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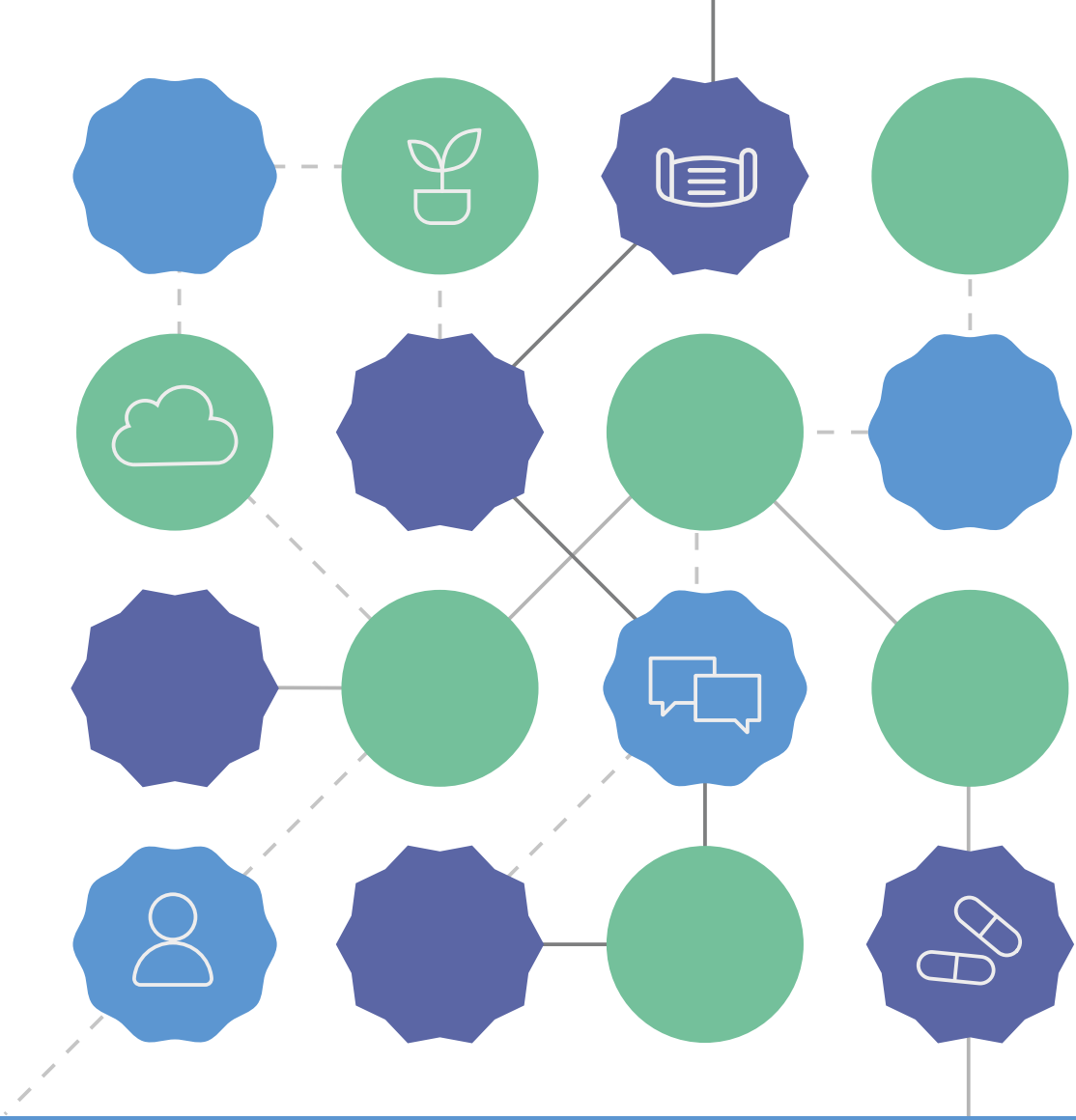
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Creating Sustainable Hospitals

A practical handbook

Editors: Cecile Cuijpers, Jotte de Koning, Amina Pereno

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Colophon
Creating Sustainable Hospitals | A practical handbook

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Editors: Cecile Cuijpers, Jotte de Koning, Amina Pereno

Creating Sustainable Hospitals

A practical handbook

IN COLLABORATION WITH

TU Delft Delft University of Technology | NCSH Nordic Center for Sustainable Healthcare | Politecnico di Torino 1859 | ESCI upf. School of International Business

Foreword

Written by **Jotte de Koning**
Jan-Carel Diehl

Hospitals are more than buildings where care takes place. They operate as living ecosystems, where people, materials, technologies, and spaces interact continuously to sustain life. In hospitals, every corridor, waste bin, medical device and digital record form part of a vast network that connects clinical practice with logistical functioning, emotional care and material consumption. As the need for and interest in sustainability increase, the hospital ecosystem becomes even more complex. For example, efforts to reduce waste, cut carbon emissions and close material loops introduce new interdependencies, such as those between hygiene and reuse, efficiency and empathy, and short-term care and long-term planetary health. The previously linear sequence of medical actions now unfolds as a dynamic web of flows and decisions that shape not only patient outcomes but, increasingly, environmental impact.
The transition towards more sustainable hospital is a complex process involving many stakeholders, technologies, materials, spaces, regulations and requirements. The interconnectedness of these issues pushes organisations to adopt new ways of working and explore creative modes of collaboration and innovation. Ultimately, this level of complexity calls for a systemic and creative design thinking approach.

This handbook focuses on how to apply a systemic design thinking approach to make hospitals more sustainable and transform of our healthcare system in a step-by-step manner.
This process of transformation requires the collaboration of multidisciplinary teams that have a broad set of competencies and are capable of engaging with the layered nature of hospital systems in order to find novel and more sustainable ways of working.
With this handbook, you will learn about the basics of sustainability and circularity, the characteristics of a design process, how to perform an environmental assessment, the role of procurement and business models, the value of visual mapping, and how to set-up creative co-creation processes.

This handbook, which was developed within the DesHealth project (2022–2026), represents a joint effort between experts in design, sustainability and clinical practice across four nations: the Netherlands, Spain, Sweden and Italy. We hope that this handbook will make you feel motivated and better equipped to take the first steps towards developing more sustainable hospitals in your own setting.
On behalf of the entire author-team, enjoy and be inspired!

Acknowledgement

This book is an outcome of a collaboration within the DesHealth project. The DesHealth project (A systemic design approach to education and training in sustainable healthcare) is funded by the European's Union Erasmus+ programme.

The following individuals significantly contributed to the development of this handbook: Amina Pereno, Jotte de Koning, Jan-Carel Diehl, Ilija Sazdovski, Marta Santamaria Molina, Sara Ghione, Cecile Cuijpers, Diego Angelino, Shushanta Acharjee, Marc Gibert Guilera, Daniel Eriksson, Eugenio Mimosi, Jasper Klasen, Nicole Hunfeld, Carles Oliete, Mariangela Squarciafico, Sara Falvo, Rosa Vidal, Wen Lu and Davide Nonis.

Special appreciation goes to the review team Dr. ir. Silvia Barbero and Dr. ir. Ayşegül Özçelik.

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The editors of this book were Cecile Cuijpers, Jotte de Koning and Amina Pereno.

Preface

Why we wrote this handbook

The transition of European healthcare systems towards improved environmental sustainability is a priority for both human and planetary health. However, since sustainable healthcare is an emerging field, a new set of design and management skills from a multidisciplinary and environmental perspective is needed, alongside new approaches to education and training. The Erasmus+ DesHealth project has developed such approaches and interdisciplinary training tools for improving skills in creating sustainable healthcare systems.

The development was achieved by uniting cross-sector partners to deliver interdisciplinary training in systemic design, sustainable management and hands-on projects addressing health sector emissions and environmental challenges. Additionally, online training tools were developed to allow students and young professionals to gain core skills for supporting the sustainable transition of the European Union's healthcare sector.

Given that hospitals are one of the biggest providers of healthcare and the biggest polluters within the healthcare sector, DesHealth wanted to share their insights with hospitals specifically to inspire them to use their multidisciplinary tools and methods to meet sustainability requirements. Since hospital professionals face significant time constraints, this inspiring handbook aims to provide an overview of the most relevant tools and methods available, together with encouraging case studies.

We hope that this handbook will provide an easily accessible way to motivate hospital professionals to change their ways of working and develop more environmentally sustainable hospitals.

Who we wrote the handbook for

Although DesHealth is concerned about healthcare in general, this handbook primarily focuses on hospitals to enable the presentation of dedicated information and case studies relevant to this significant player in healthcare. We wrote the handbook for individuals and teams aiming to make hospitals more environmentally sustainable, such as hospital managers, green teams and clinicians who want to make their working context more sustainable, but also medical product manufacturers. With the insights presented in this handbook, we hope to inspire all stakeholders to work together to decrease the footprint of hospitals and to soon develop more sustainable hospital products and solutions.

How to use the handbook

This handbook presents different phases of the improvement process in a chronological order with distinct colours and titles. For each phase, the relevant tools and methods are clearly introduced and described to inform the reader about the development of sustainable healthcare. Curious and driven individuals can read the whole handbook and are referred to sources of more in-depth knowledge if desired. More task-oriented readers can read only the sections they need, and novices can browse and explore the parts that resonate with them. Overall, we hope you will enjoy the handbook and are inspired to make a difference!

Glossary

Biodegradable
Substances capable of being broken down by natural biological processes and, thus, returning to the environment without causing harm.

Carbon footprint
The total amount of greenhouse gases (GHG), including carbon dioxide (CO_2), that are emitted directly or indirectly by an individual, organisation, event or product.

Circular economy
An economic model aimed at minimising waste and making the most out of resources, with emphasis on reusing, recycling and refurbishing products and materials to create a closed-loop system.

Climate change
Long-term changes in weather patterns.

Closed-loop system
A system that eliminates waste by reusing materials in the production process. In a closed-loop system, outputs from one process serve as inputs for another, effectively recycling resources and reducing the need for virgin materials.

Carbon dioxide equivalent - CO_2e
A standard that allows for emissions of different greenhouse gases to be compared and for their global warming potential to be assessed.

Co-creation
The efforts of collaborations of multiple stakeholders towards creating interventions, developing new products and services and establishing change.

Design thinking
A combination of both mindsets and design-based activities that foster the collaboration required to solve problems in human-centred ways.

Ecology
The relationship between living organisms and their environment.

End of life – EoL
The stage in a product's life cycle when it is no longer usable or desired by the consumer.

Environment
The natural environment, including air, water, land and ecosystems.

Environmental sustainability
The responsible management of the planet's resources to maintain the health of both ecosystems and biodiversity.

Environmentally friendly
Practices or products that are not (or are less) harmful to the natural environment.

Environmental hotspot
Parts within a system that contribute most to the total environmental footprint.

Green
Environmentally friendly or environmentally sustainable.

Green teams
Groups within organisations who aim to identify and implement sustainable solutions, reduce environmental impact and create a more sustainable context.

Greenhouse effect
The process through which heat is trapped near the earth's surface by substances or greenhouse gases.

Greenhouse gases - GHGs
Gases that trap heat in the atmosphere, contributing to the greenhouse effect. Key greenhouse gases include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) gases.

Healthcare
All medical care and services aimed at promoting health, preventing illnesses and treating patients.

ISO standards
International Organization for Standardization standards are globally recognised guidelines that ensure quality, safety and efficiency across various industries. ISO standards, such as ISO 14001 for environmental management systems, provide frameworks for organisations to improve their environmental performance and sustainable practices.

Iterative process
A process of continuous feedback loops during design and development that enable the repeated testing and further improvement of solutions or insights.

Life cycle
Refers to the stages through which a product or service goes, from conception and design through production, use, and ultimately disposal.

Life cycle assessment - LCA
A systematic process for evaluating the environmental impacts of a product, process, or service throughout its life cycle.

Linear process
A traditional economic model of production and consumption that follows a straight path from raw material extraction to product disposal, often resulting in waste.

Procurement
The process of acquiring goods and services.

Product system
A product system considers the entire life cycle of a product, including its design, manufacturing, usage, disposal and sustainability.

R-strategies
Circular economy principles that can be applied in product design to improve sustainability and resource efficiency, such as the principle of 'reuse, reduce and recycle'.

The three scopes
Three categories for measuring greenhouse gas emissions:

- **Scope 1**: Direct emissions from owned sources.
- **Scope 2**: Indirect emissions from purchased electricity, steam, heatingand cooling.
- **Scope 3**: All other indirect emissions not covered in Scope 1 and 2. These emissions occur outside an organisation's direct control but arise from its activities. They represent the full value- chain emissions, both upstream (i.e. the whole supply chain) and downstream (i.e. product use and end-of-life).

Stakeholders
Individuals or groups that are affected by a product or service and should be involved in the design process.

Sustainability
The principle of meeting present-day needs without compromising the ability of future generations to meet their own.

Sustainable business model
An integrated framework that aligns services, infrastructure, procurement, governance and community engagement with the goal of protecting both patient and planetary health.

Supply chain
The sequence of processes involved in the production and distribution of a product, from raw materials to delivery to end-users.

Systemic
Considering the interconnections and relationships within a system instead of focusing on one part only.

Value chain
All of the activities in the full life cycle of a product or process where value is added to it, from raw material extraction to end-of-life management and recovery.

Value hill
A conceptual model describing how value is created, maintained and, ultimately, lost across the life cycle of a product or system.

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Introducing the Handbook's Approach

Design thinking towards Sustainable Hospitals

Written by **Jotte de Koning**
Amina Pereno

Hospitals are more than buildings where care is provided; they function as ecosystems where networks of people, materials, technologies and spaces interact continuously to sustain life. Every corridor, medical device, digital record and even waste bin form part of a larger system that connects clinical practice with logistical efficiency, emotional care and material consumption. As the need for sustainability increases, the hospital system becomes even more complex. For example, efforts to reduce waste, cut carbon emissions and close material loops introduce new interdependencies, such as those between hygiene and reuse, efficiency and empathy, and short-term patient care and long-term societal and planetary health. The previously linear sequence of medical actions in healthcare now acts as a dynamic web of flows and decisions that shape not only patient outcomes but also environmental impact. It is clear that the creation of more sustainable hospitals is a complex process, involving collaboration with many stakeholders at different levels of the system and, thus, requiring a comprehensive understanding of requirements and effective problem solving. Against this backdrop, design thinking can be used to effectively create more sustainable hospitals.

Design thinking refers not only to the way designers think but also how they act, work and combine methods, ideas and strategies to guide them (Design Council, 2025). Design thinking can produce different design types: a new product, an updated or novel service, a different experience, an intervention or an alternative way of working.
To design is a verb, referring to a specific way of working, and thus, everyone (including you) can be a designer. Design combines creativity with an understanding of the human, the context and the technological opportunities available. In the context of sustainability, design thinking increasingly needs to integrate design with an understanding of systems. This integration helps designers understand interactions and dynamics across multiple levels, ensuring that the interventions they design are not only innovative but also responsive to wider ecological and social issues.

Who is involved in design thinking?

Design thinking involves a constellation of actors, each contributing their own expertise and perspectives. In complex environments such as hospitals, having a multidisciplinary team, including clinicians, designers, engineers, managers and patients, enables challenges to be successfully and collectively navigated in a way that no single individual could achieve. This team diversity also fosters richer problem understanding and supports the development of solutions that are feasible, sustainable and sensitive to the realities of hospital contexts.

How can design thinking be applied to sustainable hospitals?

Applying design thinking to sustainable hospitals involves translating systemic and creative principles into a coordinated pathway for change. As such, a design process must comprise different types of activities. These activities do not follow a linear process but are used iteratively and applied depending on the context and the people involved. The phases of this process may include seeking and developing understanding, engaging and reflecting, and creating through seeing, thinking or doing.

Typically, the early phases of design are characterised by higher levels of uncertainty, which means openness and receptivity should be encouraged. In this phase, the first key step is to **understand what sustainable healthcare entails**, recognising the sector's specific clinical, organisational and regulatory challenges (Section 1). This understanding is only possible through transdisciplinary collaboration, especially since no single viewpoint can fully capture the problem or its potential solutions. As such, diverse stakeholders should be engaged through the use of **co-creation tools** (Section 4) **and processes** that facilitate dialogue, align perspectives and enable informed, collective decision-making across disciplines and sectors.

A second step in this design process is to build a **shared and tangible understanding** of the system. Qualitative and quantitative methods, such as environmental assessments (Section 2) and visual mapping (Section 2), help reveal flows (i.e workflows, material flows), key impacts and dependencies, thus enabling teams to grasp and reframe complexity within the system.

Finally, **sustainable design** must be collaborative and iterative. Through R-strategies (Section 3) and structured implementation processes (Section 5), teams can co-create, test and refine solutions that are feasible, scalable and meaningful for hospital contexts.

Together, these phases form a practical pathway for applying a design approach to sustainable healthcare.

FURTHER READING

Design Council. (2025). *Framework for innovation*. https://www.designcouncil.org.uk/our-resources/framework-for-innovation/

Design thinking is:



1. Systemic
Building a holistic understanding of interconnected challenges and focusing on long-term change



2. Context-sensitive
Attentive to the specific conditions, constraints and embeddedness of each situation



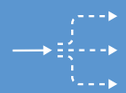
3. Collaborative
Incorporating diverse perspectives by involving multidisciplinary stakeholders through co-creation at different stages of the design process



4. Iterative
Advancing through repeated cycles of prototyping, testing in real contexts, observing outcomes and refining or redirecting solutions



5. Creative
Expanding possibilities by combining analytical reasoning with hands-on exploration, imagination and experiential insight (i.e. thinking–doing–seeing)



6. Generative
Being both analytical and productive, aiming not only to interpret problems but also to create new opportunities and pathways for change

Understand

Sustainability

Written by **Daniel Eriksson**
Cecile Cuijpers



Windturbines

INTRO

Sustainability is the principle of meeting present day needs without compromising the ability of future generations to meet their own (WCED, 1987). Sustainable development is often described as a three-legged stool or the triple bottom line, which includes 1) people, 2) the planet, 3) profit (see Figure 1, Elkington, 1994). However, sustainable development also encompasses many different goals, as exemplified by the UN sustainable development goals, which include reaching zero hunger, reducing poverty and addressing climate change (UN, 2025). In this handbook, the focus is on environmental sustainability, which emphasises the responsible management of the planet's resources.

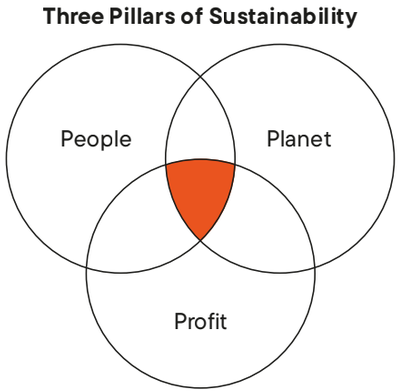
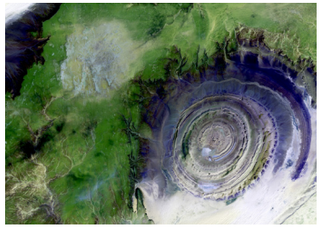


Figure 1:

The three pillars of sustainability. Adapted from triple bottom line, by Elkington (1994).

Sustainability is the principle of meeting presentday needs without compromising the ability of future generations to meet their own.

There are several key factors related to environmental sustainability. The main ones are the following (based on PBScience, 2025; IPCC 2021; WHO, 2024):



Climate change

Climate change refers to significant and long-term shifts in global temperatures and weather patterns, which pose serious threats to ecosystems, agriculture and human health and challenge both the environment and societies worldwide. Climate change is driven by both natural and human causes. Human activities, such as burning fossil fuels, deforestation and agriculture, contribute significantly to climate change by releasing GHGs such as CO_2 and methane.

To compare the GHG emissions associated with various products, activities, or countries, their **carbon footprints** are calculated. Comparisons show that GHG emissions from human activities have increased since industrialisation, which begun around 1800, primarily due to the burning of fossil fuels. As such, it appears that current climate change is predominantly caused by these human activities.



Depletion of (scarce) natural resources

Due to human activities, certain natural resources are being consumed faster than they can be replenished, causing resource depletion. These resources include energy (e.g. fossil fuels), water and materials, as well as critical raw materials used to make medical devices and electronics.



Pollution

Pollution is the contamination of the natural environment. Recently, the Stockholm resilience centre reported that the planetary boundary of having synthetic substances in the environment (novel entities) has been largely surpassed. This boundary is closely linked to biosphere integrity, which is under threat, as evidenced by significant biodiversity loss. Finally, our fresh water flows and land systems are also under threat due to pollution. For all of these critical issues, humans have already crossed the boundaries of what the planet can manage.



Waste

Waste is related to resource use and pollution and represents a consequence of high natural resource use. After use (especially single use), these resources are often discarded in natural ecosystems. Most of our unwanted or unused products are thrown away, and this waste is then abandoned at enormous landfills, or incinerated, causing pollution of the water, land and air.

This unsustainable consumption of natural resources contributes to environmental degradation through deforestation, pollution and biodiversity loss. Additionally, unsustainable resource consumption fuels economic instability by increasing resource prices and disrupting supply chains, and it exacerbates global inequality, as fragile countries and communities are often the most vulnerable to resource scarcity while benefiting the least from their exploitation. All of these issues will only become more prominent with the increasing human population and the related increase in consumption and production needs and each person's carbon footprint. Regarding healthcare, the growing and ageing population has a double effect. Specifically, more people will need care in the future and for longer periods of time because life-expectancies are increasing alongside the population. This increase in care needs will also lead to an increased environmental impact. Environmentally unsustainable practices will also add to an increase in diseases related to the pollution of air, water, food and land (e.g. respiratory diseases and heart attacks). Therefore, it is essential that new methods and changes are identified to keep the population and planet healthy.

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The Environmentally Sustainable Hospital

Written by **Daniel Eriksson**
Cecile Cuijpers



Reusable Medical Products

INTRO

Hospitals are designed to prevent, diagnose and treat illnesses while improving quality of life and supporting social wellbeing. However, the healthcare sector accounts for approximately 5% of global CO_2 emissions, and hospitals are among the largest contributors due to their intensive energy use, resource consumption and waste generation (World Bank, 2017). In many industrialised nations, hospitals alone consume more energy per square metre than any other type of public building, thus highlighting their substantial environmental footprint. In addition, hospitals generate large volumes of hazardous waste, specifically infectious waste, pharma waste and even radioactive waste, they consume significant water, and they rely heavily on chemicals and single-use materials (HCWH, 2026).
By embedding sustainability into hospital planning and operations, hospitals could:

- **Improve overall health**: Hospitals can reduce their carbon footprint and, thus, improve environmental health and the health of future generations while simultaneously providing optimal patient care.
- **Lower operation costs**: Sustainable practices can lead to cost savings through energy efficiency, the reduction of consumables, waste reduction and smarter procurement.
- **Anticipate and be ahead of new regulations**: By becoming more environmentally friendly, hospitals can implement emerging regulations, mitigate supply-chain risks and enhance their brand value in an increasingly environmentally conscious market.
- **Create a competitive advantage**: A more sustainable focus can attract motivated employees and inspire patient and public trust in hospitals.
- **Enhance ethical and social dimensions**: By reducing their environmental footprint, hospitals can contribute to global equity, ensuring that care for today's patients does not compromise the health of vulnerable individuals or future generations.

Globally, the healthcare sector accounts for approximately 5% of total CO_2 emissions, and hospitals are among the largest contributors.

How can a hospital transform into a sustainable hospital?

Transforming hospitals into sustainable systems requires reducing their negative impacts on natural systems, namely air, water, soil and biodiversity, while ensuring patient and staff safety and maintaining financial viability.
Up to 71% of healthcare related emissions arise in the supply chain, which encompasses the production, transport and disposal of pharmaceuticals, medical products and food (HCWH, 2019). Therefore, a systemic transformation beyond the hospital walls is desired.

Healthcare related emissions arising along the supply chain:

up to 71%

Here are some areas in which such a systemic transformation can be achieved (e.g., World Bank, 2017; Turnstedt, 2019):



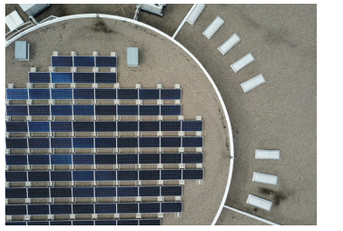
Sustainable supply chains

As supply chains account for most emissions in hospitals, sustainable procurement policies are crucial. Hospitals could require suppliers to disclose environmental data, prioritise eco-labelled medical products and adopt circular economy principles, such as by reusing, repairing or recycling materials wherever possible. Collaboration with suppliers to reduce packaging, shift towards the use of biodegradable materials and favour local sourcing can further lower a hospital's footprint.



Pharmaceuticals and chemicals

Pharmaceuticals contribute significantly to environmental pollution, both through their production and improper disposal. Hospitals can minimise the impact of pharmaceutical use through rational prescribing, safe disposal programmes and purchasing from manufacturers that implement green chemistry principles. Similarly, substituting harmful cleaning and disinfectant agents for non-toxic alternatives will protect both ecosystems and hospital staff.



Energy

Hospitals could adopt low-carbon energy strategies, including using renewable electricity, efficient heating and cooling systems and smart energy management. Consider energy- efficient insulation, LED lighting, and advanced ventilation or even following green building standards, such as the widely used LEED or BREAAM.



Waste and water management

Hospitals generate a wide range of waste streams, including infectious, chemical and general waste. Implementing waste segregation at source, waste minimisation and closed-loop recycling systems could reduce environmental harm and costs. Additionally, water-saving fixtures, rainwater harvesting and wastewater treatment systems could further improve sustainability and resilience, especially in hospitals in water-scarce regions.



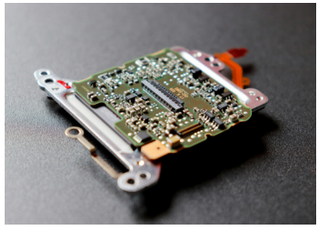
Green buildings and logistic

Hospital buildings themselves and their transport systems can be redesigned for sustainability. Encouraging green mobility, such as through electric ambulances, bicycle infrastructure for staff and digital consultations between patient and physician to reduce travel, lowers emissions. On-site renewable installations and efficient logistics management would further enhance sustainability performance.



Sustainable governance and culture

Embedding sustainability into hospital governance requires committed leadership, supported by clear targets, monitoring and transparent reporting. Staff training and engagement programmes on sustainability help to create a culture of shared responsibility. Long-term change requires removing barriers between clinical, technical and administrative departments and fostering continuous dialogue across the hospital organisation.



Data collection, innovation and digitalisation

Accurate data collection and lifecycle analysis, which will be discussed in section 2 of this handbook, are key to informed decision-making. Digital tools can be used to optimise energy use, monitor emissions and support predictive maintenance of medical equipment. Innovation in materials, such as using bioplastics or energy-recovery systems, can make hospital operations cleaner and more efficient. Finally, partnerships with research institutions and startups would further drive the adoption of sustainable technologies.

Although general ideas were given, the following chapters can help achieve significant changes in a hospital. Achieving this goal calls for an improved understanding of green procurement and value chains, since these foster sustainability in hospitals most.

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Procurement and Value Chains for Sustainable Hospitals

Written by **Diego Angelino**



Cargoship with supplies

INTRO

Robust infrastructure, intensive collaboration and numerous decision-making processes are required (see Figure 2) to ensure that medical products and services are available exactly when needed in a hospital.
If hospitals prioritise sustainable practices throughout the lifecycle of healthcare products and services, including in their manufacturing, transportation and disposal, their impact on the environment can be significantly reduced (HCWH, 2022). To better facilitate the understanding of these sustainable practices, two tools are introduced: sustainable procurement and sustainable value chains. Indeed, these two tools are among the most effective strategies for advancing sustainability in hospitals.

Sustainable procurement and value chains are among the most effective strategies for advancing sustainability in hospitals

TOOL 1

Sustainable Procurement



Medical Supplies

TOOL 1

Based on HCWH, 2019; WHO, 2024 and Turnstedt, 2019

Procurement refers to the process of obtaining goods or services from external sources, typically through purchasing or acquisition (see Figure 2). Procurement represents a significant portion of global economic activity, with hospitals accounting for a large share. Hospital procurement tends to focus on medical equipment and supplies, pharmaceuticals, as well as construction and catering. Although procurement currently acts as an important driver of economic growth, it also has the potential to act as a powerful catalyst for sustainability by influencing what goods are obtained, used and discarded. Indeed, sustainable procurement can support the use of sustainable products and manufacturing practices, the efficient use of resources, the creation of more stable supply chains, cost reduction, and compliance with emerging laws and regulations.

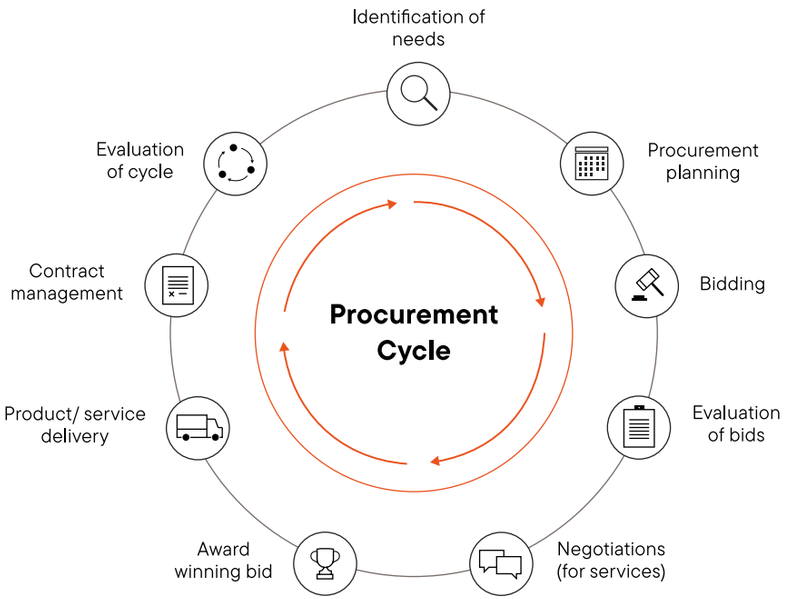


Figure 2:

The Procurement Cycle.
Adapted from NCSH, TEM.

HOW TO CREATE SUSTAINABLE PROCUREMENT

1 Start a team and define a goal

Create a multidisciplinary procurement team, identify needs and requirements and collaborate.

2 Rethink

Before procuring again, consider whether the service or product is really needed.

3 Define a strategy

Define goals and approaches to include sustainability in the procurement process.

4 Procure

Obtain products through a transparent and rule-based process, with clear indicators and descriptions of each assessment step.

5 Evaluate

Following a procurement process, assess the results to identify opportunities for enhancing sustainability in future acquisitions.

TIPS

- Prioritise environmentally certified products.
- Choose products with a low carbon footprint and with minimal environmental impact throughout the entire life cycle, including resource extraction, production, transport, use and disposal.
- Choose reusable products.
- Consider the supplier's sustainability practices.
- Encourage local sourcing.
- Use the Sustainable Procurement Index for Health (SPIH, 2022)

LIMITATIONS

Procurement options are restricted, as procurement decisions always need to comply with quality standards, current regulations, patient safety and ethical sourcing.

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TOOL 2

Sustainable Value Chains



Hospital Waste

TOOL 2

Based on HCWH, 2019; Turnstedt 2019; WHO, 2024

To further advance sustainability in hospitals, the procurement process should be integrated into a wider analysis that includes a vision for the value chains of hospital products. In particular, the value chain refers to the complete life cycle of a product, service or process, from material extraction to end-of-life disposal or recycling. Understanding the value chain involves considering the chain of suppliers engaged when creating a product and the value generated by that chain. Ultimately, this chain can include different activities, such as raw material extraction, material processing, manufacturing, packaging, transportation, usage and end-of-life disposal or recycling (Figure 3).

Value chains are often complex, and the stages may be distributed globally, with different subcontractors adding value to the goods. This complexity can lead to challenges, such as a lack of traceability of product materials, finger-pointing and the denial of responsibility, resulting in negative consequences such as environmental pollution and human rights violations. Having a more sustainable supply chain can mitigate these negative impacts, for example by ensuring materials are recycled to prevent pollution. Additionally, sustainable supply chains can reduce supply disruptions and pressure from stakeholders regarding adverse effects and, ultimately, allow hospitals to comply with new rules and standards.

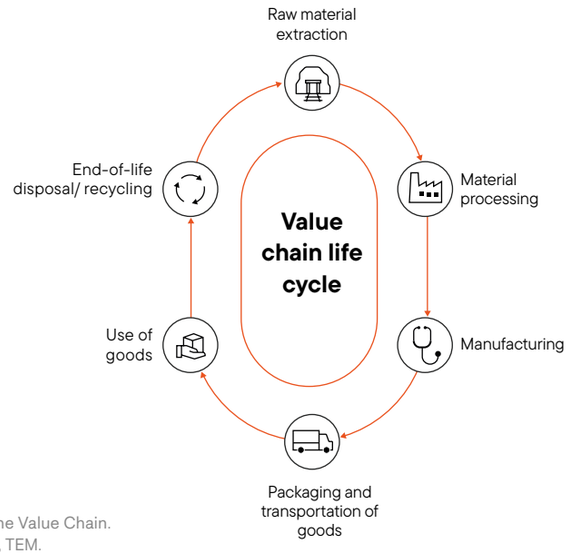


Figure 3:

Different phases in the Value Chain. Adapted from NCSH, TEM.

HOW TO CREATE A MORE SUSTAINABLE VALUE CHAIN

1 Know

Know the hospital's value chains and their environmental impact.

2 Identify

Identify bottlenecks and potential areas for improvement.

3 Improve

Try to improve the value chain where possible.

4 Recognise

Recognise the limitations of the value chain and take full responsibility for them.

TIPS

- Use the Life cycle assessment tool to understand the value chain; more information can be found in the section on environmental assessment (section 2).
- Understand that the action taken by the hospital can affect the whole supply chain and thus, has a significant effect on the environment.

LIMITATIONS

With more complex products (e.g. Med-tech), the value chain also becomes more complex.

There are products with an extremely limited number of providers, which limits the opportunities for influencing the value chain.

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KEY TAKEAWAYS - UNDERSTAND

- **Understand** that hospitals have a substantial environmental footprint and generate large volumes of waste. While they may deliver excellent patient care today, this comes at the expense of future generations' ability to meet their own needs.
- By transforming hospitals into sustainable hospitals, the planet's resources can be managed responsibly, without compromising the quality of care.
- **Understand** the importance of having sustainable procurement and sustainable value chains in a hospital; they are among the most effective strategies for advancing the hospital's sustainability.

Identity

Environmental Assessment

Written by **Marta Santamaria Molina**
Ilija Sazdovski



Assessment Session

INTRO

To understand which products and activities in a hospital are the least sustainable and how sustainability can be improved, an environmental assessment can be carried out. Specifically, an environmental assessment refers to the process of identifying, measuring and understanding the environmental impacts of healthcare activities, organisations and facilities. Such assessments can help hospitals to reduce their environmental impacts and can also support improvements in patient and staff health, optimise costs and resource use and contribute to global sustainability goals. In addition, these assessments facilitate compliance with environmental management standards and regulations, such as EMAS and ISO 14001.

Frequent methods used for environmental assessment in healthcare include the following:

- Carbon footprinting
- Life cycle assessment (LCA)
- Sustainable quality improvement (SusQI)

An environmental assessment is the process of identifying, measuring and understanding the environmental impacts of a system.

TOOL 3

Carbon Footprint Approach



Industrial Port

TOOL 3

The carbon footprint approach measures the amount of GHG emissions released into the atmosphere by an organisation, product or activity. By measuring GHG emissions, it is possible to identify how human activities contribute to global warming and, ultimately, climate change. GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases, such as CFCs and HFCs. To allow for comparisons among GHGs, all of these emissions are expressed as carbon dioxide equivalent (CO_2e).

CO_2e emissions can be divided into three distinct categories (Figure 4), including direct emissions from hospital operations **(scope 1)**, energy-related emissions **(scope 2)** and indirect emissions from resources in the supply chain **(scope 3)** (HCWH, 2026; WRI & WBCSD, 2004). As mentioned in section 1, up to 71% of emissions come from scope 3, and direct emissions from energy use (scope 2) and hospital operations (scope 1) account for the remaining 29% (HCWH, 2019).
As such, sustainability goes beyond the hospital walls, and all three scopes of emissions need to be addressed.

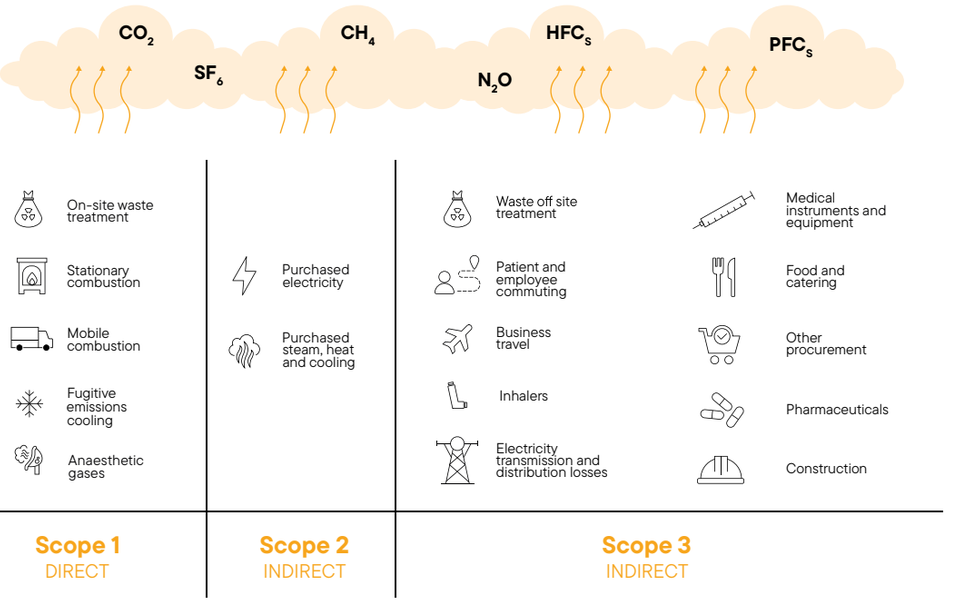


Figure 4:

The three emission scopes of a hospital.
Adapted from HCWH (2026).

HOW TO USE THE APPROACH

1 Define the boundaries

Decide what to assess: an entire healthcare organisation, a single facility or a specific product.
Additionally, define which categories of GHG emissions to include and explain any exclusions. Categorise the emissions within scopes 1,2, and 3.

2 Create a data inventory and collect data

Gather relevant data through surveys, utility bills, internal inventories or digital tracking systems. Remember that collaboration between departments and stakeholders is essential during the data collection process.

3 Calculate emissions

Quantify emissions using the following basic formula: Emissions = Activity data x Emission factor. Activity data can be in kWh, litres of fuel, tonnes of waste. Emission factors can be found in online databases.

4 Interpret results

Categorise the emissions by source (e.g. energy, waste, supply chain, clinical processes) and identify carbon hotspots. Hotspots are the areas that contribute most to the total footprint. Compare results with previous years or with similar organisations to track progress.

TIPS

- Align the assessment with recognised standards, such as the GHG protocol (WRI & WBCSD, 2004) and ISO 14064 (ISO, 2018).
- Use tools such as the Climate Impact Checkup (HCWH, n.d) and Sustainability Accelerator Tool (AHA, 2024), to structure data, automate calculations, and visualise results.
- Explicitly state what is included and what is excluded in the assessment (e.g. pharmaceuticals, medical devices), and prioritise high-impact categories, or hotspots, from the start. Be transparent about assumptions in the analysis.
- To get started, remember that common hotspots in healthcare include anaesthetic gases, metered-dose inhalers, pharmaceutical products, medical supplies, energy use and transport.
- Adopt a continuous improvement approach to enhance the completeness of the analysis and data quality each year.

LIMITATIONS

Although carbon footprinting is often a good first assessment step, climate change represents only one aspect of a much larger environmental impact picture (Figure 5). Therefore, a life cycle assessment (see Tool 4 on the next page) is recommended to gain deeper insights and develop more comprehensive sustainable hospital solutions.

Carbon footprint is just one slice of the full life cycle assessment cake!

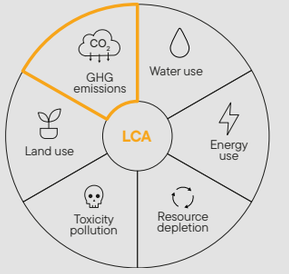


Figure 5:

The responsible management of the planet's resources to maintain the health of both ecosystems and biodiversity.

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TOOL 4

Life Cycle Assessment



Disassembly of a Medical Product

TOOL 4

Life cycle assessment (LCA) is a comprehensive approach to evaluating the environmental impacts of hospital products, services or processes throughout their entire life cycle.
A LCA goes further than only calculating the carbon footprint, as it also considers factors such as water use, energy consumption, land use, toxicity, resource depletion and the impact of other pollutants (see Figure 6).

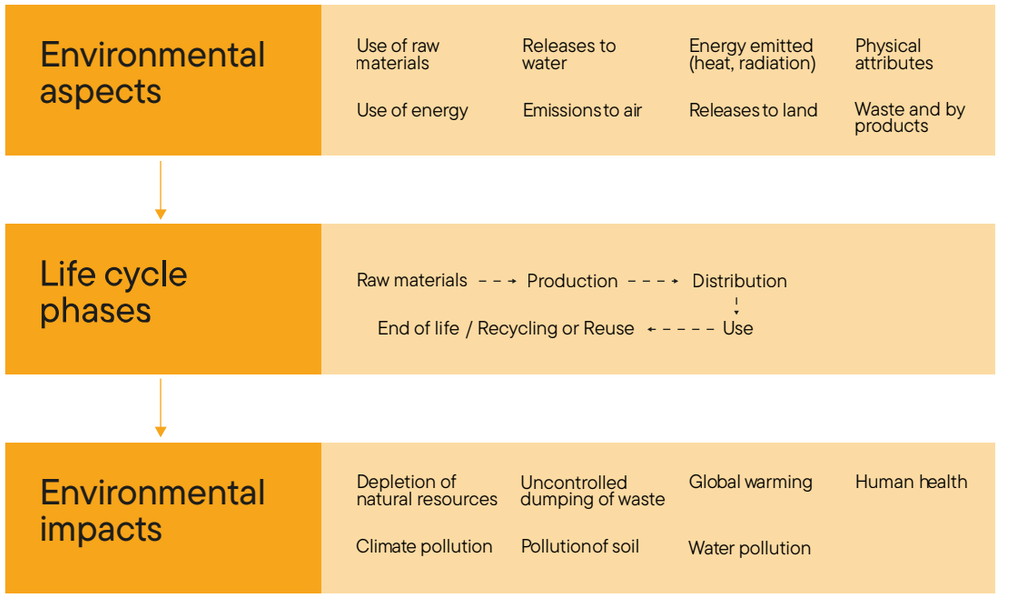


Figure 6:

The figure shows that the LCA translates emissions and waste into specific environmental impact categories, following a clear cause-and-effect pathway (based on ISO, 2006).

HOW TO USE THE LCA

1 Define the study goal

Define the product, product component, service or process to be analysed.

2 Define the functional unit

Select the functional unit, one of the most important choices during an LCA, and thus define exactly what is being measured and how the LCA outcomes will be compared. The funtional unit can be defined in different ways, depending on the study's goal. For example, the functional unit could be one of the following:

- Product-based (e.g. one sterile, single-use 5mL syringe ready for injection).
- Service based (e.g. the administration of one 5mL injection dose using a disposable syringe).

3 Define the system boundaries

Specify which life cycle stages and processes are included in the analysis, such as raw materials, manufacturing, use or end-of-life, and justify any exclusions.

4 Collect data

Use data from suppliers, manufacturers or life cycle inventory databases.

5 Assess hotspots

From the input data, compile output data for each life cycle stage. This impact assessment phase translates resource use and emissions (inputs) into measurable environmental effects (outputs) to identify hotspots.

TIPS

- Validate the functional unit and the life cycle model early. For example, create a flow diagram to confirm that all the relevant processes, inputs and outputs are captured before running the analysis.
- Use LCA software tools, including widely used tools such as SimaPro (PRé Sustainability, 2024), Sphera's LCA for Experts (Sphera Solutions GmbH, 2024) or OpenLCA (Ciroth, 2007).
- Other valuable resources include the following: IDEMAT, a TU Delft Excel-based LCA database/tool that helps calculate the environmental impact of products and materials (Idemat, n.d.); and HealthcareLCA, an up-to-date repository of LCA studies to explore real examples (Drew & Rizan, 2022).

LIMITATIONS

An LCA is time-consuming, and its accuracy depends on the available data. In addition, conducting an LCA might require technical knowledge about material properties, manufacturing processes, use phases and waste treatment options, among other factors.

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TOOL 5

Sustainability in Quality Improvement



Planting a Seedling

TOOL 5

The Sustainability in Quality Improvement (SusQI) framework, developed by the Centre for Sustainable Healthcare, is a well-established approach to embedding sustainability within the healthcare sector and provides a structured, step-by-step method for integrating sustainability principles into the hospital. (Centre for Sustainable Healthcare, n.d.).

The SusQI framework does not map pain points but rather aims to achieve optimal health outcomes while minimising financial and environmental impacts and creating social value whenever possible.

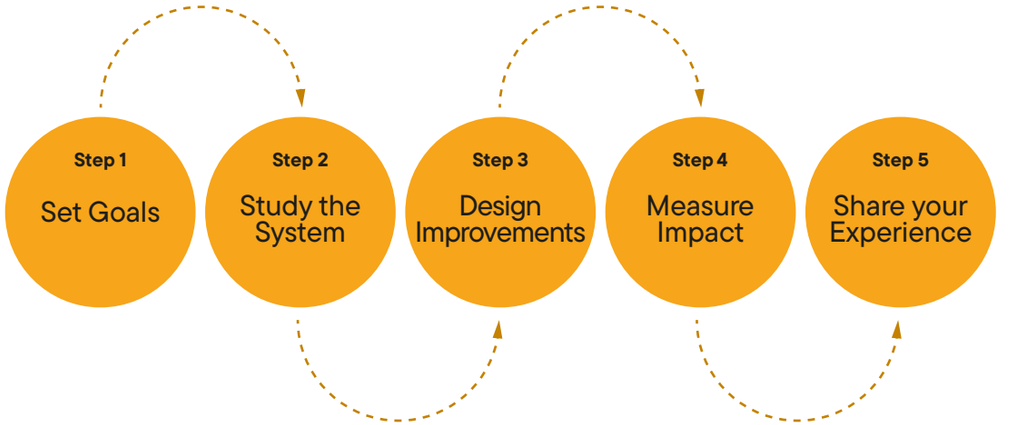


Figure 7:

Steps of the SusQI framework, based on https://www.susqi.org/step-by-step-guide

HOW TO USE THE SUSQI

The steps needed to generate a SusQI are as follows (see Figure 7):

1 Set goals

Identify and define the problem within the hospital that needs improvement. Next, set a specific, measurable, achievable and realistic goal with a defined timeline to ensure a focused direction and a clear target for success.

2 Study the system

Analyse the parts of the system that need improvement. Identify the key processes, stakeholders and interdependencies involved to clarify critical hotspots for intervention. Assess the types of resources used and sources of waste in order to prioritise actions, optimise resource use and support sustainable practices.

3 Design improvements

Develop actions to improve the targeted part of the system and align them with the Principles of Sustainable Healthcare. (Centre for Sustainable Healthcare, n.d.; Mortimer, 2010)
Each proposed measure should be well-structured, with clearly identified stakeholders, defined roles and responsibilities, and detailed implementation timelines.

4 Measure impact

Design a framework to assess the effectiveness of the implemented actions. This framework should provide feedback on the success rate and efficiency of improvements and enable the identification of additional interventions if necessary.

5 Share and disseminate your knowledge

Share experiences and results to allow others to replicate and adapt the approach, while also allowing to learn from the experiences of other institutions. This exchange of knowledge fosters continuous improvement and strengthens sustainability practices across different hospitals.

TIPS

- SusQI offers a range of tools, templates and resources to support the development and implementation of sustainability improvements within a hospital (Mortimer et al., 2018).

LIMITATIONS

Evaluating the success of SusQI interventions is complex. This evaluation involves not just whether the project was completed, but also whether it led to sustainable improvements in outcomes, such as environmental, social and clinical metrics. It is important to note that assessing social outcomes within the triple bottom line can be particularly challenging.

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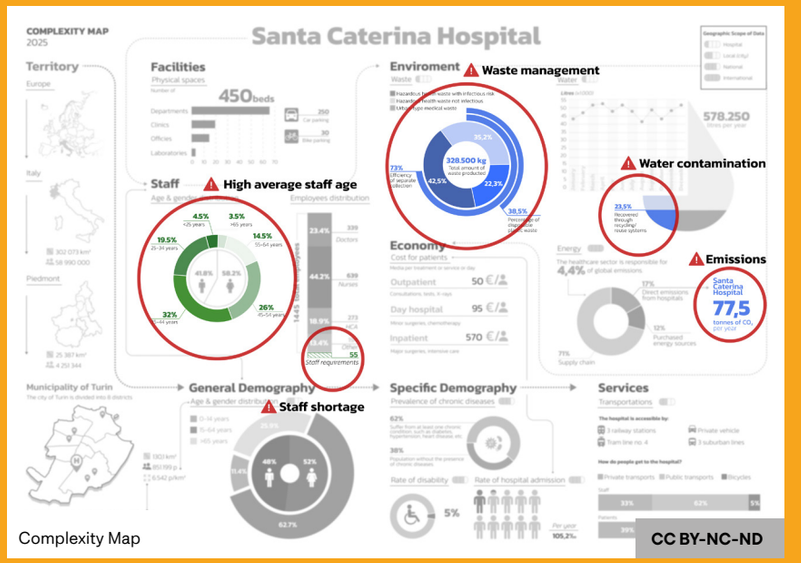
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Understanding Complexity: Visual Mapping of Hospital Systems

Written by **Jotte de Koning**
Amina Pereno
Sara Ghione



Complexity Map

INTRO

Designing environmentally sustainable strategies in hospitals requires a thorough understanding of the context. The field of design has developed numerous visual methods and tools for grasping complexity in systems, which can be collectively referred to as visual mapping. This mapping practice collects fragmented data and processes and transforms the data into clear, interpretable visual knowledge, thus fostering shared understanding and systemic change. Visual mapping helps designers, clinicians and managers to understand how the system functions, where resources circulate efficiently, where waste accumulates, how behaviour unfolds in the system and where hidden opportunities for change may exist.
Visualisations transform information into insights, clarifying relationships and fostering dialogue among diverse stakeholders with different perspectives (Pereno & Eriksson, 2020). Overall, visual mapping serves as an analytical, creative and strategic tool, effectively supporting decision-making across different scales and time periods.

Visualisations transform information into insights, clarifying relationships and fostering dialogue among diverse stakeholders with different perspectives.

Why to use visual mapping

Visual mapping is not an end goal but a diagnostic and strategic process (Prakash et al., 2021). The value of visual mapping lies in what the visualisations reveal, such as the patterns, contradictions and opportunities that emerge once complex data are made clearer. Analysing such visualisations allows teams to move from seeing to understanding, and then from understanding to acting.

There are three clear objectives when creating visual maps:

1

Identifying hotspots

A key step in improving hospital performance is recognising hotspots: the obstacles, bottlenecks or inefficiencies that reduce a system's effectiveness, equity or sustainability.
With visual maps, these criticalities often appear as areas of intense activity, resource imbalance or disconnection between stakeholders. For example, visual maps may show a waste stream concentrated in one department, or an overreliance on single-use products linked to specific procedures. Identifying these areas allows designers to question why they exist and what systemic conditions maintain them.

2

Spotting potentials and synergies

Alongside identifying hotspots, it is equally important to identify potential and opportunities, which are places where the system already shows signs of resilience or innovation. In visual maps, these areas often appear as overlaps or intersections where multiple actors, flows or functions align naturally. Identifying synergies means recognising opportunities where a single action can address several challenges at once. For instance, a change in material procurement may simultaneously reduce waste, simplify logistics and improve user experience.

3

Engaging stakeholders

Analysing visual maps should be a collaborative activity. Stakeholders bring different types of knowledge (e.g. operational, technical, managerial, experiential) that enrich their interpretation and ensure accuracy. In workshops or during co-creation (see Section 4), visual maps can be used as boundary objects or shared referencess that enable diverse participants to discuss problems and opportunities in a common visual language. This process helps to validate data, uncover hidden issues and develop ownership of potential solutions. Stakeholder engagement also reinforces a culture of transparency and continuous learning, thus transforming analyses into an ongoing dialogue rather than a one-time report.

How to use visual mapping

Visual mapping can take many forms, depending on the type of knowledge to reveal and the level of the system to explore, from material flows to people's routines to organisational structures. Regardless of the system level selected, the mapping process follows a shared logic: collecting, organising, visualising and interpreting data to uncover meaningful patterns.
While each visualisation method has its own process, there are four fundamental steps for visual mapping:

1 Define the system's scope and boundaries

Identify which parts of the hospital to analyse, the flows to track and the stakeholders to involve. Gather relevant quantitative data (e.g. energy consumption, material use, costs) and qualitative data (e.g., routines, behaviours, perceptions).

2 Organise and collect the data in a clear database

Use databases such as Excel or Google Sheets for easy access to the data. The data allows transparency, foster collaboration and allows to share evidence rather than having isolated assumptions.

3 Visualise the data

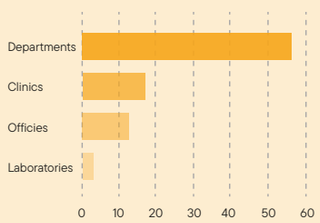
Effectively visualise the data, following the principles of clarity, simplicity and precision. Tools such as Miro, Canva, RAW Graphs, Google Looker Studio, Power BI or AI-assisted platforms can help create these representations.

4 Create an integrated overview

Combine all of the visuals into a cohesive map or dashboard. This visual combination provides insight into how different processes connect, from patient beds to supply chains.

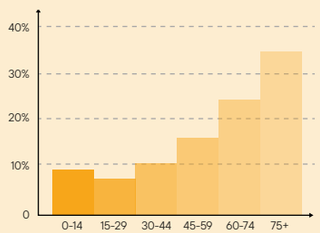
Examples of Charts and Graphs

The following typologies can be powerful tools to visualize data, e.g. when creating system maps (see p. 65).



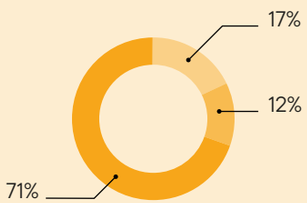
Bar chart

Bar charts can be used to present data clearly by ordering categories logically, using contrasting colours, starting the x-axis at zero and limiting categories to avoid clutter.



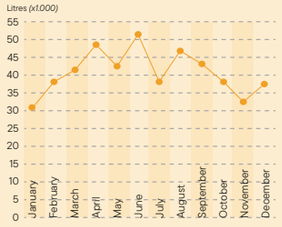
Histogram

Histograms illustrate the frequency distribution of continuous data. Their clarity can be ensured by using appropriate and equal bar widths to reveal patterns clearly, labelling axes with unitsand avoiding gaps between bars to emphasise data continuity.



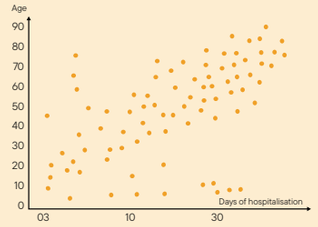
Pie chart

Pie charts effectively show how the parts of something relate to the whole. Clarity can be achieved by limiting the number of slices, ordering them by size, using contrasting colours and labelling each slice directly.



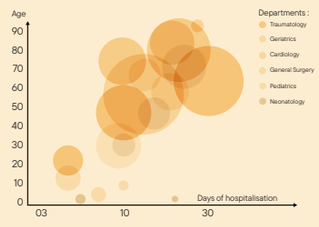
Line Chart

Line charts Ilustrate trends over time or in a continuous sequence. They effectively visualise changes, patterns and fluctuations in the data.



Scatter plot

Scatter plots can be used to visualise relationships, correlations and trends between two continuous variables.
The pattern of the data points delineates the nature of the correlation.



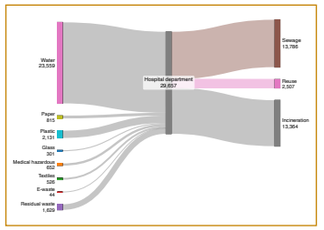
Bubble plot

Bubble plots enable the visualisation of relationships among three numerical variables, represented by a point's horizontal position, vertical position and size. Colours can indicate a fourth categorical variable.

What to map in a hospital

Here, we briefly present the six visual mapping practices that are most relevant for hospitals.

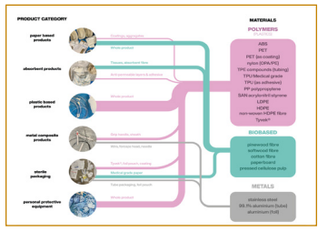
Images from S.F.M Starre in (Simonse, Albayrak, & Starre, 2019), and master theses of (Ghione, Lombardo, & Pedraza Olaya, 2025) of Politecnico di Torino and (Clercx Lao, 2024) and (Malkhede, 2026) of TU Delft.
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Material flow analysis

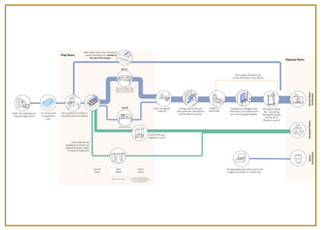
This type of analysis provides a quantitative overview of the flows of materials and resources within a hospital department, identifying major environmental impacts and potential areas for savings (Hunfeld et al., 2023).
By examining key inputs and outputs, this analysis builds a systemic understanding of how materials enter, are used and are then disposed of in the system. As data collection can be complex, collaboration with departments such as procurement and finance is essential. The results of the material flow analysis support strategic planning and sustainability decision- making.

www.sankeymatic.com could be used to visualize the material flow.



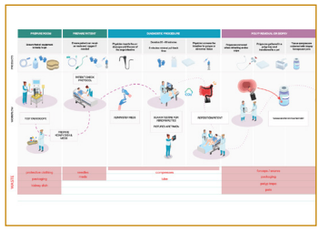
Waste audit

A waste audit visualises the quantity and type of waste produced during everyday hospital operations, factors that are often invisible (Izci et al., 2026). This type of audit involves the direct observation, collection and categorisation of materials used in specific procedures or units. By turning waste data into visual evidence, this method raises awareness among staff and creates a shared understanding of where and why each type of waste is generated. The visual element supports the implementation of R-strategies (see Section 3) and helps prioritise interventions that deliver the highest environmental and economic benefits.



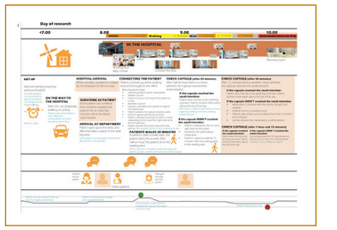
Product journey mapping

A product journey map (TU Delft Learning for Life, 2026) tracks a medical product throughout its life cycle inside the hospital. Mapping this journey uncovers hidden dependencies between departments and clarifies how material and operational decisions intersect. This type of map allows designers and procurement teams to identify opportunities for reuse, leasing or modular redesign, thus transforming linear supply chains into circular value loops. (Ellen MacArthur Foundation, 2016). The final visual shows a chronological flow of where the product goes, who inter-acts with it and why.



Workflow analysis

Workflow analyses in hospital settings systematically examine how clinical and administrative tasks unfold across people, technologies and spaces (Izci et al., 2026). Mapping activities and bottlenecks reveals inefficiencies that impact both care quality and staff wellbeing.
A workflow analysis also highlights interdependencies, enabling process optimisation and improved coordination among key actors.



Patient journey mapping

Patient journey mapping visualises the path a patient takes through the healthcare system (Simonse et al., 2019). This type of map reveals not only clinical touchpoints but also the spatial, emotional and logistical dimensions of care. From a sustainability perspective, this map reveals resource waste and inefficiencies.
The visualised journey also helps identify opportunities to enhance patient experience and sustainability.



System mapping

This mapping method integrates insights from all of the previous mapping activities into a single, comprehensive visual system, also called a 'gigamap' or 'complexity map' (Sevaldson, 2022). This type of map connects people, processes, materials and infrastructures, highlighting how they influence one another across scales and providing a holistic representation of the hospital. System mapping reveals feedback loops, interdependencies and leverage points where circular strategies can have systemic impact. See Page 63 for inspiration on charts and graphs which can be used for a system map.

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KEY TAKEAWAYS - IDENTIFY

- **Identify** unsustainable hospital practices by using environmental assessment and visual mapping.
- Environmental assessment allows to identify the least sustainable products and activities in a hospital and provides an understanding of how these can be improved. The tools used for this are the carbon footprint approach, LCA and SuSQI.
- Visual mapping helps to clarify the flow of resources and waste within the hospital, identify hotspots and facilitate strategic decision-making.

Propose

The Value Hill with Circular R-strategies

Written by **Jan-Carel Diehl**
Cecile Cuijpers



Discarded Surgical Mask

INTRO

An effective way to enhance sustainability is by maximising the value and circularity of hospital products. In a linear economy, products are manufactured and then disposed of typically after a single use, as if resources are unlimited and pollution is not harmful. Many businesses prioritise maximising economic outcomes, and hospitals often desire to purchase single-use devices, since they are assumed to result in higher patient safety and do not require device reprocessing for reuse (i.e. decontamination and sterilisation).

However, as discussed in section 1, our linear consumption patterns come with significant societal and environmental costs. As such, this type of consumption behaviour does have a limit. Furthermore, maintaining a product's value for as long as possible can reduce costs and minimise geopolitical dependencies, all while preserving the quality of care provided.

This section presents the value hill with circular R-strategies, an effective tool which helps to sustain the value of medical devices as long as possible.

An effective way to enhance sustainability is by maximising the value and circularity of hospital products.

The Current Value Hill

Currently, medical devices follow a process of value adding steps, referred to as “the value hill” (Potting et al. 2017). This process starts with the extraction of raw materials, followed by these materials being refined during manufacturing. Next, the individual components are assembled into medical devices, and these are then distributed and sold to a hospital.
At the top of the value hill, where the product holds its highest value, the product is used. At this stage, significant investments in materials, energy and labour have been made. The environmental impact of these processes involved in manufacturing and delivering the product include emissions, land use and water consumption. In most cases, after a single use, the device is discarded and sent to waste incineration or landfill (see Figure 8).
From that moment on, the product’s value declines, meaning the value created during the first part of value chain is lost.
In this make-do-waste value hill, as illustrated in Figure 8, the focus is on creating, selling and using as many products as possible. In this value hill, the economic and environmental value of the product is destroyed at the highest point, resulting in significant pollution and resource loss.

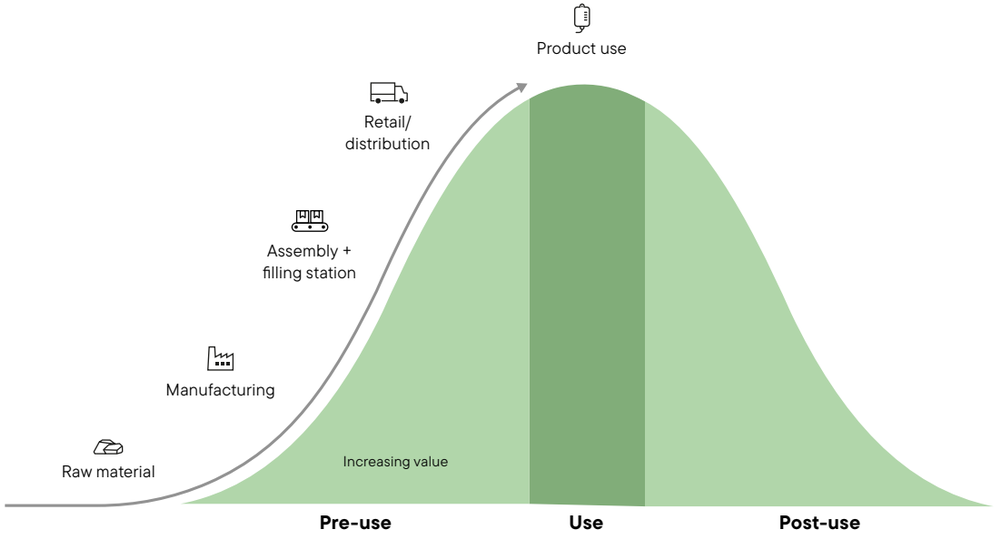


Figure 8:

Current make-use-waste value hill, based on Buck (2025) and Achterberg (2016).

R-strategies

Fortunately, more sustainable alternatives to the make-use-waste value hill are possible, which facilitate the transition towards a more circular economy, namely the sustainable value hill. To facilitate this transition, the so called “ten R-strategies” need to be introduced first (Hoveling et al. 2026). These strategies, which all start with the letter “R”, are designed to maintain a product’s value for as long as possible, thereby making products and services more circular and sustainable.
These R-strategies are presented on Page 74.

The R-strategies can be organised into three clusters as follows:

1. Strategies that help to reduce the inflow of materials and products into the hospital – refuse, rethink & reduce.
2. Strategies that enable products to remain operational for a longer time – reuse, repair, refurbish, remanufacturing and repurpose.
3. Strategies that facilitate the recovery of materials and energy after they leave the hospital – recycling & recovery.

In general, the strategies of refuse, rethink, reduce, reuse, repair, refurbish and remanufacture are preferred, as they considerably reduce a product’s carbon footprint.

Strategies that help to reduce the inflow of materials and products into the hospital – **refuse, rethink & reduce**

R0 Refuse	The intentional act of rejecting the production, consumption or use of a medical product, material or procedure, particularly those that are unnecessary, unsustainable or harmful.
R1 Rethink	Systemically enhancing the procedures surrounding product use in order to drive environmentally sustainable practices, such as by rethinking patient transport and telemedicine, sharing products or introducing multifunctionality.
R2 Reduce	Increasing efficiency in healthcare delivery and medical product manufacturing by minimising energy use, resource use and waste generation at the source, avoiding unnecessary production or consumption, limiting hazardous substances, and carefully minimising unnecessary procedures while still meeting healthcare needs.

Strategies that enable products to remain operational for a longer time – **reuse**, **repair**, **refurbish**, **remanufacturing** and **repurpose**

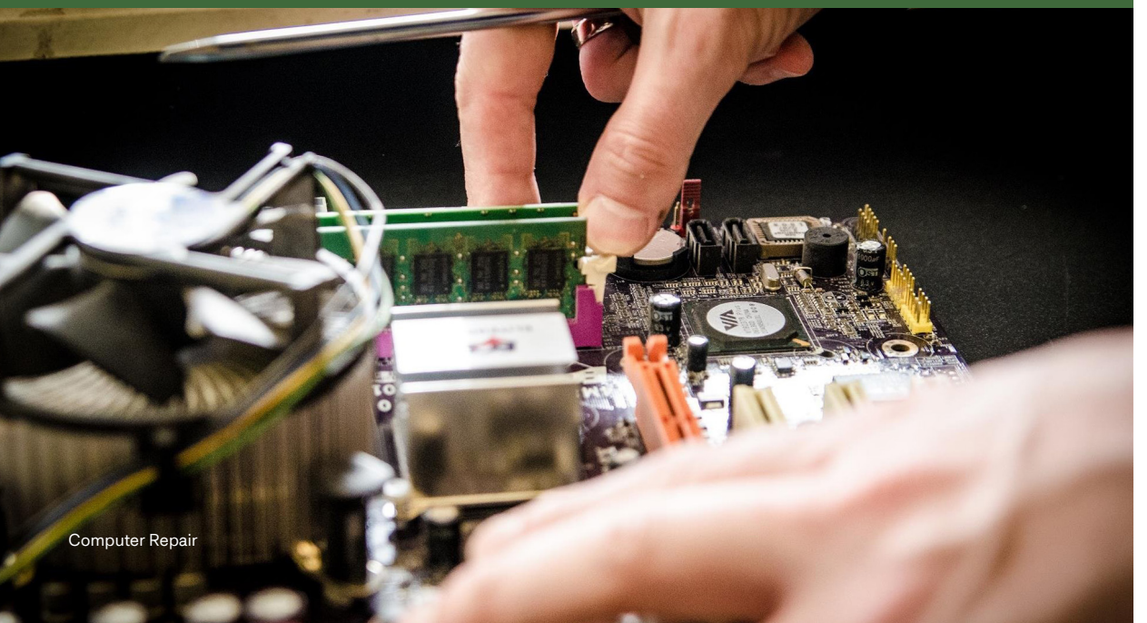
R3 Reuse	The repeated use of a medical device on multiple patients for the same intended purpose without significant modification, and after decontamination when necessary.
R4 Repair	Restoring a faulty or broken product or component to a usable state, typically through corrective maintenance, so that it can fulfil its intended use, while ensuring that safety and performance specifications are met for an extended period of time.
R5 Refurbish	Restoring a product to good working condition through decontamination, repairs, upgrades, cosmetic changes, performance checks, reinstallation, warranty assurance and parts replacement.
R6 Remanufacture	Restoring products and components, often by using parts from discarded products with the same function, to achieve as-new condition through disassembly, decontamination, quality control, certification, repackaging and redistribution.
R7 Repurpose	Using discarded products or parts in other ways than originally intended, such as in different contexts (e.g. veterinary care procedures), for different purposes (e.g. different human procedures) and in different locations (e.g. low-income settings).

Strategies that facilitate the recovery of materials and energy after they leave the hospital – **recycling** & **recovery**

R8 Recycle	Transforming waste materials from used products or resources into new raw materials, either of the same or lower quality, through processes such as decontamination, shredding and moulding.
R9 Recover	Incineration (or medical incineration) of waste materials with energy recovery.

TOOL 6

Sustainable Value Hill



Computer Repair

TOOL 6

By positioning the R-strategies within the value hill framework, a more sustainable value hill can be created (see Figure 9). Specifically, by applying these strategies during the product's use or after its initial use, the product's life cycle and value can be extended.

Various loops could be integrated into the product's life cycle to further increase the product's value and extend the end-of-life phase. Ultimately, applying these strategies enables hospitals to become more sustainable while also reducing resource consumption and costs.

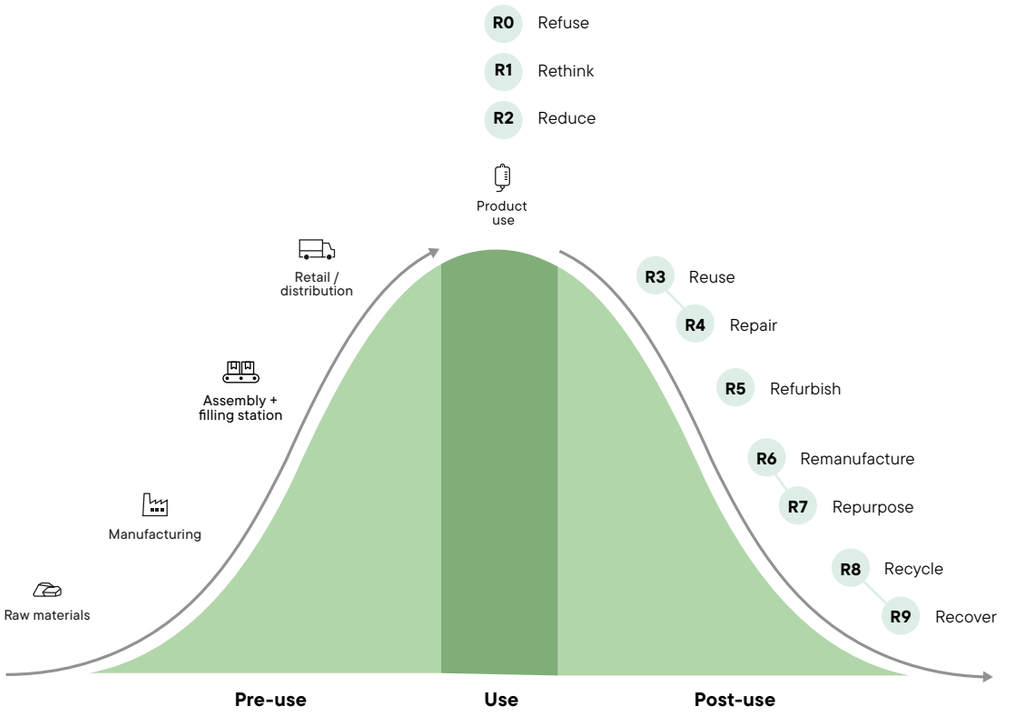


Figure 9:

Value Hill with R-Strategies, based on Buck (2025) and Achterberg (2016).

HOW TO USE THE SUSTAINABLE VALUE HILL

1 Select

Select a product with a high environmental footprint.

2 Draw

Draw the value hill for a product: what steps are taken from cradle to grave?

3 Identify

Identify the possible R-strategies that provide opportunities to maintain the value of the product for as long as possible.

4 Choose

Choose the R-strategies that will create the most impact while also being feasible.

5 Define

Define which collaborations (e.g. with other stakeholders) and actions should be taken to maintain the value as long as possible.

6 Formulate

Formulate the strategy with the stakeholders, collaborate and create impact.

TIPS

- To determine what strategies are best for the product or service, consider the potential barriers to creating more sustainable hospitals. A list with examples can be found in the paper of Hoveling et al. (2024).
- Although it may seem tempting to choose the strategies high on the R-ladder, these may not always be most sustainable for the hospital.

LIMITATIONS

It takes time to fully understand which R-strategy would be the most suitable.

Due to the many dependencies in a hospital, strategies with the highest impact cannot always be implemented in the short term.

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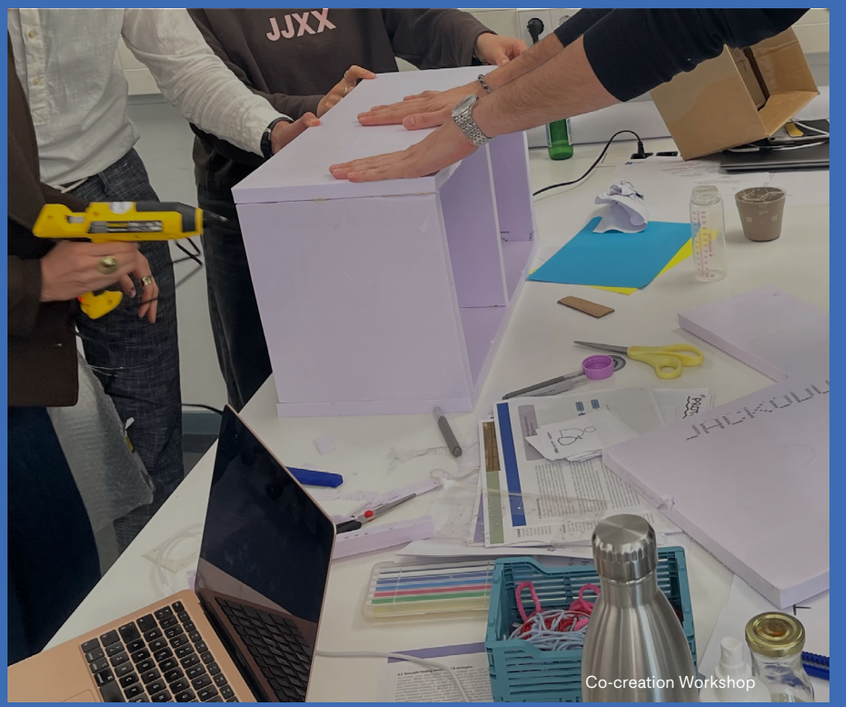
KEY TAKEAWAYS - PROPOSE

- A value hill is a conceptual model that describes how value is created, maintained and eventually lost across the life-cycle of a product or system.
- R-strategies are circular economy principles that can help to improve sustainability and resource efficiency in the hospital.
- Use the R-strategies and the value hill to **propose** effective sustainable solutions.

Develop

Co-creation

Written by **Jotte de Koning**
Amina Pereno



Co-creation Workshop

INTRO

Sustainability issues in hospitals are interrelated and dynamic and generally involve human, environmental and technical aspects. Together, these aspects form the hospital system. As such, to accelerate the transition towards sustainability in these systems, it is essential for different disciplines and stakeholders to collaborate. Change can only be created together through iteratively creating visions and solutions for a sustainable future.

Co-creation describes the efforts of multi-stakeholder collaborations towards creating interventions, developing new products and services and establishing change in a certain context (Sanders, 2002).

Specifically, co-creation is the purposeful act of a heterogeneous group of people creating an output together (van Boeijen et al., 2017). In the hospital context, these different stakeholders could include patients, pharmacists, procurement officers, clinicians, waste managers and suppliers, among others.

Co-creation facilitates multi-stakeholder work by providing methods for meaningful collaboration while ensuring that the participants are not overburdened, which is especially important given that stakeholders in hospitals often face demanding workloads. Additionally, using an iterative way of working allows people to engage at moments that align with their expertise, whether this relates to clinical insight, organisational knowledge, technical engineering or design capability.

To accelerate the transition towards sustainability, it is essential for different disciplines and stakeholders to collaborate.

When to use Co-creation

Co-creation in design is based on three streams of thought:

1 Democracy in participatory design

The value of co-creation, when starting from the idea of more democracy, is to create more empathy. Participation and inclusion will create more shared understanding and build trust, leading to higher levels of democracy.
For example, patients are also asked to consider how treatments might be improved. Involving them is sensible, since they are the recipients of the product or system and should have a voice too.

- Focus of the practice: Participation, inclusion, engagement.
- Role of design: Facilitator.

2 Innovation and new product development

The value of co-creation, when starting from the idea of innovation and new product development, is a better understanding of people. Because a better understanding of what people want, leads to better adapted products, greater buy-in and higher adoption rates of the product. In hospitals, when introducing new products, for example co-creation with nursing staff can lead to adaptations to products that better fit their working processes.

- Focus of the practice: Understanding users and improving efficiency through the co-creation of products and services
- Role of design: Translator of human needs.

3 Marketing and branding

The value of co-creation, when starting from the idea of creativity, is a higher variety of ideas. Therefore, aim to include diverse participants from different departments and organisations, covering various responsibilities, experience levels, genders and roles. Co-creation will then lead to higher levels of innovation of the ideas, because new combinations of knowledge are formed.

- Focus of the practice: Engaging front-runners, gathering a variety of input.
- Role of design: Combiner of input.

Co-creation glossary

Co-creation, co-design and co-production are used to describe practices that are vastly different, such as a 1 hour creative workshop or a continuous effort of working together in a living lab.

Participation
A term often used in governance that broadly describes processes that involve citizens.

Participatory design
The parent concept of involving others in design processes. Participatory design originated in the 1960s to promote more democratic processes in design.

Co-creation
A broad term often used in marketing and design. This term is often used in phrase ‘co-creating value’.

Co-production
A collaboration among people to produce something together. In the public sector, this term is also used to describe producing services together, such as managing green spaces for both citizens and municipalities.

Co-design
This term is used in product design and software development. Co-design is the act of making something together, such as a product or part of a software code.

Open innovation
Open innovation integrates co-design in software development and innovation management, fostering collaboration among stakeholders, promoting a democratic perspective on the creative process, encouraging contributions from various participants.

How to use Co-creation

Co-creation can be used at different stages of a design process, between different stakeholders and in different settings (Prahalad Ramaswamy, 2004). Co-creation can be applied throughout the whole design process, including during reflection, analysis, synthesis and evaluation. When working on design for sustainability, the perfect solution or set of solutions is not known. So, it is necessary to try, prototype, experiment, sense, fail and learn again, together. As such, not only an understanding of the technical possibilities in a certain context is needed but also, and perhaps even more importantly, of the human factors that affect system dynamics (Sanders & Stappers, 2012).
Envision long-term changes while also understanding the actionable steps to take in the short term. On Page 89, some examples of co-creation methods are presented:

Examples of co-creation methods

TOOL 7



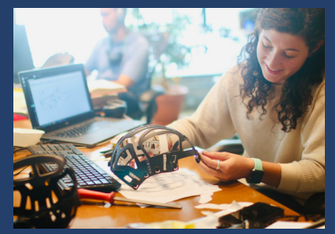
Context mapping
Context mapping is a method used to gather information about how products and services are used in their context. The method allows the users to be the experts. Specifically, this method helps users to express their goals, motivations, meanings, and latent needs. To support context mapping, you can give people different tools, such as booklets, diaries, or photo-challenges. These tools enable the user to become more aware of the experiences they have and to express their perspectives, which are important for creating meaningful solutions.

TOOL 8



Brainstorming
Brainstorming is a process of collective creativity. Brainstorming is generative and divergent and is often used at the start of the creative process. In this method, there are clear processes and defined rules that are used to generate many ideas. For example, these rules include keeping a positive attitude, not criticising others and, instead, building on their ideas. After brainstorming, a process of converging and quality selection takes place, according to specific criteria, to select the best ideas generated.

TOOL 9



Prototyping together
Prototyping together allows people to think in shapes and forms. Prototyping is a process where things are built with simple materials, such as cardboard, foam, fabric or wood, meaning only few resources are spent on creating a prototype. The goal of this process is to gain feedback on design aspects, not to have the perfect prototype. The creation process allows people to physically interact with and experience the solution space in a different way. Creating together also enables ideas to be tested quickly in an early stage of the design process, thus supporting iteration cycles and learning by doing. Use the designed prototypes to check if assumptions are correct with other stakeholders who are not involved in the prototyping. In this process, evaluate and iterate based on the acquired feedback, create new prototypes and test these as well, until a satisfying concept is created.

How to co-create:

1



Staging

Co-creation outcomes depend on the collaboration skills of the team. Importantly, this collaboration can be staged in different ways: facilitating an open mindset, willingness to listen to each other and addressing tensions, laying down simple communication rules, such as saying ‘yes, and...’ instead of ‘no...’, letting people finish their sentences, and promoting an open setting by sharing yourself.

2



Guiding people

Not everyone is conformable with the creative methods that are often used in co-creation. Guide participants through the process to give them comfort and start with small tasks. Provide general and familiar material, such as coloured pencils and paper, alongside context-specific images or photos. In general, do not start with a blank sheet, but give examples or suggestions and provide stickers, icons, materials or shapes.

3



Physical space

Carefully create physical spaces for co-creation. Have a neutral space to co-create that allows different stakeholders to meet more equally. Provide enough food, drinks and comfortable chairs but also switch around sitting down and standing up between exercises.

4



Inclusivity

Aim for diversity of involvement, but involving many different voices may bring tensions, whether they are existing or new. Be open about these tensions, and formulate a strategy together on how to manage them.

5



Expectation management

Expectation management is crucial. Make sure people know why they are involved in the process. Additionally, when the goal is broad, be transparent about this. Sometimes, there is a dual goal that is not explicitly mentioned (e.g., developing both more collaboration and a design outcome). Implicit goals can hinder the process towards achieving the desired value, so make the goals explicit.

6



Balance

Think carefully about the time you ask people to spend on co-creation. Balance people’s presence in the process well. For example, ask yourself whether they all need to be there or can just join for part of the process. Consider what can already be prepared online or at home.

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KEY TAKEAWAYS - DEVELOP

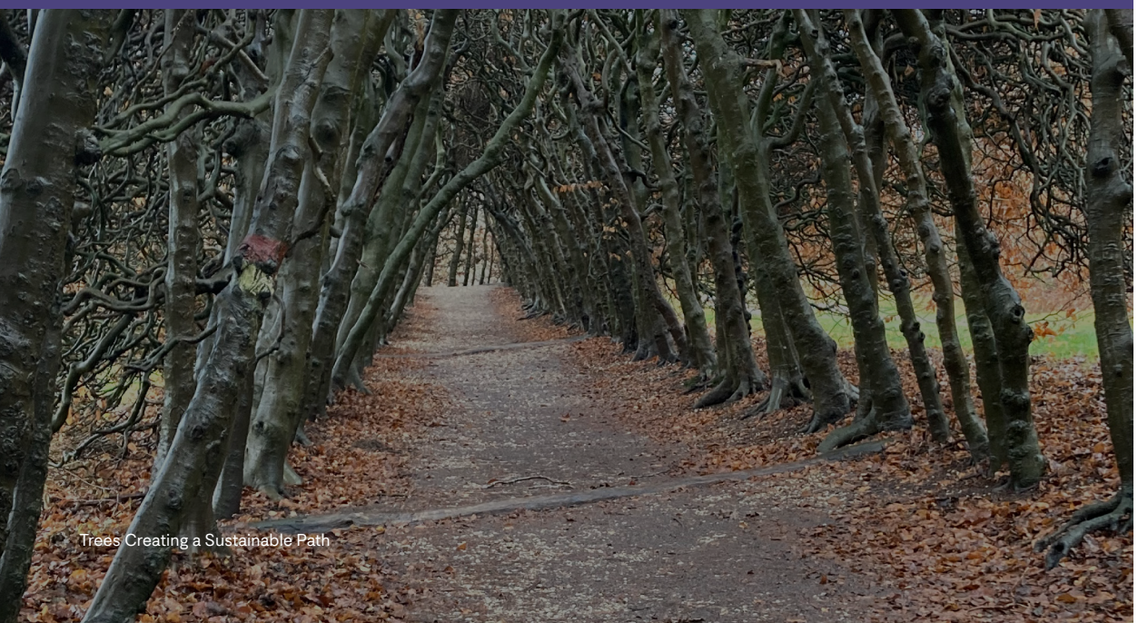
- Sustainability issues are complex and interconnected. Use co-creation to collaborate with multi-disciplinary stakeholders and to **develop** a shared vision, impactful solutions and effective implementation.
- Use powerful co-creation tools, such as context mapping, brainstorming or prototyping, to successfully co-create.

Implement

TOOL 10

Sustainable Business Model

Written by **Shushanta Acharjee**



Trees Creating a Sustainable Path

TOOL 10

A business model outlines how a hospital creates, delivers and captures value while aligning clinical excellence, environmental protection and financial resilience. Enhancing sustainability in a hospital is not only beneficial for the environment but also supports the hospital's own business model in many ways. Specifically, a sustainable hospital business model is an integrated framework that aligns clinical services, infrastructure, procurement, governance and community engagement with the goal of protecting both patient and planetary health. Overall, developing and implementing a sustainable business model enables hospitals to reduce their environmental footprint while also improving their care quality, equity and organisational resilience.

A sustainable hospital business model is an integrated framework that aligns clinical services, infrastructure, procurement, governance and community with sustainability.

HOW TO CREATE A SUSTAINABLE BUSINESS MODEL

1 Redefine value

Focus on delivering safe, high-quality care while respecting ecological and social systems. Position the hospital not just as a treatment centre but also as a partner in disease prevention and long-term wellbeing.

2 Emphasise financial sustainability

Seek measurable cost savings and predictable budgeting. Look for external funding for large capital investments from organisations, banks and governments that prioritise sustainability. Implement value-based healthcare schemes that reward quality outcomes over volume of services, thereby creating incentives to invest in disease prevention, integration and continuity of care, which lowers long-term costs.

3 Transform operations

Transition to efficient and sustainable energy systems, implement conservative water (re)use strategies and waste reduction, prioritise sustainable purchasing and embrace digitalisation and circular economy approaches.

4 Integrate design and management principles

Incorporate sustainability criteria in strategic planning, facility design, procurement policies and clinical protocols. Set clear targets and indicators, regularly monitor progress and align sustainability goals with performance management and governance. In this way, environmental and social objectives can be managed with the same rigour as clinical quality and financial performance.

5 Engage communities

Sustainable hospitals enhance local economies and improve population health. Organise health screenings and educational programmes, provide training and job opportunities for local residents and support both social inclusion and economic development. Collaborate with schools, municipalities, universities and social enterprises to address broader health determinants, such as nutrition, housing quality and air pollution. Maintain transparent reporting on environmental and social performance to build trust and reinforce the hospital's role as a responsible community partner.

WHEN TO USE SUSTAINABLE BUSINESS MODELLING

- During major construction, renovation, or equipment replacement, as this is when long-term resource consumption is determined.
- When hospitals experience rising energy, water or waste disposal costs and seek structural savings rather than temporary budget cuts.
- During accreditation processes, such as ISO 14001 or Green Hospital certifications.

TIPS

- Start with a simple baseline assessment of energy, water, waste and key purchasing categories.
- Select a few high-visibility, high-impact projects to build confidence and momentum among the different stakeholders.
- Engage clinical, technical and financial staff early to align goals and remove barriers.
- Use clear indicators, such as energy use per bed, emissions per patient or waste segregation rates, to track progress.
- Communicate progress regularly to staff and community stakeholders to build ownership and transparency.

CHALLENGES

- Translating sustainability principles into context-specific actions that create lasting impact for patients, professionals and communities.
- Balancing short-term financial pressures and the need for long-term sustainability investments.
- Ensuring staff engagement while avoiding change fatigue and maintaining the consistent implementation of sustainability initiatives.

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KEY TAKEAWAYS - IMPLEMENT

- **Implementing** a sustainable business model enables hospitals to reduce their environmental footprint while improving care quality, equity and organisational resilience.
- To effectively create a sustainable business model, hospitals should redefine value, transform operations, emphasise financial sustainability, engage communities and integrate sustainability principles into their operations, governance and design.

Three Cases

CASE 1

Fundacio Sanitaria Mollet (FSM)

Written by **Marc Gibert Guilera**
Rosa Vidal
Carles Oliete

CHALLENGE

Fundació Sanitària Mollet (FSM) is a university hospital in Catalonia that provides acute, intermediate and community care. In 2014, the hospital management decided to reduce the hospital's footprint and define a climate change strategy while maintaining the same quality of care. This initiative was carried out by a green team consisting of multidisciplinary volunteers from the different hospital departments, including hospital managers, clinicians, procurement experts, facility managers and environmental sustainability professionals. The goal of this initiative was to achieve net zero in direct emissions by 2040.



Figure 10:

The hospital from above: the transition of the hospital to 100% renewable energy, by using solar energy

WHAT METHODS WERE USED

1 Co-creation

Collaboration with different stakeholders to find solutions that fit the context of FSM.

2 Visual mapping

Mapping of clinical and operational processes, identifying hotspots and visualising interdependencies across departments to support collective understanding and decision-making.

3 Carbon footprint analysis

Identifying environmental hotspots in the hospital and comparing solutions.

4 R-strategies

Determining which strategies could be used to reduce CO_2 emissions.

5 Procurement and value chain analysis

Identifying high-impact products and suppliers and supporting more sustainable purchasing and sourcing decisions.

SOLUTIONS



Figure 11:

The green team proudly showing the Green Lab Certification in front of their hospital.

Several solutions were identified and implemented by the team. These included the following: the use of more sustainable anaesthesia practices (e.g. reducing high-impact anaesthetic gases), anaesthetic gas capture systems, reusable surgical textiles, biological liquid collection systems, more sustainable dialysis programs, biodegradable dis-infectants, reusable waste containers, locally sourced food, as well as the transition to 100% renewable electricity and the progressive elimination of natural gas.

ACHIEVEMENTS

1

Carbon footprint reduction

By implementing the solutions mentioned above, in 2024, FSM achieved a 92% reduction in CO_2e emissions compared to 2010.

2

Economic benefits

The implementation of this initiative resulted in economic benefits from the decreased use of anaesthetic gas and reduced biological waste.

3

Certification

The hospital obtained the first Green Lab certification in Spain, giving it a competitor advantage (see Figure 11).

4

Positive organisational and cultural impact

The actions of this initiative were supported by a green team, which included 20 motivated volunteers working in the different departments of the hospital. As a result of their efforts, there is strong environmental awareness amongst the staff and an increasing commitment to continuously reducing CO_2 emissions. In addition, a roadmap strategy was created by the team to further reduce emissions by 2040.

RECOMMENDATION

Create green teams to foster staff ownership and continuous improvement and strengthen the institutional commitment to sustainability.

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CASE 2

Addax Biosciences

Written by **Eugenio Mimosi**

CHALLENGE

For over 100 years, 10% neutral buffered formalin (NBF), which contains formaldehyde (see Figure 12), has been the standard for preserving biological tissue (e.g. dead parts of the human body) from decay in a process called tissue fixation. Tissue fixation is an important step in preparing biological samples for the microscopic examination of diseases. However, the use of FNB is facing increasing scrutiny due to three primary concerns:

1. **Health hazards:** Formaldehyde is a highly toxic, volatile substance. Exposure is linked to side effects such as respiratory irritation, skin damage, nasopharyngeal cancer and leukaemia.
2. **Analytical Limitations:** The chemical cross-linking caused by NBF can damage DNA (fragmentation) and mask proteins (epitope masking). This reduces the accuracy of modern molecular testing and precision diagnostics.
3. **Regulatory Pressure:** Due to formaldehyde's carcinogenic and mutagenic status, European regulations now mandate the substitution of formaldehyde with safer alternatives wherever technically possible.

Clearly, a nontoxic alternative for tissue fixation is preferred.



Figure 12:
Formaldehyde.

WHAT METHODS WERE USED

To address these challenges, Addax Biosciences adopted a structured and multidisciplinary innovation approach involving the following methods:

1 Co-creation

Collaboration with key stakeholders across the healthcare ecosystem, including pathologists, laboratory technicians and researchers, to identify unmet needs and define the performance requirements for a safer fixative.

2 R-strategies

A deliberate decision to refuse and reduce the use of toxic formaldehyde by rethinking tissue fixation through chemical substitution.

3 Value chain analysis

Evaluation of the entire lifecycle of fixative solutions, from raw material sourcing and production to laboratory use and waste disposal, in order to identify critical health, safety and environmental impacts.

4 LCA

Quantitative assessment of formaldehyde emissions and environmental burdens, enabling comparisons with alternative fixation technologies and supporting evidence-based decision-making.

SOLUTIONS

Through this approach, Addax Biosciences internally developed **Glyoxal Acid-Free (GAF®)**, a formaldehyde-free, non-toxic and non-carcinogenic histological fixative (see Figure 13). This glyoxal based formulation ensures effective tissue fixation while avoiding the hazardous properties associated with formaldehyde.

GAF® has been extensively validated and has obtained the following certifications:

1. Conformité Européenne (CE) certification, which indicates compliance with European Union health, safety and performance requirements.
2. Approval from the Food and Drug Administration (FDA), giving U.S. clearance for clinical use in the United States.

Both certificates highlight the clinical effectiveness, safety and regulatory compliance of GAF.



Figure 13:
Internally developed Glyoxal Acid Free (GAF).

ACHIEVEMENTS

1

Improved Safety

GAF® provides hospitals and pathology laboratories with a safer and economically sustainable alternative to formalin. Eliminating formaldehyde exposure significantly reduces occupational health risks, improves patient safety and lowers environmental impact.

2

Financial and operational benefits

The substitution of NBF with GAF® has resulted in clear operational and financial benefits for the hospital, such as reduced costs of hazardous waste disposal, the use of specialised ventilation systems, the implementation of mandatory personnel training, insurance premiums, air quality monitoring and the substitution improved regulatory compliance.

Overall, the adoption of GAF® transforms routine histological workflows into safer, more efficient and more sustainable practices without compromising diagnostic quality or analytical performance.

RECOMMENDATION

Clinical laboratories and pathology departments should proactively evaluate the substitution of formaldehyde-based fixatives with validated, non-toxic alternatives wherever technically feasible. This decision-making should be supported by structured risk assessment approaches, such as LCA and value chain analysis, in order to move beyond short-term cost considerations and towards a value-based evaluation of performance, safety and long-term efficiency within the healthcare system. In line with European policy objectives for sustainable healthcare, procurement strategies should increasingly favour innovative and value-added solutions that reduce environmental impact, limit hazardous emissions and lower the burden of healthcare waste management. Integrating sustainability principles alongside clinical quality and system effectiveness supports a high-value care approach, in which environmental, economic and social dimensions are considered jointly. From an institutional perspective, hospitals have a responsibility to align laboratory practices and procurement decisions with evolving chemical safety regulations, zero-pollution objectives and the development of safer and more sustainable alternatives. Achieving these outcomes is possible through co-creation, as this allows multidisciplinary teams of laboratory professionals, safety officers, procurement personnel and regulatory experts to work together to develop suitable practices and solutions, ensure that diagnostic quality is maintained and contribute to long-term system resilience and population health.

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CASE 3

Erasmus University Medical Centre (Erasmus MC)

Written by **Jasper Klasen**
Nicole Hunfeld

CHALLENGE

Erasmus MC is an academic hospital and operates a large, high-complexity intensive care unit (ICU) with approximately 50 beds. The environmental footprint of the ICU is significant, as it generates approximately 17 kg of product waste per patient daily, equalling 12 kg of CO_2e.
A major hotspot identified in this waste stream were infusion bags with medication (see Figure 14). One type of these bags contain fluids used in continuous renal replacement therapy (CRRT). During this therapy, patients with failing kidney function require continuous dialysis, and it was estimated that, per day, they consume 14.5 large fluid bags of 5L. This usage resulted in roughly 4.3 kg of packaging waste per patient daily. The bags contain a mix of different types of plastics, meaning they cannot be recycled. As a result, the bags were wasted, and CRRT was responsible for a massive stream of single-use plastic being incinerated as hospital waste.

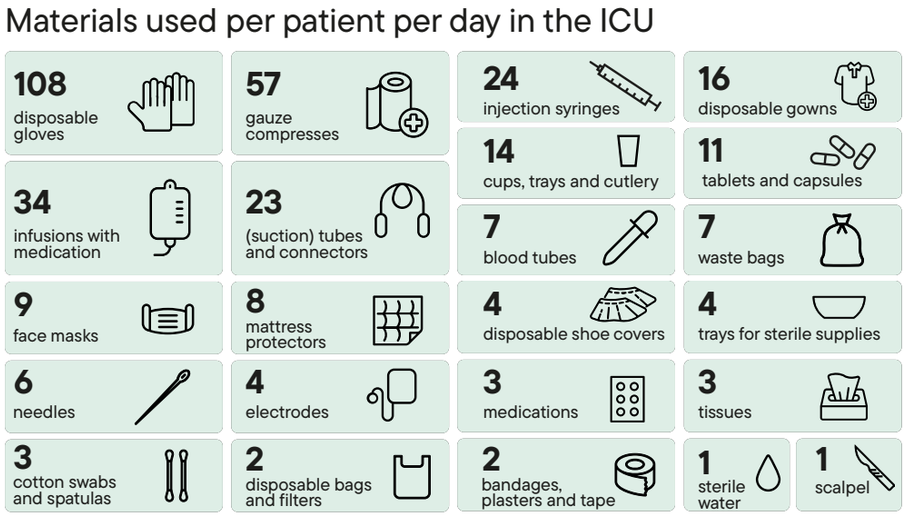


Figure 14:

Used materials per day at the ICU. Modified from L.Hazelaar, https://convergence.nl/green-team-fights-against-waste-in-icu/

WHAT METHODS WERE USED

1 Material analysis and LCA

These analyses allowed for a better understanding of the materials used for the current bags, their environmental impact and potential solutions for reducing the current footprint.

2 Co-creation

Co-creation was initiated by the green team of the ICU, empowering frontline nurses and pharmacists to collaborate and drive the initiative from the “bottom up”. In addition, the green team collaborated with the waste processor PreZero and students at the Technical University of Delft to design solutions that could meet all the different requirements, such as ease of use.

3 Value chain analysis

In terms of value chain analysis, collaboration with the plastic compound producer Wittenburg, the internal waste logistic department and the waste processor PreZero Nederland allowed the team to understand the problem and product requirements on a higher level.

SOLUTIONS

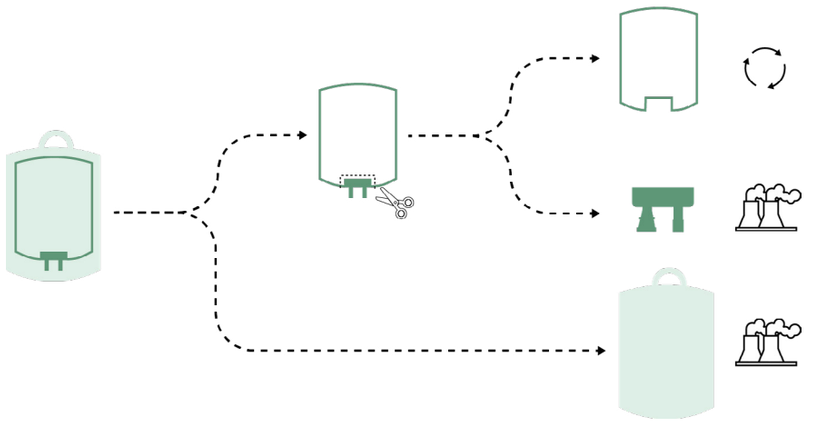


Figure 15:

Representation of the solution of enabling parts of the dialysis bag to be recycled; from graduation report Han Buck, TU Delft.

The green team focused on the large amount of waste caused by dialysis bags and found that the carbon footprint could be reduced when parts of the bags could be recycled instead of incinerating them all. The following steps were needed to facilitate this recycling (see Figure 15):

- **Customised separation tools:** A specific cutting device was designed to allow nurses to quickly sever the hard, non-recyclable plastic taps from the recyclable soft plastic bags.
- **Dual stream logistics:** Waste stations were updated with two distinct clear bags: one strictly for the recyclable dialysis bags made from polypropylene and one for soft plastics that could not be recycled. These stations facilitated the effective separation of the material streams.

The initiative succeeded because it not only addressed environmental concerns but also focused on including nurses, their requirements and, thus, creating a realistic operational process. This process was formed using the following steps:

- **Creating incentives:** Nurses witnessed the "bizarre amount" of waste daily, filling bin after bin with disposables. Many expressed that "the world has to last longer than just today and tomorrow," reflecting a widespread desire among the staff to do better.
- **Removing the "hassle"**: Staff working in a 50-bed ICU are time-poor. The team recognised that "seperating waste is a hassle". The recycling pathway was designed in such a way that separating the bags could be done at any- time. The nurse can decide when they bring the bags to the waste station.
- **Ownership:** The solution was not imposed by the management but initiated and co-created by the nursing staff and green team, which resulted in a strong sense of pride and ownership.

ACHIEVEMENTS

The project successfully reduced a large amount of waste that was otherwise being incinerated and enabled this waste to be recycled instead, thus lowering the related carbon footprint. Measurements from 2023 indicate the significant potential of this intervention:

1

Massive volume recycled

During the measurement period, the ICU recycled approximately 10,000 kg of material, consisting entirely of CRRT bags.

2

Incineration reduction

This single targeted intervention reduced the total measured packaging mass sent for incineration by approximately 14%.

3

High impact per patient

For every CRRT patient, an estimated 4.3 kg of plastic packaging from dialysis bags could be saved from incineration for each dialysis day.

RECOMMENDATION

- **Create green teams:** Find clinicians and stakeholders who will be affected by the change, motivate them to team up and empower them to make a change. These teams will understand the workflow and requirements best and can, thus, identify practical barriers to recycling that management might overlook.
- **Design for convenience:** In a high- stress environment, such as the ICU, adoption of new initiatives relies on ease of use. Therefore, use custom tools (cutters) and point-of-use bins to allow waste separation to be as simple for nurses as throwing waste in the general bin.
- **Target hotspots first**: Do not try to recycle everything at once. Focus on high-volume, homogeneous items (e.g. dialysis bags) where a single process can already create a big positive impact.

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Epilogue

Written by **Cecile Cuijpers**
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In this handbook, we present a design approach that helps you to navigate the complexity of sustainable hospitals and develop solutions that contribute to systemic change. The handbook provides practical tools to understand your hospital's existing value chain and procurement processes. It shows how visual mapping and environmental assessment can be used to identify key environmental hotspots. Finally, the handbook explores environmentally sustainable opportunities that can make a difference.
Beyond inspiring actions that benefit the environment, this handbook demonstrates that implementing these solutions can also benefit hospitals.

At the same time, as authors, we acknowledge that real and lasting change can only be achieved through co-creation. For this reason, effective co-creation methods are discussed throughout the handbook, as they enable teams to initiate changes that stakeholders can implement. Therefore, we challenge you to take these principles and actively apply them in your own hospital, with the ambition of creating real impact. Keep in mind that change requires practice and persistence. You cannot transform everything at once. Instead, continue repeating the process, keep motivating, inspiring, and involving others and gradually build momentum over time. The act of looking back and reflecting is equally important.
You should communicate progress and celebrate successes. Doing so will encourage others to join your movement and contribute to collective change. Together, we can make a difference.

To our knowledge, this handbook is the first to present a structured set of methods and tools specifically aimed at developing solutions for more sustainable hospitals. This handbook is the outcome of a 2-year project, it should therefore be understood as a first exploratory step towards creating sustainable hospitals rather than a definitive model of how to do so. The author team of this handbook is made up of people from diverse disciplines and actors from different hospital environments, healthcare systems and industrial contexts. Making the handbook itself was a design experiment, focusing on collaboration and co-creation.

The diversity of stakeholders was a key strength, enabling the exchange of perspectives and the testing of systemic approaches across organisational and sectoral boundaries. Finally, sustainability in hospitals should not be understood as a short-term project but rather as a complex and ongoing transformation. Indeed, sustainability requires systemic thinking, cross-sector collaboration and a sustained commitment to continuous improvement.

Looking ahead, we hope to learn from future case studies and to further refine our methods and tools so that they become easier to use, more effective and more widely accessible. We also aim to expand and improve our e-learning courses and handbooks to reach a broader audience and continuously enhance the quality and relevance of our learning materials.
Most importantly, we hope we can soon look back and recognise how much has changed for the better. Over time, new insights will inevitably emerge, supporting the ongoing evolution of sustainable hospitals. We invite you to join us via the QR code at the bottom of the page to access our online training programme and learn more about the topics presented in this handbook. We also encourage you to share your feedback, as this will enable us to continuously improve our methods and, in doing so, better support hospitals in making significant and lasting change towards sustainability.

Overall, this handbook demonstrates that environmentally sustainable hospitals are not a utopia but an achievable reality. By aligning environmental stewardship with patient care, hospitals can play a leading role in the transition towards a healthier planet and healthier people. Sustainability, ultimately, is not an add-on but an integral part of hospital operations.

Scan the QR code and learn more about the topics

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A sustainable transition in our European healthcare systems is essential for human and planetary health. However, new skills and knowledge are needed for realizing more sustainable futures.

This handbook is the result of a collaboration within the Erasmus+ DesHealth project, involving participants from different disciplines and sectors to develop training tools on Systemic Design and Sustainability Management, that can be used for making healthcare more sustainable in practice. This handbook contains sustainability knowledge, different innovative tools and design methods, together with practical tools and inspiring examples to start yourself.