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Hospitals of the future series

Planning - Design - Evaluation

THE ROLE OF ARCHITECTURE IN CARE ENVIRONMENTS

A methodological study on inpatient ward evidence, design recommendations and assessment tools

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Abstract

abstract

La ricerca propone un'indagine sul rapporto tra architettura e salute e trova come oggetto lo studio volto all'evoluzione di strutture ospedaliere che si trovano a dover rispondere al progresso della tecnologia, della scienza e alle nuove esigenze della società. Obiettivo finale della ricerca è il miglioramento delle prestazioni di un'area specifica dell'ospedale, in relazione all'insieme elle esigenze del paziente, del medico e degli altri utenti. Il processo di indagine si inserisce in un contesto di generale attenzione per questi temi, di cui la piattaforma tecnologica, Joint Research Partnership Healthcare Infrastructures (JRP), è una chiara testimonianza. Come modello di riferimento per il miglioramento delle architetture per la salute del futuro, il lavoro di ricerca mira alla profonda comprensione di come un adeguato sviluppo dell'ambiente ospedaliero possa favorire il benessere psico-fisico delle persone che lo vivono.

La progettazione degli ospedali, in passato, si è concentrata principalmente sull'aspetto clinico, trascurando altri fattori e caratteristiche dello spazio che possono influire sul benessere delle persone. La ricerca si concentra sull'area di degenza e si propone di fornire criteri e linee guida specifiche per una migliore progettazione e valutazione di questa specifica area funzionale, attraverso criteri e indicatori misurabili e basati su evidenze della letteratura scientifica.

Una prima parte prevede la stesura di un background teorico relativo all'hospital design, seguito da un'analisi sistematica di letteratura scientifica e un'indagine sull'evoluzione degli ospedali contemporanei tramite comparazione di casi studio. Verrà illustrata la declinazione delle prime strategie volte alla flessibilità, resilienza, sicurezza e sostenibilità tramite approcci progettuali contemporanei esemplificativi. Verrà poi presentata la definizione dei criteri e indicatori rispondenti a una serie di requisiti prestazionali che si sono rivelati tali da garantire un valido supporto all'erogazione delle cure.

In conclusione, dal contributo teorico si passerà al supporto verso il processo progettuale: tramite analisi, ricerca e raccolta di dati secondari si giungerà alla definizione di una serie di requisiti dimensionali e indicazioni qualitative e quantitative per la progettazione di reparti di degenza. Verrà generata una checklist basata sui criteri emersi dalla ricerca, che rappresenterà lo strumento di valutazione di questa specifica area dell'ospedale. Infine, per entrambi gli strumenti, verrà illustrata un'applicazione.

The research proposes an investigation into the relationship between architecture and health, and its object is the study of the evolution of hospital structures that have to respond to the progress of technology, science and the new needs of society. The final objective of the research is the improvement of the performance of a specific area of the hospital, in relation to the overall needs of the patient, the doctor and other users. The investigation process is part of a general focus on these issues, of which the technology platform, Joint Research Partnership Healthcare Infrastructures (JRP), is a clear testimony. As a reference model for the improvement of future healthcare architectures, the research work aims at a deep understanding of how an adequate development of the hospital environment can foster the psycho-physical well-being of the people living in it.

Hospital design, in the past, has focused mainly on the clinical aspect, neglecting other factors and space characteristics that can affect people's well-being. This research focuses on the in-patient area and aims to provide specific criteria and guidelines for a better design and evaluation of this specific functional area, through measurable criteria and indicators based on evidence from the scientific literature. The first part includes a theoretical background on hospital design, followed by a systematic analysis of scientific literature and a survey on the evolution of contemporary hospitals through comparison of case studies. The first strategies aimed at flexibility, resilience, safety and sustainability will be illustrated through exemplary contemporary design approaches. This will be followed by the definition of criteria and indicators responding to a series of performance requirements that have proven to be a valid support for the delivery of care.

In conclusion, the theoretical contribution will move on to support the design process: through analysis, research and collection of secondary data, a series of dimensional requirements and qualitative and quantitative indications for the design of in-patient wards will be defined. Finally, a checklist will be generated based on the criteria that emerged from the research, which will represent the assessment tool for this specific area of the hospital. An application will be illustrated for both tools.

01.

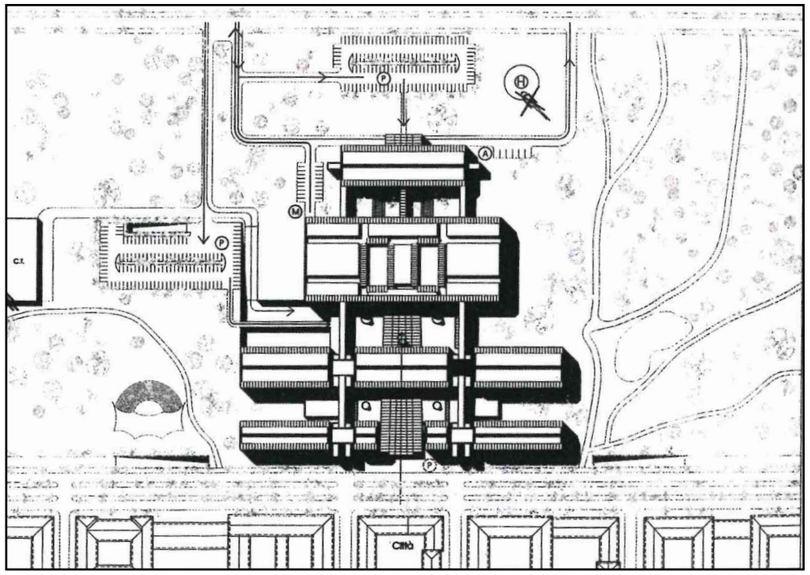
Theoretical background

1. Theoretical background

1.1 Introduction to hospital design

1.1.1 Architecture and health

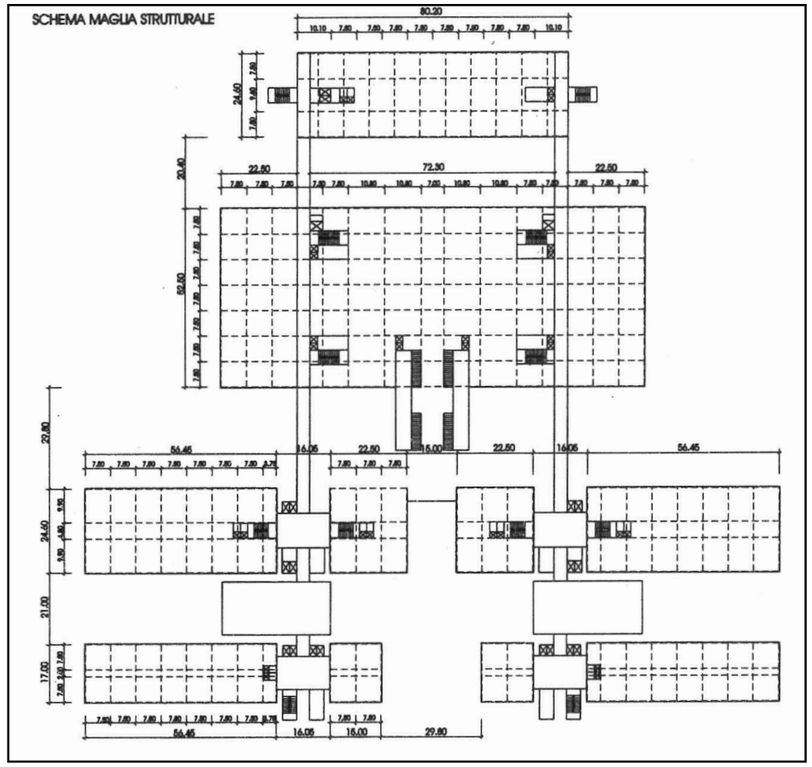
Hospital building design represents one of the most fascinating challenges because of the high importance and complexity of services to be met and the social and urban impact that hospitals have on the contemporary city. Recent research shows that in Europe at least 20 percent of the population is reported to be a patient in a hospital facility each year and that more than 3 percent of the workforce is employed in the 30,000 hospitals spread across the territory. Moreover, the topic of hospital design represents one of the areas of greatest interest due to the functional complexity of buildings and the high social value of the subject, also in light of the many transformations that have affected both the city and the healthcare system.
Talking about hospital design means understanding a wide sphere of needs, values and activities that must find a place in adequately designed buildings, capable of going along with the evolutions of medicine and technology and, at the same time, responding to the different expectations of contemporary society.
Over the last few years, an awareness has emerged of the need for a revision of consolidated typological schemes, based on a functional approach, in order to find innovative responses, satisfying both the needs of operators and patients.
For many years, in fact, the design of hospital wards had been approached in purely functional terms, aimed at satisfying care through the needs and technical indications of doctors and operators, often considering the patient as a 'disease' to be attacked and not a being in need of both care and other help. Today we are seeking sustainable development, which places the centrality of man (present and future) as a fundamental and unavoidable principle of every activity. Hence, hospital design must also renew the architecture of places of care, recognising not only a public service connotation (as places of the community) but also a private connotation (places where one is confronted with the experience of solitude and suffering). The research presented here moves from the recognition of this reality in which the designer is called upon to operate a synthesis between the new functional dimension (adaptability, transformability and maintainability) and the sustainable dimension (humanisation, comfort, privacy).
This inertia to change that characterizes hospital design tends to become progressively more relevant: the need arises to make a design effort to conceive structures capable of balancing a rational typological-distributive layout with a high capacity for adaptation and flexibility of use. The current scenario is marked by the presence of a lack of relationship between the parties involved in the building process: the client, the designer, and the contractor.
A number of investigation themes were identified whose development could have an effective impact on the field of design practice.
In fact, the hospital is to be understood not only as an organism that delivers health services but also as a center where scientific research is carried out and professional training is implemented: therefore, consideration must be given, along with the established requirements of tradition that identify it as a place of hope, welcome, serenity and care, to some innovative demands, aimed at the purposes of functional flexibility. The concept of sustainability introduced within the building process also relates to the planning, design, implementation and maintenance of the healthcare facilities.
United with this, it should not be forgotten that hospitals and health services in general, are nowadays located in a context characterized by increasingly rapid changes both in terms of technical-scientific and organizational as well as in terms of socio-cultural demographics: this requires a systematic but innovative approach to design issues.
From the technical-scientific point of view throughout history there has been a continuous evolution of care for the patient. From a place of simple reception and hospitalization, the hospital has seen an increase in the number of functions required over the centuries and, consequently, has been confronted with an increasing volumetric articulation of the spaces required for the various activities.
The organization of hospital facilities has had to change more and more often and more rapidly. But the organization of the hospital remains the protagonist of internal functionality through meeting the demands and needs of users (patients, medical staff, providers, visitors) leading to the efficiency of the services provided.
Therefore, innovative solutions were searched for from a typological and distributional point of view, moving from a pavilion articulation, to the later monobloc structures to return to structures of limited heights, with less environmental impact and spread over the territory. In Europe, particularly since the 1980s, there has been a reorganization of the health care system that consists of the spread of hospital facilities throughout the territory, organized according to a network in which each facility represents the point of reference for a specific medical sector.



Marco Morandotti, *Modelli progettuali per l'edilizia ospedaliera*

New Hospital Model, Renzo Piano, 2001. Planivolumetric of the model. The building, constituting a theoretical study model is not located in a real context, but is assumed to be built in a semicentra or suburban area, to play a role as a "social thickener".

The most recent contribution advanced on the subject is certainly the “New Hospital Model,” drawn up by Renzo Piano on behalf of the Ministry of Health and presented in March 99. The content of this study is a meta-project, graphically depicting a set of guidelines for the design and management of hospitals “of high technological and managerial complexity and of medium size”; it “should be interpreted as a manifesto of intent and not as a replicable type.” The proposed model seems to be able to fit with difficulty into a traditional typological classification. In fact, it is configured as a relatively compact planivolumetric layout - the maximum planned height is four stories above ground - obtained by a kind of morphological hybridization of a polyblock hospital with a gallery one. The layout is marked by a strict axial symmetry, scanned by a glazed gallery that distributes the most “public” functions of the complex on the ground floor; transversely to this distributive element, which assumes a central role in the formal



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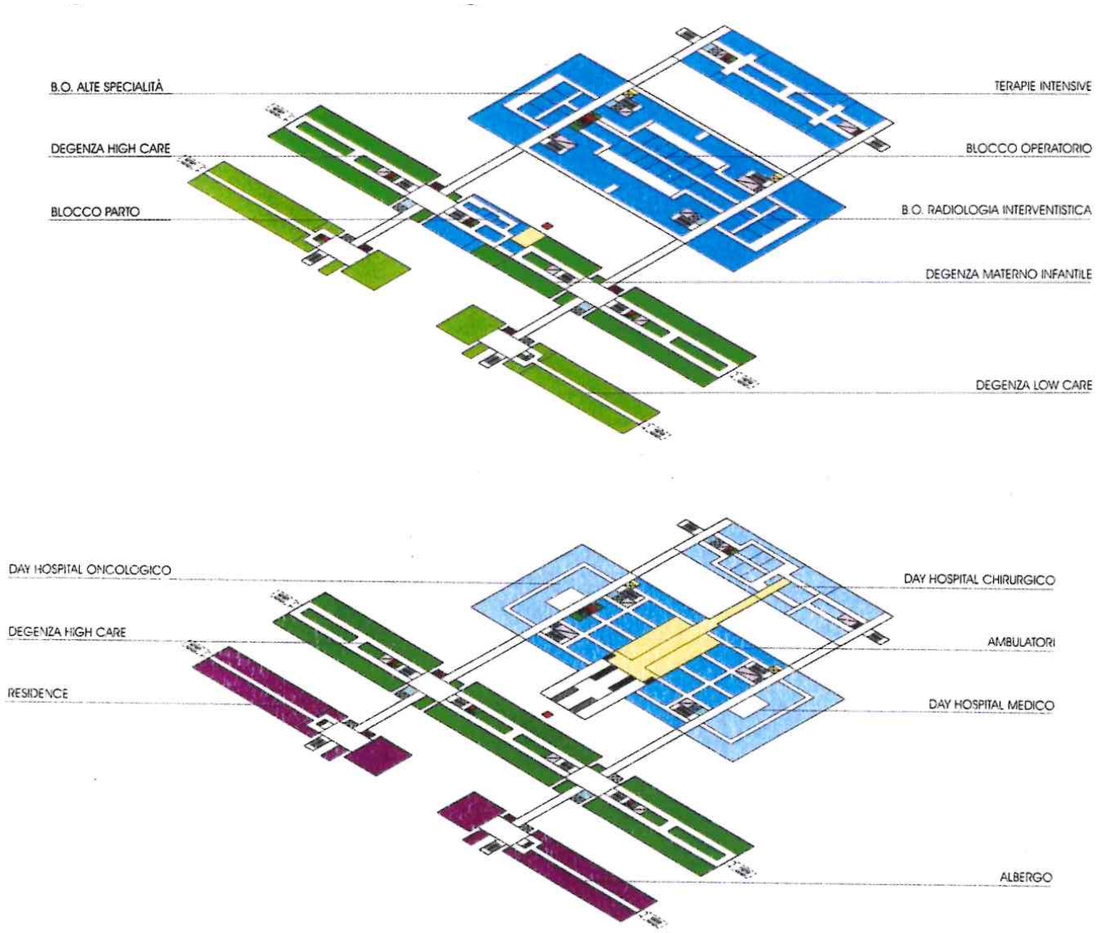
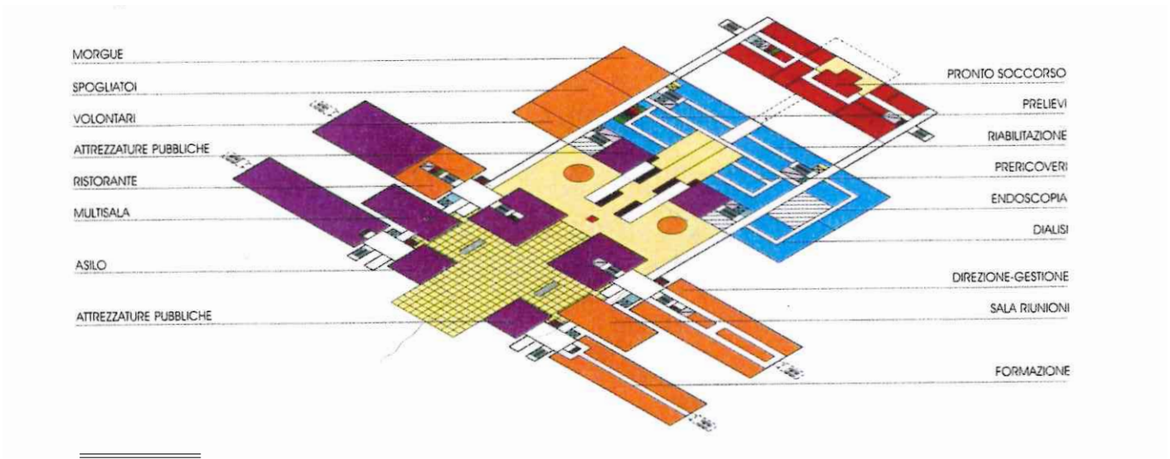
Schematic diagram of the structural layout. Coherent plan development with a constant dimensional mesh is evident.

definition and urban recognizability of the settlement, four distinct building bodies are developed, in which house, strictly separated, the reception-hotel and therapeutic-health functions. In addition to the glazed gallery on the ground floor, the different volumes are connected by two horizontal connections on each floor, running the full length of the building. One of the most interesting elements in the definition of the model is the organization of inpatient services. The hospital is in fact articulated according to the intensity of care to be provided, overcoming-where clinically possible-the traditional separation by referring specialty.

This has resulted in an articulation into four distinct levels by intensity of care, and





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the related unit costs of hospitalization.

- intensive care: very high assistive technology and very high management costs per day of hospitalization;
- inpatient high-care: articulated by departmental areas, with high technology of care and high management costs per day. Patient stay at this level of inpatient care should be contained within three days;
- day hospitalization (day hospital, day surgery): takes place in dedicated spaces characterized by specific planimetric arrangements that by definition do not require the patient to stay overnight in the facility. The patient is accommodated with a traditional hospitalization only if complications arise during surgical treatment, or in the subsequent postoperative difollow-up phase;
- inpatient low care inpatient: need for greatly reduced levels of technological service equipment, with greatly attenuated medical and nursing valence and so very little daily management. Patients are transferred to this specific category of care when there is still a need for a stay in a controlled hospital environment, but the clinical picture has stabilized and the recovery phase prior to discharge has begun.

The model takes up many suggestions from the most up-to-date international debate on hospital design, developing some elements of particular interest. From a morphological and distributional point of view, a clarity of horizontal paths and connections between functional blocks emerges. Likewise, the choices of structural and constructive modularity characteristic of numerous recent realizations are emphasized, through the definition of a rigorous and strictly homogeneous structural grid. Internal space flexibility was pursued as a top priority- such that it conditioned both the planimetric choices of the facility and the materials and techniques for its construction. The building allows - precisely by virtue of the construction choices - some room for planivolumetric growth, such as the extension of the transverse slats of the inpatient wards or the enlargement of the surgical plate. It is interesting to point out one element in this regard: the designer envisages the dislocation at some strategic points of spaces and rooms that can be used for future expansion. That is, it is planned to provide the facility with internal spaces that are “available,” that is, made rustic and not functionally allocated at the time of construction, but available to accommodate future functional destinations, that is, without internal partitions, and prepared to receive the most appropriate connections with the plant networks already present in the hospital.

1.1.3 The contemporary hospital

The convergence of worldwide shifts such as an aging populace, digitalization, and climate change is embodied in architectural projects. Notably, the hospital stands out as a prime example of social architecture that interprets these changes, while also serving as a catalyst for urban revitalization. Healthcare facilities are currently influenced by profound demographic, technological, and epidemiological changes, yet they possess the potential to advance the well-being of the global community by fostering healthier, more efficient, and more user-friendly care environments.

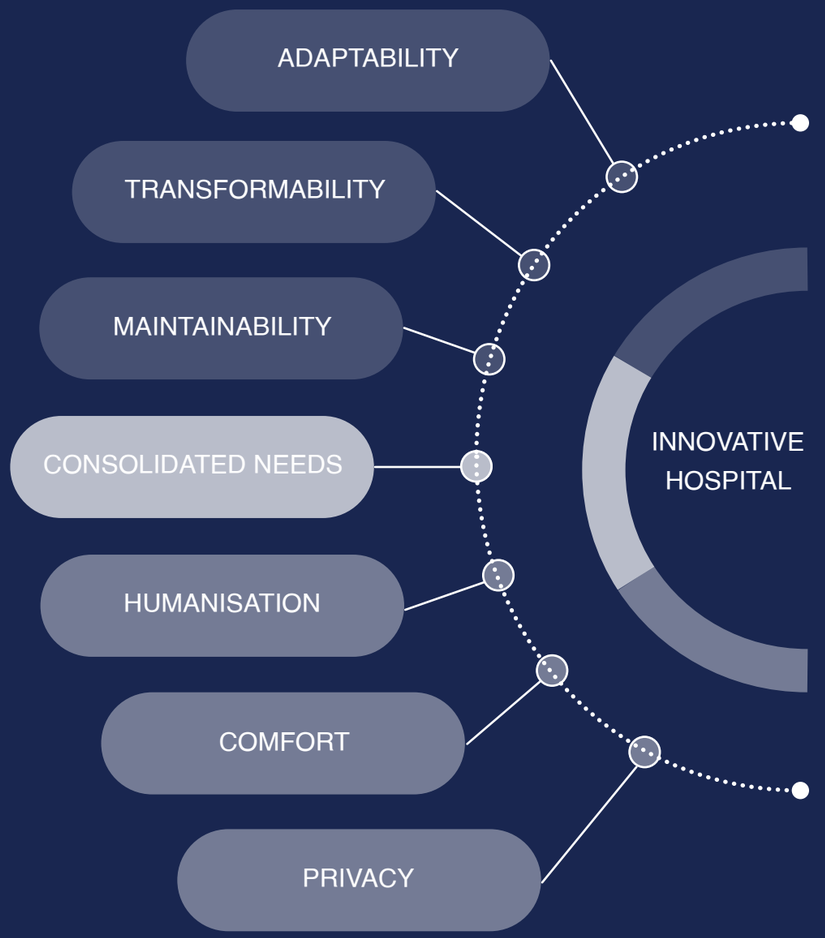
Giving the hospital an urban significance as a place open to the city, devoid of the character of exclusive, impermeable, and specialized function. This objective involves two different levels: one urban-environmental and the other architectural. The hospital is conceived as a structure open to the territory, capable of enhancing the surroundings as a primary element in the city's design and its areas, including peripheral ones.

Giving the hospital an urban value as a place open to the city, without the character of an exclusive, impermeable and specialised function. This objective involves two different levels: an urban-environmental one and an architectural one. The hospital is conceived as a structure open to the territory, capable of enhancing its surroundings as a primary element in the design of the city and its areas, including the suburbs.

Certainly, a prominent contemporary theme in design and architecture revolves around the concept of flexibility. This theme is closely intertwined with the essential need for adaptability within organisms, and it significantly shapes the decisions made regarding typological and formal aspects of design. In order to effectively address the challenges posed by processes of change and growth, it becomes imperative to provide a building with an organizational and formal structure that is not only responsive but also capable of managing the continuous and simultaneous variations in both its individual components and its overall composition.

The founding element of the procedural pathway is the safeguarding of the patient's dignity of his personal and community dimension and therefore the centrality of his needs and rights. Examples are being informed and guided, living in a reassuring and comfortable environment and having the guarantee, on the one hand, of an adequate level of privacy and, on the other, interpersonal exchange, with the possibility of receiving relatives without time restrictions.

The Joint Research Partnership Healthcare Infrastructure has been established to



address this inquiry. This platform, led by the Politecnico di Milano – Department of Architecture, Built Environment, and Construction Engineering (Design & Health Lab) in collaboration with Fondazione Politecnico di Milano, serves as a center of excellence for innovation. Its primary objective is to engage with companies and healthcare institutions, offering a space for the development and experimentation of pioneering research and infrastructure projects in the healthcare sector.

The JRP Healthcare Infrastructures aspires to set the groundwork for the Hospital of the Future. It stands as a pioneering model in Italy where researchers, businesses, and institutions collaborate closely to tackle the social, epidemiological, and technological challenges associated with creating innovative and sustainable healthcare facilities. This multidisciplinary initiative led by Politecnico di Milano is expected to spark numerous groundbreaking endeavors, with significant potential benefits for the healthcare sector.

1.2 Healing and therapeutic architecture

1.2.1 Psychosocially Supportive Design

Clinical practice primarily addresses illness, but research indicates that the quality of our everyday surroundings plays a crucial role in maintaining well-being. For decades, architecture and design have been heavily influenced by industrial societies, resulting in public buildings like airports and hospitals often resembling factories in both form and function. Unfortunately, hospital care typically prioritizes medical treatment, often overlooking patients' psychological, social, and spiritual needs. The potential for environmental elements that support psychosocial well-being remains largely underdeveloped.

Psychosocially supportive design aims to engage individuals mentally and socially while bolstering their sense of coherence. Its fundamental purpose is to initiate a cognitive process by capturing human attention, potentially reducing anxiety and fostering positive emotions. By implementing Salutogenic design principles, focusing on factors that promote wellness rather than those that cause illness, health processes can be reinforced and enhanced.

Psychosocially supportive design seeks to stimulate the mind to generate pleasure, creativity, satisfaction, and enjoyment. Notably, an individual's sense of coherence is closely tied to the characteristics of their physical environment.

Environmental psychology seeks to understand this interplay between people and their sorroundings, and to determine how one's environment might be changed to maximize environmental quality. Understanding and applying both EBD and environmental psychological principles will help design be simultaneously more effective, functional and beautiful. Applying EBD in practice means understanding the individual/client preferences, intersected with the evidence and expertise.

In order to create supportive physical environments it is crucial to understand an individual's fundamental needs. It is also necessary for different professional disciplines to willingly cooperate in creating the best conditions for humans.

Dak Kopec, a notable figure in advancing environmental psychology in design, delineates three essential programming phases that designers should follow to more effectively cater to the requirements of end-users. These phases consist of pre-design research, occupancy evaluation, and post-occupancy evaluation.

The initial phase, pre-design research, aligns well with the typical workflow of most designers. It involves a thorough assessment and evaluation of the clients' needs

before the actual design process begins. This assessment may encompass various elements, including evidence-based design (EBD) findings or conductive studies, as deemed suitable for the specific project.

The next stage in design programming involves occupancy evaluation. This phase involves collecting evidence through observations, interviews, and/or surveys of end users who possess a good understanding of the project's requirements and limitations. The goal is to identify necessary improvements and review existing precedents and contemporary literature on relevant subjects.

The last phase is post-occupancy evaluation, conducted after the project is in use, to assess whether the design effectively fulfills the user's requirements and identify opportunities for enhancement. When a design team applies these approaches, it increases the likelihood of aligning with the client/user's values and results in a space that fosters well-being.

1.2.2 Healing architecture

There is a growing body of evidence indicating that the constructed environment can have a significant impact on human well-being, as documented by researchers such as Sternberg (2009), Mallgrave (2013), and Williams Goldhagen (2017). Despite a widespread consensus that the idea of a therapeutic environment has a positive effect on patients, ongoing research in this area has seen limited practical application. This is primarily because architects have seldom integrated these findings into the design of modern hospital structures, as noted by Tétreault and Passini (2003). In a noteworthy study from 1984, Roger Ulrich demonstrated, through health outcome measurements, that the hospital environment indeed influenced the recovery of surgical patients. Patients in rooms with windows offering views of nature were discharged earlier compared to those in rooms with windows facing a blank wall.

The distinction between a healing environment and a therapeutic one depends on their primary focuses. "Healing" primarily pertains to physical recovery and medical aspects, while "therapeutic" encompasses a broader scope that includes psychological well-being, and sometimes, physical health as well. In both cases, the essence revolves around the process of alleviating discomfort or improving one's condition. Etymologically, "heal" has its roots in Old English, signifying the restoration to wholeness and soundness, while "therapeutic" traces its origins to the ancient Greek word "therapeutikós," carrying the meaning of usefulness and curative properties.

In practice, these terms are often used interchangeably, despite "healing" being more frequently employed within healthcare contexts. For instance, "healing" might relate to achieving relief from physical symptoms or reducing stress, while "therapeutic" generally applies to situations aimed at enhancing people's overall well-being, even in settings such as spas or workplaces.

The concept of well-being, which extends beyond mere comfort, encompasses an individual's emotional state in relation to their surroundings. It hinges on various personal factors like satisfaction, happiness, a sense of freedom, and overall quality of life. However, it's also deeply intersected with the characteristics of the built environment, including ethical, social, and physical dimensions. As suggested by Clements-Croome (2011), well-designed architecture can significantly impact people's mood, emotions, and ultimately, their decision-making processes. In parallel, personal factors encompass physiological, psychological, and social needs, which, when met, contribute to good health and a state of well-being, as elucidated by Stokols (1992).

Within healthcare facilities, the term "healing architecture" underscores the built environment's capacity to influence not only patients' physical health but also their overall well-being, acknowledging the dynamic interaction between architecture and human experiences.

1.2.3 Nature and biophilia

Our inherent reactions to the environment that surrounds us could be the most influential factor when it comes to shaping our health and well-being. The sense of vitality and connection with life is closely linked to our perception of health. It's fair to assert that our interaction with the natural world has a genuinely rejuvenating effect. In fact, substantial evidence supports this notion. This paragraph provides an overview of some of this evidence and recommends incorporating our natural inclination for biophilia into the programming process.

Certainly, the Biophilia Hypothesis, first articulated by Edward O. Wilson and Stephen R. Kellert in 1993, centers on the intrinsic human connection to nature and its profound implications for overall well-being. A substantial body of scientific research reinforces this concept.

For instance, studies conducted in simulated office environments have revealed that biophilic interventions consistently lead to reduced stress levels and enhanced creativity among participants. Furthermore, a comprehensive meta-analysis of the health benefits of exposure to natural environments underscores the significant reductions in diastolic blood pressure and heart rate associated with increased access to green spaces. Conversely, urban settings have been linked to alterations in neural social stress processing and higher rates of conditions such as psychosis, anxiety disorders, and depression when compared to more rural environments.

Delving deeper into the biophilic impact, it becomes evident that the fractal patterns found abundantly in nature directly stimulate human neural activity and parasympathetic system mechanisms. Rachel and Stephen Kaplan's Attention Restoration Theory (ART) delves into the influence of nature on cognitive processes. ART posits the existence of a state known as "effortless attention" induced by nature, characterized by "soft fascination." This state not only captures our interest but also allows for concurrent mental activities such as reflection and imagination. Beyond enhancing attention, ART extends its reach to stress management and health promotion through nature exposure.

The significance of biophilic stimuli in influencing the autonomic nervous system underscores its role in stress management and overall well-being. Armed with this knowledge and equipped with tools for assessing environmental impacts virtually, a new dimension emerges in design—one that recognizes the paramount importance of integrating biophilic elements into built environments to enhance human health and well-being.

Biophilic design encompasses two fundamental dimensions. The first, direct experience, involves unstructured engagement with the self-sustaining aspects of the natural environment, such as daylight, plants, habitats, and ecosystems. This direct connection has played a pivotal role in our evolutionary history, encompassing vital elements like light, sound, scents, wind, weather, water, flora, fauna, and untouched landscapes. Indirect engagement encompasses activities like maintaining fountains, gardens, or caring for plants, while symbolic contact involves representations like wall murals or projected images of natural scenes.

The second dimension of biophilic design revolves around the connection between landscape, its formal characteristics, built structures, and geometries that symbolize our deep affinity for nature. This concept is particularly evident in buildings and landscapes that reflect the local culture and traditions of a specific place or region, contributing to the sense of place.

1.3 Measuring hospital quality for human centered design

1.3.1 Evidence-based design

EBD is a field of study emphasizing credible evidence to influence design. This approach has become popular in healthcare to improve patient and staff well-being, patient healing, stress reduction, and safety.

EBD suggests that well-designed physical settings play an important role in making hospitals safer, improving the recovery of patients, and reducing the frequency of hospital-acquired infections. The findings support the importance of improving effective ventilation systems, a good environment, appropriate lighting, better ergonomic designm and improved floor layouts and work settings. Il also improves the staffs' work environment.

The hospital's sorroundings play a big role in reducing the stress experience by patients and their families as well as caregivers. The healthcare environment is multifaceted. It is a place of cure and care for the patients and their families, a place for staff to earn their livelihood, a business sorroundings, and a cultural environment for the organization to pursue its mission. The EBD addresses issues of the customer and stakeholders values or desires for hospitals. It is based on the ideology that at each stage of the planning and execution, evidence is gathered, meausured, correlated, analyzed, improved and documented. It is also a cross-functional communication tool for the forward-bacward exchange of information between all stakeholders in the project/process change. It helps them in the decision-making process. This approach allows the design to be based on evidence from the past as well as the present and into the future, in a logical manner.

Evidence-based is a type of theory based on evidence found in scientific practice. It originated in the medical field with Evidence Based Medicine (EBM) and only later is transferred, with the necessary simplifications, to the field of architecture. The term EBM refers to a behaviour applied in patient care that is based on the conscious use of the best scientific evidence available at the time. It is a deductive-experimental scientific method that moves from the generality of scientific research data to the specific care of the individual patient. The logic of evidence-based practice identifies a cyclic relationship between evaluation, evidence, practice and further evaluation. The reports of these evaluations are an important resource of evidence to maximise benefits, to reduce hazards in public health practice and to provide a basis for new research. This evidence-based

method has also been transferred to the discipline of architecture. Although much less scientifically rigorous than EBM, Evidence Based Design (EBD) consists of the designer's use of the best evidence made available from research and project evaluation, with the aim of improving the results and to continue monitoring the success of the project (Ulrich and Zimring, 2004). Over the last decade, the concept of Evidence Based Design related to hospital construction has developed a substantial body of evidence which, by orienting design towards compliant solutions, identifies good design as a factor in increasing the level of satisfaction. of the patient and healthcare staff. The evidence gathered can be traced more generally to a number of principles, by which a benefit is definitely generated because it improves the quality of life oflife of patients and staff, and the gain given gives real savings over the life cycle of thelife cycle of the building. The principles can be summarised as follows:

- encourage privacy and companionship for the patient at the same time;
- facilitate the view outside the building
- favour contact with nature either in an artificial manner or as a natural access natural, if the climate allows it;
- create places that are spatially legible, where elements are recognisable;
- adopt art as a therapeutic element.

2.2.2 Post Occupancy Evaluation

The idea behind POE is that by assessing how the design is appraised by users and how it supports certain activities, new knowledge is generated that can be included when new environments are planned.

In the evolving landscape of healthcare facilities management, marked by increasing complexity, the need for innovative tools to enhance understanding of building operation, utilization, and performance has become imperative. One such tool is Post-Occupancy Evaluation, a proven method for examining buildings in active use. Here are some key aspects and considerations for conducting a POE in healthcare architecture:

- Objectives and Goals: identify the specific objectives and goals of the POE. These may include assessing patient satisfaction, staff efficiency, safety, infection control, and overall functionality.
- Data Collection: collect quantitative and qualitative data through various methods, including surveys, interviews, observations, and data analysis. Gather feedback from patients, healthcare providers, staff, and visitors to understand their experiences and needs within the healthcare facility.
- Focus Areas: evaluate various aspects of the healthcare facility, such as the layout, room configurations, lighting, acoustics, HVAC systems, signage, wayfinding, and accessibility. Assess the impact of design elements on patient privacy, comfort, and well-being. Evaluate the effectiveness of infection control measures and the overall cleanliness of the facility.

Perhaps, in the context of healthcare facilities management, POE could gain greater significance by shifting its focus from merely gathering information to emphasizing the generation of knowledge. While information certainly holds value, we currently live in a world inundated with data, and traditional POE methods often place the responsibility on individuals to sift through this data to find what is pertinent. In contrast, knowledge is acquired differently, even though it may stem from available information. By striving to not only collect but also cultivate and disseminate new knowledge, we can transform the essence of POE from a data-gathering exercise into a genuine learning process, thereby reorienting its purpose.

Post-occupancy evaluation (POE) principally includes gathering data about users and buildings using questionnaires, interviews, visiting sites and field remarks.

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1.3.3 Joint Research Partnership Healthcare Infrastructure

The Politecnico di Milano-Department ABC (Department of Architecture, Building Engineering and the Built Environment), together with the Fondazione Politecnico di Milano, has set up a technological platform, the Joint Research Platform Healthcare Infrastructures, aimed at enterprises and institutions to develop and test evolutionary strategies of design, technological, organisational, construction and management innovation that will lead them to be competitive in relation to the transition of healthcare from an exclusively hospital-centric model to a sustainable user-centre model, included in a physical and digital territorial network.

The Joint Research Platform Healthcare Infrastructures intends to facilitate the discussion on the construction of scenarios concerning the technological evolution, shared between the Politecnico di Milano and the companies of the Healthcare Infrastructures supply chain. The initiative intends to realise highly challenging multi-actor and multidisciplinary projects, encouraging collaboration between universities, enterprises and public administrations.

Research focused on systematising the main areas of design, technological, organisational, construction and management innovation related to the hospital of the future.

The objective of this first year of research, mainly oriented towards systematising the state of the art and the requirements framework, was twofold:

- to propose a new vision of a new-generation hospital that is grounded on key, simple and impactful principles that are based on reference scientific evidence and are intended to anticipate future developments in the field. Elements that do not constitute innovation for themselves but propose a new reference model, systematising the most important evidence and practice-based results also at international level. In fact, there is a lack of regulations or performance guidelines on hospital design, which in the Italian context represents a significant urgency; in fact, 70% of hospital buildings have exceeded their optimal life cycle and 50% of the physical infrastructures are not adequate to host the new organisational and healthcare models.
- turn the focus on the importance of measuring all aspects of the physical space and the close relationship that exists between the physical environment and health with particular reference to the impact that quality design can have on the organisational outcomes of the healthcare facility. An increase in quality in the infrastructure should no longer be seen as a cost but as an investment. It is estimated that the increase in initial design and construction costs to achieve Evidence-Based Design principles with added value for the operator leads to equivalent savings in operating costs already in the first year of operation due to e.g. better control of adverse events, infections, falls and increased satisfaction and productivity. Although healthcare is a strongly measurement-oriented sector with many excellent tools, there are no tools dedicated to the subject of Healthcare Infrastructures thus far.

Operationally, the activities started with the definition of meta-design strategies in the form of performance requirements. Subsequently, operational indications were proposed with respect to specific areas of innovation that could sensitise the service providers of the health industry to derive measurable and tangible benefits from their application, both in the case of new realisation and re-functionalisation of existing structures. The results produced will eventually form the basis for the definition of a new UNI standard on hospital design.

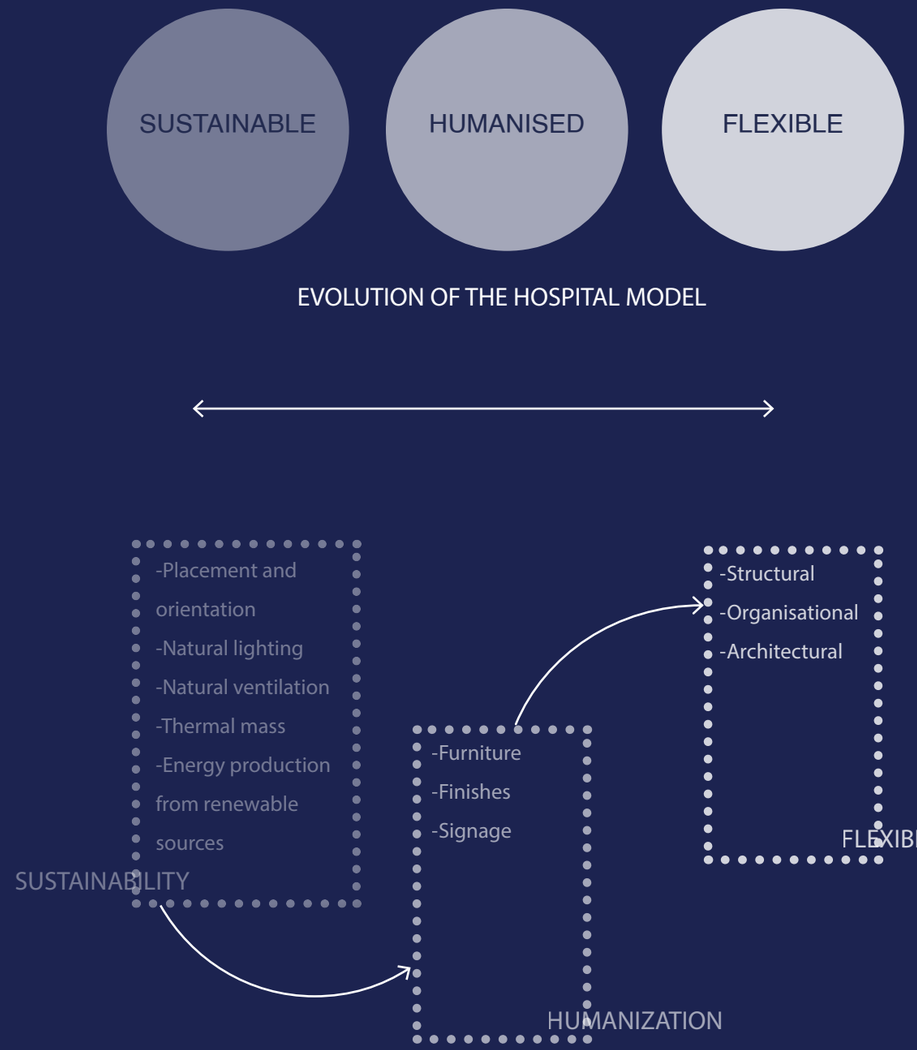
Starting from the recognition of the demand framework, i.e. the macro-trends affecting the transition of healthcare with particular reference to the challenges of ageing and rapid technological transformations, three main characteristics were identified for the modelling of new development scenarios related to health infrastructures:

1. the rethinking of the Post-Pandemic Hospital, starting with the Decalogue proposed by the ABC Department during Covid19 listed the principles around which the design of a hospital evolves in the light of the challenges highlighted by the recent pandemic on a global scale.
2. the territorial network as a support to the Healthcare of the Future; meaning an initial examination of elements useful for implementing the models proposed by the PNRR and the institutional bodies to complete the transition of healthcare towards a network model integrated with the territory.
3. Safe, Sustainable and Technological Hospital; an initial meta-design model defined as ‘Next Generation Hospital’ was proposed, consisting of the listing of performance requirements clustered in precise thematic areas to support the design of the Hospital of the Future. In fact, the Next Generation Hospital will have to be an ecosystem resilient to change and capable of protecting the health of its various users as the social, economic, environmental and epidemiological needs of the context in which it is inserted change. Incorporating the concepts of Smart Hospital, Green Hospital and Covid Hospital, the Next Generation Hospital is proposed as a reference model for improving the health architecture

of the future.

The vision for the new generation hospital is based on a series of key principles identified by a decalogue of meta-design strategies:

- definition of homogeneous macro areas such as emergency, plate, outpatient, inpatient;
- flexibility and resilience right from the definition of the structural mesh;
- efficient logistics systems and facilities relocated from the main building;
- strategic location in close relation to the context;
- use of innovative materials and focus on infection reductiongrowth of widespread research and training spaces;
- pervasive and transversal digitisation;
- sustainability in social, environmental and economic terms;
- high prevalence of single rooms;
- focus on the wellbeing of all users;



02.
Methodology

2. Methodology

2.1 Research gap and objective

2.1.1 Research gap

The research gap in the field of hospital design can be identified as a lack of analysis and guidance on non-clinical aspects of hospital design: there is a dearth of comprehensive research and practical indications focusing on critical elements related to both patients and staff.

Patient Experience: there is a need for more research on designing hospitals that prioritize the patient experience. This includes factors like wayfinding, privacy, comfort, noise reduction, and creating a calming and healing environment.

Staff Well-being: Hospital design should also address the well-being of healthcare professionals. Research is lacking in understanding how the physical environment affects staff productivity, job satisfaction, and overall well-being. Designing spaces that promote collaboration, reduce stress, and enhance efficiency can contribute to a positive work environment.

Adaptability and Flexibility: Hospitals need to be adaptable and flexible to accommodate changes in healthcare delivery and advancements in medical technology. Research is lacking on designing spaces that can easily adapt to future needs, such as modular designs, flexible room configurations, and scalable infrastructure.

Addressing these research gaps would provide valuable insights into the design of hospitals that go beyond clinical aspects and create environments that optimize patient outcomes and staff well-being.

For reasons of economic feasibility and urban sustainability, intervention on existing complexes is predominantly assumed. The issue of improving the performance of building complexes in use therefore arises with growing intensity.

The multiplicity of punctual and specific cases does not allow the formulation of standardised design solutions; however, it is possible to prefigure some general intervention strategies that can be adopted in a large number of cases.

An example of this is the reduction in the number of beds, related to the planned reduction in average hospitalisation times together with the progressive distribution of surgical services, which will produce a reduction in the need for traditional hospitalisation of surgical wards.

2.1.2 Research objective

The research aims to provide a comprehensive analysis of the state of healthcare in the current historical context. Its primary objective is to explore different facets of hospital design, with a specific focus on understanding strategies and innovations for creating hospitals of the future. The research encompasses a wide range of aspects, including the physical, psychological, and managerial dimensions of the hospital system.

Given that a significant portion of the reviews examined in the research were centered around inpatient care units, the study places particular emphasis on this specific ward. This focus allows for a detailed examination of the challenges and opportunities in designing and improving inpatient care facilities.

To guide the review process, several key questions were formulated.

INNOVATION - How to create facilities that can change and update their services over time? The first question pertains to the creation of flexible facilities that can adapt and evolve their services over time. This recognizes the dynamic nature of healthcare, where advancements in medical technologies and changes in treatment approaches continually reshape the services provided by hospitals. By understanding how to design flexible facilities, healthcare institutions can proactively respond to emerging needs and ensure that their infrastructure remains relevant and effective.

WELLBEING - How can spaces be made responsive to the psycho-physical needs of patients?

The second question addresses the importance of making hospital spaces responsive to the psycho-physical needs of patients. Recognizing that patients' well-being is influenced not only by their physical health but also by their psychological state, the research investigates how hospital environments can be tailored to enhance patients' overall experience. This involves considering elements such as lighting, noise levels, privacy, access to nature, and the integration of supportive services and amenities. By creating spaces that promote healing, reduce stress, and support the emotional well-being of patients, hospitals can contribute to better treatment outcomes and overall patient satisfaction.

Through the exploration of these questions, the research endeavors to shed light on innovative approaches and best practices in hospital design. By considering the physical, psychological, and managerial aspects of the hospital system, the study aims to provide valuable insights for architects, healthcare administrators, and policymakers who are involved in shaping the hospitals of the future.

2.2 Methodological steps

1

STATE OF THE ART

Hospital design background

2

LITERATURE REVIEW

Hospital wards and wellbeing

3

CASE STUDIES ANAYSIS

Contemporary hospitals

4

RESULTS

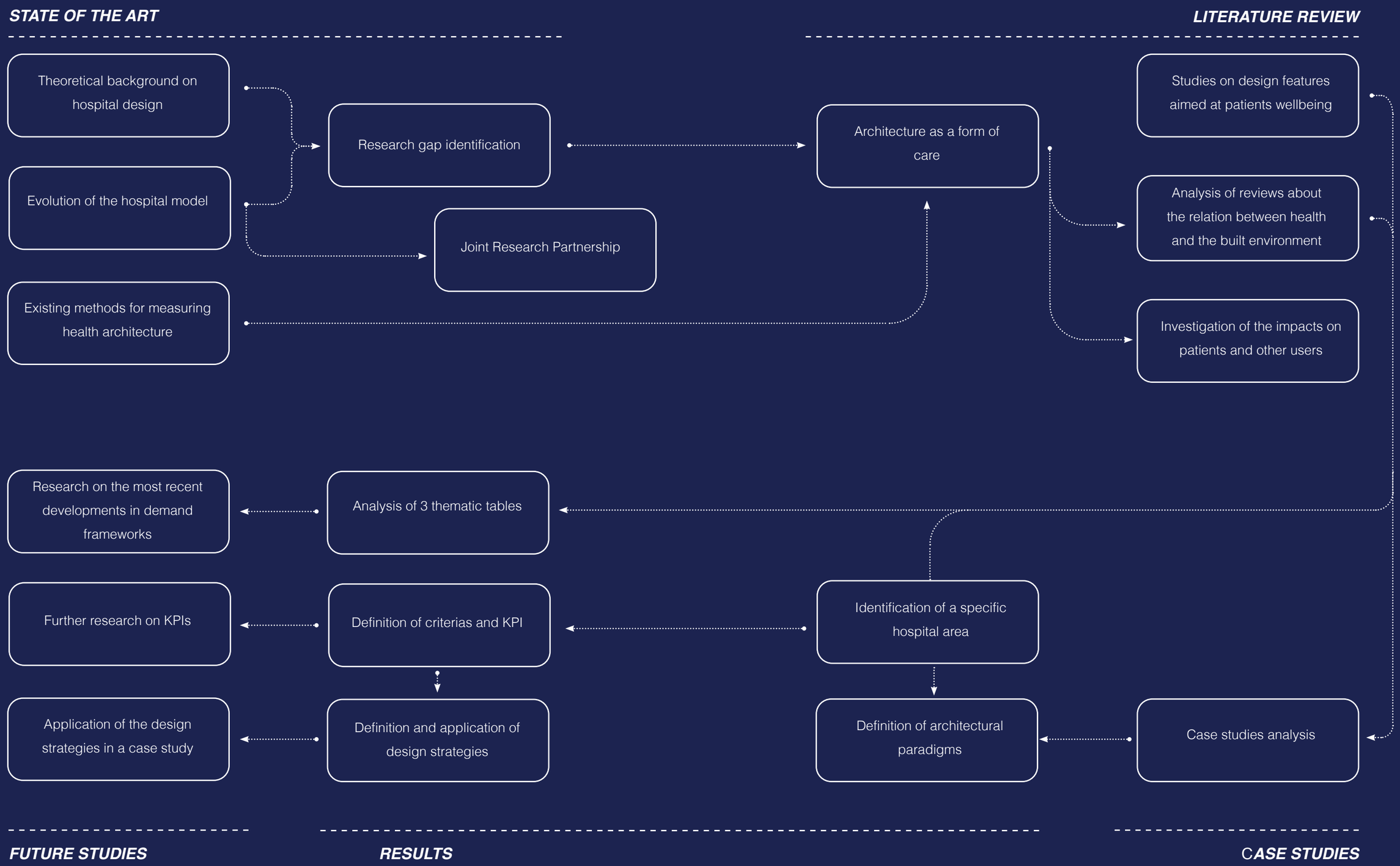
KPI and strategies to design for wellbeing

5

CONCLUSIONS

Hospital ward design proposal

2.2.1 Framework



2.2.2 Literature review

Why?

1. To identify what is already known aand what is not on the subject.
2. To frame the research questino with clearly defined concepts.
3. To help choosing the appropriate methodology.
4. To define the scientific fields to which the research contributes.
5. To enrich the interpretation of the results.

The steps of the review were identifying the research question, identifying relevant studies, selecting studies, charting the data, and collating, summarising, and reporting the results.

About n articles as well as other literature have been read. They all had a relevant connection with hospital design, physical environment, health and ward solutions.

The search strategy was determined iteratively by applying key words, for instance “healthcare infrastructure” or “wellbeing”.

Only studies and reviews that attempted to examine the “hospital ward” or “healthcare infrastructure” and the “innovation” or “wellbeing” were included. Reviews published before 2000 were ecluded.

Only articles about the folllowing subjects were considered: Nursing, Social Sciences, Health Professions, Environmental, Psychology, Decision Sciences, Arts&Humanities, Multidisciplinary, Neuroscience, Energy, Materials Science, Immunology and Microbiology.

All adult hospital environments were considered, especially the emergency departments. In addition key journals (e.g. Academy of Architecture for health, Progettare per la Sanità).

Articles about maternity settings, psychiatric wards or nursing management were excluded. The databases searched were Scopus, GoogleScholar, PubMed, Medline?

The screening of literature was conducted in a 5-stage process:

Stage 1: 2238 articles

Stage 2: 342 articles

Stage 3: 87 articles

Stage 4: 32 articles

Stage 5: 17 articles

Keywords

“hospital ward” OR “healthcare facility”

AND

“innovation” OR “wellbeing”

Elibility criteria

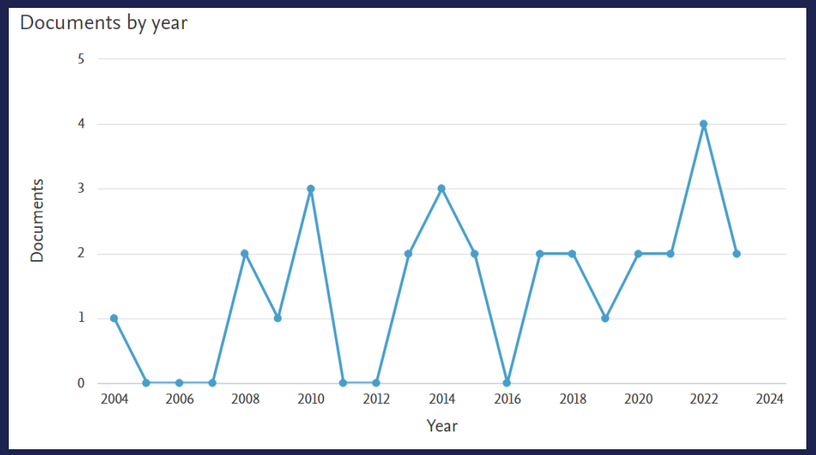
Published after 2000

Subject area included

Nursing, Social Sciences, Health Professions, Environmental, Psychology, Decision Sciences, Arts and Humanities, Multidisciplinary, Neuroscience, Materials Science, Immunology and Microbiology.

Subject area excluded

Computer Science, Engineering, Business, Management and Accounting, Biochemistry, Genetics and Molecular Biology, Pharmacology, Toxicology and Pharmaceutics, Marhematics, Economics, Econometrics and Finance, Physics and Astronomy. Agricultural and Biological Sciences, Chemical Engineering, Chemistry, Earth and Planetary Sciences, Dentisry, Veterinary.



2.2.3 Best practices

After the systematic literature an analysis of best practices has been done.
In this comprehensive study, a meticulous best practices analysis was conducted, focusing on the inpatient units within four contemporary hospitals. The overarching goal of this analysis was to identify and understand the architectural paradigms and innovative design solutions employed in these crucial healthcare spaces. To achieve this, each of the selected hospitals underwent a detailed case description, including representations of the functional programs that guided their design and layout.
The analysis encompassed a holistic comparison of various parameters and features across these healthcare facilities. It began with an examination of the site characteristics, highlighting the different environmental contexts in which these hospitals were situated.
Additionally, the analysis considered the diverse building types represented in the selected hospitals, such as modern high-rises, suburban complexes, and urban healthcare centers. This diversity allowed for a nuanced exploration of how building type influences the design of inpatient units.
Outdoor green spaces were also a key point of comparison, as the integration of natural elements within healthcare environments has been shown to positively impact patient well-being.
A significant portion of the analysis was dedicated to evaluating the typical floor plans of the inpatient wards, which served as the foundation for patient care. These floor plans were critically examined for their layout, distribution typology, and adherence to best practices in healthcare design. Each hospital's standard room layouts and dimensional relationships were scrutinized to identify design strategies that promote patient comfort, privacy, and efficient healthcare delivery.
Detailed measurements were taken of the inpatient areas, service spaces, and circulation zones within each hospital. This data-driven approach allowed for a quantitative assessment of spatial efficiency and functionality.
Moreover, the study explored the location of nurses' stations in relation to patient rooms. This aspect of the analysis delved into the impact of layout and proximity on patient care, nurse-patient interaction, and overall staff efficiency.
By thoroughly examining and comparing these critical elements, including the representation of functional programs in each case, this best practices analysis aimed to provide valuable insights into innovative design approaches in contemporary healthcare architecture. It sought to inform future design endeavors, ultimately contributing to the creation of patient-centered, efficient, and functional inpatient units in healthcare facilities.

2.2.4 Criteria and KPI definition

The result of this rigorous process is the extraction and compilation of a set of criteria rooted in two primary sources of knowledge: a deep dive into scientific literature and a careful examination of best practices in modern healthcare architecture. These criteria, drawn from a wealth of research and real-world examples, form the foundation for evaluating healthcare facilities, with a special emphasis on inpatient units. To enhance the assessment process, a comprehensive set of key performance indicators (KPIs) has been thoughtfully developed and linked to these criteria. These KPIs cover a wide range of metrics, from measurable data-driven aspects to more qualitative evaluations, ensuring a well-rounded evaluation of healthcare environments that goes beyond mere numbers.
What's particularly noteworthy is the attention given to patients, the primary users of healthcare facilities, in this endeavor. The framework has been carefully tailored to uncover both the direct and indirect effects of the identified criteria and KPIs on hospital users, with a strong focus on the patient experience. This approach recognizes the significant impact that architectural design, layout, and functionality can have on the physical and emotional well-being of patients throughout their healthcare journey.
Furthermore, transparency and traceability are embedded in this framework through a dedicated column that cites the sources from which these KPIs have been drawn. This meticulous referencing not only reinforces the credibility of the assessment framework but also makes it easier for future revisions and enhancements, ensuring that the field of healthcare architecture continues to evolve with a strong foundation in data and a commitment to improving the well-being and experiences of those it serves. In summary, this comprehensive framework stands as a robust tool for architects, healthcare administrators, and stakeholders, guiding the design and evaluation of healthcare spaces with a steadfast dedication to enhancing the lives of those who utilize them.
Following the criteria mapping process, a crucial step involved creating detailed descriptions for each of the identified criteria. These descriptions were enriched with visual aids such as pictures, diagrams, and relevant studies that offered

valuable insights into each specific aspect under consideration. This added layer of visual and contextual information served to provide a more comprehensive understanding of the criteria and facilitated a deeper analysis of their significance within the evaluation framework.

2.2.5 Setting analysis and definition

In the course of this comprehensive evaluation process, a crucial initial step involved conducting a setting analysis and precisely defining the focal point: the inpatient ward. To offer a clear visual representation of the contextual landscape, a table and diagram were employed to showcase the distribution of settings within the scientific reviews that were consulted. These visual aids provided an insightful breakdown of where these reviews were situated in terms of healthcare settings. This analysis allowed us to ascertain that the majority of the reviewed literature, often around the 50% mark, was concentrated on inpatient units, reaffirming their pivotal role in healthcare architecture. By visually mapping out the distribution of settings, this step set the stage for a more focused and contextually informed evaluation, ensuring that the subsequent analysis was rooted in a deep understanding of the specific area under examination: the inpatient ward.

2.2.6 Design & Evaluation of strategies

This phase was a process that includes insights from both scientific literature, best practice analysis and especially the kpi definition which deals with a specific area of the hospital. At this point a tool was crafted, comprising dimensional requirements and qualitative recommendations that would guide the design of various environmental units within the inpatient ward. These units include critical spaces such as circulation areas, waiting zones, patient rooms, and outdoor green areas, each deserving its own dedicated sheet for in-depth exploration. These sheets were organized into two columns, in order to show the relation between evidence, extracted from research, and the practical design considerations that would shape the healthcare environment. Furthermore, a layout application is represented, ensuring that every aspect was taken into consideration. It has been considered a ward for 100 patients, which led to the various dimensions definition. After a series of schemes showing different principles, a floorplan at 1:500 scale is shown, followed by a zoom of the two patient rooms typologies.

The assessment tool is then illustrated: a comprehensive checklist, designed for preliminary assessment or during project development, to evaluate its effectiveness. This checklist includes two types of assessments: a scoring system that ranges from 0 to 3, providing a nuanced evaluation, and yes/no questions to indicate the presence or absence of certain elements.
The ultimate test of the developed tool consists of an application to an existing hospital project. Specifically, it was employed to evaluate an inpatient ward floor plan: the case is the project for the new hospital in Salento, by Mario Cucinella Architects. This application of the tool allows for the validation of its efficacy and relevance in practical healthcare settings. In summary, this final step shows the how this holistic approach to healthcare facility planning and design was driven by evidence, best practices, and represents a commitment to improving patient care and well-being.

03.
Results

3.1 Literature review

With the initial question ‘How can spaces be made responsive to the psycho-physical needs of patients?’ and the aim of understanding the relationship between architecture and patients wellbeing in the constitution of a therapeutic environment, this chapter analyses the logical progression of methodology. It evolved through the following phases: data collection, data analysis and application.

The research plan followed a step process by collecting data through: (i) scoping review about hospital ward and wellbeing, (ii) further review on specific aspects related to healthcare outcomes, (iii) selection and comparison of healthcare facilities case studies, (iv) definition of design guidelines.

The scoping review is a traceable method of ‘mapping’ areas of research and highlighting gaps in the literature for future research. This approach involves systematically examining and analyzing existing research and scholarly articles on a specific topic. Its purpose is to provide an overview of the current state of knowledge in a particular field or subject area. The objective of the scoping review was to map key concept for a deeper understanding of the relation between the built environment and the patient’s wellbeing. Moreover, it was aimed to identify gaps in our current knowledge to inform design of future hospitals.

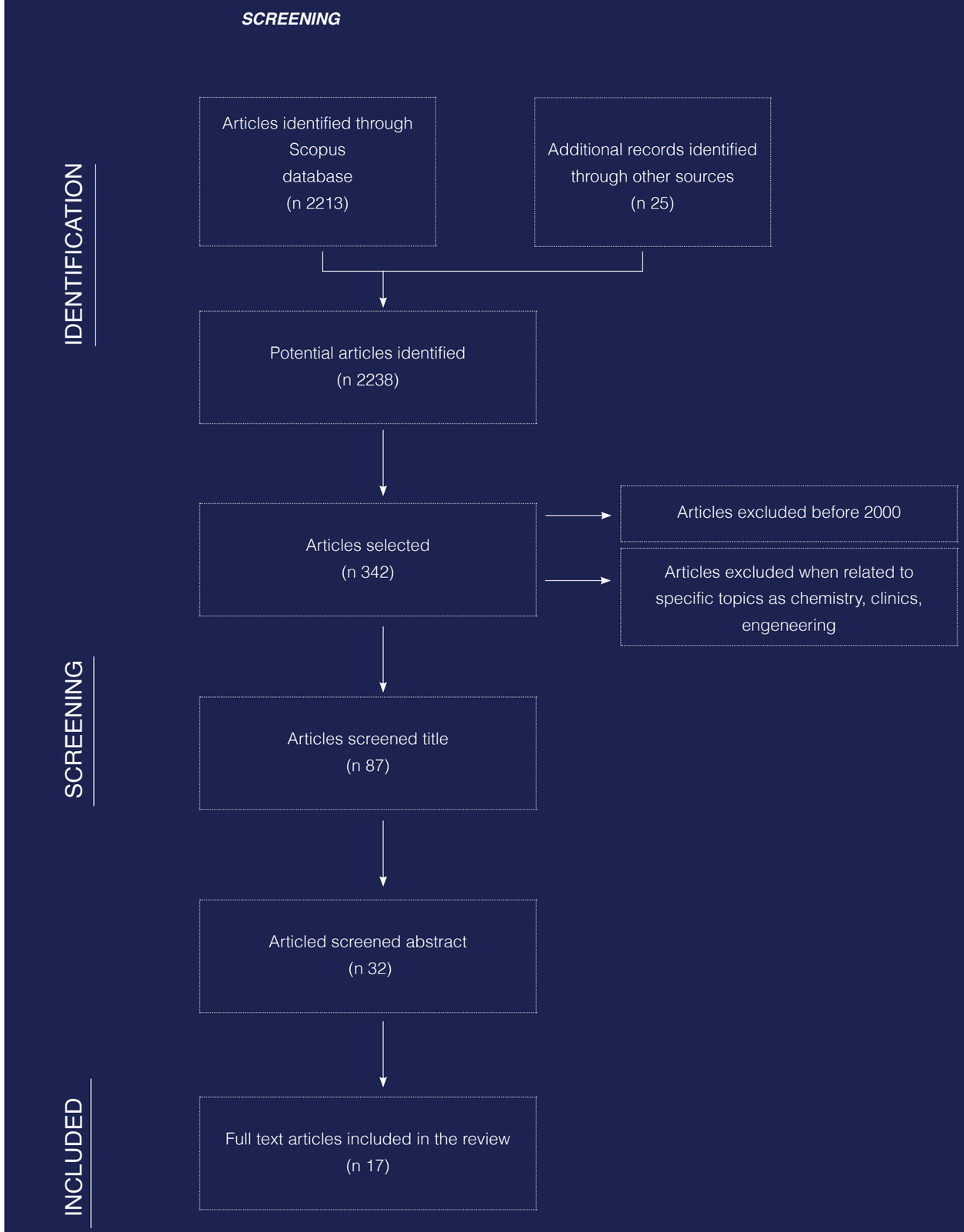
The initial search was undertaken on studies published from 2000 and today. The review of the literature was conducted by identification of search string keyword and appropriate operators (OR, AND) in database Scopus and PubMed with supplementary searches on Google Scholar.

Among the findings, some reported specific data on post occupancy evaluation, while others provided general consideration on managerial, clinical or architectural aspects.

The analysis of the selected articles revealed several aspects that can be grouped into the following five macro-themes, which correspond to the five tables studied by the Joint Research Platform.

Of the papers consideres five focus on Functional layout, one concerns the Digital and Technological five papers gives information about Safe and Healthy, four provide considerations about Comfortable and welcoming also in relation to experienced based design and one is related to Sustainability. Table 2 and 5 are excluded in this research.

Therefore, the results are clustered accordingly and the main findings are reported below, in the following sections.



1. Functional layout

- (M. Mead & AM. Ibrahim, 2022). *Strategies to evaluate the quality of hospital design with clinical data*
- (Tom Clark & Scott Combs, 2017). *Hospital Inpatient Unit Design Factors Impacting Direct Patient Care*
- (Aalto et al., 2017). *Usability evaluation (IEQ survey) in hospital buildings*
- (Lynette Cusack et al., 2021). *Anticipated advantages and disadvantages of a move to 100% single room hospital*
- (Yi Lu et al., 2014). *Patient Visibility and ICU Mortality: a conceptual replication*

2. Digital and technological

- (Bendik Bygstad & Egil Øvrelid, 2020). *Architectural alignment of process innovation and digital infrastructure in a high-tech hospital*

3. Safe and healthy

- (Anjali Josepha & Mahbub Rashid, 2007). *The architecture of safety: hospital design*
- (Thorben Simonsen et al.). *Healing Architecture in Healthcare*
- (Fouad Jalal Mahmood & Abdullah Yosif Tayib, 2019). *Healing environment correlated with patients' psychological comfort*
- (Amerigo Rossi et al., 2023). *Exploring the Association Between the Healthcare Design Elements and Physician Well-Being*
- (Deborah Trau et al., 2016). *Nature Contacts: Employee Wellness in Healthcare*

4. Comfortable and welcoming

- (Marina C: Gimenez et al., 2016). *Patient room lighting influences on sleep*
- (Erica E. Ander et al., 2012). *Using museum objects to improve wellbeing"*
- (Sarah L. Brand et al., 2017). *Whole-system approaches to improving the health and wellbeing*
- (Jeanette Lindahl et al., 2023). *The perceived support from light and color before and after an EBD intervention*

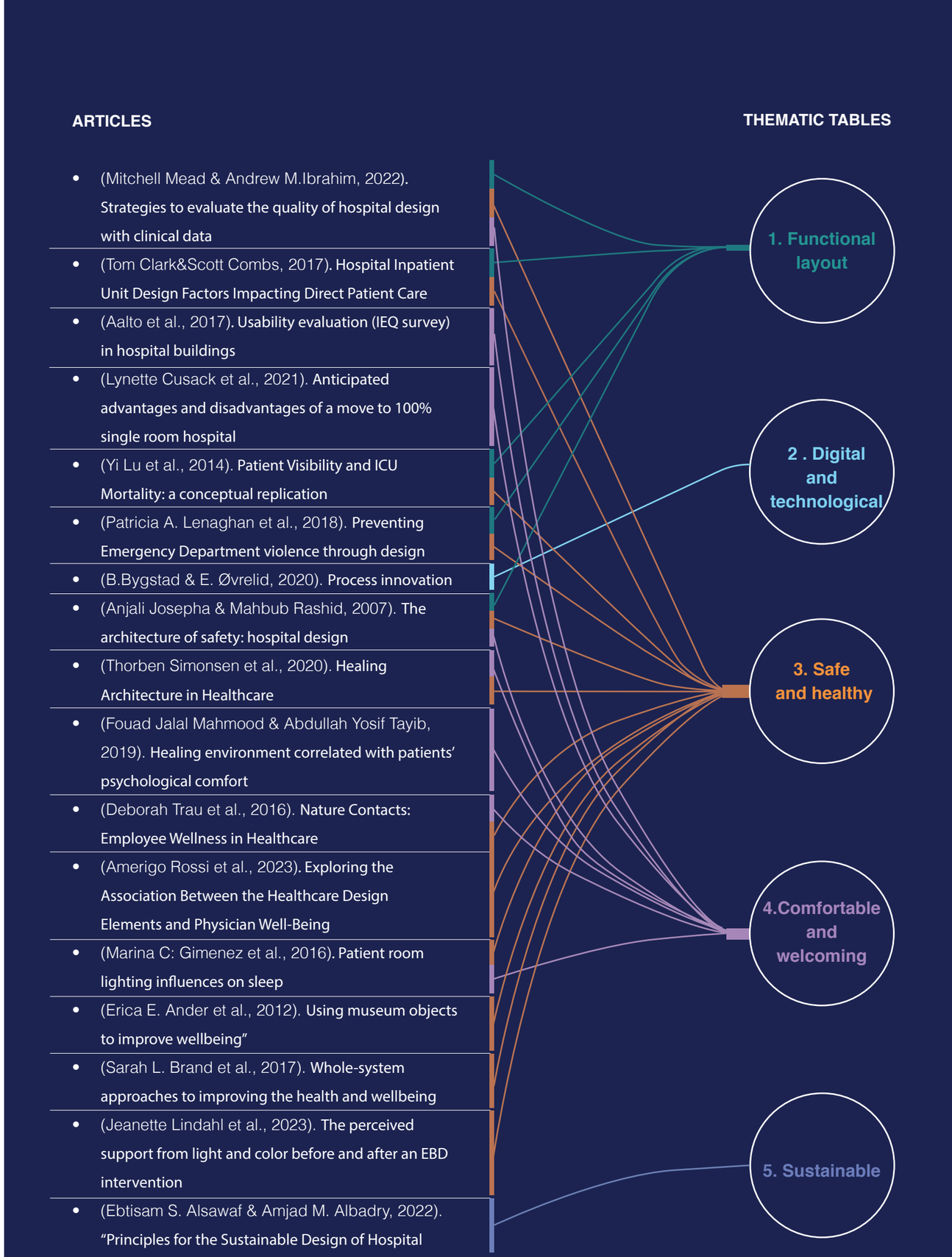
5. Sustainable

- (Ebtisam S. Alsawaf & Amjad M. Albadry, 2022). *Principles for the Sustainable Design of Hospital Buildings"*

From the literature review a work of classification has been done, in order to better understand the thematic of each review considered. Since the research focuses on the architecture's role relared to the enhancement of people's physical and emotional wellbeing, only the following thematic tables have been considered: Functional layout, Safe and Healthy, Comfrotable and welcoming. Although a classification has been done, studies and reviews possess the remarkable ability to address a multitude of subjects across the board. This versatile nature allows them to be associated with different tables of content, covering a wide range of topics. In the context of hospital design, this feature becomes particularly evident.

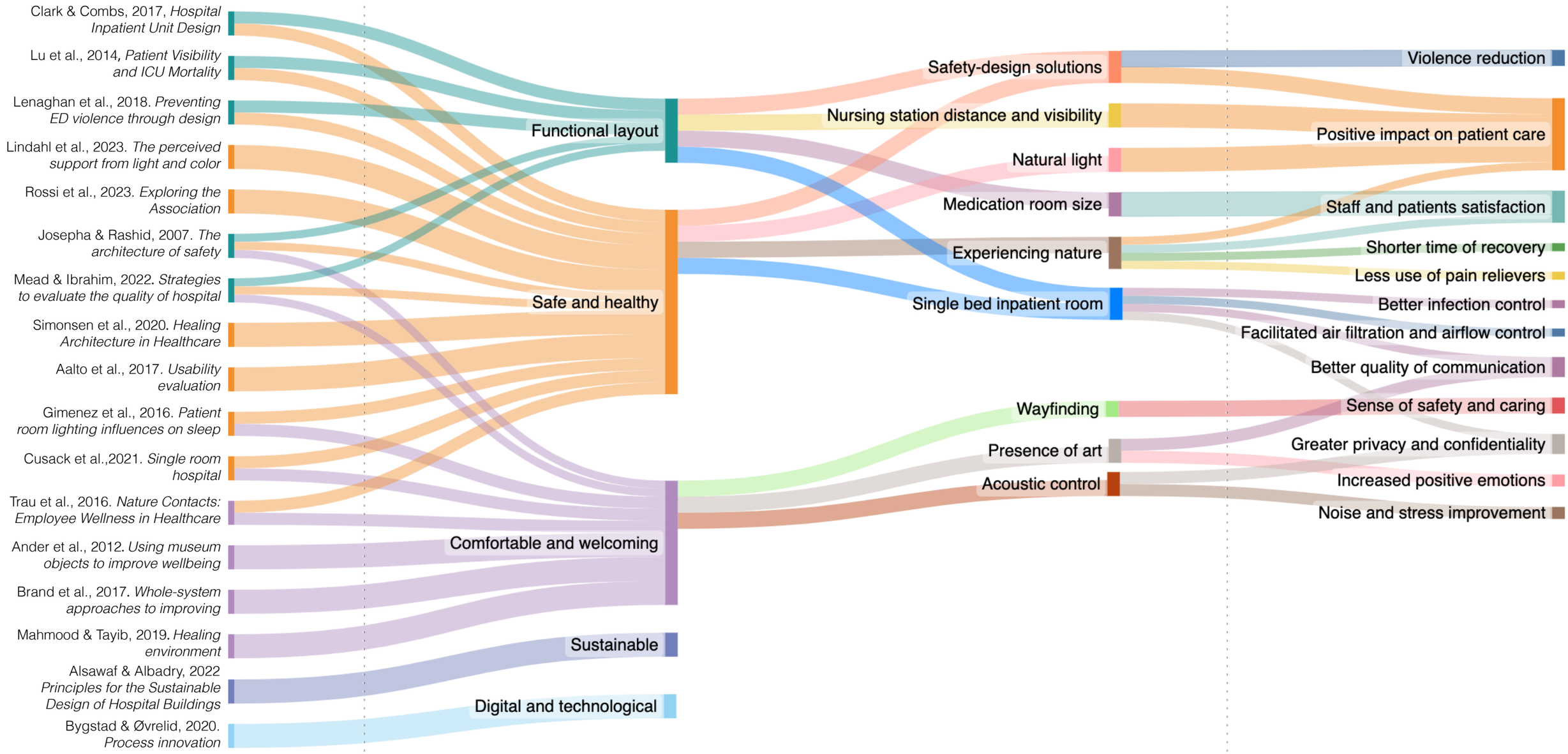
Consider a study that primarily focuses on the functional layout of a hospital. While its central theme revolves around optimizing efficiency and workflow, it is not uncommon for this study to reference and touch upon other crucial subjects, such as safety. The diagram opposite beautifully illustrates this principle.

Just like a hospital comprises various interconnected departments and units, writings on hospital design intricately intertwine different facets. They acknowledge the interconnectedness of various elements and highlight how they interact and influence each other. While one may dive into the specifics of space allocation, the text may seamlessly transition into discussing infection control measures or patient well-being, shedding light on the multifaceted nature of the subject. This inherent quality of writings to address multiple subjects across the board enriches our understanding of hospital design. It encourages a holistic approach, emphasizing the importance of considering diverse factors in the creation of a safe, efficient, and patient-centered healthcare environment.



SANKEY DIAGRAM

Extrapolation from the literature of criteria and their respective impacts on hospital users



The thematic tables Sustainable and DIgital&Technological are not covered in this research.

3.2 Best practices analysis

3.2.1 Martini Hospital | Dutch Hospital Design 2007 | Groningen, Netherlands

Source: *Burger Grunstra Architecten*

3.2.1 Martini Hospital | Dutch Hospital Design 2007 | Groningen, Netherlands

Architect: Burger Grunstra Architecten

Location: Groningen, Netherlands

Year of realisation: 2003-2007

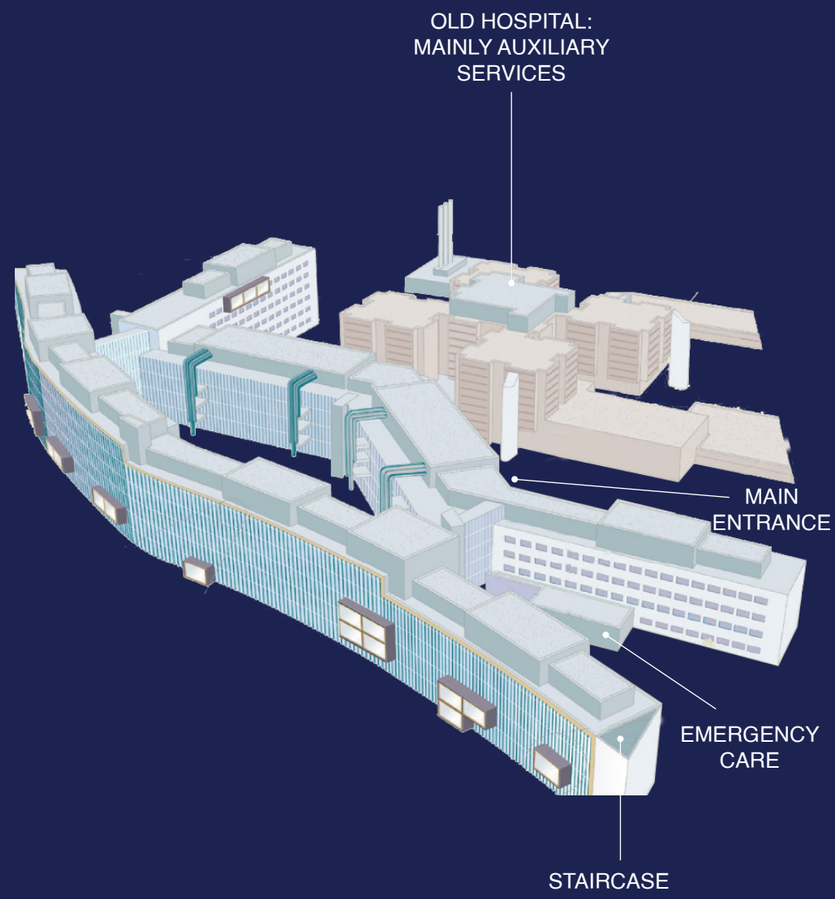
Surface area: 250,000 sqm

FLEXIBILITY

NATURAL LIGHT

The recently built Martini Hospital, southwest of Groningen City (NL), capital of the province of Groningen, represents the realisation of a long and articulated flexibility study, which involved all stages of design from the planning of the intervention to the executive and plant design. The current Martini Hospital is therefore located in a semi-peripheral area of the city, easily accessible by both private and public transport and characterised by the presence of a large park with sports facilities and a lake. The idea of having two distinct buildings with some converging points, starts from an analogy with the chromosome. This planimetric organisation makes it possible to have two autonomous buildings connected to each other at two points where the vertical connections are located. The two building strips, however, have different characteristics according to the various activities offered within the hospital. The block facing outwards has a more sinuous, the one facing inwards is a break that is oriented according to the surrounding buildings. This makes orientation within the hospital area easy. Both buildings are in fact subdivided into 4 blocks of 4 floors of approximately 1000 m2. each. These blocks have a rectangular floor plan of 16 m x 60 m, instead of the traditional 25 m x 40 m, which allows a 30% increase in **natural light** on the façade, and allows future reuse of the building, enabling it to be converted into a residential or office complex, thanks also to the plant engineering system used.

For the outermost building, it was decided to locate the plant conduits in a cavity at the centre of each module, while in the blocks containing the operating rooms it was decided to locate all the plant ducts externally in order to create a free and more **flexible space**.



Source: *Healthcare Facility Design for Flexibility*

Industrial, flexible, demontable

The hospital project is therefore part of a long quest for flexibility that has involved all stages of design. To begin with, this project respects the principles set out in the IFD programme, which stands for industrial-flexible-demountable, principles of a programme at the initiative of several ministries.

The principles that guided the designers are based on the theory that while there are factors that in forty years would radically change and that it is not possible to predict, such as such as technological changes in the medical field or functional-managerial organisation. on the other hand there are elements that have remained unchanged over the years and that over the years that have remained unchanged and that are independent of refunctionalisation, such as the presence of natural light, the welcoming and sense of security in the environment or the presence of greenery. All this has resulted in result a building characterised by a strong flexibility and adaptability, combining the complexity of the hospital structure with architectural quality.

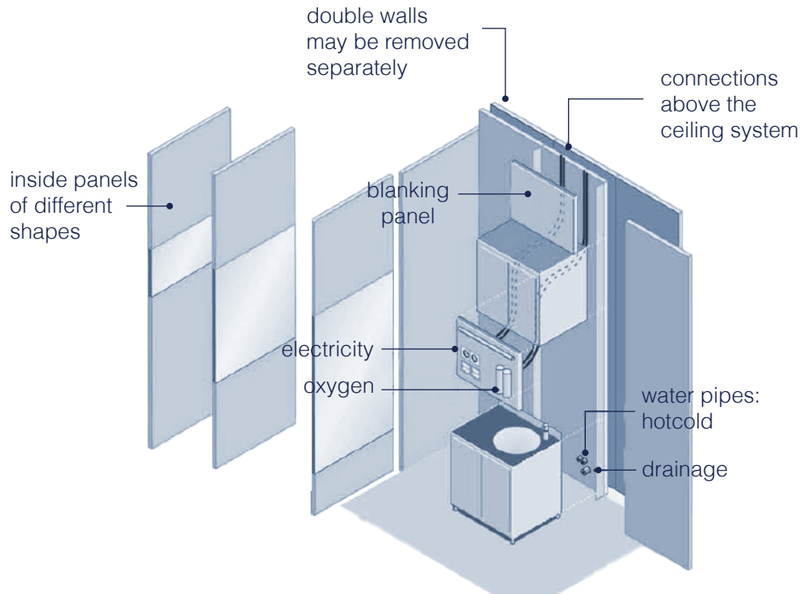
IFD principles

By utilizing modular partition walls, integrated services, and adaptable furniture, it becomes feasible to make various modifications within a room without causing disruptions to adjacent areas. Electrical, medical gas, and water access points, along with cabinets and counters, can be easily repositioned. The furniture is likewise composed of modular components that can be interconnected or disengaged to accommodate different purposes. Furthermore, the curved facade positioned behind the glass climatic curtain wall consists of detachable panels, allowing adjustments to match the enclosed functions.

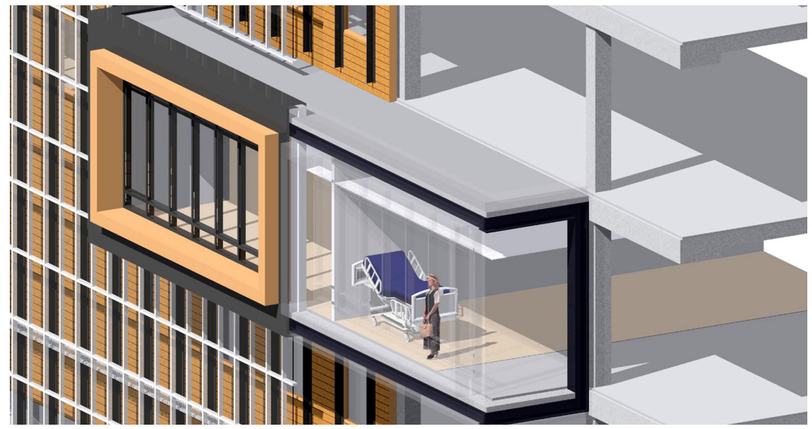
Extensions

As part of the architecture extensions can locally add space to the building block even now the building is in use. In this way a potential of 10% extra floor area is available. It is an example of small extra investments for a lot of extra flexibility.

The only fixed elements are the services shafts which always remain in the middle of the block. The structure is actually prefabricated, consisting of a reinforced concrete frame with cross members 7.2m apart capable of allowing future upwards development and accordingly the possibility of vertical expansion up to 6 floors above ground.



Source: *Healthcare Facility Design for Flexibility*



Source: *Burger Grunstra Architecten*

3.2.2 The General Hospital of Thessaloniki | Renzo
Piano's studio 2025 | Thessaloniki, Greece

Source: *Renzo Piano Building Workshop*

3.2.2 The General Hospital of Thessaloniki | Renzo Piano's studio
2025 | Thessaloniki, Greece

Architect: Renzo Piano Building Workshop

Location: Thessaloniki, Greece

Year of realisation: 2025

Surface area:

Points of interest:

NATURE

NATURAL LIGHT

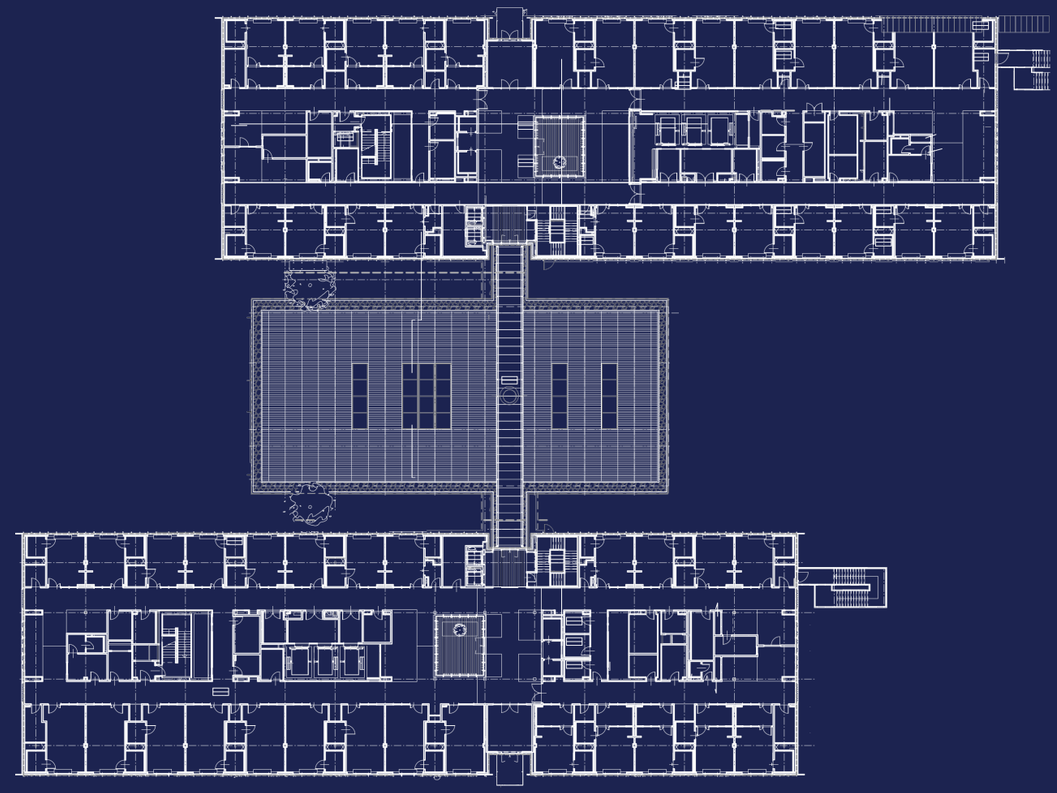
The hospital in Thessaloniki, located in the Greek region of Central Macedonia, will serve as a pediatrics facility.

In terms of masterplan, the campus is organized around two primary nodes: the first being the main hospital and all its clinical functions, the Child Mental Health Unit, gardens, and healing garden, and the other being the Research Center, which includes research laboratories, educational spaces and academic offices, administrative offices, a cafeteria, public parking, staff parking, the central energy center, and a helipad. The design pays close attention to the user experience of the patients, their families, and the hospital staff.

The relationship with nature is a fundamental aspect of the design; the park offers gardens and play areas, spaces for activity and recreation for kids and their relatives, as well as for doctors and staff. The interior spaces feature transparent and permeable connections to the outdoor park, such as large windows in the inpatient rooms on the ward level.

The structure is designed as a three-story building surrounded by an extensive park about 70,000 square meters. Only two stories of the new hospital will be visible from the surroundings due to the sloped contours of the site and greenery, making the hospital building appear lower, and more domestic in scale.

All of the core clinical functions, such as operating rooms, labs, and emergency department, will be located on the ground level, offering natural daylight and protected views towards the park. Driven by a sustainable approach, the hospital will use the right materials and resources, incorporating strategies to reduce energy consumption as much as possible, recycling materials, and using the roof to generate energy.



Floor plan. Source: *Renzo Piano Building Workshop*

3.2.3 New North Zealand Hospital | Competition 2013 |
Hillerød, Denmark | Herzog & de Meuron

Source: *Renzo Piano Building Workshop*

3.2.3 New North Zealand Hospital | Competition 2013 | Hillerød, Denmark | Herzog & de Meuron

Architect: Herzog & de Meuron

Location: Hillerød, Denmark

Year of realisation: 2024

Surface area: 120 000 sqm

Points of interest:

NATURE

NATURAL LIGHT

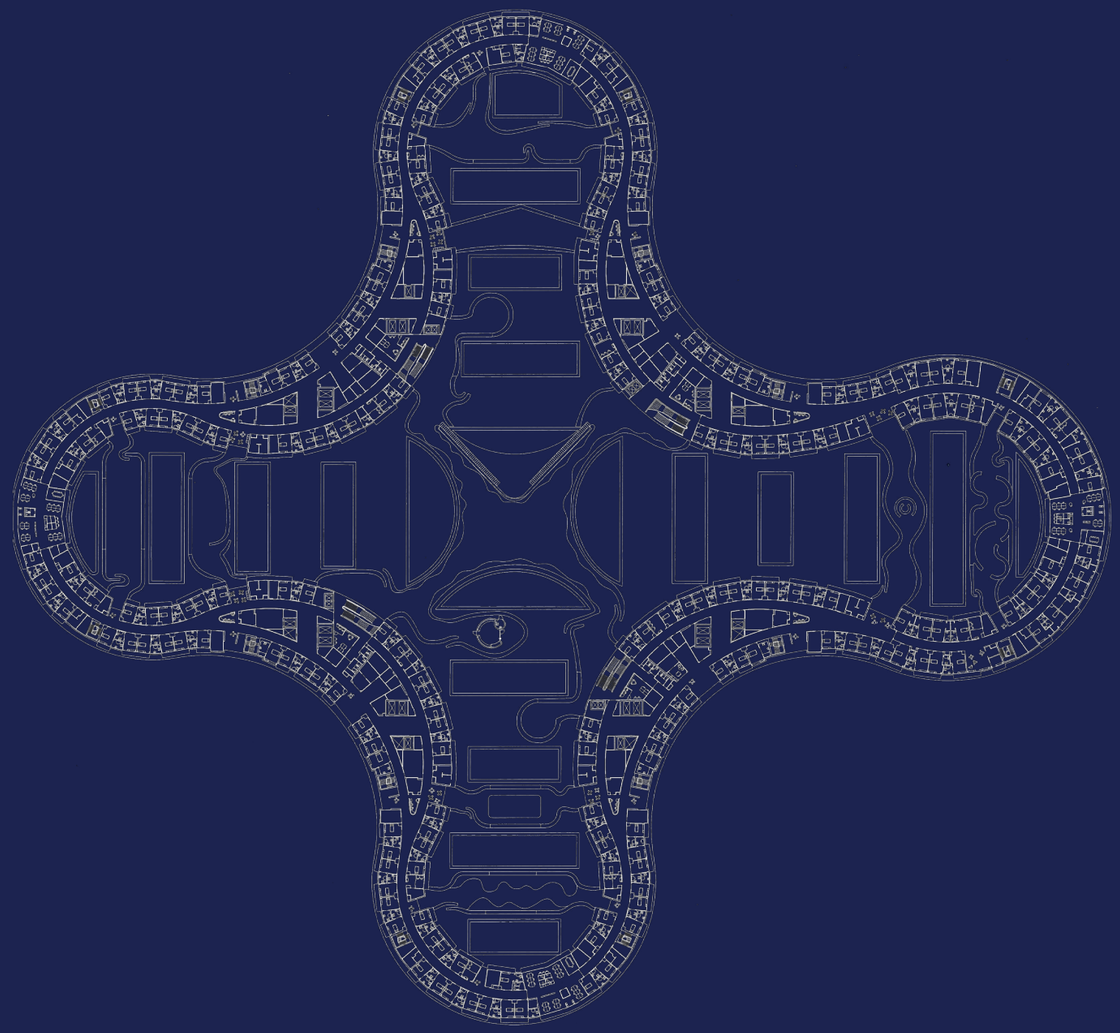
The hospital is surrounded by nature and contains a **garden** in its center. The horizontality of the building and its undulating form responds to the location of the hospital in the midst of the wide Danish landscape. A horizontal building is an appropriate building typology for a hospital, because this fosters exchange: across the various departments, the employees work on a shared goal: the healing of the ailing human being. The new hospital shall overcome conventional operational borders.

The new facility serves a catchment area of around 310,000 inhabitants, a task previously served by three smaller hospitals. With 570 beds spread across a total area of approx. 120,000 m2, it consolidates and improves the emergency and intensive care services for the region.

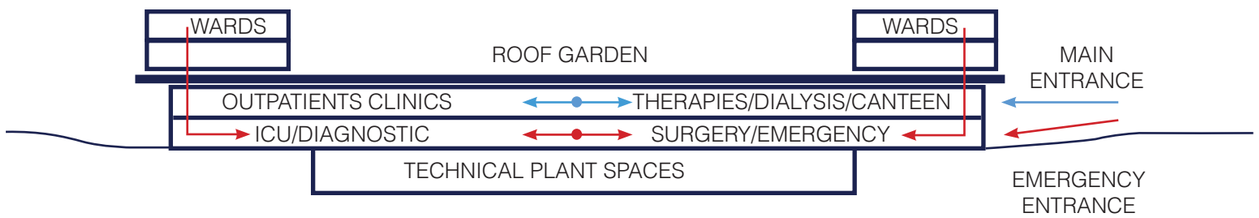
The examination and treatment rooms are accommodated in a total of 20 departments on the two lower floors. Circular **inner courtyards** are cut into the plinth in a repeating pattern so that daylight can permeate the lower levels of the hospital, and four circular courtyards illuminate a central hall at the heart of the complex. The roof of the plinth becomes an **open-air park** landscape.

The neonatology and paediatric patient rooms are equipped with an alcove that serves as a seating niche for greater privacy and moments of peace and seclusion and where the parents can spend the night. From the rooms, patients have an expansive view into the treetops of the surroundings or the garden landscape in the interior of the hospital.

In the corridors and rooms of the ward floors, the use of wood as the dominating design element creates a friendly atmosphere. In those areas of the hospital that are accessible for patients, the ceilings consist of an industrially manufactured system of wooden slats fixed on minerai wool panels.



Ward floor plan



Source: herzogdemeuron.com

3.2.4 Haraldsplass Hospital I Competition 2012 I Bergen, Norway I C.F. Møller Architects

3.2.4 Haraldsplass Hospital | Competition 2012 | Bergen, Norway | C.F. Møller Architects

Architect: C.F. Møller Architects

Location: Bergen, Norway

Year of realisation: 2018

Surface area: 14,200 m^2/187 beds

Points of interest:

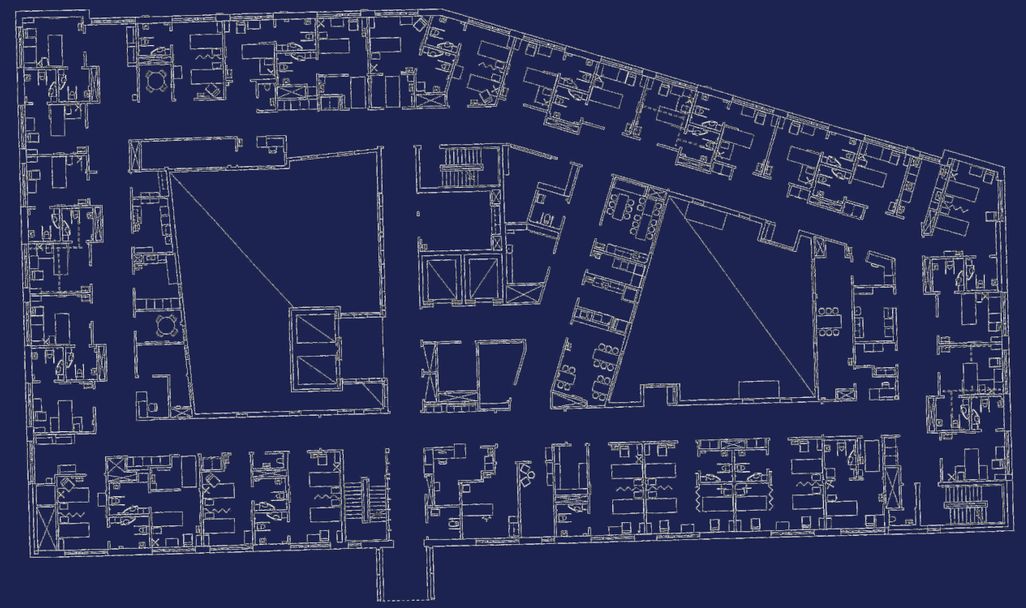
SINGLE UNIT

NATURAL LIGHT

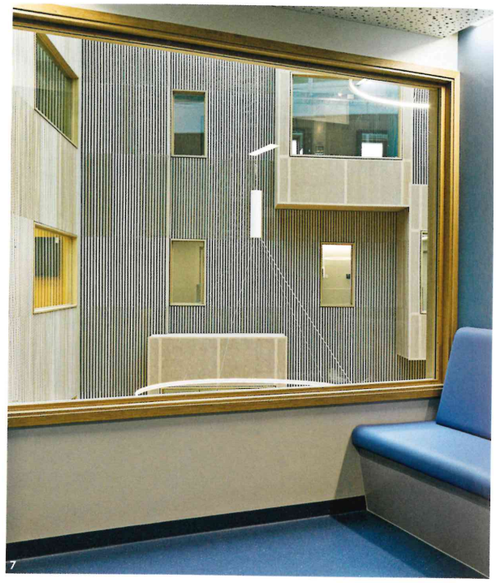
The idea of having two distinct buildings with some converging points, starts from an analogy with the chromosome. This planimetric organisation makes it possible to have two autonomous buildings connected to each other at two points where the vertical connections are located. The two building strips, however, have different characteristics according to the various activities offered within the hospital.

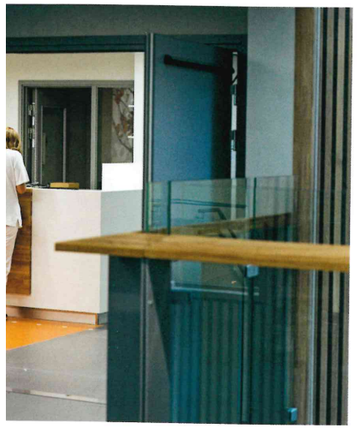
The block facing outwards has a more sinuous, the one facing inwards is a break that is oriented according to the surrounding buildings. This makes orientation within the hospital area easy. Both buildings are in fact subdivided into 4 blocks of 4 floors of approximately 1000 m2. each. These blocks have a rectangular floor plan of 16 m x 60 m, instead of the traditional 25 m x 40 m, which allows a 30% increase in natural light on the façade, and allows future reuse of the building, enabling it to be converted into a residential or office complex, thanks also to the plant engineering system used.

For the outermost building, it was decided to locate the plant conduits in a cavity at the centre of each module, while in the blocks containing the operating rooms it was decided to locate all the plant ducts externally in order to create a free and more flexible space.

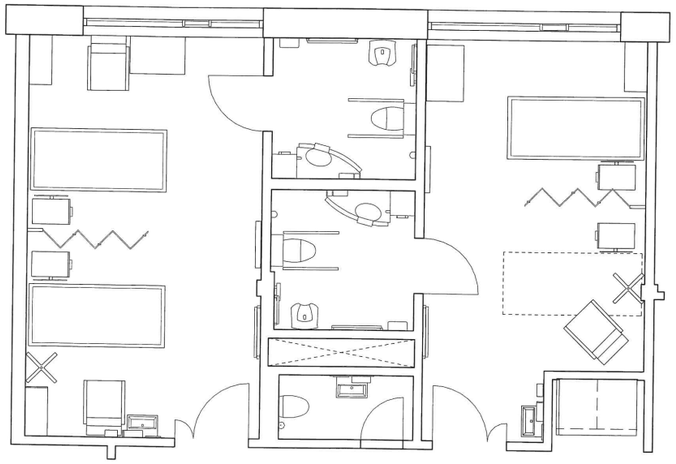


Ward floor plan

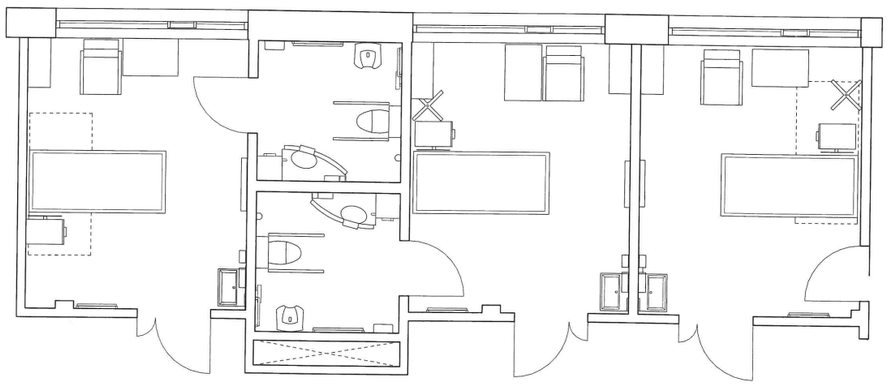




DOUBLE
ROOMS



SINGLE
ROOMS



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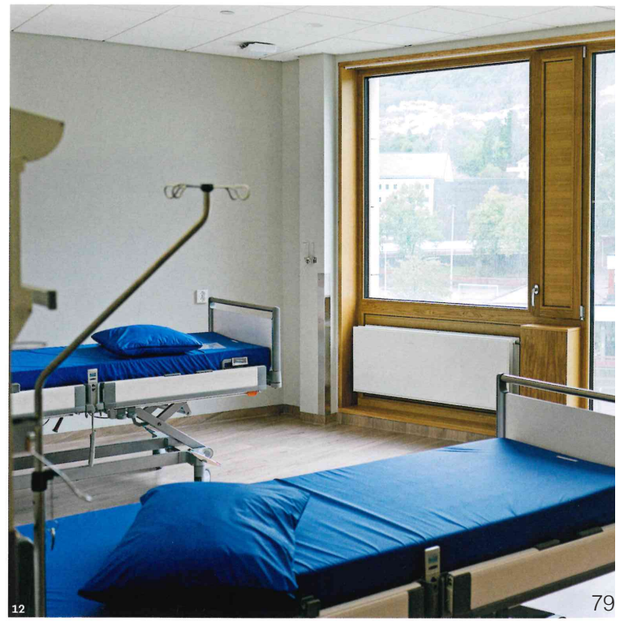
10

11

W.Sunder, J.Moellmann, O.Zeise, LA. Jurk,
The Patient Room



12

6 Atrium with projecting oriel boxes
7 Seating niche with a view into the atrium
8 A ward corridor
9 Floor plans of single and two-bed rooms, 1:100
10 Full-height window in a standard room
11 Wall cabinet for patients' belongings
12 A patient room with two beds

3.2.5 Doctor Moisès Broggi Hospital | 2010 | Sant Joan Despí, Barcelona | PINEARQ

Source: *brulletdeluna*

3.2.5 Doctor Moisès Broggi Hospital | Competition 2012 | Bergen, Norway | PINEARQ

Architect: C.F. Møller Architects

Location: Bergen, Norway

Year of realisation: 2010

Surface area: 45.725 sqm

Points of interest:

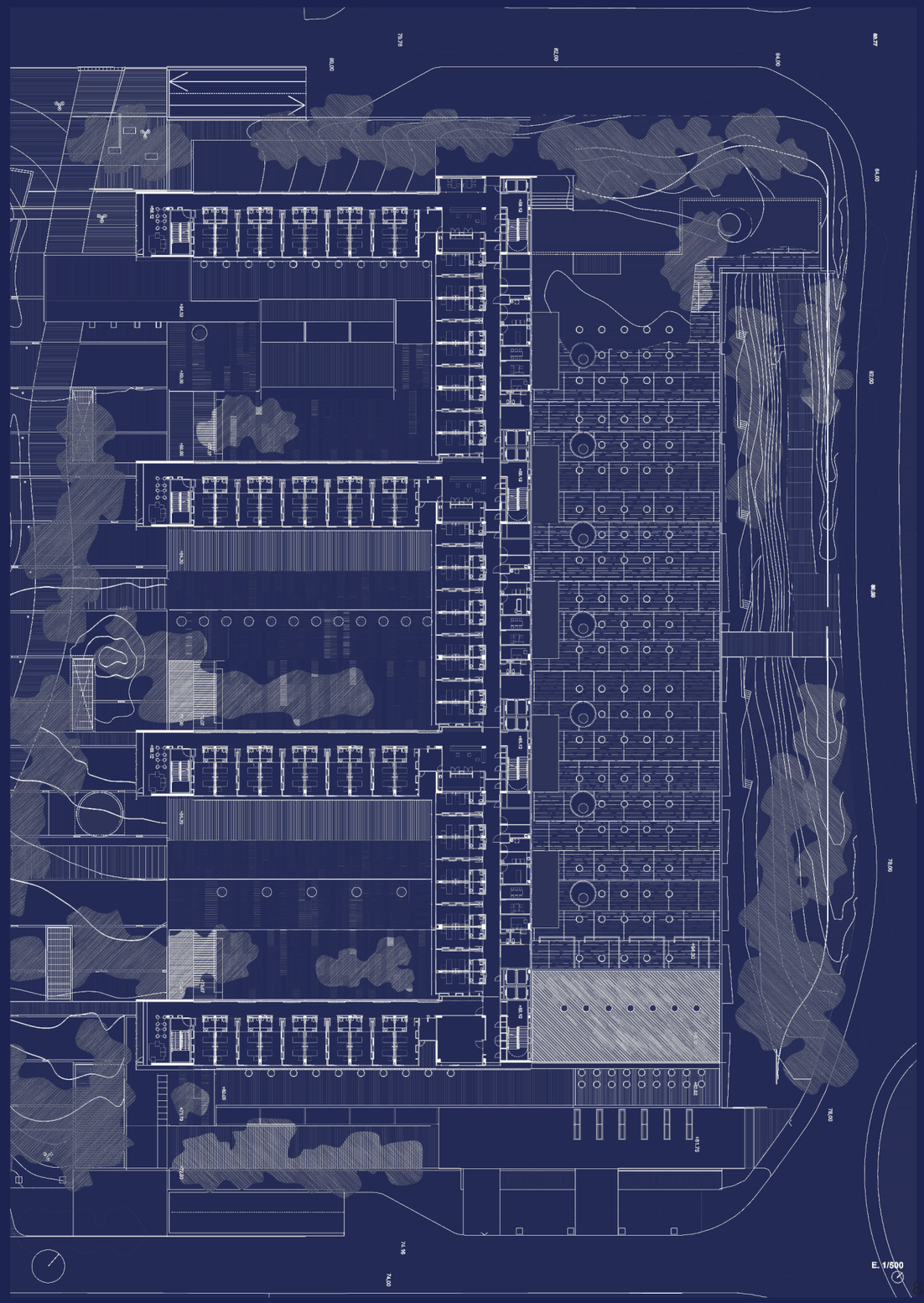
SINGLE UNIT

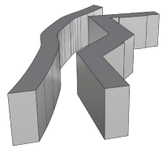
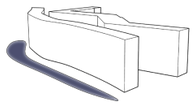
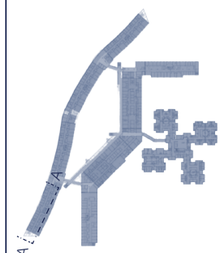
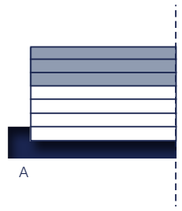
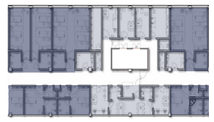
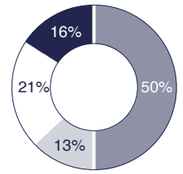
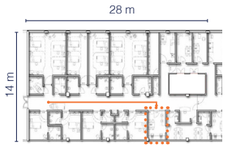
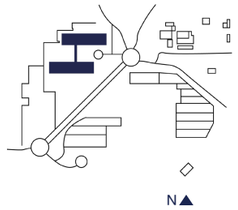
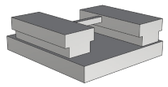
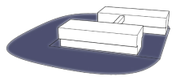
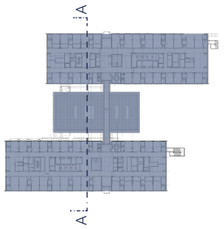
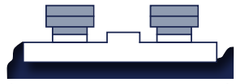
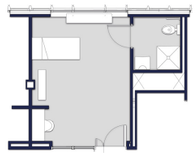
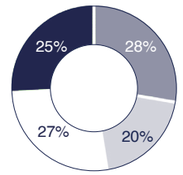
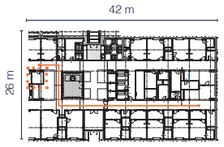
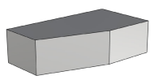
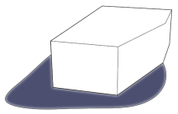
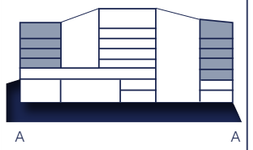
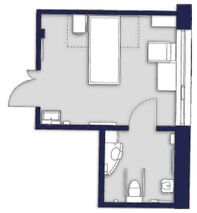
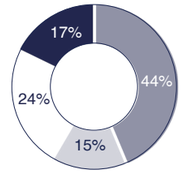
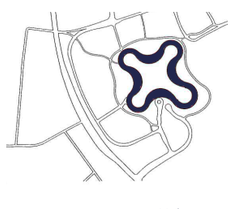
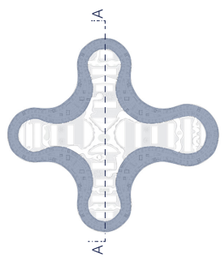
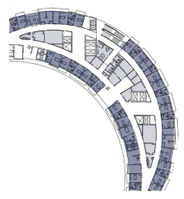
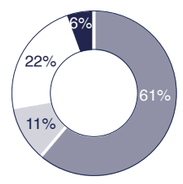
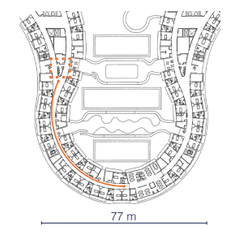
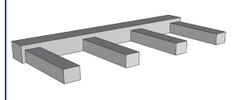
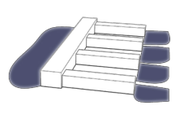
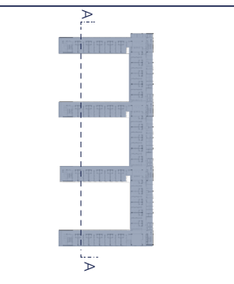
NATURAL LIGHT

The hospital's layout and positioning on the site are determined by factors such as the hospital entrances, site orientations, and the topographical features of the terrain. To connect the hospital with the city, a spacious park is being developed, tailored to meet the hospital's specific needs in terms of ambiance and functionality. This green space, complete with trees, extends all the way to the hospitalization unit courtyards, creating a seamless connection between the hospital and the park. There is a stretch of green land with a topographical design that acts as a buffer, shielding the outpatient area and the hospital from the noise generated by the avenue's traffic. The primary hospital entrance is strategically positioned within this green area, located at the highest point of the site.

The health center's main entrance is self-contained and situated on the north facade, closer to public transport stops. Meanwhile, the entrance for emergencies is located at the lowest elevation, at the northeast corner of the site. This segregation of healthcare and public traffic is intended to prevent any potential disruptions and ensure ease of navigation.

Throughout the project's conception, key priorities included the creation of hospitalization units that receive ample sunlight and offer picturesque views. This design also took into account the utilization of natural light and the selection of appropriate construction materials to create a hospital that truly serves the needs of its patients and the community.he plant ducts externally in order to create a free and more flexible space.



	SITE PLAN	BUILDING TYPE	GREEN SPACES	TYPICAL FLOOR PLAN	SECTION	DISTRIBUTION TYPOLOGY	STANDARD ROOM	DIMENSIONAL RELATIONS (one floor)	DISTANCE FROM NURSING STATION	FOR CONSULTATION
MARTINI HOSPITAL (2007)										inpatient units circulation services other inpatient ward nursing station longest distance (ns-patient unit)
THESSALONIKI RPBW (2025)										
HARALDSPLASS HOSPITAL (2012)										
NOTH NEW ZEALAND HOSPITAL (2024)										
MOISÈS BROGGI HOSPITAL (2010)										

The following diagram shows the 20 concepts that provide detailed information about the requirements applying to the new building facilities, requirements that must be met to enable hospital operations from the end of 2020 and many years ahead.

The 5 guiding principles

The hospital that offers the best treatment

The effective and professional hospital

The hospital that works across conventional boundaries

The welcoming hospital

The safe hospitall

The 10 space management principles

24/7/365, emergency department

Maximisation of shared facilities

Flexibility for the future

Flow and function zoning

Majority of activities close to patients

Right of use rather than ownership

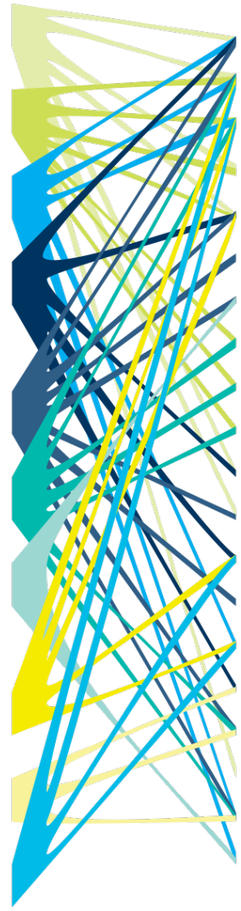
Centrally organised interdisciplinary functions

Standardisation

Digitalisation and automation

Simple, obvious and optimised

The 20 concepts



Emergency department (FAM)
Wards and departments
Outpatient clinic operations
Surgery and other invasive procedures
Intensive care
Rehabilitation
Diagnostic functions
Office and meeting facilities
Research
Human resources
Public spaces
Architecture and art
Facility management
Education and training
Technical infrastructure
Service and distribution
Medication and medicine distribution
Food
IT and point of care
Medical technology

3.3 Criteria and KPI definition

3.3.1 Functional layout

Efforts to further develop a scientific understanding of how other hospital design features may influence clinical outcomes continue to evolve in terms of improving methods and content.

Due to its high complexity, hospital design requires special coordination and organisation between the various actors contributing to the design and construction process. Financiers and planners offer perspectives on cost-effectiveness and constraints. Architects and facility managers work oscillating between the ideal design and the practical constraints of operating and maintaining the building. Doctors and patients focus on how the hospital space will function, focusing on direct patient care. Because it is such a complex process where design and construction are the result of many different perspectives, projects must have clear metrics.

Overall building circulation planning is used to determine the space allocation and to manage the floor plans, suchs as floor configuration, vertical circulation, and horizontal circulation.

The planning of a patient room is the start of a hospital's internal plan. It will determine the column positions of a hospital's main structure and appearance. Usually, the nurses' station will be located with a clear view of the patient rooms and adjacent to elevators in order to be aware of patient flows and to provide efficient assistance within the shortest time. A general ward floor plan contains the healthcare facility, lounge, pantry, laundry room, accessible toilet to meet the daily living needs. A special patient room such as a positive/negative pressure isolation room should be located at a site with a suitable circulation design. Patient room floor plans should focus on efficiency, safety, and comfort. The space required for medical treatment and services should be taken into consideration when planning the floor layout and circulation to provide a comfortable and safe healthcare environment.

3.3.2 Safe and healthy

In relation to this thematic table several articles have been found. The criteria that emerged from the literature are related to safety and health and concern both patients and hospital staff.

Natural light is with no doubt an aspect of notable relevance since its absence have a negative impact on fatigue (60%) and stress (65%). Symmetrical windows and south facing units are the design recommendation to take into account for the inpatient units design, for patinets wellbeing. (Amerigo Rossi et al., 2023).

Experiencing nature is another element which appears in several review. Having contact with nature employees are less stressed and report better health. Sounds and sights of nature have a positive impact on patients experience of care; moreover experiencing nature reduces time of recovery and use of pain relievers. (Deborah Trau et al., 2015). Contact with nature can be achieved in different ways as: directly through indoor and autdoor gardens or other types of outdoor areas such as terraces or courtyards, and indirectly through window views and artwork of nature scenes.

In the end, an other relevant indicator on which depends patient safety is the nurse station location: more precisely, distance and visibility. In fact a study reports that between severly ill patient it has been calculated 82% of mortality with low visibility rooms and 64% mortality with high visibility rooms. (Yi Lu et al., 2014). Shorter distance between patient unit and nurse station have a positive impact both on the staff work condition and the patient care.

In the paper considered, nurses' ratings were correlated with average distance between the patient room and the closest medication station(s) to accurately test the hypothesis that the nurses would feel that shorter walking distances would support the three patient care goals (Tom Clark et al., 2017).

3.3.3 Comfortable and welcoming

Since one of the keywords of the research was wellbeing, this thematic table is particularly relevant for this research. However, as illustrated by the graph at the end of the literature review, the topics are interconnected and an article and its contents can be traced back to several thematic tables. As humanisation is one of the main themes related to the space of care, the research highlights the following set of criteria.

Neglecting acoustic control compromises patients privacy, moreover noises causes tiredness and stress to physicians. By providing alcoves between units in order to have a space for consultation would reduce the spread of noise. Quality of sleep is also a relevant factor: Patient room lighting influences on sleep, appraisal and mood in hospitalized people (Marina C. Gimenez et al., 2016). A controlled clinical trial

among 196 cardiology ward patients investigated how a patient room lighting intervention affects sleep, appraisal and mood across hospitalization.

In healthcare settings, the arts can support clinical care and help to de-institutionalise clinical environments. Importantly, art practice can empower people to take a leading role in improving their health and wellbeing. (Justine Clark, 2023).

It can be said that the presence of art have the following impacts on hospital users: increased positive emotions, enhanced vitality and tactile stimulation, improved social skills and sense of identity and it is a significant predictor of physicians health. (Erica E Ander et al., 2013).

Colors can possibly affect the brain's activity and create a sense of wellbeing and originality within architecture The so-called warm colors (red, yellow and orange) are considered to have an activating affect, while the so-called cold colors (blue, purple and green) are considered to have a calming effect.

In the end, clear signage or wayfinding create a sense of safety and caring, other than less need for staff to guide patients and visitors. (Aalto L. et al., 2013). This is why circulaton routes should be clear, simple and logical and wayfinding should be as straghtforward as possible.

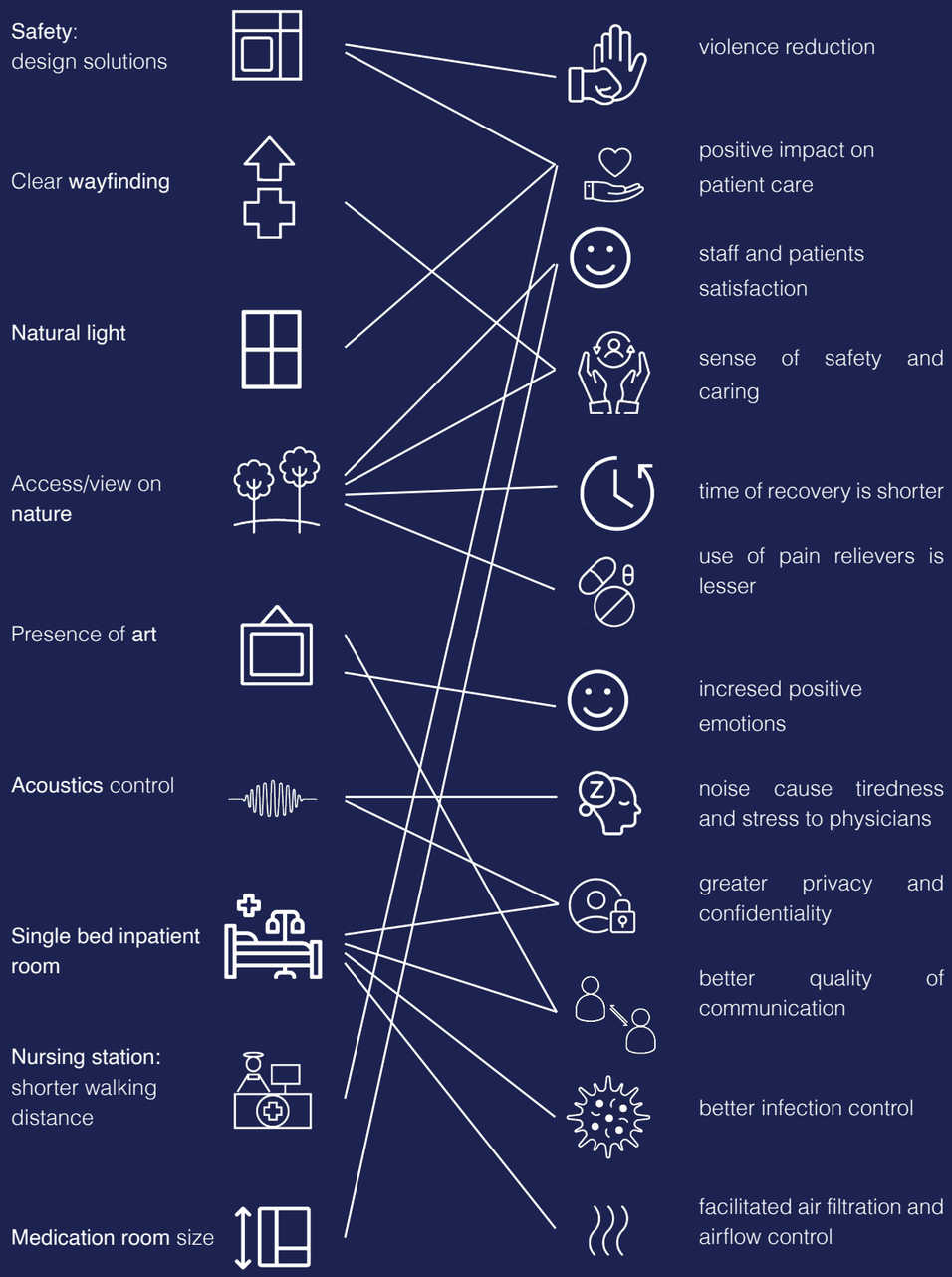
Criterias	Kpi	Indicators	Impacts	Source
Safety and Security 	• entry zone	- 100% visibility - security presence - distinction of areas by acuity	• gang related violence • behavioural health issues • dissatisfaction • patient satisfaction	- *Preventing emergency department violence through design p.8* - *Security Implications of Physical Design Attributes in the Emergency Department p.54*
	• traffic management	- patients shoould move in one direction		
	• patient room clustering	- patient rooms should never be completely cut off from the nurse station's line of sight		
Wayfinding (or clear signage) 	• the circulation routes should be clear, simple and logical and wayfinding should be as straightforward as possible		• sense of safety and caring • less need for staff to guide patients and visitors	- *Usability evaluation (IEQ survey) in hospital buildings p.7*
Natural light 	• symmetrical windows • south facing units		• the lack of it have a negative impact on fatigue (60%) and stress (65%)	- *Exploring the Association Between the Healthcare Design Elements and Physician Well-Being p.12*
Experiencing nature 	• access to nature by providing indoor and outdoor gardens • views of nature through windows • artwork of nature scenes	- 20-30% sqm outdoor	• employees are less stressed and report better health • sounds and sights of nature have a positive impact on patients experience of care • time of recovery is shorter • use of pain relievers is lesser	- *Healing environment correlated with patients' psychological comfort p.181* - *Nature Contacts: Employee Wellness in Healthcare p. 55* *Healng environment correlated with patients psychological comfort p.181*
Presence of art 	• heritage objects		• signficant predictor of physicians health • increased positive emotions • enhanced vitality and tactile stimulation • improved social skills and sens of identity	- *Using museum objects to improve wellbeing*

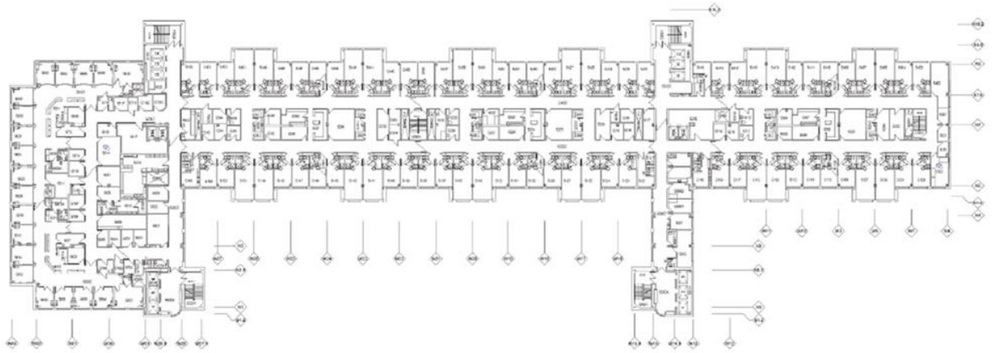
Fields	*Kpi*	*Indicators*	*Impacts*	*Source*
Acoustics 	• patient room location • corridor alcoves • decentralized nurse stations	- alcoves every module (2/3 units) - unit-nurse station from 2 to 20m.	• privacy of patients is compromised • noise cause tiredness and stress to physicians	- *Hospital Inpatient Unit Design Factors Impacting Direct Patient Care p. 27*
Inpatient room 	• trend for building hospitals with more single-occupancy rooms	- 80% single bed rooms - 20% bay rooms	• greater privacy and confidentiality • better quality of communication between health • better infection control: reduced spread ofbetter infection control: reduced spread of infection • facilitated air filtration and airflow control	- *Anticipated advantages and disadvantages of a move to 100% single room hospital p.4-5*
Nursing station 	• distance • visibility	- distance unit-station: around 5m - visibility: from 44° (75%)	between severly ill patinet: • 82% mortality with low visibility rooms • 64% mortality wit h high visibility rooms	- *Patient Visibility and ICU Mortality p. 93* - *Hospital Inpatient Unit Design Factors Impacting Direct Patient Care p. 19*
Medication room 	• medication room size	- units with 0.7 sqm per bed and above	• high ratings abuot larger medication rooms	- *Hospital Inpatient Unit Design Factors Impacting Direct Patient Care p. 23*

SYNTHESIS OF THE CORRELATION BETWEEN INDICATORS AND IMPACTS

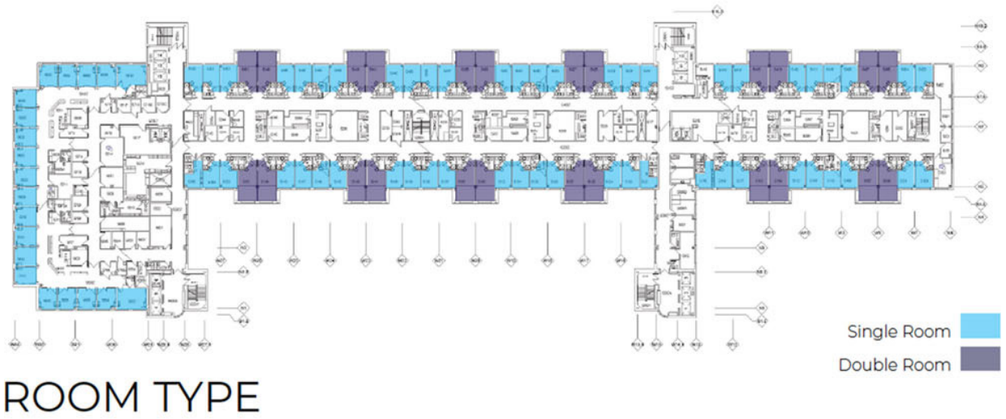
KPI
Built Environment

KPI
Impacts



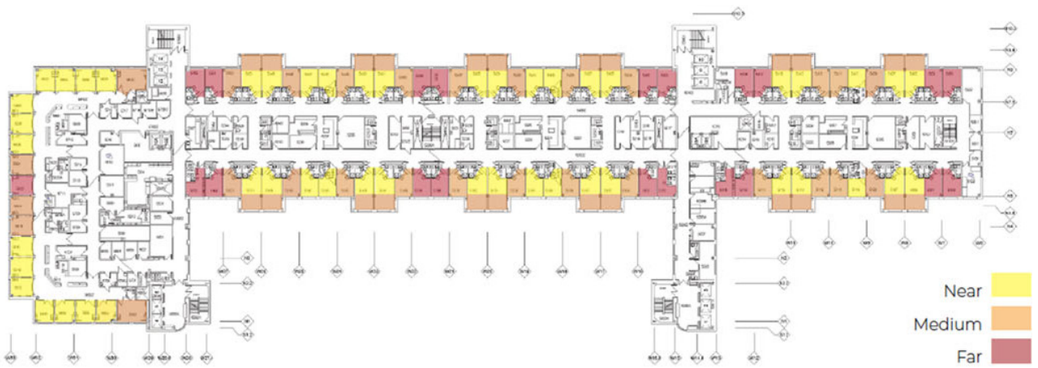


HOSPITAL FLOOR PLAN

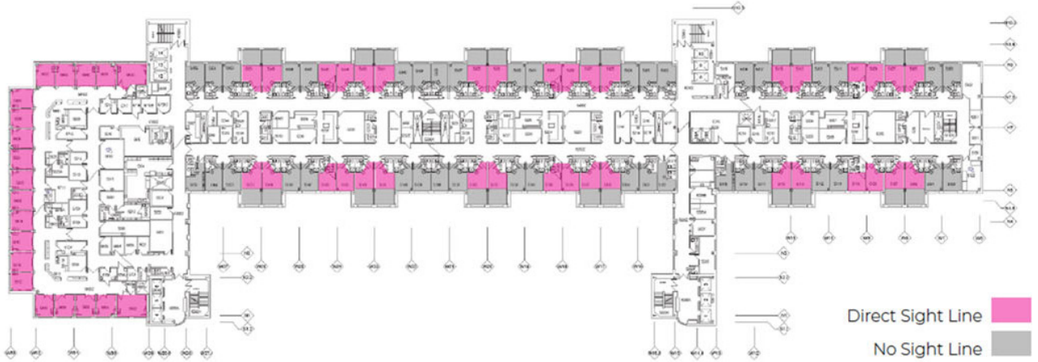


ROOM TYPE

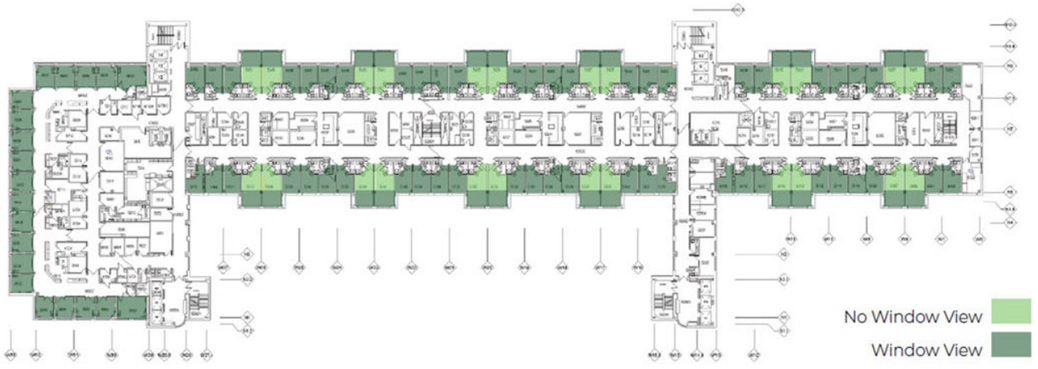
DISTANCE TO ANY NURSING STATION



DISTANCE TO MAIN NURSING STATION



DIRECT SIGHT LINE



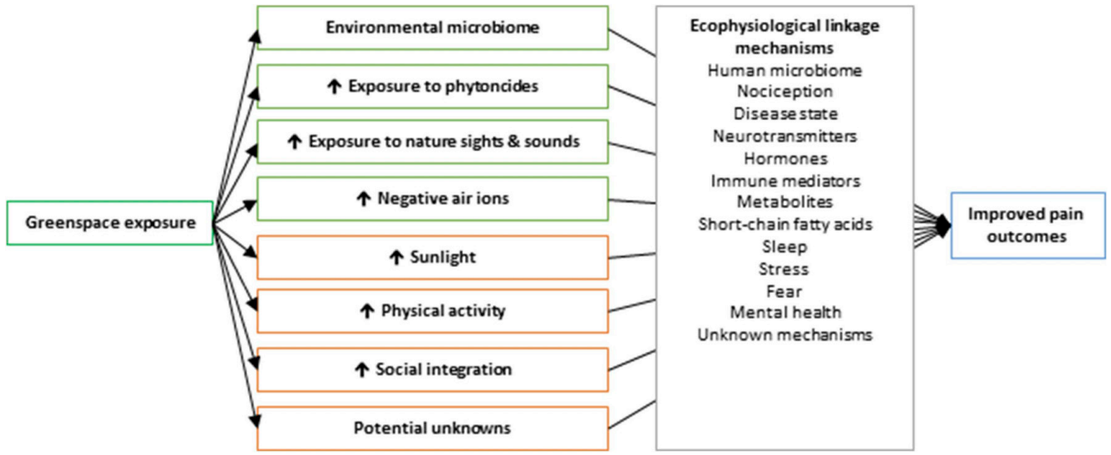
WINDOW VIEW

(Mitchell Mead & Andrew M.Ibrahim, 2022). *Strategies to evaluate the quality of hospital design with clinical data*

GREEN EXPOSURE

Criterion: EXPERIENCING NATURE

Macro area : SAFE AND HEALTHY



(Jessica Stanhope & al., 2020) **Exposure to greenspaces could reduce the high global burden of pain**

Aarau Cantonal Hospital | Competition 2nd position, 2019 | Aarau, Switzerland

Gardens will form a key part of the campus. with a mix of green spaces and play areas for patients and families but also for the staff. The interiors are lines with large windows to ensure visual connections to these areas.

Several studies and guidelines suggest that hospitals should aim for a minimum of 20% to 30% of the total site area dedicated to outdoor spaces. This includes gardens, courtyards, green spaces, and other open areas. These outdoor spaces can offer numerous benefits, such as:

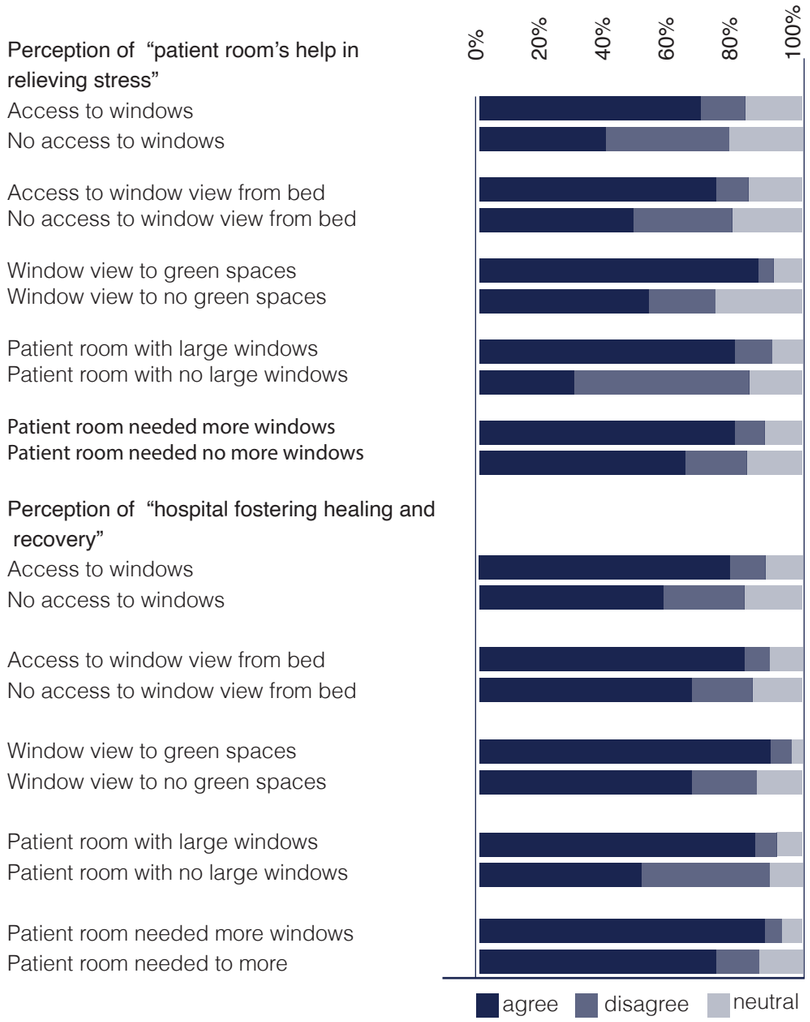
1. Physical and mental well-being: Access to nature and sunlight has been linked to reduced stress levels, improved mood, faster recovery times, and overall well-being for patients and staff.
2. Improved patient outcomes: Outdoor spaces can serve as therapeutic environments that support healing, reduce pain perception, and contribute to better patient outcomes.
3. Staff well-being: Providing staff with access to outdoor areas can help reduce stress and burnout, increase job satisfaction, and promote a healthier work-life balance.
4. Rehabilitation and recreational opportunities: Outdoor spaces can be utilized for rehabilitation exercises, physical therapy, and recreational activities, enhancing the recovery process for patients.
5. Environmental benefits: Green spaces contribute to improved air quality, reduced noise levels, and overall environmental sustainability.

While these percentages provide a general guideline, it's essential to consider the specific needs and requirements of the hospital and its users. Factors such as urban settings, space limitations, and budgetary constraints may influence the achievable percentage of outdoor space. Ultimately, the goal should be to create a balance that maximizes the benefits of outdoor areas within the given constraints.

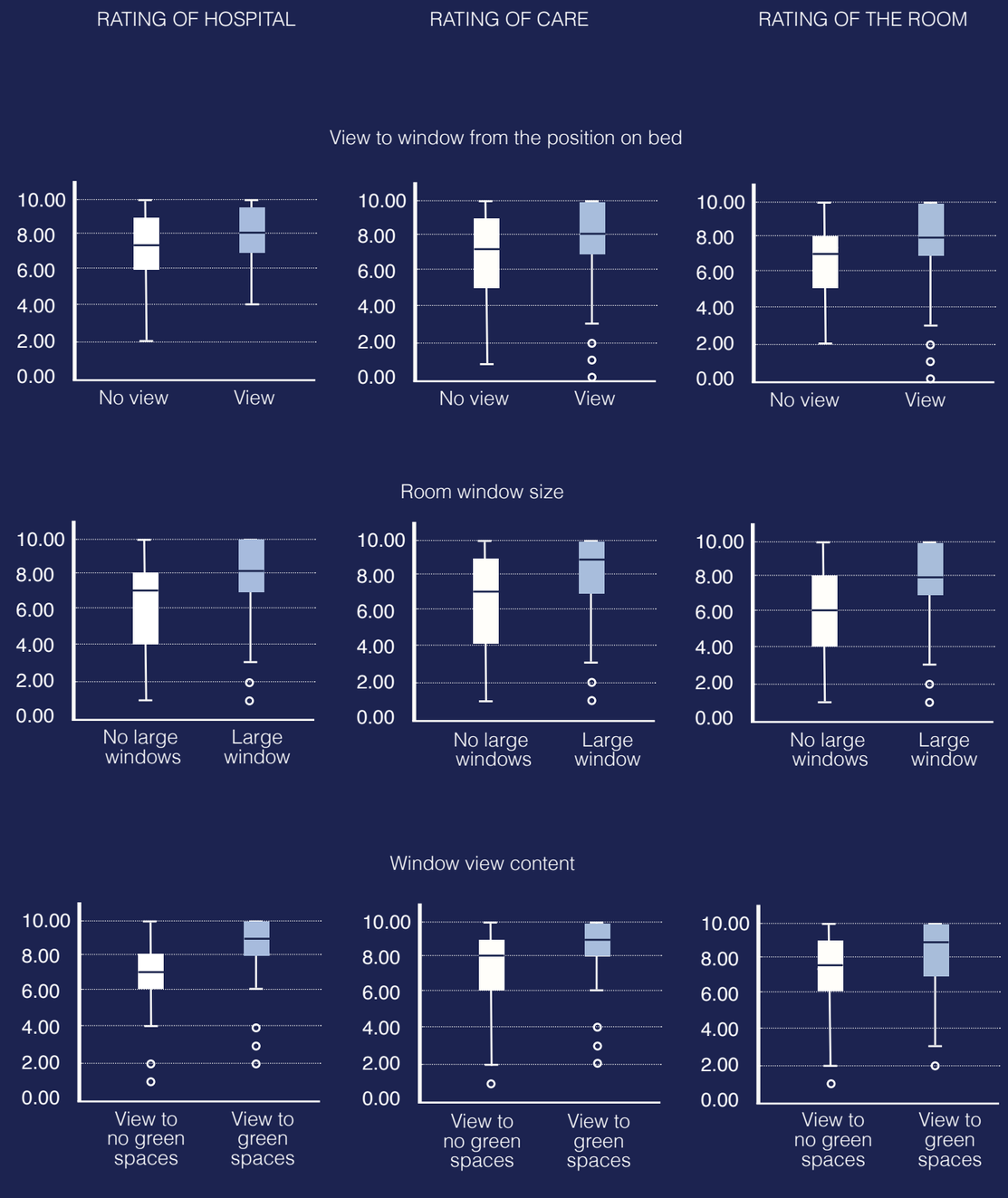
VIEW ON NATURE

Criterion: EXPERIENCING NATURE

Macro area : SAFE AND HEALTHY



(Sahar Mihandoust & al., 2021). *Exploring the Relationship betweenWindow View Quantity, Quality, and Ratings of Care in the Hospital*



(Sahar Mihandoust & al., 2021). *Exploring the Relationship betweenWindow View Quantity, Quality, and Ratings of Care in the Hospital*

HERITAGE OBJECTS

Criterion: PRESENCE OF ART

Macro area : COMFORTABLE AND WELCOMING

Aarau Cantonal Hospital

Hospitals are no longer, or should no longer be, a place of physical desegregation and sensory deprivation. We have seen how the environment can positively influence well-being and healing. Art, as an integral part of it and not only as a decorative and aesthetic element, can enhance its qualities, giving identity to the place (also as an attractor for orientation), providing positive distractions and promoting social interaction (Verdeber, 2010; Cintra, 2000; Senior, Croall, 1993). Art can contribute concretely to the project of humanisation, acting directly on the nature of places, their potentialities and their qualities, because it is “capable of re-reading the sense of the place, drawing new traits of liveability (also poetic), by acting directly on the nature of the place, its potential and its qualities, because it is ‘capable of re-reading the meaning of the place, designing new traits of liveability (also poetic), acting as a valid orientation tool for those who live it, support for the healing process, stimulus for the maintenance of the various cerebral activities, an effective vehicle for breaking the silence and roughness of fruition, alleviating the pain of hospitalisation and the time impairments it entails’ (Mello, 2000).

CLEAR WAYFINDING

Criterion: WAYFINDING

Macro area : COMFORTABLE AND WELCOMING

Helka Typeface & Hospital signage

When one enters a hospital, it is necessary to easily and clearly identify where one has to go and how to get there, because the loss of orientation, together with the agitation one feels on entering an unfamiliar place, and what is more, one destined for treatment, generates a strong sense of unease. It is therefore indispensable that the user, in a short time, be able to “make use of spatial schemes and construct ‘mental maps’, which are indispensable for orientation” (Terranova, 2005, p.222). Helping the person to orientate him/herself represents a secondary partnership of the need for humanisation in the hospital environment. In fact, disorientation, the absence of reference points and the inability to move autonomously, is the cause not only of delays and malfunctions, but also of anxiety, stress and irritation.

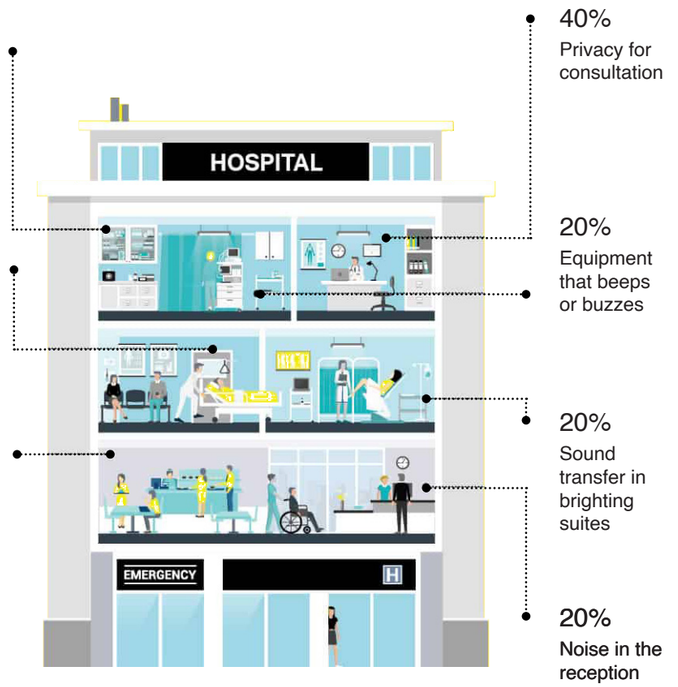
The answer to this problem lies in considering the way in which the built space is organised, through the design of wayfinding, according to which the recognisability of places is linked to the physical characteristics of the built environment, which are defined by: spatial patterns (the morphology and spatial distribution with the hierarchy of paths, junctions and the system of spaces); architectural elements (pillars, beams, staircase-elevator blocks, doors, etc.); the layout of spaces (furniture, colour, materials, finishes, natural and artificial lighting, interior views, exterior views and the presence of a signage system); and the presence of a system of signs and signals.), by the layout of the spaces (furniture, colour, materials, finishes, natural and artificial lighting, internal views, external views and artwork) and by the presence of a signage system. Wayfinding, therefore, encompasses the design of all those elements that make an environment, an organism capable of communicating The basis of a wayfinding project is the analysis of user needs and the planning of people’s behaviour in the environment, identifying the points of greatest traffic and confluence. All the elements involved in the project must be coordinated with each other, so that they do not interfere with each other, creating confusion and making the message incomprehensible.

ACOUSTIC CONTROL

Criterion: ACOUSTICS

Macro area : COMFORTABLE AND WELCOMING

HOSPITAL ACOUSTIC ISSUES IDENTIFIED BY SURVEY RESPONDENTS



** percentage of respondents that raised the issue*

AECOM study

Florence Nightingale said:"... Unnecessary noise is the cruelest absence of care". Numerous studies have shown that noise leads to sleep deprivation, increased use of medicine, slow healing, and increased percpeption of pain. Noise is known to raise blood pressure and heart rate, to alter the respiratory rate, and it may cause vasoconstriction. Noise is a contributor to medical error.

The noise in a hospital has two sources:

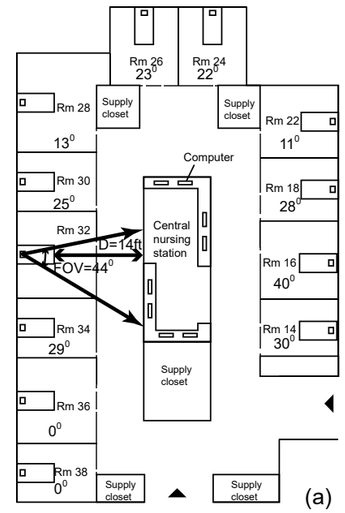
- operational noise is generated by loud conversations between the staff, medical professionals, visitors, and from the equipment used. Staff, doctors and visitors are made aware of this by putting up appropriate signage highlighting the adverse effects of noise on patients. Unnecessary noise from medical equipment is muted whenever possible.
- structural noise is generated by the hospital building, by ventilation, the air-conditioning system, back up electrical generatiors, and squeaking doors. The design team should grasp these factors at the planning stage. Efforts to reduce the structural noise could be: sound-insulated electrical generators, insulated false ceilings, double glazed glass with an air gap.

In a survey encompassing health departments, hospital administrators, and design professionals, over 50% of the participants underscored the prevalence of sleep disturbances as a prominent concern in hospital projects. Similar levels of feedback were received regarding acoustic reverberation issues within and around patient wards, as well as the disruptive effects of noise originating from nurses' stations in these wards. Furthermore, nearly half of the respondents highlighted a shortage of privacy during patient consultations. This privacy deficit was attributed to various factors, including inadequate sound insulation between rooms and suboptimal acoustic conditions within shared spaces like wards.

DISTANCE from nursing station

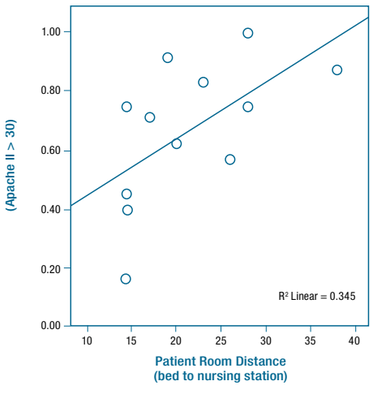
Criterion: NURSING STATION

Macro area : FUNCTIONAL LAYOUT



The shortest walking distance from patient bed to central nursing station and the field of view (FOV), in degrees, from the patient head.

...



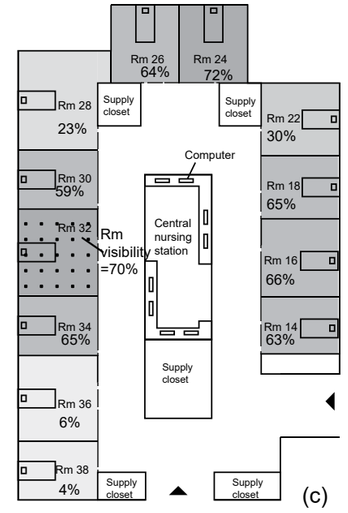
The field of view from the patient head to the central nursing station explained 33.5% of the variance in ICU mortality (p = 0.049) by room for patients with the greatest
severity of illness (APACHE II > 30).

(Yi Lu & al., 2014). *Patient Visibility and ICU Mortality: a conceptual replication*

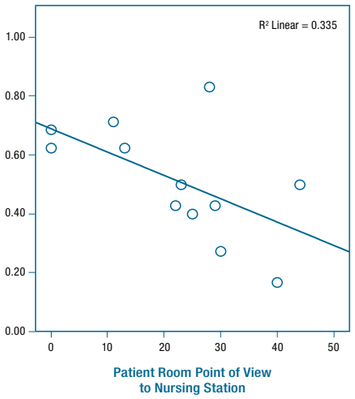
VISIBILITY from nursing station

Criterion: NURSING STATION

Macro area : FUNCTIONAL LAYOUT



One important way to avert adverse events related to patients is for the staff to have the ability to observe patients continuously and provide assistance as needed. Multiple decentralized nurse work areas and charting alcoves next to patient rooms may help facilitate this activity. Such designs enable the staff to attend patients' needs without delays. In at least one prospective study,
Hendrich showed that falls were cut by two-thirds, from six per 1000 patients to two per 1000, after a move from an old unit with a centralized nursing station to a new unit with decentralized observation units.
(Anjali Josepha & Mahbub Rashid, 2007). **The architecture of safety: hospital design.**



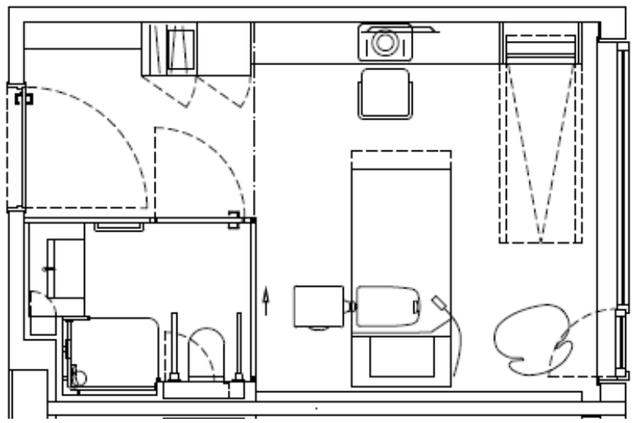
The field of view from the patient head to the central nursing station explained 33.5% of the variance in ICU mortality

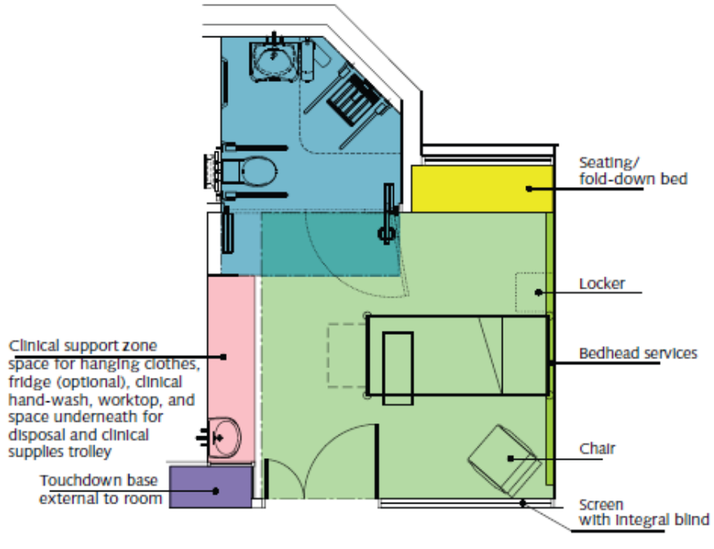
(Yi Lu & al., 2014). *Patient Visibility and ICU Mortality: a conceptual replication*

SINGLE BED UNIT

Criterion: INPATIENT UNIT

Macro area : FUNCTIONAL LAYOUT





Health Building Note 04-01 2013

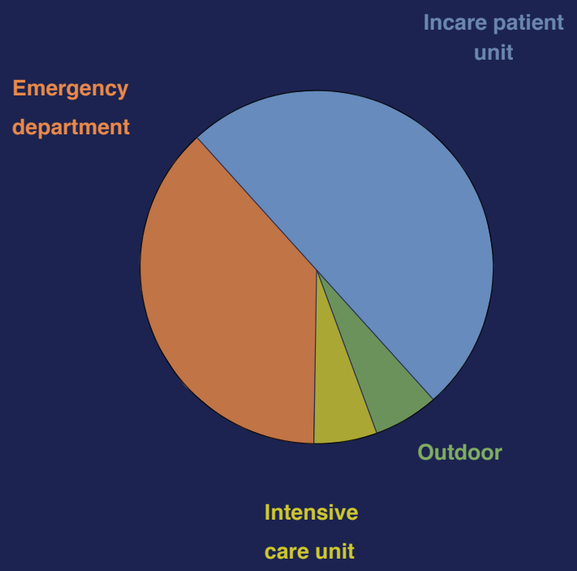
The literature review provided highlights several potential advantages associated with single-bed acute care facilities. These advantages include:

1. Greater privacy and confidentiality: Single rooms offer patients increased privacy and reduce the risk of information being overheard by others, thus enhancing confidentiality (Ulrich et al., 2008).
2. Improved communication: Single rooms facilitate better communication between healthcare professionals and patients and their families. This enhanced communication can lead to better quality of care and increased patient satisfaction (Ulrich et al., 2008; Maben et al., 2015; Wiechula et al., 2015
3. Enhanced family involvement: Single rooms promote increased family involvement in patient care. Having family members present can help reduce nurse workloads and contribute to a safer care environment by potentially decreasing the occurrence of adverse events (Wiechula et al., 2015).
4. Patient control over the environment: Single rooms allow patients to have more control over their environment, including factors like noise and light. This increased control can improve patient comfort and enhance sleep quality (Maben et al., 2015; Wiechula et al., 2015).
5. Better infection control: Single rooms offer advantages in terms of infection control. They provide increased capacity for isolation, better air filtration, and airflow control. The efficiency of cleaning and decontamination is also improved in single rooms, reducing the spread of infections (Ulrich et al., 2004; Boardman & Forbes, 2007; Maben et al., 2015).
6. Reduction in medication errors: Single rooms have the potential to reduce medication errors due to fewer interruptions and distractions. Additionally, the reduced need for patient transfers in single rooms decreases the chances of mistaken patient identification (Ulrich et al., 2004; Boardman & Forbes, 2007; Maben et al., 2015).

3.4 Setting analysis and definition

	Emergency department	Incare patient unit	Outdoor	Intensive care unit	General (not considered)
n articles	5	7	1	1	3

ARTICLES	SETTING
• *35%*	**Emergency department**
• *50%*	**Incare patient unit**
• *7,5%*	**Outdoor**
• *7,5%*	**Intensive care unit**



A comprehensive setting analysis was conducted through a series of research papers aimed at exploring the diverse contexts in which healthcare-related studies have been conducted. The analysis encompassed a wide range of medical settings, providing valuable insights into the distribution and prevalence of research conducted in various healthcare environments. The results shed light on the prominence of different settings within the realm of healthcare research.

Among the numerous settings examined, four main categories emerged: inpatient units, emergency departments, intensive care units, and outdoor settings. Each of these settings plays a critical role in healthcare delivery, and understanding the distribution of research within them can provide valuable guidance for future studies.

Incare patient units constituted the largest proportion of the studies, with 50% of the papers centered on this setting. Incare patient units are dedicated areas within healthcare facilities where individuals receive comprehensive medical care and treatment over an extended period. This emphasis on inpatient units highlights the significance of understanding the experiences, interventions, and outcomes associated with prolonged hospital stays and continuous medical supervision.

The research papers revealed that approximately 35% of the studies focused on emergency departments. Emergency departments are dynamic environments where healthcare professionals address urgent medical needs and provide initial care to patients. The significant proportion of research in this setting reflects its pivotal role in managing acute medical conditions and the need to continually improve emergency care practices.

Intensive care units (ICUs) accounted for 7.5% of the research papers. These highly specialized units cater to critically ill patients requiring close monitoring and advanced life support interventions. Research in ICUs often focuses on critical care practices, innovative treatments, and patient outcomes in high-stakes medical scenarios The remaining 7.5% of the papers were set in outdoor environments. These studies explored healthcare interventions, programs, or activities conducted beyond the confines of traditional medical facilities.

The findings of this setting analysis highlight the varied contexts in which healthcare research is conducted. It underscores the importance of encompassing different settings to comprehensively address healthcare challenges and deliver improved patient outcomes. Future researchers can draw from these findings to guide their study designs, target specific settings for further exploration, and identify gaps in knowledge across different healthcare environments.

Moreover, by considering the distribution of research among these settings, healthcare policymakers and professionals can gain insights into where resources, training, and interventions are most needed. This knowledge can inform decisions regarding resource allocation, quality improvement initiatives, and the development of evidence-based practices across diverse healthcare settings.

In conclusion, the series of papers analyzing healthcare settings revealed that emergency departments and inpatient units were the primary focus, comprising 35% and 50% of the studies, respectively. Intensive care units and outdoor settings accounted for 7.5% each. These findings provide a valuable foundation for understanding the distribution of healthcare research and offer guidance for future studies, resource allocation, and healthcare policy decisions.

3.4.1 Typological analysis of inpatient wards

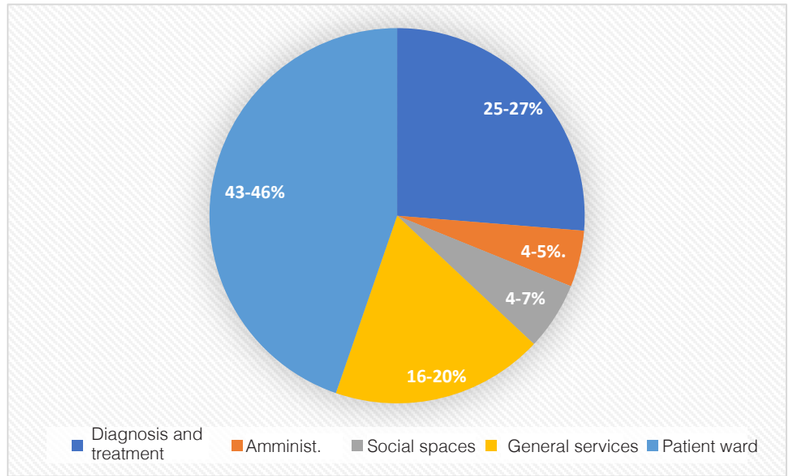
Compared with the surface area of the entire hospital, the part devoted to inpatient care covers a variable portion. A recent survey of a sample of German hospitals (Gatermann and Labryga 1986) found that inpatient care covers on average 43 to 46 percent of the total area.

The layout of the inpatient wards remained virtually unchanged from the 13th century until the second half of the 19th century: it was essentially an extended communal space with the beds attested against the walls. Some bold new concepts were studied at the John Hopkins University Hospital of Baltimore Medical School. Compact, square and octagonal facilities all concentrated toward the guard station were developed. Although these ideas did not have direct consequences until 70 years later, the open ward began to be divided into rooms distributed by a side or central corridor, while nurses had to resign themselves to traveling many miles a day (in 1947 a study by the American Hospital Association showed that 40 percent of nurses' time was spent in travel).

To assess the impact of distances, a series of methods were prepared in order to identify the functional relationships that absorb the most connections. Other survey tools were developed, among which the measurement of the average distance from the nurses' station (or staff work rooms) to the patients' beds emerged as being concisely effective. Further investigation of these issues has led to more compact facilities with nurses' station arrangements in close contact (including visual contact) of a smaller number of beds than previously (16-20). Further impulse to the study of compact forms has come from the extensive use of single rooms (U.S.): to avoid extremely elongated distribution spaces, partially comb-like solutions have been proposed with small groups of single rooms, or with diagonal bed layouts (allowing savings of about 25 percent in linear pathway development).

The objective of a conscious design approach based on the centrality of humans leads to some general considerations.

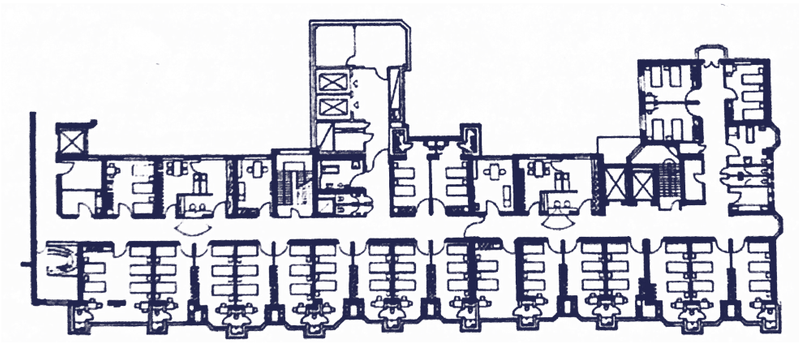
It was important to carry out a study of the pre-established typological schemes for their possible updating. Within the various functional areas into which the hospital is divided (wards, diagnosis and treatment, general services), it can be said that the ward area is the one most affected by the new requirements. On the one hand, in fact, it is necessary to identify distribution solutions aimed at increasing the effectiveness and efficiency of the hospital and, on the other hand, it is necessary to recognise and satisfy the needs of the user (the resident, the visitor and the medical staff). Typological studies conducted on hospital construction have led to the recognition of three basic schemes for the distribution of wards.



Linear

In the linear development scheme, the longitudinal dimension prevails over the transverse dimension of the building housing the patient rooms. It is the most frequently adopted solution due to the possibilities of development in the longitudinal direction and the simplicity of the structural and plant engineering solutions.
Layout with central corridor, rooms on one side and inpatient services on the other, or with both sides occupied by rooms, alternating with inpatient services. Toilets are often accessible directly from the rooms. This solution became progressively established starting in the 1930s and is still widely used today.
Inpatient wards with linear development can in turn be classified according to 3 distribution patterns:

- single sided corridor, with a horizontal distribution element and the rooms arranged sequentially on one side, chosen according to the best exposure.
- simple corridor, with rooms and services (understood as common inpatient facilities and staff spaces) on opposite sides from the horizontal circulation way.
- simple corridor, with rooms on opposite sides of the horizontal distribution path and services concentrated at the beginning or end of the corridor.
- double corridor, with rooms on the perimeter sides of the building and services " enclosed" between the two horizontal circulation corridors.



Restoration of St. Franziskus Hospital, Cologne, Germany 1973

Diagram of a single sided corrdipor inpatient ward

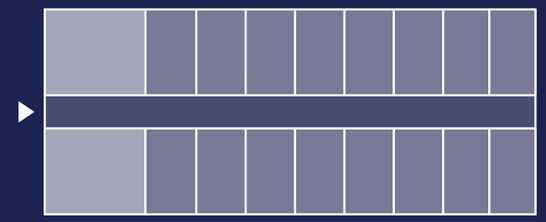


Diagram of a simple corridor inpatient ward
rooms-corridor - rooms

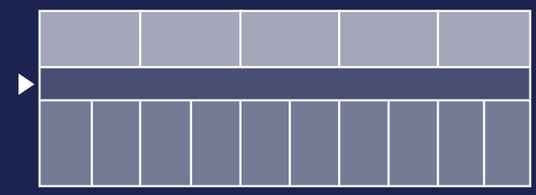


Diagram of a simple corridor inpatient ward
rooms-corridor - services

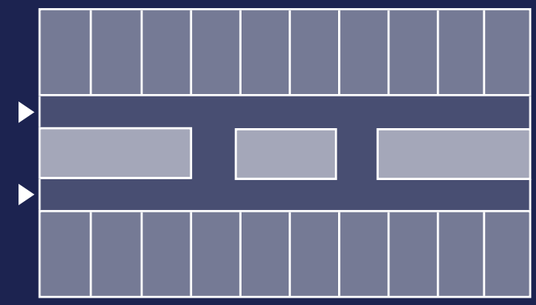
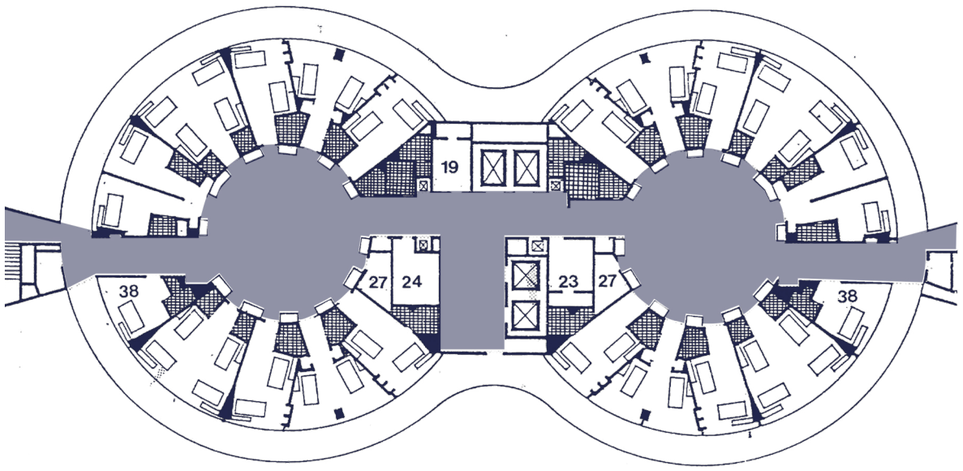


Diagram of double-corridor inpatient ward

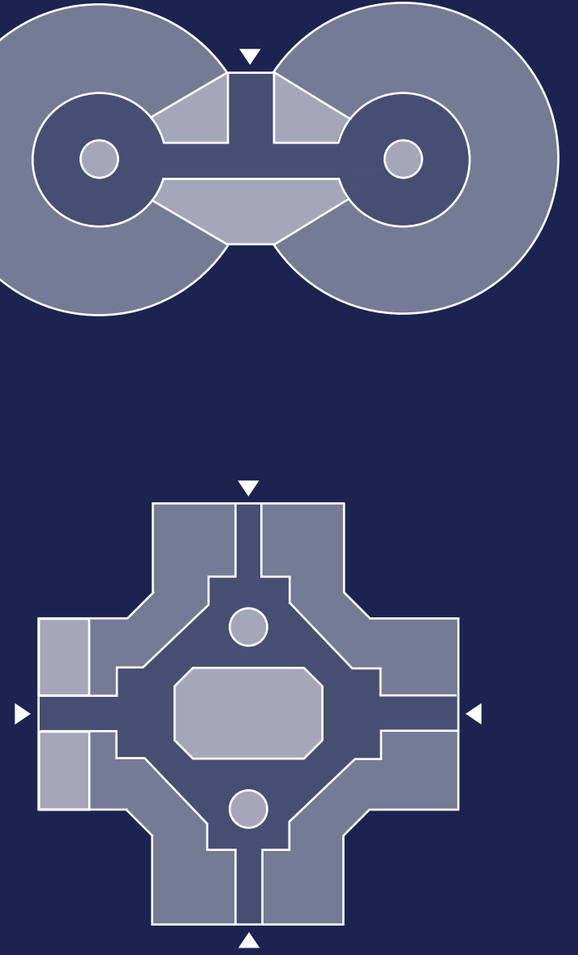
patients units
connective spaces
staff spaces
vertical connections

Radial

Radial scheme, in which the transverse dimension overcomes the longitudinal dimension, allowing a distribution of inpatient rooms around a central area containing all functional support services. The distribution corridor to the rooms also connects with the common areas reserved for inpatients and vertical connections.
The outer ring is entirely dedicated to inpatient wards, while the services, depending on the case, may be located in the centre of the system or in areas where there is a connection to other parts of the hospital. This typology therefore presents a considerable advantage from the point of view of control by healthcare personnel: from a central location, all the in-patient rooms can be monitored. On the other hand, the distribution flexibility is limited and therefore this solution is suitable for smaller hospitals.



Kaiser Foundation Hospital Panorama City

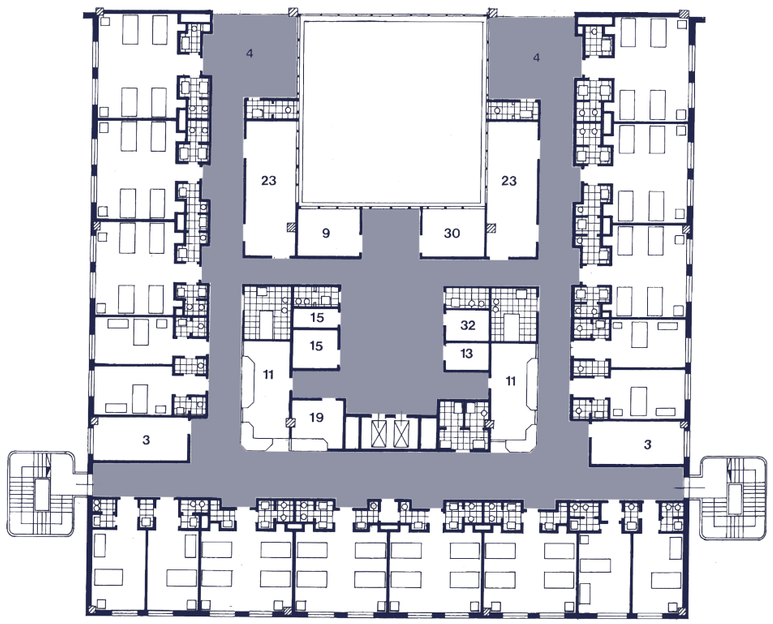


patients units connective spaces staff spaces

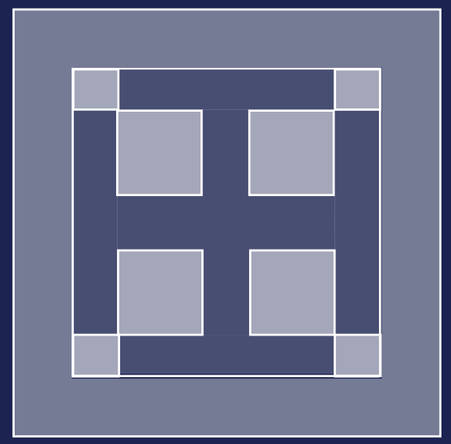
James, W.P. & Tatton-Brown, W. (1986). *Hospital, Design and Development.* London: Architectural Pr

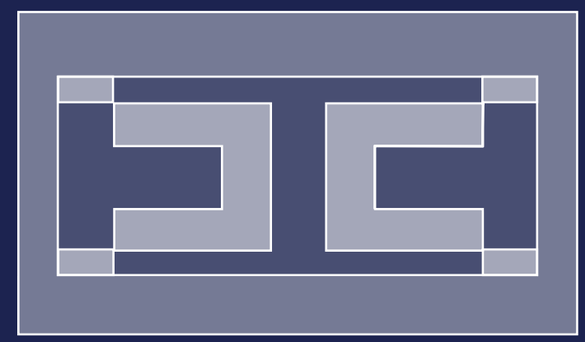
Cluster

The inpatient ward according to a plate development is an arrangement that tends to occupy a large area, without having a prevailing direction, and in which service spaces are placed between the different wards, playing the role of functional hinges between the different units that make up the hospital. It represents a further evolution: this type consists of a more or less continuous strip of variable-size inpatient rooms-tending to be equipped with their own toilet facilities- flanked by the inpatient pathway and, later, the inpatient services (artificially ventilated and illuminated). Even further inside the care and service plate is located. After initial experiments, it was considered preferable to equip the inner portion of the plate with patios capable of providing direct lighting and ventilation to the rooms concerned.
In conclusion, the outer sides are occupied by the rooms, while the central part houses the inpatient services.
The reason for the emergence of this typology, as well as the other core typologies, is due to a compromise between a need for privacy felt by the patient, which is expressed in the reduction in the number of beds per room, and a need for control and reduction of distances by the staff.



Ospedale Generale Provinciale Chiese-Garda Nord





patients units connective spaces staff spaces

James, W.P. & Tatton-Brown, W. (1986). *Hospital, Design and Development.* London: Architectural Pr

ANALYSIS AND COMPARISON OF SPATIAL DISTRIBUTION AMONG THE 3 TYPOLOGICAL SOLUTIONS

Characteristics of the main typological solutions, verified on realized buildings	LINEAR St Vincent-Elizabeth, Germany	RADIAL Fraubrunnen di Jegenstorf	CLUSTER Hospital Chiese-Garda Nord
			
TOTAL AREA PER BED	24.5	16.4	23.2
INPATIENT AREA PER BED	13.6	4.1	11.5
SERVICES AREA PER BED	5.8	3.7	4.7
CORRIDOR AREA PER BED	5.1	3.6	7.0
AVERAGE DISTANCE FROM NURSING STATION	13	13.1	18.9

3.4.2 Inpatient care unit

In the megahospitals of the post World War II era the patient housing was often located in a tower atop a platoform that housed all other functions of the hospital. Recently, the prevailing trend has been to locate the patient ward beside the other components parts of the hospital. This horizontality has allowed for the patient care unit to be closer to the ground, configured as a wing rather than a tower. In a subsequent construction phase, additional levels can be stacked atop existing ones. An alternate strategy is to create an internalized health village where patient wards are configured as pavillions with connections to various support facilities. Each pavillion is semi-autonomous, with exterior space interspersed in-between.

The primary criterion for the location of nursing wards is their optimal connection to other relevant functional areas in the hospital. Trave! distances between the nursing wards and the surgical, medicai examination and specialist departments should be kept as short as possible. Close proximity to intensive care and IMC (Intermediate Care) is also desirable as many logistical and staffing processes overlap with those of normai care wards. For patients and visitors, proximity to services locateci at the entrances, access to outdoor areas and to other care facilities is also important.

A significant aspect is to provide a standardized ward layout for ensuring efficient operations and profitability. An inpatient ward with a consistent number of beds and uniform room sizes allows for better standardization of operational processes and staffing organization.

Profitability: The profitability of a ward is directly related to its efficiency and effectiveness in delivering care. A well-organized and standardized nursing ward can optimize resource allocation, reduce waste, and improve patient care, leading to increased profitability.

Nursing Organizational Standard: the inpatient unit should adhere to a specific organizational standard, which is typically defined by having a certain range of beds, preferably between 28 and 41 beds. This standardization helps in streamlining processes and achieving consistent results.

Spatial-Functional Arrangement: The nursing ward's layout is divided into two main areas: Core Services and Nursing Areas.

- Core Services: The core services are spatially grouped together and are exclusively used by doctors and nurses. These core services include preparatory facilities for delivering care services, staff and rest areas for internal use, and spaces for consultation among colleagues.

Examples of core services are nurses' stations, staff rooms, examination rooms, and storage rooms for supplies and disposal.

- Nursing Areas: These areas encompass the ward corridor and patient rooms. They are the primary spaces where patient care is provided.

3.4.1 Nurse station

The nurses' station is the centrai point of every ward and should be easy for patients and visitors to find and reach. It is the contact point for patients and visitors as well as for staff, and the piace where all process cycles and information in the ward converge. As a rule, it adjoins the medication store, where further work processes can be carried out.

3.4.2 Staff room

This group of rooms includes a common room for the nursing staff, with a kitchenette and workstations for the nursing staff along with sanitary facilities and staff changing rooms.

3.4.3 Doctors' consultation rooms

Consultation rooms located within hospital wards typically have equipment and resources tailored specifically for ward-related activities. This includes facilitating doctor-patient consultations and handling administrative tasks associated with the hospitalization of patients.

3.4.5 Ward corridor

The circulation system within an in-patient unit occupies on average about 20% of the total area, although this figure varies greatly depending on the type of floor plan solution adopted for the unit as a whole. The most significant parameter in this respect is the distance from the guard post to the patient's bed: this value must be kept as low as possible. In order not to constitute an obstacle to circulation, the width of the corridors must be more than 2.40 m. (Usually the dimensions range between 2 m and 2.40 m). As in the rest of the hospital, a clear, if possible physical, distinction of the corridors, with a separation between clean and dirty corridors, would be appropriate.

The central axis of the nursing ward is embodied by the ward corridor, which necessitates a sufficiently spacious and well-organized design. Typically, patient rooms are symmetrically positioned on either side of the corridor, demanding a

Figure 4 Corridor with passing space and 90 degree corner for general traffic

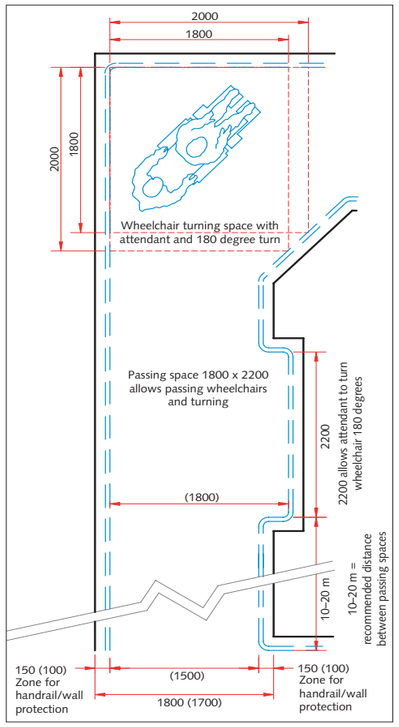


Figure 5 Space for two independent wheelchair users to pass

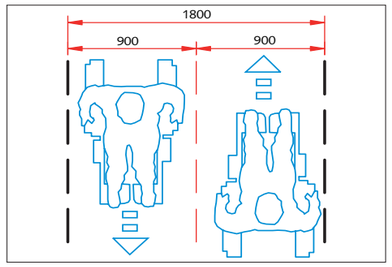


Figure 6 Space for independent wheelchair user and semi-ambulant person with walking frame to pass

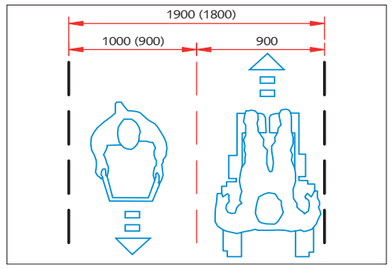


Figure 7 Space for wheelchair user and semi-ambulant user with crutches to pass

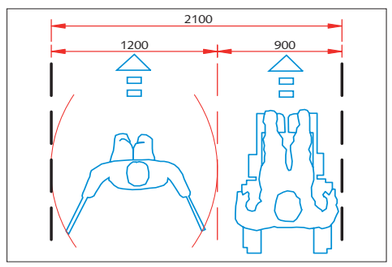


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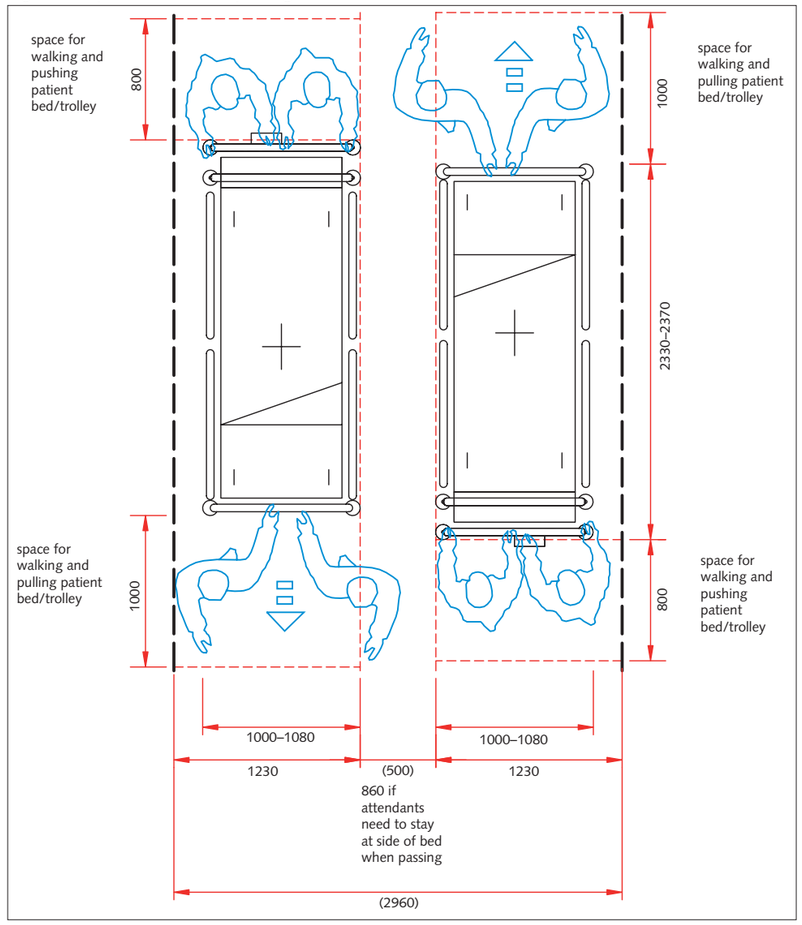
Figure 10 Space for two beds passing



width that accommodates the smooth passage of two patient beds. Beyond its functional necessitates a sufficiently spacious and well-organized design. Typically, patient rooms are symmetrically positioned on either side of the corridor, demanding a width that accommodates the smooth passage of two patient beds. Beyond its functional purpose, the nursing corridor serves as a dual-role environment for patients, staff, and visitors—a workspace and a place for interactions. Activities such as preliminary and post-treatment care frequently occur in front of patient rooms rather than within examination spaces. The corridors incorporate small alcoves intended for essential equipment, storage, or disposal units, catering to the needs of nursing and medical personnel. This layout also enhances the management and treatment of patients with diverse medical conditions. Furthermore, the ward corridor transforms into a setting for social connections and exchanges, enabling individuals from varying social and cultural backgrounds to engage in diverse interactions.

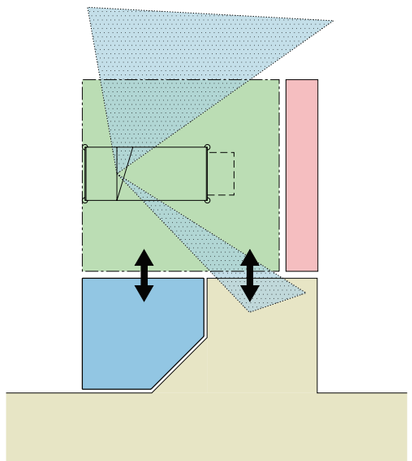
3.4.5 The patient room

The hospital remains the central hub where patients, their families, caregivers, and administrators converge with the shared goal of rejuvenating a patient's well-being. The challenges encountered by each of these groups become particularly prominent within the confines of the patient room. This is the very space where the evolution of healthcare delivery is undergoing unprecedented transformations, surpassing any previous point in history.

In recent decades, the average area indicated as adequate for each bed has been estimated to be approximately 10-12 m2 for a single room and 8-10 m2 for each bed in a multi-bed room. Each single bed, in fact, requires at least a rectangle of 2.50 m, 2.40/2.90 m deep, so 6-7 sqm, to which must be added a 2.50 sqm wide, at least 90 cm wide, corridor strip, in addition to any further areas for living space. If beds are placed against a single wall, the minimum width of the room should be at least 3.50 m, while in the case of opposing beds the minimum width should be 7 m. Generally, a single room measures approximately 10-12 sqm, a double room 16-18 sqm, and a quad room 30-32 sqm. In open wards with a much smaller area per bed than in rooms, the free space between two adjacent beds is larger. The North American hospitals, which are exclusively single room hospitals, show an average surface area of 15-18 sq.m. per bed: these are very high standards, which also have an impact, as mentioned above, on the distance that healthcare personnel must cover to provide care, causing delays in emergency situations. It should be kept in mind that to all these areas, the space to be reserved for the toilet in the room must be added, which is variable.

The location of the en-suite has a major influence on the subject room in terms of:

- Access points
- Support facilities including the nurse “touchdown” base
- Views to and from the bed
- Privacy
- Floor area



Internal en-suite

a) Access to en-suite and to the room are on the same side and this determines the minimum width of the room.

b) Views of the bed from the corridor are restricted.

c) External views are maximised.

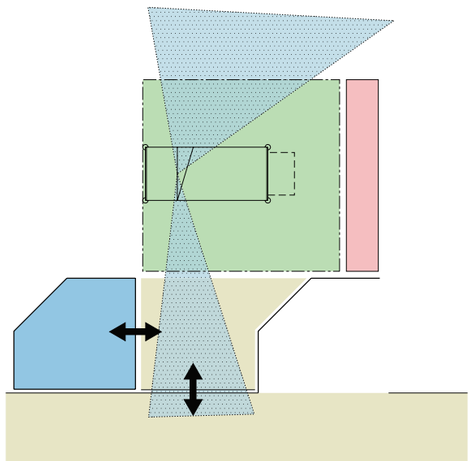
d) Privacy for the patient is maximised especially for views into the en-suite.

e) There are two options for support services: external
wall or partition wall.

f) Bed turning can be accommodated adjacent to the bedroom, which increases the circulation space but minimises corridor width.

g) The door position can be optimised to increase or decrease space within the room.

h) A nurse “touchdown” base can be accommodated adjacent to the bedroom door.



Internal adjacent en-suite

a) Access to en-suite and to the room are on the same side and this determines the minimum width of the room.

b) Views of the bed from the corridor are improved in comparison to the inboard option.

c) External views are maximised.

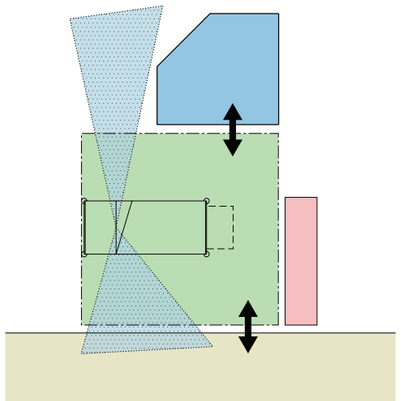
d) Privacy for the patient is reduced. Entry to the en-suite can be seen from the corridor.

e) There are two options for support services: external wall or partition wall.

f) To accommodate bed turning, either the corridor or
the bedroom doors will need to be wider.

g) The bedroom door position is fixed.

h) Accommodating the nurse “touchdown” base is difficult without adding additional width to the corridor.



External en-suite

a) Access to room and en-suite are on opposite sides, which is less restrictive on room width.

b) View of the bed from the corridor is maximised.

c) External views are minimised.

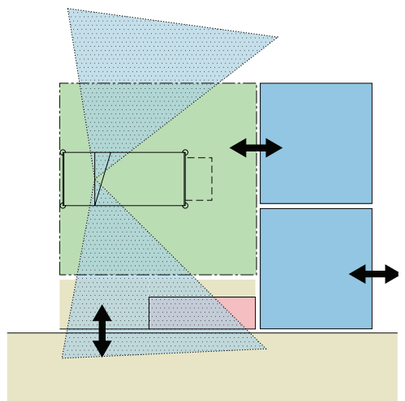
d) Privacy for the patient is minimised and entry into the en-suite can be observed from the corridor.

e) There are three options for support services: part external wall, part corridor partitions and room partitions.

f) To accommodate bed turning, either the corridor or the bedroom doors will need to be wider.

g) The bedroom doors can be located flexibly on the corridor wall.

h) A nurse “touchdown base” can be accommodated adjacent to the bedroom door.



In-between en-suite

a) Interlocking en-suites increases overall width and depth of the room.

b) Views of the bed from the corridor are maximised.

c) External views are maximised.

d) Privacy for the patient is minimised and entry into the en-suite can be observed from the corridor.

e) There are two options for clinical support services: external wall or corridor partitions. This will be influenced by whether the en-suite is “nested” on the external or internal wall.

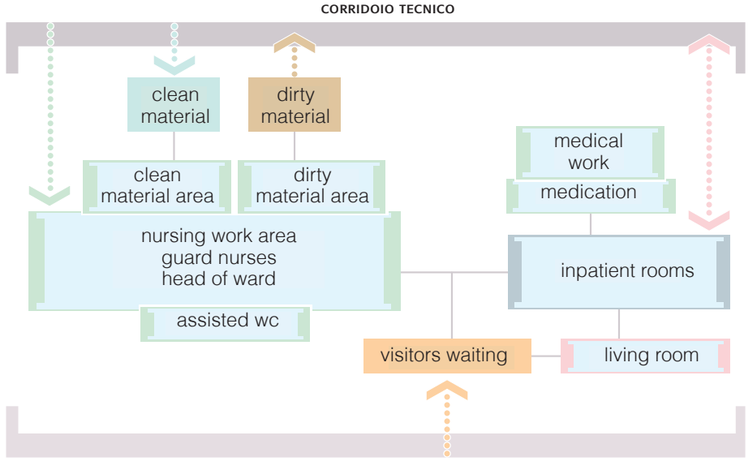
f) To accommodate bed turning, either the corridor or the bedroom doors will need to be wider.

g) The bedroom doors can be located flexibly on thecorridor wall.

h) A nurse “touchdown” base can be accomodated adjacent to the bedroom door.

HIGH CARE INPATIENT WARD

TECHNICAL CORRIDOR

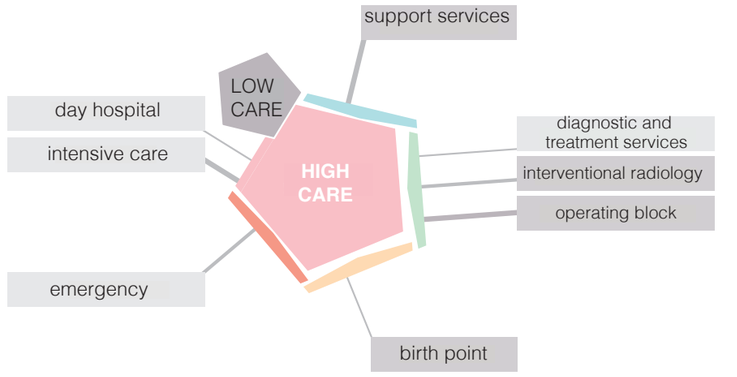


INTERNAL RELATIONS

RELAZIONI INTERN

- visitors
- inpatients
- doctors
- staff
- urgencies
- clean
- dirty
- doctors-patients
- access
- filter
- operating areas
- service areas

PUBLIC CORRIDOR



EXTERNAL RELATIONS

- diagnosis and treatment
- inpatient ward
- birth point
- emergency
- services

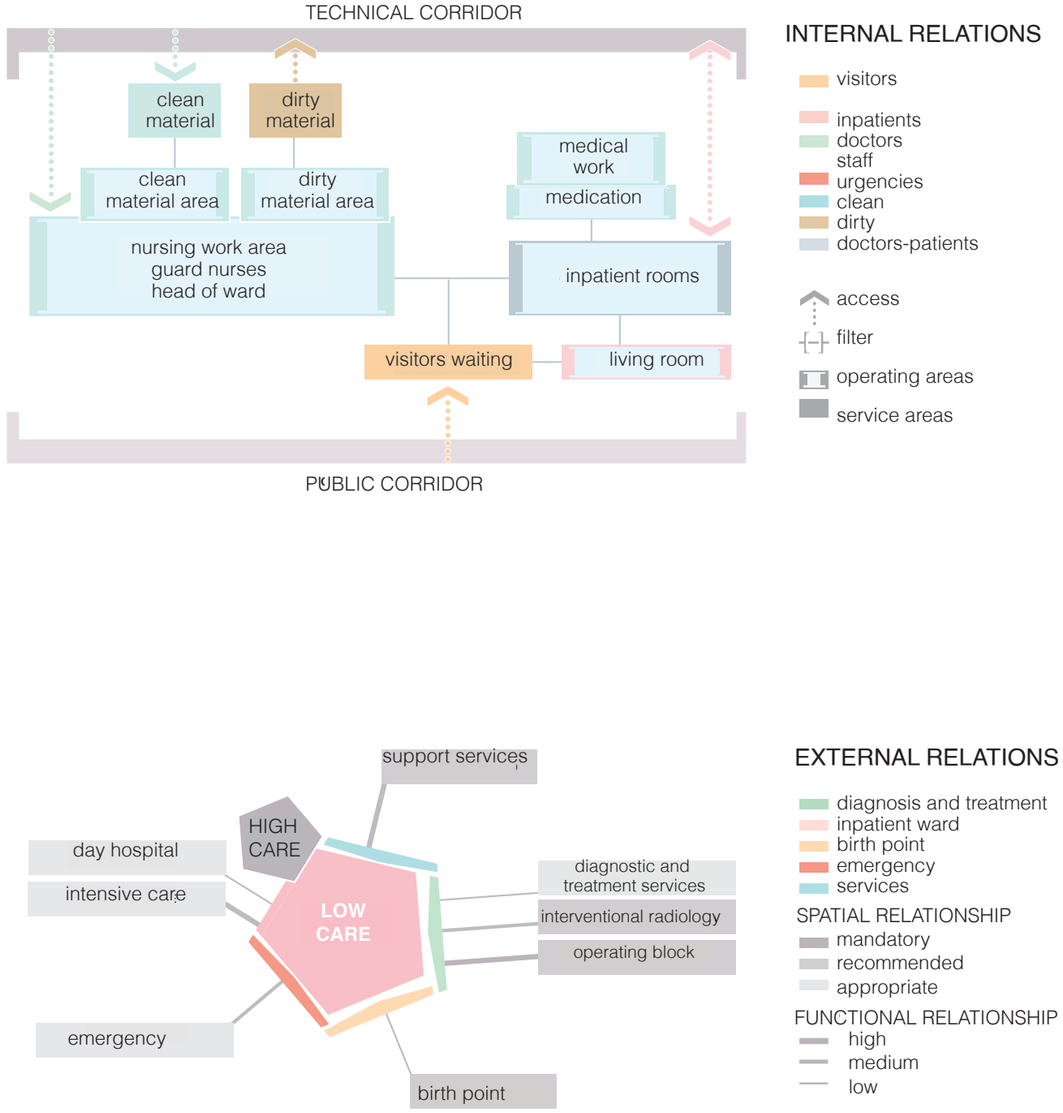
SPATIAL RELATIONSHIP

- mandatory
- recommended
- appropriate

FUNCTIONAL RELATIONSHIP

- high
- medium
- low

LOW CARE INPATIENT WARD



04.
Discussion

4. Discussion

This chapter presents a discussion of the key findings of the research which highlighted some performance requirements, the best practices used in contemporary hospitals and a series of measurable indicators brought out by the literature review. The aimes and objectives of the research were achieved; the investigation phase led to the identification of a range of references for the design of inpatient units, aimed at wellbeing and innovation. From theoretical contribution the study led to support towards the design process.

The research provides a tool for evaluation and design of inpatient care units. The list of parameters are divided into two sections: dimensional requirements and qualitative recommendations for each environmental units.

The indicators stem from both scientific literature and the best practices analysed: it has been made an avarage of the data collected from the different case studies. The section Dimensional Requirements and the guidelines that follow represent the first step for the overall project design of the area in question. On the other hand, the Checklist serve both for a preliminary assessment and during project development to evaluate the quality of progress. The importance of evaluation is emphasised as it is an essential step in order to have a starting point for implementing what is most needed.

When speaking of a tool, it is essential to specify the entities that could make use of it. This type of tool could facilitate and direct all the entities involved in the realisation and construction of hospital complexes: public clients, private clients, architecture studios, technical offices of construction companies and the entire network of companies involved in the health sector. The members of the Joint Research Platform Healthcare Infrascture could represent an example.

4.1 Design strategies and evaluation

Instead of merely serving as treatment locations, healthcare facilities ought to create a therapeutic environment that aids in the healing process and minimizes the risk of healthcare-associated infections. The overall building design should play a crucial role in achieving these goals.

The primary purpose of healthcare buildings is to accomodate the needs of patients and other users. Evidence suggests that a well-designed healthcare facility not only enhances patient satisfaction but also leads to better health outcomes and increased staff productivity.

The typological and formal choices concern both the hospital as a whole and the in-patient units. These choices, also partly related to orientation, must overcome the rigid functional approach that characterised hospital design for large tractsm of the 20th century. First and foremost, a design approach must be developed, aimed at defining spaces where the quality of living is not inferior to that of other social collective architectures and where the good proportioning of the spaces intended for in-patient care and meetings can contribute to improving the physical and psychic health of the patient.

It is necessary to respect the typological and morphological characteristics of the context (height, shape, distribution and organisation of the buildings) rather than ignore them, adopting, among other things, technological and formal solutions that can contribute to improving the overall image of the urban compartment in which the building is inserted.

It is necessary to orient volumetric choices towards externally compact forms that allow for a rationalisation of the functional distribution of the hospital structure but which, at the same time, can be articulated internally through patios, gardens, double-height rooms.

The distribution schemes based on a single corridor (both the “rooms-corridor-services” scheme and the “rooms-corridor-rooms” scheme) respond more satisfactorily to the requirements of transformability and humanisation than the other linear typological layouts.

The distribution solution with a single corridor, in fact, makes it possible to “isolate” the less qualified and noisier service rooms, obtaining undoubted advantages in terms of privacy and comfort as well as functionality, compared to a double corridor solution where the services are all located in the centre, indiscriminately.

FUNCTIONAL LAYOUT

The overarching principle for patient rooms and wards should be to support the new or renovate structure, while ensuring high-quality treatment and patients wellbeing.

Ward standardization would facilitate operations efficiency, inpatient units should be shared among different department, based on their specific needs. This approach allows for collaboration across specialties and maximizes space utilization.

To enhance patient care, wards should be organized into smaller **units** centered around **decentralized nursing stations**. The primary focus should be on simplifying patient monitoring for nursing staff. These

units will be part of a **resource-sharing** system that includes shared facilities and support functions.

In each ward, there must be at least one patient room designed for patients requiring more space, such as bariatric patients or those with large families. These rooms should have the capacity to accommodate **two patients** in case of overcrowding. All patient rooms should adhere to standardized functionality to ensure adaptability to future needs and requirements. **Standardization** also enhances recognizability, leading to improved patient safety and better working conditions for staff.
However, there are three exceptions to this concept: patient rooms for pediatric, neurological, and intensive-care patients necessitate different functionalities. **Single patient rooms** are preferred, in order to reduce infection spread.

Careful planning of patient room layouts has the potential to enhance the caregiving experience, benefiting both caregivers and patients. By enhancing efficiency and providing caregivers with more time to focus on patients, thoughtful design can make caregiving more fulfilling. Moreover, it can also encourage family members to actively engage in the recovery process, rather than hinder it. Furthermore, for hospital administrators, effective design sets the stage for accommodating future changes and developments.

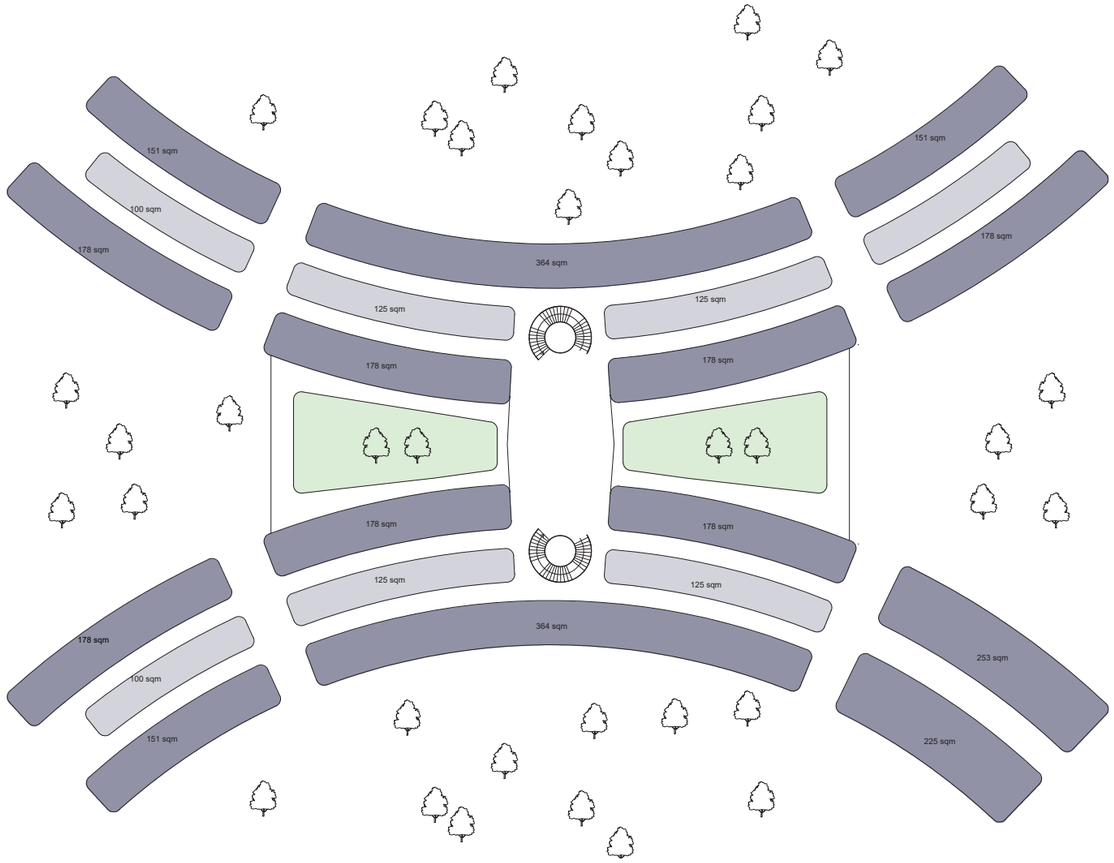
4.1.1 Dimensional requirements

Total area of inpatient ward	**At**	At= 56 sqm per bed
Inpatient area	Ia	Ia = 45% At
Circulation area	Ca	Ca = 24% At
Service area	Sa	Sa = 15% At
Outdoor green area	Oa	Oa = 30 sqm per bed
N common areas		1 per 14 patients
N nursing stations		1 per 22 patients
N public WC		1 per 30 patients
Patient room area	**Pa**	
Bed space		55% Pa
Visitor space		11% Pa
Clinical support		9% Pa
WC		25% Pa

4.1.2 Layout application

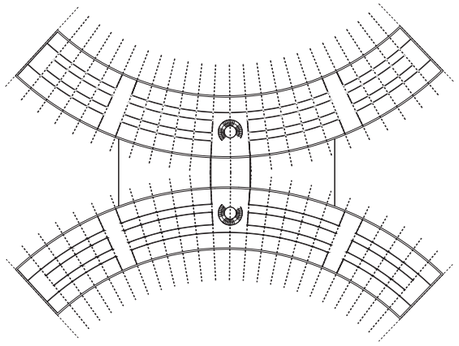
Having reached the definition of dimensional requirements and a set of quantitative and qualitative indications, a practical application is proposed. In the following pages, will be represented a proposal of an impatient ward possible layout, taking into consideration the parameteres previously developed. A ward that can accommodate 100 patients is considered. Beds = 100.

Total of beds		B = 100	Required dimensions
Total area of inpatient ward	At	At= 56 sqm per bed	5600 sqm
Inpatient area	Ia	Ia = 45% At	2520 sqm
Circulation area	Ca	Ca = 24% At	1344 sqm
Service area	Sa	Sa = 15% At	840 sqm
Outdoor green area	Oa	Oa = 30 sqm per bed	3.000 sqm
N common areas		1 per 14 patients	7
N nursing stations		1 per 22 patients	4
N public WC		1 per 30 patients	3
Patient room area	**Pa**		
Bed space		55% Pa	
Visitor space		11% Pa	
Clinical support		9% Pa	
WC		25% Pa	

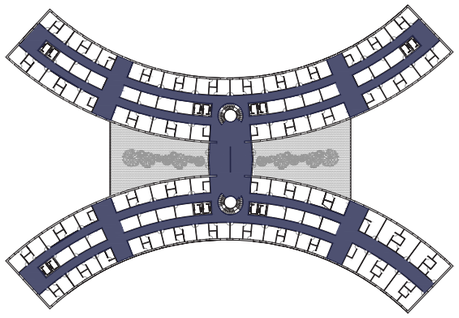


	Required dimensions	Dimensions achieved
Total area of inpatient ward	5600 sqm	5488 sqm
Inpatient area	2520 sqm	2900 sqm
Circulation area	1344 sqm	1788 sqm
Service area	840 sqm	800 sqm
Outtoor green area	3.000 sqm	3.000 sqm

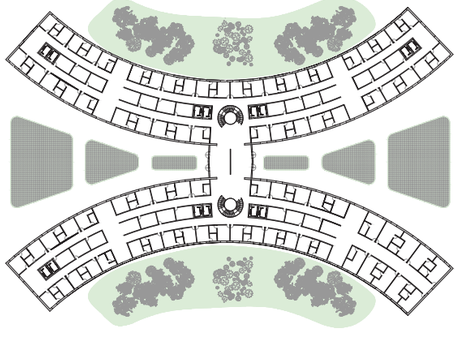
Functional diagram
- inpatient area
- service area
- circulation
- terrace



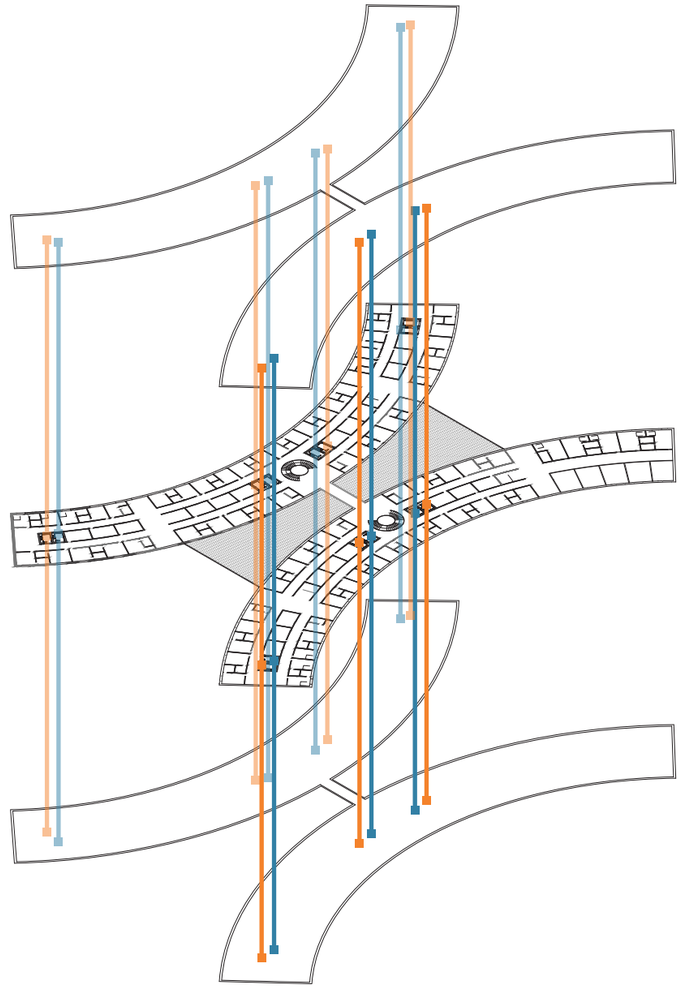
Structural grid



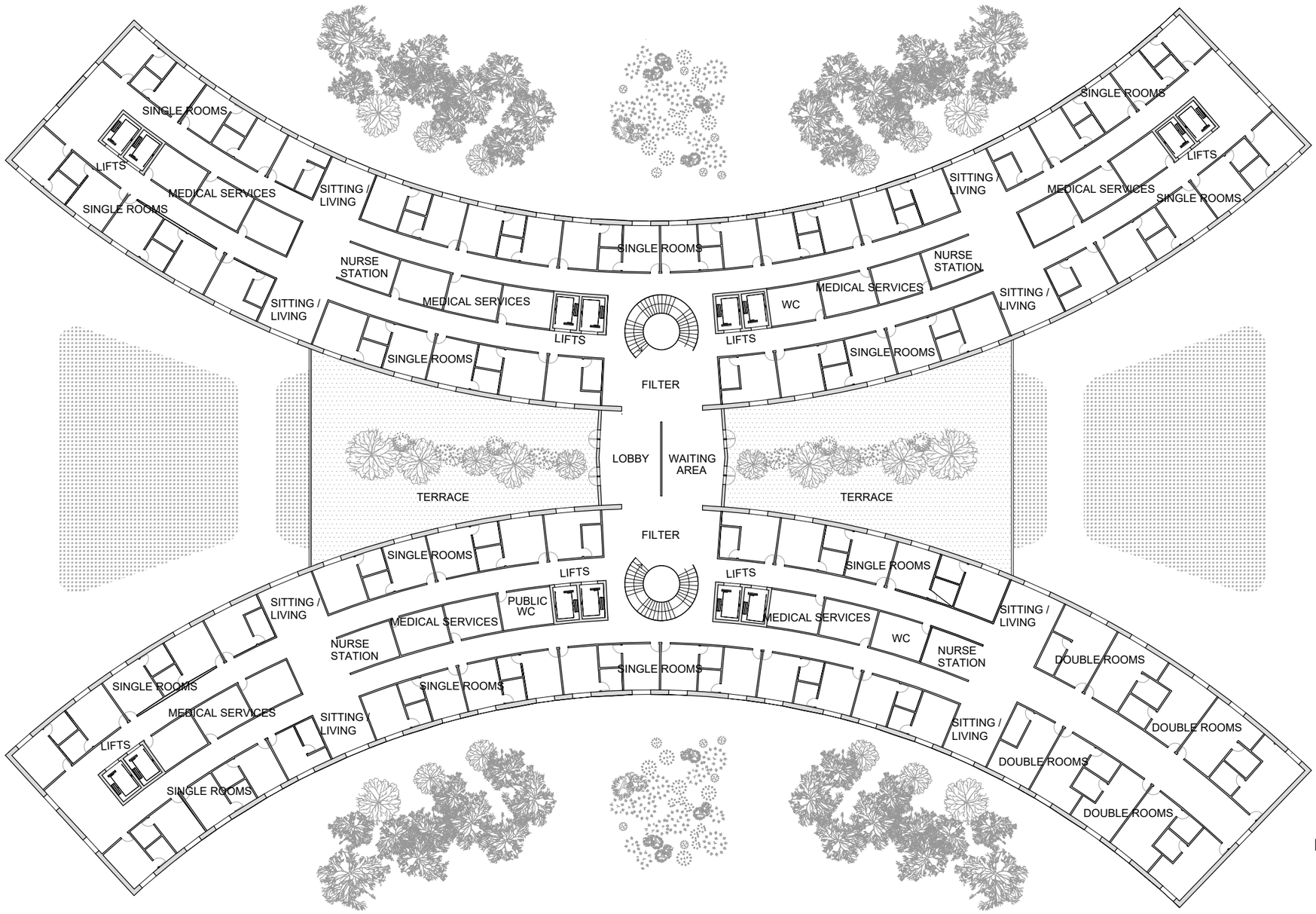
Circulation



Green area

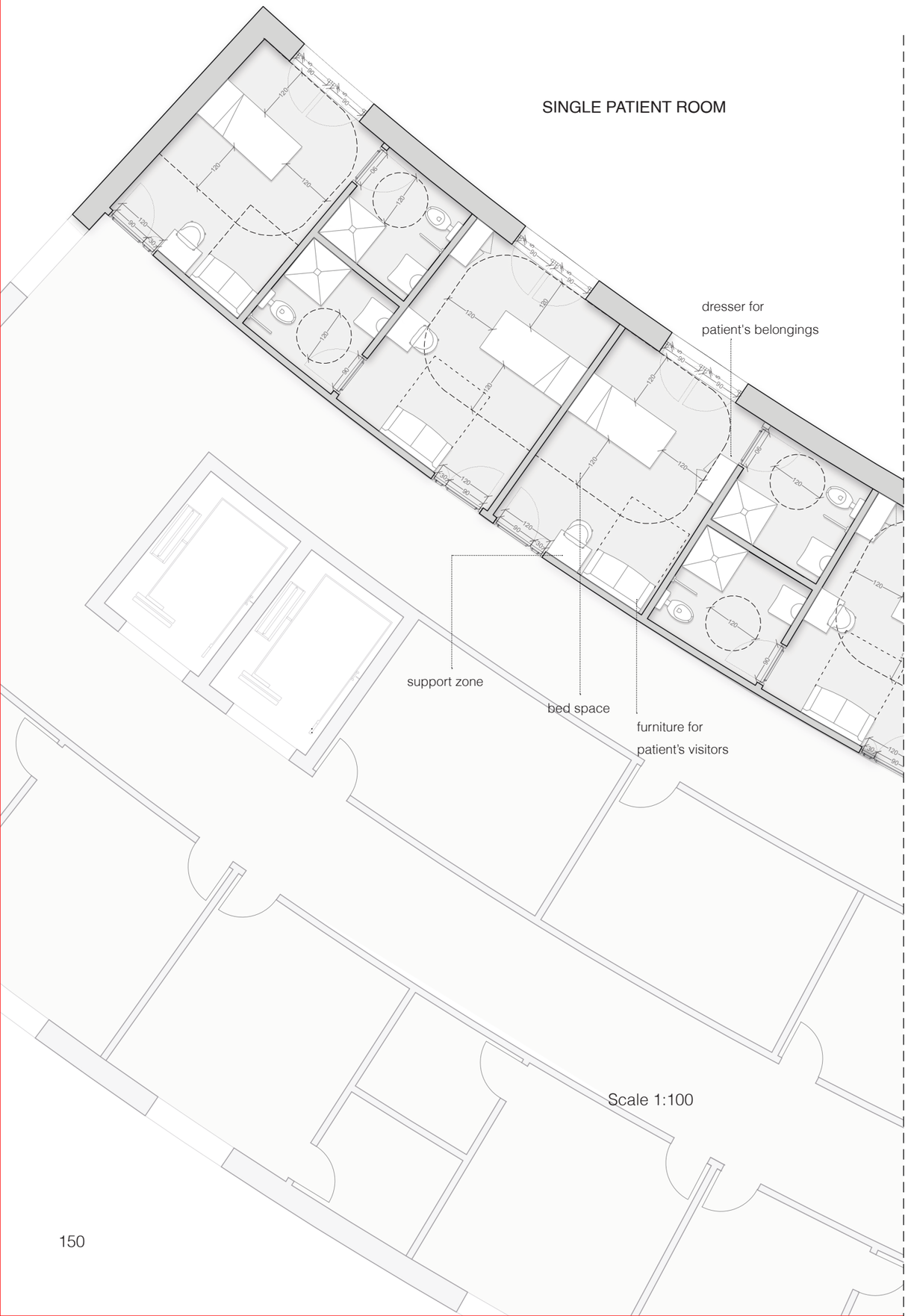


Vertical connections



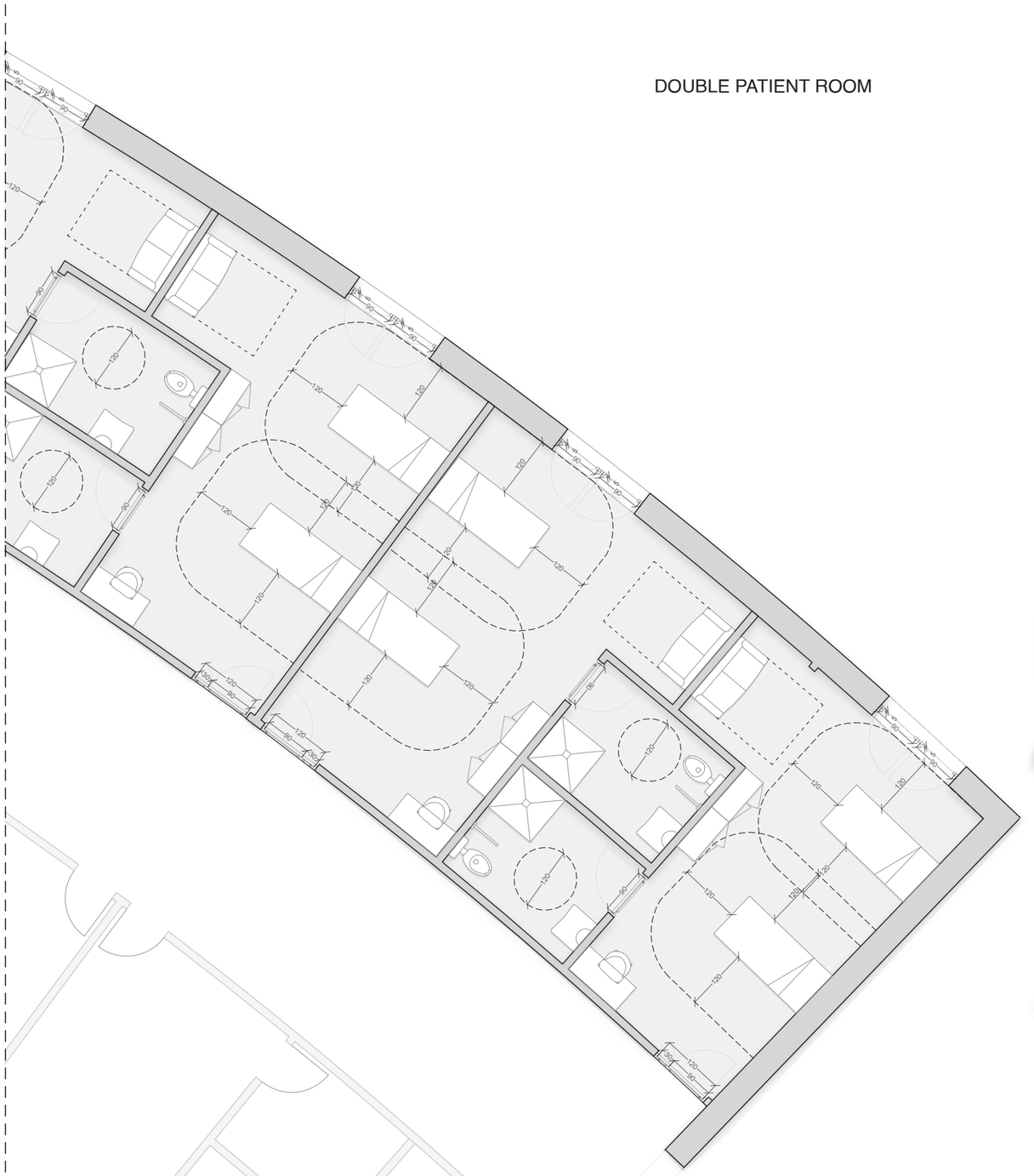
Floor plan - Scale 1:500

SINGLE PATIENT ROOM



Scale 1:100

DOUBLE PATIENT ROOM



Scale 1:100

CIRCULATION

EVIDENCE	DESIGN CONSIDERATIONS	MEASURABLE VARIABLES
• Scientific studies provide evidence that both comfortable conditions and the ability to regulate comfort levels in different environments play a crucial role in reducing stress and alleviating anxiety.	• Seating areas along corridors serve as convenient meeting and resting spots for both patients and staff. Placement should be aligned with outside views.	SCORE SEATING AREAS 0 No seating areas along corridors 1 Up to 30% of seating areas are aligned with outside views 2 Up to 60% of seating areas are aligned with outside views 3 Up to 80% of seating areas are aligned with outside views
• Successful building designs boost the morale of those who work or receive treatment. Feedback from post-occupancy evaluations reveals that in places with a significant number of similar areas, minor changes in elements like color, texture, or material contribute to a more meaningful sense of location for individuals.	• By installing character into these spaces, dedication to human values goes beyond mere functionality and addresses emotional well-being. • To guide people along typical routes, walls and floors can suggest pathways using distinct materials and colors. • Large open circulation spaces can create clear pathways by using specific flooring colors and materials. • Flooring changes can effectively suggest preferred routes and designate “no entry” areas.	Is there a sense of spaciousness with overcrowding avoided? Long, narrow corridors without daylight or views out of the building are avoided? Are different materials or colours used on walls and floors to indicate routes? Are there panels of a suitable size, contrasting with the background, positioned at eye level to give directions?
• Patients and staff value the autonomy to control their privacy and interactions with others. Environments that offer this freedom receive higher satisfaction ratings from occupants.	• To ensure privacy, views from circulating spaces into bed and patient spaces should be restricted.	Are there sound absorptions or blocking measures to minimize sound transmission between patient room and corridors?

Design day/night lighting to make passage a pleasant + safe experience. Minimise “tunnel” effect in corridors

Provide rest seating at convenient locations in long corridors

Provide seamless handrails to be grasped by the hand for stability + support

Distinguish major nodes that form intersections of routes from minor ones

Obvious visual references for wayfinding + easy transition (signs, art + sculptures)

North Zealand Hospital, Basel, Switzerland. Herzog & de Meuron

North Zealand Hospital, Basel, Switzerland. Herzog & de Meuron

WAITING AREAS

EVIDENCE	DESIGN CONSIDERATIONS	
• Research affirms how, especially in waiting rooms, wall transparency can reduce an individual's stress due to natural light, warmth from the outdoors, and views of nature.	• Incorporate natural elements. • Visual connection means transparency of the facade.	SCORE SEATING AREAS 0 No seatings in waiting areas 1 Up to 30% of seating areas are aligned with outside views 2 Up to 60% of seating areas are aligned with outside views 3 Up to 80% of seating areas are aligned with outside views
• Patients prefer toilets to be near and to be clear about their location with the actual door not in full view of many other people.	• The location of toilets should be immediately apparent and within convenient reach. • Entrances to toilets should be discrete and not in view of the waiting area	SCORE DISTANCE 0 No sanitary facilities close to the reception 1 Up to 16 meters from the reception 2 Up to 12 meters from the reception 3 Up to 8 meters from the reception
• Research studies show that not only comfortable conditions but the ability to control levels of comfort for oneself may be very important in reducing stress. • Allowing patients control over their environment is desirable and may also reduce demands on reception and staff. • Stress and heart rates have been proved to rise in noisy hospitals.	• Comfortable seating is a prerequisite if people are waiting a long time. • Views of reception and staff are crucial to feeling in control. • View of a clock and being able to keep track of time helps people feel in control. • Access to communications (telephone, internet etc) helps people feel in control and connected. • Refreshment should be readily available and close to the waiting area.	Requirements for the level of environment control. • sound control (TV, music, radio) • natural light control (courtains or other shading devices) • artificial control • possibility of moving seats SCORE CONTROL LEVEL 0 No requirements met 1 1/2 requirements met 2 3 requirements met 3 4 requirements met

Light, spacious + airy atmosphere through plenty daylight + doubleheight space

Plants to give a homely + non-institutional feel

A visible + easily recognisable reception/ information point

A variety of seating arrangements: to encourage interaction and to promote seclusion

Future Academic Hospital – Entrance 100, Uppsala, Sweden, White Arkitekter

Städtisches Klinikum Braunschweig, Germany, C.F. Møller

PATIENT ROOM

EVIDENCE	DESIGN CONSIDERATIONS		MEASURABLE VARIABLES
• Patients and staff like to be able to control their **privacy** and their interaction with others.	• Provide for single patient units • Multi-bed rooms can be made more personal by arranging furniture, screens, and beds thoughtfully • Efforts to reduce the structural noise could be: sound-insulated electrical generators, insulated false ceilings, double glazed glass with an air gap.		SCORE SINGLE PATIENT UNITS 0 No use of single patient units 1 Up to 30% of single room in the inpatient ward 2 Up to 60 % of single room in the inpatient ward 3 Up to 80% of single room in the inpatient ward SCORE BED ORIENTATION 0 Absence of noise consideration and visual access to patient 1 Patient not visible from the corridor but away from the door 2 Patient visible from the corridor but close to the door 3 Patient head visible from corridor and away from the door
• Evidence indicates that providing sufficient **space for relatives** to stay with the patient yields numerous advantages, such as decreased nurse-call button activity and patient falls.	• Designating specific zones for visitors. • By offering a comfortable sofa and desk for visitors, they are encouraged to prolong their stay with the patient.		Is there furniture dedicated to day visitors? Is there forniture to accomodate visitors for the night?
• Studies show that when **daylight** is available, many building occupants prefer to reduce artificial lighting. Patients and staff express a need for a **range of lighting** effects to avoid glare, provide bright light for reading, dim lights for sleeping at night, etc.	• It is necessary for all beds to receive exposure to daylight. • It is advisable to prevent direct sunlight or provide shading. • Patients should have the ability to control their own lighting. • The artificial lighting should be varied in types and levels to accommodate different activities.		SCORE EXPOSURE TO NATURAL LIGHT 0 No units have exposure to natural light 1 Up to 30% of units have exposure to natural light 2 Up to 60 % of units have exposure to natural light 3 Up to 80% of units have exposure to natural light Are there shading devices to prevent direct sunlight? Is there an electric panel to let the patients control their lighting?
• sounds and sights of **nature** have a positive impact on patient's experiences of care.	• Provide views on natural elements.		SCORE VIEW ON NATURE 0 Unit with no view 1 Unit with view on inner couryards or other 2 Unit with view on urban context 3 Unit with view on green spaces

Involvement art in the space

Design to give a view on nature

Use of technology to give comfort: let users control lights, blinds, temperature

Inclusion of a space for visitors and allow privacy, company and dignity

Design of private bathrooms at a short distance from the patient's bed to avoid falls

Aarau Cantonal Hospital, David Chipperfield Architecs, Itten+Brechbühl AG

REHAB, Clinic for Neurorehabilitation and Paraplegiology, Basel, Switzerland. Herzog & de Meuron

OUTDOOR GREEN AREA

EVIDENCE	DESIGN CONSIDERATIONS		MEASURABLE VARIABLES
• Hospital green areas contribute to the improvement of the patient's condition of well-being, as shown by the qualitative and quantitative data emerging from the studies.	• A percentage of 20/30% of the total surface should be designated as outdoor green area		SCORE — SURFACE PERCENTAGE 0 — Absence of outdoor green area 1 — Up to 10% of surface deisgnated as outdoor green area 2 — Up to 20 % of surface deisgnated as outdoor green area 3 — Up to 30% of surface deisgnated as outdoor green area
• The principle of **co-location** represents a strategic guide that reconsiders the entire hospital design, accentuating the importance of integrated hospital green space design from the planning stage of the project.	• At the level of strategic design, this translates into a hospital space with permeable boundaries, inviting in the influence of nature, achieved through strategic decisions as roof terraces, roof gardens, courtyards, hanging gardens.		Are there green elements as roof terraces, roof gardens, couryards or hanging gardens?
• A clear connection between inside and outside ensures that patients have the opportunity to easily access the green space,	• Integration between the interior and exterior can be achieved through two approaches: - a visual link, such as utilizing transparent walls or designing expansive windows that overlook the natural surroundings. - b functional link, involving the arrangement of comparable activities both inside and outside		SCORE — PERCENTAGE OF FACING ROOMS 0 — Absence of room facing the green area 1 — Up to 30% of rooms facing the green area 2 — Up to 60 % of rooms facing the green area 3 — Up to 90% of rooms facing the green area

Design to give people contact with nature and the outdoors (healing gardens)

Slopes, steps, bridges, a range of walking surfaces and parallel bars to aid in physiotherapy

Multi-sensory experience through colourful plants and flowers

Surfaces designed to instill confidence in individuals undergoing mobility relearning

Obvious visual cues for wayfinding + easy transition (landmarks, signs, art + sculptures)

Kinderspital Zürich, Switzerland, Herzog De Meuron

Aarhus University Hospital - AUH, Denmark C.F. MøllerC.F. Møller

4.2 Assessment tool (checklist) for inpatient ward design

CRITERIA	SCORE
CORRIDOR SEATING AREAS	
No seating areas along corridors	0
Up to 30% of seating areas are aligned with outside views	1
Up to 60% of seating areas are aligned with outside views	2
Up to 80% of seating areas are aligned with outside views	3
WAITING SEATING AREAS	
No seatings in waiting areas	0
Up to 30% of seating areas are aligned with outside views	1
Up to 60% of seating areas are aligned with outside views	2
Up to 80% of seating areas are aligned with outside views	3
DISTANCE	
No sanitary facilities close to the reception	0
Up to 16 meters from the reception	1
Up to 12 meters from the reception	2
Up to 8 meters from the reception	3
Requirements for the level of environment control.	
• sound control (TV, music, radio)	
• natural light control (courtains or other shading devices)	
• artificial light control	
• possibility of moving seats	
CONTROL LEVEL	
No requirements met	0
25-50% requirements met	1
75% requirements met	2
100% requirements met	3
SINGLE PATIENT UNITS	
No use of single patient units	0
Up to 30% of single room in the inpatient ward	1
Up to 60 % of single room in the inpatient ward	2
Up to 80% of single room in the inpatient ward	3

CRITERIA	SCORE
BED ORIENTATION	
Absence of noise consideration and visual access to patient	0
Patient not visible from the corridor but away from the door	1
Patient visible from the corridor but close to the door	2
Patient head visible from corridor and away from the door	3
EXPOSURE TO NATURAL LIGHT	
No units have exposure to natural light	0
Up to 30% of units have exposure to natural light	1
Up to 60 % of units have exposure to natural light	2
Up to 80% of units have exposure to natural light	3
VIEW ON NATURE	
Unit with no view	0
Unit with view on inner couryards or other	1
Unit with view on urban context	2
Unit with view on green spaces	3
SURFACE PERCENTAGE	
Absence of outdoor green area	0
Up to 10% of surface deisgnated as outdoor green area	1
Up to 20 % of surface deisgnated as outdoor green area	2
Up to 30% of surface deisgnated as outdoor green area	3
PERCENTAGE OF FACING ROOMS	
Absence of room facing the green area	0
Up to 30% of rooms facing the green area	1
Up to 60 % of rooms facing the green area	2
Up to 90% of rooms facing the green area	3
NUMBER OF NURSING STATIONS	
1 each 30 patients	0
1 each 28 patients	1
1 each 25 patients	2
1 each 22 patients	3

QUALITATIVE RECCOMENDATIONS	YES/NO
Is there a sense of spaciousness with overcrowding avoided?	
Long, narrow corridors without daylight or views out of the building are avoided?	
Are different materials or colours used on walls and floors to indicate routes?	
Are there panels of a suitable size, contrasting with the background, positioned at eye level to give directions?	
Are there sound absorptions or blocking measures to minimize sound transmission between patient room and corridors?	
Is there furniture dedicated to day visitors?	
Is there forniture to accomodate visitors for the night?	
Are there shading devices to prevent direct sunlight?	
Is there an electric panel to let the patients control their lighting?	
Are there green elements as roof terraces, roof gardens, couryards or hanging gardens?	

QUALITATIVE RECCOMENDATIONS	YES/NO
Is there furniture dedicated to day visitors?	
Is there forniture to accomodate visitors for the night?	
Are there shading devices to prevent direct sunlight?	
Is there an electric panel to let the patients control their lighting?	
Are there green elements as roof terraces, roof gardens, couryards or hanging gardens?	

4.2.2 Test

Nuovo Ospedale del Sud Salento, mario cucinella architects

STRUTTURA ORGANIZZATIVA

FUNZIONI

ASILO

COPERTURA_QUOTA + 13.50 m

BLOCCO PARTO
DEGENZE
AMBULATORI E AREA MAMME NUTRICI
TERAPIA INTENSIVA
AMBULATORI E STUDI MEDICI

PIANO SECONDO_QUOTA +9.00 m

DAY SURGERY 16 PL
AMBULATORI + STUDI MEDICI
LABORATORI
DEGENZE
BLOCCO OPERATORIO
ENDOSCOPIA
PALESTRE LOW CARE E STUDI MEDICI

PIANO PRIMO_QUOTA +4.50 m

MORGUE E ANATOMIA PATOLOGICA
POLIAMBULATORI
INGRESSO OUT-PATIENT E CASA PARTO
BIOLOGIA MOLECOLARE
DIALISI 24 PL
CENTRO PRELIEVI
CUP
AREA DIMISSIONI FRAGILI
AREA GESSI
PRONTO SOCCORSO
HALL INGRESSO, MAIN STREET E SERVIZI
OBI 12 PL E SOAP 14 PL

PIANO TERRA_QUOTA +0.00 m

CUCINA
SPAZI E LOCALI TECNICI
DEPOSITI SPORCO
FARMACIA
SPOGLIATOI
TELERIE
ECONOMATO
DIAGNOSTICA

PIANO SEMINTERRATO_QUOTA -4.50 m

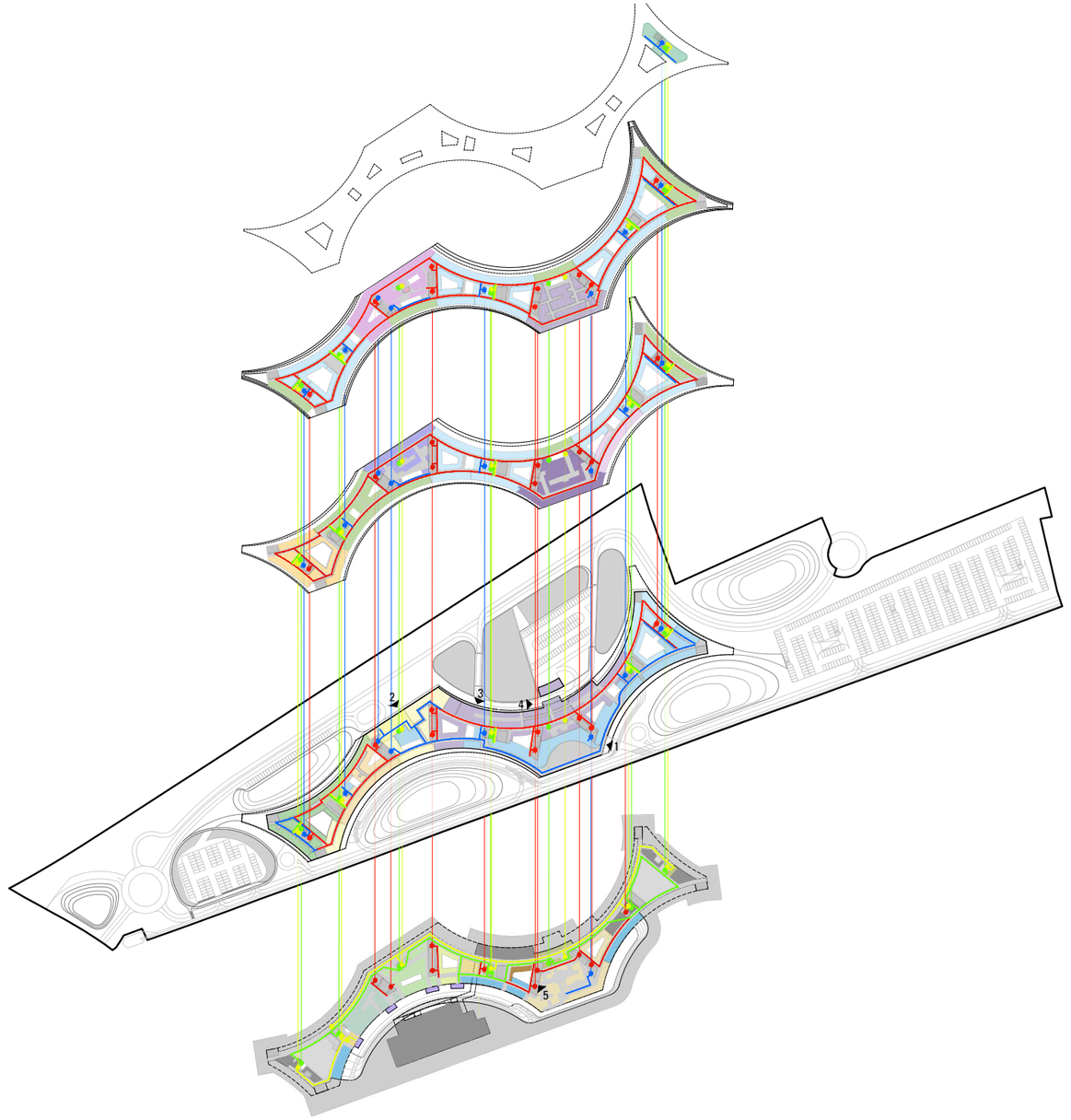
DEPOSITI SPORCO

PIANO INTERRATO_QUOTA -9.00 m

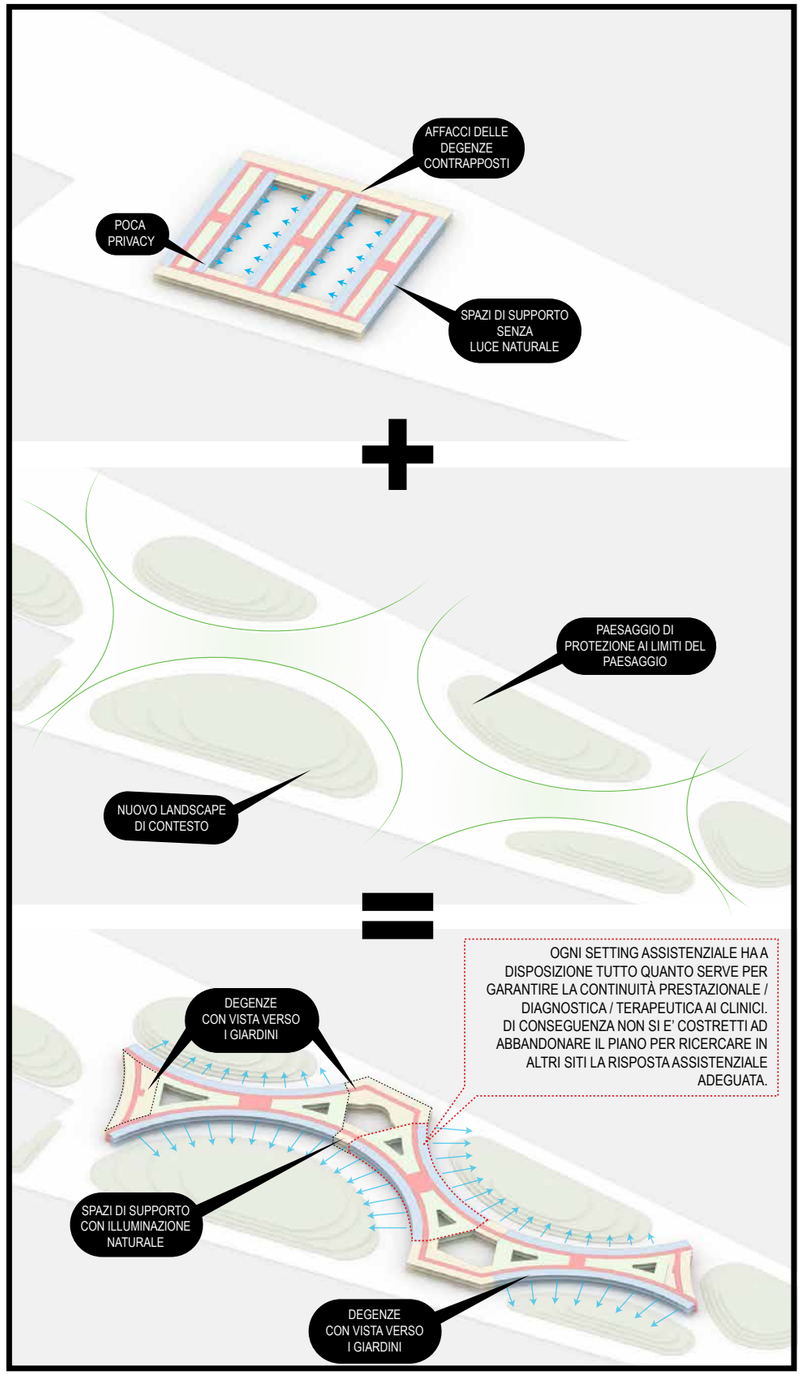
FLUSSI

FLUSSO INTERNI (PAZIENTI, PERSONALE SANITARIO)
FLUSSO ESTERNI (VISITATORI)
CONNESSIONE VERTICALE PER INTERNI
CONNESSIONE VERTICALE PER ESTERNI
FLUSSO MERCI PULITE
FLUSSO MERCI SPORCHE
FLUSSO VERTICALE MERCI PULITE
FLUSSO VERTICALE MERCI SPORCHE
ACCESSI

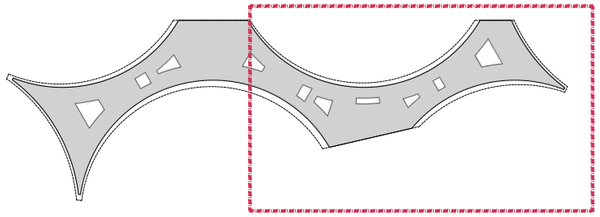
1_ACCESSO PRINCIPALE OSPEDALE
2_ACCESSO OUT-PATIENT E CASA PARTO
3_ACCESSO PEDONALE PRONTO SOCCORSO
4_ACCESSO AMBULANZE
5_ACCESSO AUTOMEZZI LOGISTICA

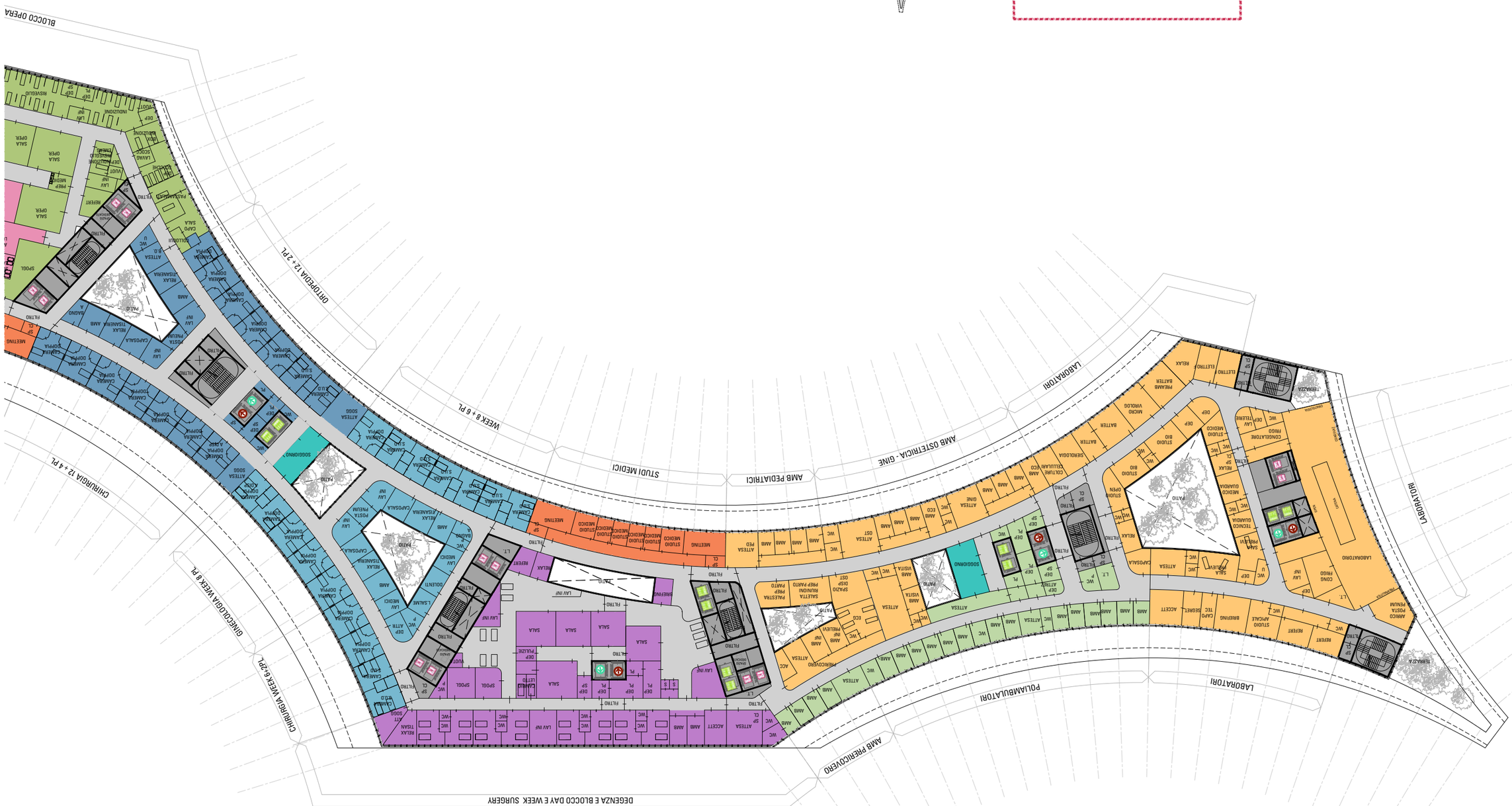


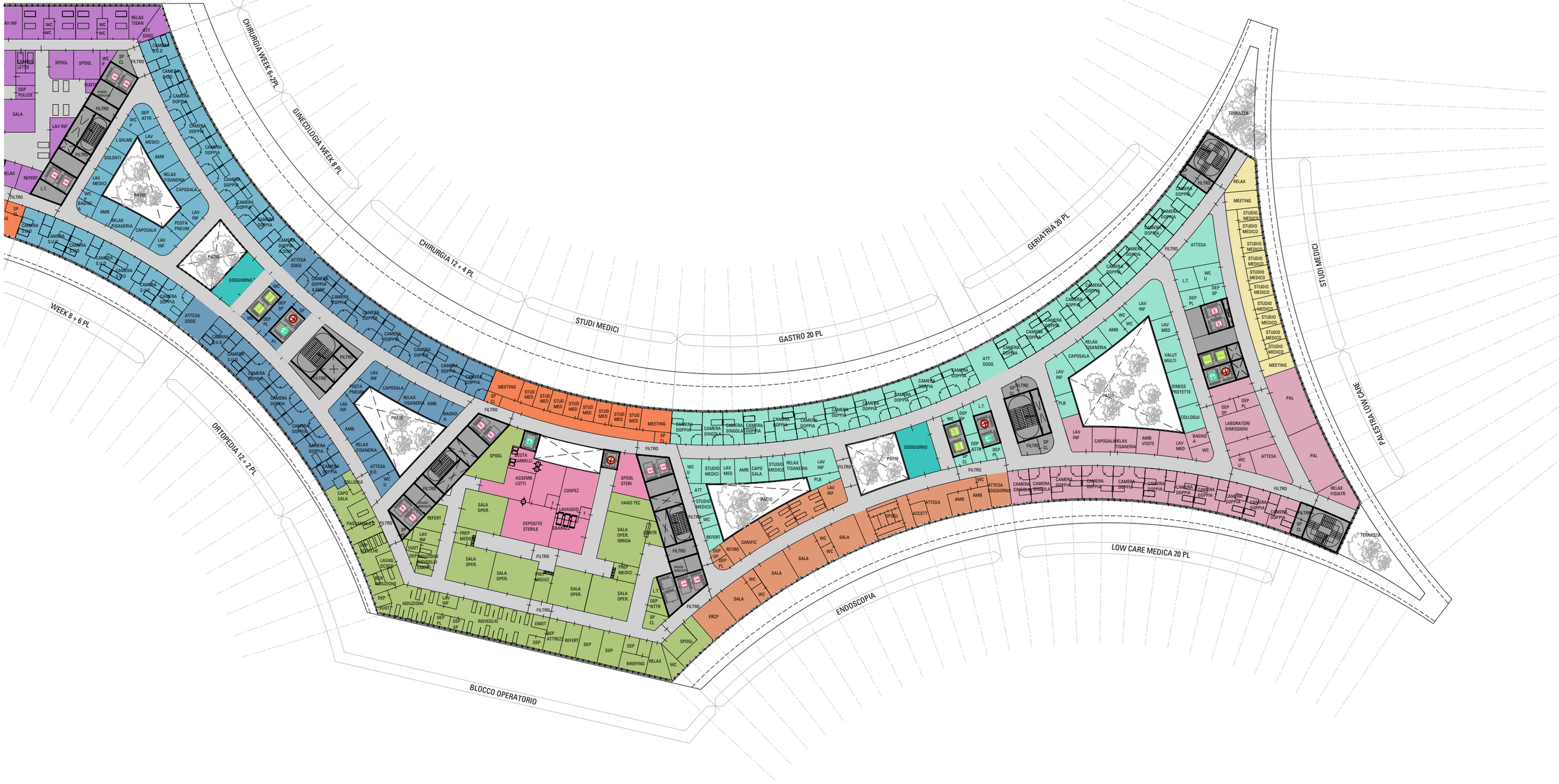
POSTI LETTO PER ARIA FUNZIONALE

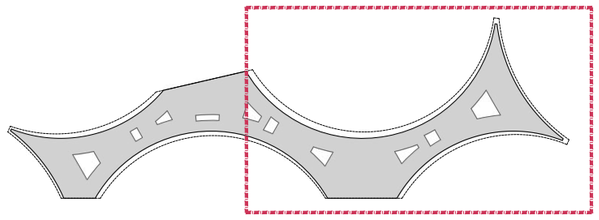


	TOTALI PL	CAMERE DOPPIE	CAMERE SINGOLE	CAMERE S.U.D	ESPANSIONE
AREA MEDICA					
MEDICINA	24	18	3	3	3
GERIATRIA	20	20	0	0	0
GASTROENTEROLOGIA	20	18	2	0	0
CARDIOLOGIA	16	16	0	0	2
NEUROLOGIA	0	0	0	0	0
PNEUMOLOGIA	8	4	4	0	0
SOAP	14	12	2	0	0
PSICHIATRIA	15	0	15	0	1
LOW CARE MEDICA	20	18	2	0	0
TOTALI POSTI LETTO	**137**	**106**	**28**	**3**	**6**
AREA CHIRURGICA					
CHIRURGIA	26	24	1	1	1
TRAUMATOLOGIA	12	8	2	2	2
ORTOPEDIA	14	10	2	0	0
GINECOLOGIA	12	10	2	0	0
WEEK	22	14	0	8	10
MATERNO - INFANTILE					
OSTETRICIA	20	10	6	4	4
PEDIATRIA	16	10	6	0	0
TOTALI POSTI LETTO	**122**	**86**	**19**	**15**	**17**
TERAPIA INTENSIVA					
UCIC	8				
EMODINAMICA	2				
RIANIMAZIONE	8				
PNEUMOLOGIA	4				
TOTALI POSTI LETTO	**22**				
TOTALI	**281**	**208**	**55**	**18**	**23**
TIPO	3	0	0	0	0
OBI	12	8	3	1	1
DH ONCOLOGICO	8	0	8	0	0
DAY SURGERY	16	16	0	0	0
PS PEDIATRICO	7	0	0	0	0
DIALISI	24	0	0	0	0
A DISPOSIZIONE	16	16	0	0	0
TOTALI	**367**	**248**	**66**	**19**	**24**









INPATIENT UNIT FOCUS

Camere a due letti per pazienti la cui degenza non richiede elementi aggiuntivi alle dotazioni presenti in camera, ma che possono avere beneficio della presenza di un altro paziente senza perdere delle valenze tipiche di una stanza singola (bagno personale, affaccio alla finestra, disponibilità di spazio per il proprio accompagnatore e famigliare).

Camere a due letti uso singolo utilizzabili per pazienti la cui degenza richieda l'utilizzo di presidi o tecnologie specifiche e pertanto sia richiesto uno spazio aggiuntivo per l'effettuazione di manovre assistenziali o per la mobilizzazione del paziente. Tale stanza in particolari condizioni di emergenza può prontamente essere attrezzata con un secondo letto mantenendo i requisiti di accreditamento

Supporti, settori strategici dove si svolgono le attività di lavoro di medici ed infermieri.

Soggiorni, modulabili tramite partizioni scorrevoli, fulcro delle attività di socializzazione. Da un massimo di quattro salotti separati si può ottenere un unico grande spazio che, come nel caso della pediatria, può fungere da sala per attività ludiche, o separato per attività specifiche (come spazio scuola, area di svago, etc.).

4.2 Assessment tool (checklist) for inpatient ward design

CRITERIA	SCORE
CORRIDOR SEATING AREAS	
No seating areas along corridors	0
Up to 30% of seating areas are aligned with outside views	1
Up to 60% of seating areas are aligned with outside views	2
Up to 80% of seating areas are aligned with outside views	3
WAITING SEATING AREAS	
No seatings in waiting areas	0
Up to 30% of seating areas are aligned with outside views	1
Up to 60% of seating areas are aligned with outside views	2
Up to 80% of seating areas are aligned with outside views	3
DISTANCE	
No sanitary facilities close to the reception	0
Up to 16 meters from the reception	1
Up to 12 meters from the reception	2
Up to 8 meters from the reception	3
Requirements for the level of environment control. • sound control (TV, music, radio) • natural light control (courtains or other shading devices) • artificial light control • possibility of moving seats	
CONTROL LEVEL	
No requirements met	0
25-50% requirements met	1
75% requirements met	2
100% requirements met	3
SINGLE PATIENT UNITS	
No use of single patient units	0
Up to 30% of single room in the inpatient ward	1
Up to 60 % of single room in the inpatient ward	2
Up to 80% of single room in the inpatient ward	3

CRITERIA	SCORE
BED ORIENTATION	
Absence of noise consideration and visual access to patient	0
Patient not visible from the corridor but away from the door	1
Patient visible from the corridor but close to the door	2
Patient head visible from corridor and away from the door	3
EXPOSURE TO NATURAL LIGHT	
No units have exposure to natural light	0
Up to 30% of units have exposure to natural light	1
Up to 60 % of units have exposure to natural light	2
Up to 80% of units have exposure to natural light	3
VIEW ON NATURE	
Units with no view	0
Units with view on inner couryards or other	1
Units with view on urban context	2
Units with view on green spaces	3
SURFACE PERCENTAGE	
Absence of outdoor green area	0
Up to 10% of surface deisgnated as outdoor green area	1
Up to 20 % of surface deisgnated as outdoor green area	2
Up to 30% of surface deisgnated as outdoor green area	3
PERCENTAGE OF FACING ROOMS	
Absence of room facing the green area	0
Up to 30% of rooms facing the green area	1
Up to 60 % of rooms facing the green area	2
Up to 90% of rooms facing the green area	3
NUMBER OF NURSING STATIONS	
1 each 30 patients	0
1 each 28 patients	1
1 each 25 patients	2
1 each 22 patients	3

QUALITATIVE RECCOMENDATIONS	YES/NO
Is there a sense of spaciousness with overcrowding avoided?	
Long, narrow corridors without daylight or views out of the building are avoided?	
Are different materials or colours used on walls and floors to indicate routes?	
Are there panels of a suitable size, contrasting with the background, positioned at eye level to give directions?	
Are there sound absorptions or blocking measures to minimize sound transmission between patient room and corridors?	
Is there furniture dedicated to day visitors?	
Is there forniture to accomodate visitors for the night?	
Are there shading devices to prevent direct sunlight?	
Is there an electric panel to let the patients control their lighting?	
Are there green elements as roof terraces, roof gardens, couryards or hanging gardens?	

The checklist has been tested on a floor plan of inpatient ward of the New Hospital of Salento, mario cucinella architects. Considering both sheets, score and yes/no questions, the results shows that the project achieves **80%** of the requirements and recommendations provided.

ELEMENTS OF INTEREST

LEGENDA

- INPATIENT ROOMS
- ROOMS WITH A VIEW ON NATURE
- GREEN INSIDE ELEMENTS
- NURSING STATIONS
- WAITING AREAS - VIEW ON NATURE
- WAITING AREAS - NO VIEW

05.
Conclusion

5.1 Research outlook

The elaboration of this research has gone through countless stages revealing complementary reasoning - developed jointly with the supervisor and co-supervisor, Prof. Stefano Capolongo and Andrea Brambilla - in which has occured the effort to systemise information and data progressively collected and processed. The work starts from a reflection on the question of the hospital built environment, on the analysis of how an architecture designed for the wellbeing of the user constitutes a fundamental asset. The privileged point of view was precisely that of the patient who finds himself experiencing spaces designed solely by virtue of therapy and functional organisation, without considering that set of elements outside the clinical aspect. A further privileged area of research is that of the healthcare workers without whom an effective treatment process would not be possible. The analysis therefore considered the concept of human-centred design and then developed research on performance requirements and an analysis of best practices of contemporary cases. The research focuses on a specific area of the hospital: the in-patient ward. Talking about inpatient unit means covering a wide sphere of needs, values and activities that have to be accommodated in appropriately designed buildings, capable of keeping up with developments in medicine and technology and, at the same time, responding to the different expectations of contemporary society.

The change that has taken place in the hospital system has become evident, with the increasing influence that hospital and city exert on each other, emphasised by the need for humanisation that characterises today's building for care and treatment. Firstly, a design approach must be developed to define spaces where the quality of living is not inferior to that of other social collective architectures and where the good proportioning of the units intended for in-patient care and meetings can contribute to improving the physical and mental health of the patient. This is why the research attempts to:

- investigate how design choices are related to healthcare outcomes, through scientific literature reading
- find out best practices from contempory case studies
- propose a methodology for evaluation, through the checklist
- provide a set of parameters on dimensional relationships
- define measurable or qualitative indicators about inpatient ward units design

At the conclusion of the planned activity, it can be said that the expected results have been achieved. The research, in fact, does not presume to exhaustively resolve the problems concerning the design of spaces supporting healthcare activities. It aims to develop a methodology and a tool for evaluation and to provide some guidelines with respect to a specific area of the hospital.

5.2 Limitations

The process of writing this thesis has enabled a deep exploration of the relation between the hospital built environment and the patient well-being. It has shed light on the current state of art and design in this field while highlighting a substantial gap between the two.

Despite the comprehensive methodology employed in the systematic literature review and the best practices analysis, there is room for enhancement and expansion in this initial phase.

This review was conducted by a single individual under supervision, rather than by a team of multiple researchers.

The scope of articles analyzed was restricted to those published between 2000 and 2020.

Considering the thematic tables defined by the Joint Research Partnership Healthcare Infrastructure, only three of them have been considered.

The collection of architectural experiences, although broad and differentiated, cannot be considered definitive and can be developed further.

5.3 Future developments

Conceived as an implementation of the state of the art, the present research work and the results to which it leads, are to be considered partial, especially when considering the implications that are aimed at the project dimension. There are two areas in particular that could be implemented in future engagements. The first concerns the inclusion of the two thematic tables of the Joint Research Partnership Healthcare Infrastructure that were excluded from the research: the sustainable and digital and technological fields of the hospital of the future. The work, in fact, focuses on the 'human' dimension of hospital architecture, of the inpatient area in particular. It would be appropriate, on the occasion of future studies, to implement the work by considering the relation that such complexes establish with the environment. Imagining sustainable buildings means opening a profound dialogue with climate and place. We have to imagine low-tech buildings in order to make form and materials, which are increasingly becoming an active part of the outcome, doing invisible work within a new circular economy, work more. This process seems to me closer to the complexity of nature rather than that of mechanical artifice.

The second area is relevant from a methodological point of view. The present work, in fact, analyses scientific articles from mainly two platforms, thus excluding a

number of papers. Furthermore, the analysis of best practices was developed on four cases and cannot be considered definitive: the number of contemporary cases shoulb be implemented.

The development of design strategies related to patient well-being in inpatient units is considered as the ultimate goal. However, the practical intention of the thesis is to illustrate a possible methodology for ward assessment, envisioning the actual use of the tool provided, at the time of design or intervention in this specific area, without having to start from scratch. In conclusion, it can be said that the intention is mainly about inspiring push in further research to those who are involved in hospital design.

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