo
Marta Carla Bottero
Maddalena Buffoli
Emanuele Lettieri *Editors*



Improving Sustainability During Hospital Design and Operation

A Multidisciplinary Evaluation Tool

 Springer

Green Energy and Technology

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Foreword

Healthcare facilities, operating with an explicit mission of healing and stewardship, are uniquely positioned to both define and demonstrate the integration of health and sustainability into the promise of the twenty-first century's built environment. We know from the astonishing success of the green building movement that buildings can be among the most powerful drivers of positive human health, environmental, social, and economic outcomes. Reflecting this shift, aspirations regarding building performance are higher and more complex and challenge us to imagine what is possible: buildings as producers of energy, light, water, and food rather than consumers; buildings connecting people to nature rather than distancing them; buildings constructed of and maintained with healthy materials rather than manufactured with chemicals of concern; and, buildings that are beautiful and create conditions conducive to health. In short, buildings are viewed as intrinsic to the healthy and positive metabolism of the ecosystems that sustain life.

Ironically, however, while healthcare structures are the places where people experience the most intimate moments of their lives, all too often, impersonal technologies and unhealthful indoor environments dehumanize what should be the most humanistic of building typologies. Their prodigious use of energy, water, goods, and services coupled with enormous solid waste and wastewater outputs and transportation dependencies creates environmental stressors that compromise the public health. Their challenging work environments lead to high levels of stress, chronic illness, and workplace injuries that can undermine the delivery of care. Further, patients' exposure to unhealthful indoor environmental conditions can result in prolonged length of stay, increased medication, and hospital-acquired infections.

The notion that buildings can be a force for healing has a heralded legacy. This is particularly so for healthcare design. Florence Nightingale's prescient 'environmental theory' acknowledged the significance of fresh air, clean water, and sunlight as essential to restore patient health (Nightingale 1860); Alvar Aalto's Paimio Sanatorium in Finland is described as a "cathedral for health and an instrument of healing" (Mindel 2013); more recently, MASS Design Group's Butaro Hospital in Burera District, Rwanda resurrected the thematic underpinnings of Nightingale's

environmental theory by relying on natural ventilation, sunlight, and connection to outdoors as fundamental design imperatives, and revived the traditional use of local materials as the project's primary building materials, employing more than 3,500 local people.

These structures and others like them, inspired by big ideas that come to life in tangible form through these architectural icons, garner widespread attention and stimulate important dialogue about the transformative potential of design. To what end? Often, operational quantitative and qualitative performance data are missing from the story. Feedback loops that correlate design decisions with operational outcomes are left incomplete. This absence of data restrains the ability to create a robust library of evidence-based design strategies of what works, and limits the ability to constructively and critically assess and evolve the places explicitly designed for healing so that they do, indeed, fulfill their mission of healing and stewardship. Such a 'learning community' of shared information would be a tremendous asset in establishing meaningful baselines and benchmarks.

While healthcare's mission aligns well with green building principles, customized tools and resources to integrate sustainability practices into the healthcare sector were slow to come, released years after commercial and residential building rating systems were well established in the marketplace. Efforts including the pioneering Green Guide for Health Care, followed by LEED for Healthcare, BREEAM for Health, and Green Star-Healthcare, represent the first generation of rating systems that align healthcare design practice around an explicit recognition of healthcare facilities' unique operational realities including 24-7 operations, caring for vulnerable patients, infection control, and unique regulatory requirements. The promise put forward with these early efforts is to position the facility as part of the healing continuum, indeed, a force for healing, and to recognize its significance at three scales: protecting the immediate health of building occupants; protecting the health of the surrounding community; and protecting the health of the global community and natural resources (GGHC 2005).

The Sustainable Healthcare Project's groundbreaking multidisciplinary tool represents a next generation effort that builds on these precedents. Its rigorous and pragmatic development process reflects three important and interrelated considerations. First, the tool is designed to be easy-to-use. Its focus on a user-centered approach informed by stakeholder feedback has the potential for widespread use and, therefore, broadly realized benefits. Many tools face the challenge of a robust development process but, in practice, are not widely used as they require too much time and effort. This is especially relevant in healthcare settings where time availability is at a premium.

Second, the tool is flexible enabling it to be customized to unique conditions and contexts of both operating and new facilities. The diversity of healthcare facility type as determined by specialization, size, location, and age requires a common framework with the opportunity for customization. Again, this should encourage the user to view the tool as relevant and yielding positive value: a motivator to use it.

Third, the tool is informed by the broadest definitions of health, *a state of complete physical, mental and social well-being and not merely the absence of*

disease or infirmity (World Health Organization 1946) as defined by the World Health Organization, and of sustainability, embracing environmental, social, and economic considerations as defined by the 1987 Brundtland Report *Our Common Future* (World Commission on Environment and Development 1987). This breadth of scope is ambitious; it is also necessary.

Healthcare is one of the largest economic sectors in the global economy. Around the world, it touches millions of lives every day, whether as patients, staff, or visitors. In many towns and cities, it is the largest employer and measures among the largest ‘footprints’ of energy, water, waste, transportation, goods, and services. With such substantial influence, coupled with its formidable civic stature, the healthcare sector can leverage positive environmental, social, and economic transformation and promote physical, mental, and social well-being at the local, regional, and national scales. The Sustainable Healthcare Project’s innovative tool is a welcome resource that can guide healthcare structures to realize their unique potential as a substantive force for health and sustainability.

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The Research Group

Andrea Bellagarda, is graduate in *Industrial Production and Technological Innovation Engineering* from Politecnico di Torino, worked on economic sustainability studies focusing on managerial solutions.

Matteo Birocchi, a graduate in *Building Engineering* from Politecnico di Milano, worked on the environmental side of the rating system and on the following evaluation, focusing especially on building engineering aspects related to envelope technologies and performances.

Marta Carla Bottero, Ph.D. in Geo-environmental engineering is assistant professor of Project Appraisal and Planning Evaluation at Politecnico di Torino. Her scientific interests are related to the sustainability assessment of urban and territorial transformations, with particular reference to multi criteria analysis.

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Stefano Capolongo, is associate professor at Politecnico di Milano and is also a teacher at the Post-graduate Schools of Hygiene and Preventive Medicine at the Universities of Parma and Milan. Scientific head for the Politecnico di Milano's Cluster on "Designing healthcare facilities" and Director of Master's program in "Scheduling, planning and designing public healthcare facilities". He is the principal academic tutor for the SustHealth research project.

Elisa Cavagliato, is a graduate in *Architecture (Construction)* from Politecnico di Torino, focusing her attention on architectural features that affect environmental sustainability and on interior elements which are involved in social sustainability.

Arlind Dervishaj, is a graduate in *Architecture (Construction)* from Politecnico di Torino, who participated in the project developing architectural strategies mainly concerning comfort issues.

Michela di Noia, a graduate in *Architecture* from Politecnico di Milano, developed and implemented solutions for humanization and social sustainability.

Giulia Gherardi, an engineer, graduate in *Management Economics and Industrial Engineering* from Politecnico di Milano, contributed to the evaluation system by creating and implementing the criteria that measure economic sustainability.

Marco Gola, an architect, graduate in *Architecture for Sustainability* from Politecnico di Torino, analyzed architectural and urban planning issues, linked both to social and environmental sustainability. He is a Ph.D. candidate in Politecnico di Milano at the ABC Department.

Emanuele Lettieri, is assistant professor at the Politecnico di Milano. His research interests deal with the assessment of technological and organizational innovation in healthcare. He is lecturer of Business Economics and Organization at Politecnico, where he is also lecturer of Health Technology Assessment and Management Accounting for postgraduate courses, and Director of the Part-Time International MBA program.

Francesco Mantua, is a graduate in *Energy and Nuclear Engineering* from Politecnico di Torino explored and applied the energy components which are related to the environmental impact of a newly designed healthcare facility.

Slobodan Miljatovic, is a graduate in *Environmental and Land Planning Engineering* from Politecnico di Milano, examined factors and solutions that involve water and waste management influencing the ecological footprint of a hospital.

Maria Nickolova, a graduate in *Architecture* from Politecnico di Milano, was responsible for the development and implementation of the social sustainability criteria that assess the humanization of a future healthcare structure.

Marco Rostagno, an engineer, graduate in *Architecture for Sustainability* from Politecnico di Torino, studied the urban design and use of specific materials that have an effect on the environmental performance of a new hospital.

Salvatore Speranza, a graduate in *Energy Engineering* from Politecnico di Milano, focused on environmental sustainability studying resource consumption and energy production.

Lia Volpatti, a graduate in *Biomedical Engineering* from Politecnico di Milano, handled biomedical and clinical issues related to the project.

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Acronyms

AHP	Analytic Hierarchy Process
ANP	Analytic Network Process
BREEAM	Building Research Establishment's Environmental Assessment Method
C&I	Criteria and Indicators
CEO	Chief Executive Officer
CHP	Combined Heat and Power
EHCI	European Health Consumer Index
EPP	Environmentally Preferable Purchasing
GDP	Gross Domestic Product
GGHC	Green Guide for Health Care
HCWH	HealthCare Without Harm
HVAC	Heating Ventilation and Air Conditioning
ICH	Humanitas Research Hospital
ICU	Intensive Care Unit
ISQua	International Society for Quality
ITACA	Istituto per l'Innovazione e la Trasparenza degli Appalti e la Compatibilità Ambientale
JCI	Joint Commission International
LEED	Leadership in Energy and Environmental Design
NGO	Non-Governmental Organization
NHS	National Health Service
OECD	Organization for Economic Co-operation and Development
UNI	Ente Nazionale Italiano di Unificazione
USGBC	United States Green Building Council
WACOSS	Western Australian Council of Social Service
WHO	World Health Organization
WMP	Waste Management Plan

Chapter 1

Healthcare Sustainability Challenge

Stefano Capolongo, Marta Carla Bottero, Emanuele Lettieri, Maddalena Buffoli, Andrea Bellagarda, Matteo Birocchi, Elisa Cavagliato, Arlind Dervishaj, Michela di Noia, Giulia Gherardi, Marco Gola, Francesco Mantua, Slobodan Miljatovic, Maria Nickolova, Marco Rostagno, Salvatore Speranza and Lia Volpatti

Abstract Healthcare structures are supposed to protect and improve Public Health, but in the meanwhile they are highly energy-demanding and socially impactful structures, which cause negative side effects on the people's health and on the environment. Building hospitals able to cope with the definition of Health as complete well-being and which can fit to the future means therefore constructing sustainable structures. Such complex realities work as a whole, single organism, that can be robust and productive only if every single part is healthy. So when it comes to healthcare facilities, sustainability has to be taken into account as both a main requirement and a quality issue, since they must be capable to deliver high standards also in changing circumstances. Starting from these assumptions the Sustainable High Quality Healthcare project is born with the aim of providing a new original insight into such a complex subject. Its goal is to define, through the construction of an innovative assessment system, solutions and strategies towards the realization of sustainable existing operative or in-design hospitals, where sustainability applies to the main macro-areas.

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