

Social sustainability in healthcare facilities: a rating tool for analysing and improving social aspects in environments of care

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Abstract

Introduction. Nowadays several rating systems exist for the evaluation of the sustainability of buildings, but often their focus is limited to environmental and efficiency aspects. Hospitals are complex constructions in which many variables affect hospital processes. Therefore, a research group has developed a tool for the evaluation of sustainability in healthcare facilities.

Methodology. The paper analyses social sustainability issues through a tool which evaluates users' perception from a the quality and well-being perspective. It presents a hierarchical structure composed of a criteria and indicators system which is organised through a weighing system calculated by using the Analytic Network Process.

Results and discussion. The output is the definition of a tool which evaluates how Humanisation, Comfort and Distribution criteria can affect the social sustainability of a building.

Conclusion. Starting from its application, it is evident that the instrument enables the improvement of healthcare facilities through several design and organisational suggestions for achieving healing and sustainable architectures.

Key words

- social sustainability
- humanisation
- distribution
- comfort
- users' perception

INTRODUCTION

A hospital is a place in which the health concept is strongly intertwined with well-being, ethics and environmental aspects; it is a complex construction in which all the aspects addressed by the World Health Organisation (WHO) come to life: "health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" [1].

A healthcare facility is one of the most complex buildings that a designer is called to develop. It is a melting pot of different skills, interests and constraints, in particular technological, economic and political ones. It is not easy to evaluate such a complex reality composed of material and immaterial aspects (from hospital structure and layout configuration to hospital management and users' needs), that are strongly linked to each other. Responding to its function, a hospital is a place with a high perceptive sensibility [2], where attention is drawn to the importance of social aspects and the emotional

side of users' experiences (in fact, psycho-social aspects and human relationships represent important factors in these kind of spaces that are able to enhance all users' well-being and hospital quality) [3].

The relationship between users and the hospital is very intricate, especially in relation to users' emotional involvement, their physical and emotive orientation and, in most cases, it is affected by their condition, particularly for patients [4]. For example, from a patient's perspective, coming to hospital is an occasional, very intense event and an unexpected public and institutionalised experience in which the patient has to live for a specific period [2, 5]; whereas, for hospital staff, it is a demanding and continuous workplace. Therefore, it is easy to understand how environmental factors (shapes, volumes, colours, green spaces, etc.) can affect the experience in hospital spaces, with effects on the therapeutic process for patients and staff efficiency, as demonstrated by Roger Ulrich's studies on evidence-based

healthcare design [6]. Users need to feel welcomed in a hospital, through a process that is able to give them a participative role in design and therapeutic processes. In fact, patients are in a state of dependence which increases their illness condition, and the hospital structure, with its staff and facilities, can represent an important factor to relieve this condition; on the other hand, staff needs are characterised by a practical workplace.

A hospital should welcome users and give them the necessary guarantees which they expect from a healthcare facility: humanity, treatment and safety. However, these aspects alone (which include several elements such as management, ethics and structure that are linked to users' psycho-physical spheres) are often neglected by the most recognised international evaluation tools. In fact, in most of the attempts to evaluate hospital sustainability, attention is given to the environments and efficiency, particularly to the impact of hospital processes on it.

The promotion of some guidelines on efficiency and social aspects in hospitals was encouraged by the *Decalogue of the hospital of the future*, a research project coordinated by Prof. Veronesi, Dr. Mauri and Arch. Piano in Italy in 2000. Among the principles which emerged, the main ones which analyse the social sphere are Humanisation (user-centred), Sociability (belonging and solidarity) and Organisation (effectiveness, efficiency and perceived well-being) [7].

Going beyond well-known concepts on sustainability, a research group developed a set of indicators which are able to comprehend most aspects that characterised social sustainability in healthcare facilities. This is seen as the process of creating an accessible, integrated and equitable community that successfully meets the needs of health and well-being of users. This aim is pursued through adequate facilities and people collaboration in order to create a safe place, a community where stimulating emotional-physical inclusion becomes a landmark in its territory, and spreading these behaviours among people and institutions in order to guarantee them in the future [8]. In the light of this concept, it is possible to understand the importance of users' centrality, the social cohesion and the relationship with the context to avoid users' sense of isolation.

There are several inherent risks for patients and staff in this type of structure such as isolation, disorientation, illness, etc. In a hospital, it is fundamental to help users to not lose their own identity and to assist them to deal with their condition, by establishing relations between the structure and the territorial context in a perspective of collaboration, social inclusion and participation. Moreover, strong attention to hospital spaces can have an important effect on users' trust [8].

The result of the research work is a global, easy and accessible rating tool, which also includes principles and strategies for the building of sustainable and healing hospitals that are both operative and in-design ones. Social aspects can be pursued through adequate policies and structures, but they are very different depending on hospital typologies. It is easier to integrate social issues in managerial policies and design in new hospitals, for new awareness is spreading with reference

to these aspects. Nowadays, attention to users' psycho-physical well-being and the importance of an accessible, comfortable and welcoming environment is a well-known factor. Consequently, architects, designers, hospital general managers and chief medical officers are called to deal with these aspects, integrating all of them into hospital policies and design. However, in operative ones, in most cases the structure represents an obstacle to the creation of a comfortable place, followed by the preceding hospital concept: a place to cure the illness instead of the patient (this case did not take into consideration the important effect of environmental and therapeutic treatment in the healing process. Attention was concentrated particularly on medicine, research outputs and its instruments).

Starting from these considerations, the research group created an evaluation tool not only for evaluating the social sustainability level of a hospital, but also able to guide the project and the decisional processes of designers for improving the quality and efficiency of the structure [9].

MATERIALS AND METHODOLOGY

State-of-the-Art presents several rating systems of sustainability, in particular the environmental aspect, with greater attention in new construction healthcare buildings (*i.e.* BREEAM Healthcare and LEED for Healthcare), unlike the existing and operative ones that are treated in a general way (*i.e.* LEED for existing buildings operations and maintenance rating system). In relation to these issues, there is a greater tendency for analysing design, construction and plant engineering aspects rather than the managerial and social ones which have a big influence on operative facilities. If on the one hand, the unbalanced focus of these systems specifically on environmental issues facilitates the comparison of performance among health facilities, on the other, it leads to the underestimation of the other aspects which characterise the entire hospital system [10].

However, to fully understand its own complexity, a hospital needs a global vision that is able to analyse both the structure and management, as well as the relations which, in turn, develop. To address this issue, the research work was carried out for a comprehensive perspective that analyses the sustainability of healthcare facilities through economic, environmental and social aspects. This rating tool is characterised by a hierarchical structure consisting of three areas of sustainability (macro-areas); each of them is composed of a set of criteria which are characterised by indicators that evaluate each aspect [11-13]. These are built in a SMART (specific, measurable, attainable, relevant and timely) logic which is able to facilitate a comparison between different health facilities [14].

Commencing from the methodology applied, the main goal of this paper is to analyse social sustainability and its repercussions in the hospital system. However, it is important to emphasise the weights of the criteria and indicators in their multiple relationships which influence the entire weighting system (macro-areas, criteria and indicators) and the overall hospital assessment. In order to study these dynamics, the multi-criteria

method of Analytic Network Process (ANP) [15, 16] was applied. Focus groups and interviews with experts and professionals in different fields (hospital planners, architects, engineers, plant engineers, doctors, medical directors and technicians) enabled the subdivision of the methodology into hierarchies that are part of individual macro-areas and different criteria. This system reduces as much as possible the risk of excessive subjectivity in the result (an aspect which many researchers criticize in voluntary rating systems) [17]. Working consisted of scholars in the field of hospital design and management, along with some experts on these topics, including the CNETO (Italian National Centre of Hospital Construction and Technology) members. Their know-how and knowledge facilitated the definition of the tool, and the criteria and indicators system.

In order to test the tool and understand its validity and effectiveness, research was subdivided into two evaluation systems: one for operative hospitals, and the other for new generation ones, in which weights and contents differ. In the former, the focus is also based on management, non-structural aspects and environmental elements while, in the latter, the focus is mainly on all those aspects related to environmental sustainability (the site, urban planning, materials, strategies for flexibility, etc.), which are easier to evaluate in the planning phase of a new generation hospital rather than in an operative one [18].

Several references were used for the definition of social sustainability indicators, including evaluation systems relating to a city, in view of the high level of complexity that makes it similar to the hospital system: the urban context, can be regarded as a microcosm, in which different aspects are strongly correlated. Therefore, to create a set of indicators which take most of the aspects of the social sphere into account, it was useful to use the WHO and the European Community tools that analyse urban aspects and population well-being [19]. The reference framework that was adopted is used by many government agencies, Non-Governmental Organisations and academic researchers to define sustainability and for the monitoring of assessment programmes. In particular, a set of indicators has been developed for the UK by the Office of the Deputy Prime Minister [20] as a guide for the sustainability of cities, as well as European City Indicators which were elaborated by *Ambiente Italia* [21].

As emerged from state-of-the-art, indicators become the basis on which the evaluation system develops because they directly measure hospital performance. Each indicator has a specific evaluation approach and data can be obtained through different methods: questionnaires, site inspections and analysis, studying hospital floor plans, data, budgets and file archives, and interviews with staff technical and health staff [13].

RESULTS AND DISCUSSION

The output of the work gives rise to two evaluation systems: one for new generation hospitals (final design and execution of the building during construction) and the other for operative hospitals (timely analysis within the structure with appropriate checks in several hospi-

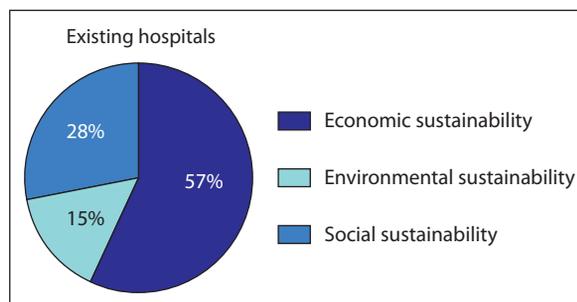


Figure 1 The weighing system of economic, environmental and social sustainability in operative healthcare facilities. The values were determined by a focus group with several experts in hospital planning and management.

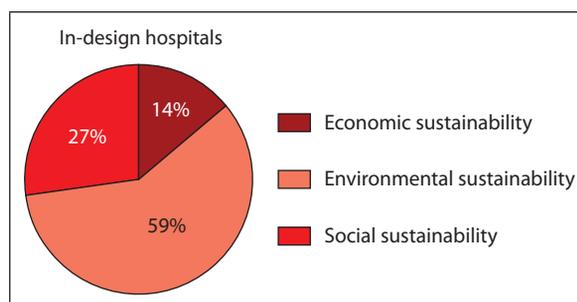


Figure 2 The weighing system of economic, environmental and social sustainability in in-design hospitals. The values were determined by a focus group with several experts in hospital planning and management.

tals and verifying the efficiency of the structure itself) (*Figure 1* and *Figure 2*).

For the definition of the rating system, a minimum number of criteria were chosen that were able to assess most of the issues which characterise social sustainability in hospitals. A common thread is represented by a user-centred vision and criteria and indicators (C&I) were identified looking at users who live in hospital environments: staff, patients and visitors. Through the analysis and users' opinions, the research work defines three criteria: Humanisation which evaluates the hospital's environment and policies; Comfort which considers the hospital environment through quantitative data that are able to indicate micro-climatic conditions (in these types of spaces, indoor quality is a very delicate issue because of the multiplicity of factors that affect the hospital during its operating phase); and, Distribution in order to take into account the impact of the organisation of spaces, paths, etc. on people's well-being.

Social Sustainability is therefore characterised by a number of criteria, each of which is composed of four indicators; in *Figure 3*, they are synthesised into the hierarchic structure.

Focus groups and interviews were set up to expertly underline the different tendencies. Economic and social sustainability plays a strategic role for an operative hospital, while environmental sustainability is funda-

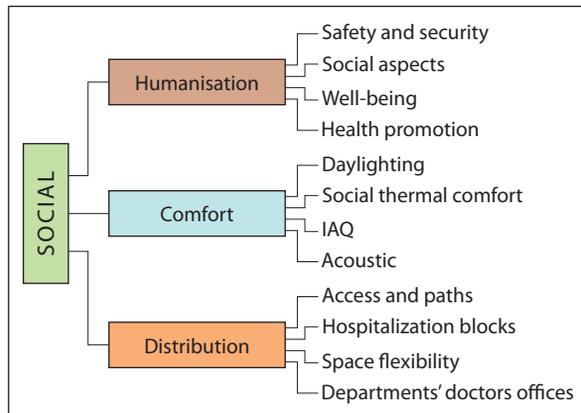


Figure 3
Hierarchical structure of social sustainability composed by criteria and indicators.

mental for a new generation one [18]. Compared to other areas of sustainability, the social element remains constant and the indicators analysed are the same for both methods, despite significant research and evaluation methodology and the processing of data change. Figure 4 and Figure 5 report all the weights for each C&I, and the results of the focus groups and interviews with experts calculated using the ANP.

According to studies conducted, it is necessary to ensure specific prerequisites for obtaining the final score for each criterion in operative structures. If this is not met, criterion cannot be calculated.

By combining the scores achieved for each macro-area, global sustainability is then evaluated through a value, from 0 to 100, divided in five bands: extremely insufficient (0-20%), insufficient (21-40%), almost sufficient (41-60%), good (61-80%) and excellent (81-100%) [13]. If the level is higher, the sustainability level achieved is innovative and effective. Through the weighing system, it is possible to identify critical issues for each indicator and possible strategic solutions for improving global hospital sustainability.

HUMANISATION

The criterion assesses the level of humanisation within the environments and services from the users' perspective. The term 'humanisation' does not only refer to the quality of spaces (*i.e.* private spaces such as patient rooms and common areas such as paths, lobbies, entrance halls and corridors), but also encompasses security and protection perception, users' involvement levels, campaigns for health promotion and the devices for social and cosy spaces and soft qualities. Starting from these suggestions, the criterion is focused on four aspects: safety and security, social aspects, well-being and health promotion. In particular, in the operative realities, this criterion represents the more qualitative indicator of the entire evaluation system with feedback obtained through questionnaires targeting the users who assessed the performance and perception of the environments and the processes of the healthcare facility [19]. As is evident from several studies carried out

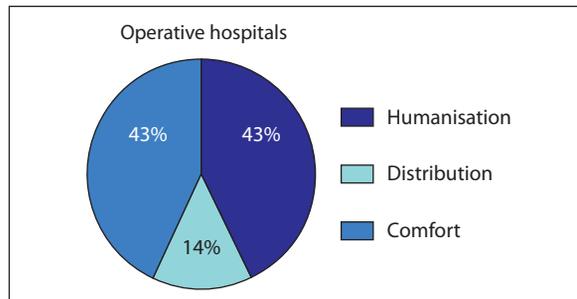


Figure 4
The weighing system of social sustainability in operative healthcare facilities. The values were determined by several questionnaires and interviews with experts in social aspects and hospital design.

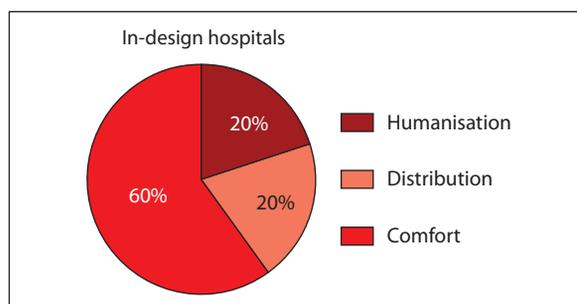


Figure 5
The weighing system of social sustainability in in-design hospitals. The values were determined by several questionnaires and interviews with experts in social aspects and hospital design.

in recent decades, it is essential to analyse hospital humanisation according to different users:

- patients: whose psychological well-being helps the healing process;
- visitors: affected by the first impression and the efficiency of the hospital system and the observation of care administered to the patient;
- medical and technical staff: whose motivation and productivity are strongly influenced by the best working environment.

According to Veronesi and Piano's Decalogue, Humanisation criterion implies the analysis of all the skills affecting users and their psycho-physical state (a user-centred system) and taking their needs into account; in particular, it is necessary to verify the wellness of the workers and the high level of stress they must endure [22]. The sense of safety is essential and it is necessary to verify users' perception as well as whether they feel protected (physical protection against theft, trust in the hospital system, medical staff and organisational processes, etc.).

Some other important aspects emerge from the study, such as social cohesion and cooperation designed for promoting collaboration among medical staff and patients and increasing the attention to social policies in hospitals, not only from a medical and therapeutic perspective, but also by identifying criticisms on the lay-

out and environments for the setting up of cosy spaces [23]. Hospitals are complex buildings with many design features which need to be clear from the design stage. Hospital planners have a high responsibility to design a structure that meets users' needs such as soft qualities, colours and materials selected, artificial and natural lighting, the quality of the furniture, signage and all routes, activities for staff and patients, the relationship with green areas and external views are so many variables that create users' well-being because, as demonstrated by Ulrich, a safer place through simple design features stimulates a faster healing process for the patients [24, 25].

For the evaluation of social issues in hospitals, it is necessary to analyse the perception of users (workers, outpatients and inpatients, etc.) as well as the present or future application of policies aimed at promoting a healthy and sustainable lifestyle with the introduction of some campaigns that promote issues regarding a healthy lifestyle, disease prevention and the use of natural and ecological materials.

Humanisation weighting system

The Humanisation criterion plays a strategic role in an operative hospital, unlike that of new ones where it appears rather marginal because it is not easy to evaluate. As mentioned previously, the high-value of this criterion in operative buildings is determined by the possibility to act on soft qualities and the relationship between the patient and hospital staff, and collaboration and perception of hospital environments. On the other hand, in newly-built hospitals, it is possible to act without affecting the constructive process, improving many aspects without any waste of resources and nowadays, it is difficult to predict users' perception and hospital management in the operating phase. Through a comparison of the results in Figure 6, it is clear that the more influential indicators are social aspects and safety & security [26].

In operative hospitals, the percentage is heavily influenced by the presence of pre-requisites that must be

guaranteed in order to evaluate the indicator and they are divided into hospital accessibility, adequate hygienic conditions, safety and security.

The criterion relies on the answers taken from the questionnaires that are administered in many departments to a heterogeneous user population (by age, sex, role, etc.), in different seasons and in different languages to adapt to users from different cultures (we live in a globalised world yet many foreign people still have not learned the language of the country they live in). The different applications require an evaluation of the questionnaires subdivided into four bands: not satisfied, very satisfied, quite satisfied, very satisfied.

The same work is applied to hospital design in which the questionnaires are evaluated by the users and medical staff of the existing hospital, so that the current needs and criticalities are analysed and, finally, verified in the new project and staff organisation.

The best sample corresponds to 10% of the users' population, divided between patients and visitors (looking at the average daily population), medical and technical staff throughout all the healthcare facility [19].

COMFORT

The comfort criterion analyses the hospital environments defining the importance of the relationship that is established between the user and space, through quantitative data which evaluate microclimate conditions. It calculates the indoor air quality of several areas of the hospital, the thermal inertia, soundproofing, natural and artificial lighting and, therefore, the suitable conditions of visual views, acoustics and comfort heat, in order to ensure occupants' full satisfaction with adequate environmental comfort during the healing process.

The presence of natural light takes on a strategic role in the configuration of a hospital: first of all, rooms need to look out onto the external environment, but so do workstations wherever possible (as Arch. Pradinuk sustains, the absence of light in working spaces is a contributor to prevent medical error) [27]. According to

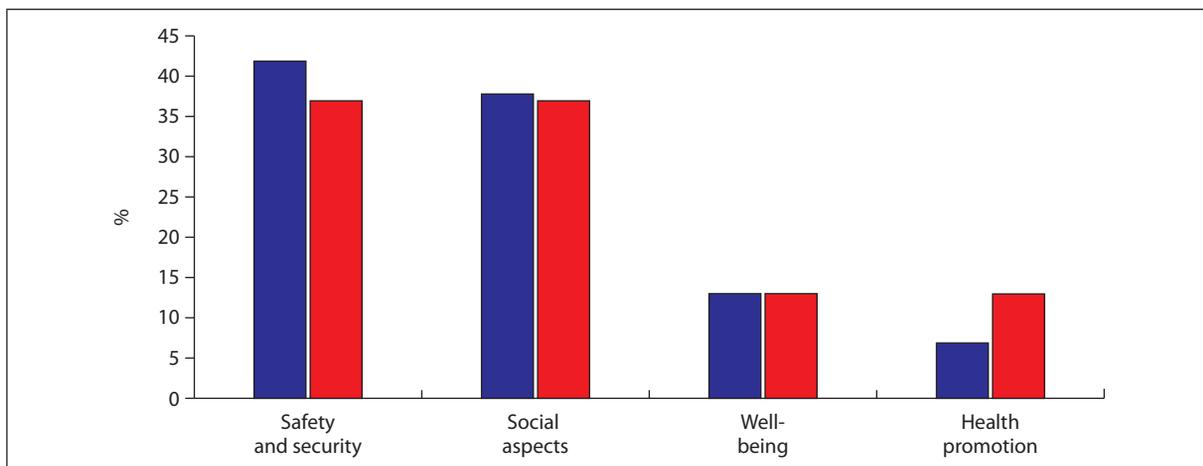


Figure 6 The weighing system of the humanisation issues for each indicator, the blue one represents the existing hospitals' weights, the red the in-design ones.

various analyses of hygiene, natural lighting results in an improvement of the productivity of medical staff and treatment for patients, and is psychologically influential contact with the outside world through large windows [28]. Nowadays, several studies and projects show that it is possible to have natural light in buildings, even in nurse stations through the planning of some areas for the nurses' activities, instead of inpatient rooms.

Starting from the operative rating systems, DF (daylight factor), UGR (unified glare rating) and CBDM (climate-based daylight modelling) are indicators that are more compliant for evaluation systems and for improving users' health and well-being in healthcare facilities. Starting from these suggestions, the criterion is defined by four indicators: daylighting, thermal comfort, indoor air quality (IAQ) and acoustics.

The Daylighting indicator is strongly linked to the layout and architectural design, energy costs and consumption of lighting systems and it is therefore important to develop aspects such as visual comfort, flexibility in the organisation of space, luminous flux throughout the day and its relative influence on the human circadian cycle, aesthetic quality of the environment (intensity and light colour), and differentiation of the reduction of illuminance in relation to the areas and the activities [29].

The criterion also analyses the temperature and the relative humidity of the environments: the purpose is to assess the value of the hospital in order to improve users' general physical and psychological states. The indicator refers to six parameters differentiated between ambient and radiant temperatures, two individual parameters related to the user, such as energy metabolism (M) and thermal resistance of clothing (Icl), and four environmental parameters, associated with the internal microclimate, such as air temperature, mean radiant temperature, air velocity and relative humidity.

Among the issues considered, in comfort and security terms, IAQ has the role of analysing and reducing the risks of infection with good air quality and correct air flow ventilation in hospital spaces; IAQ analyses the presence of physical, chemical and biological contaminants that are strongly influenced by geographic locations, and the avoidance of high-emitting materials, and naturally, components that are not present in external air [30, 31].

According to several international scholars, it is important to study the acoustics inside hospital environments. The effects of physiological, behavioural and pathological stress reduce the overall quality of life and users' sense of well-being. It is evident that stress is a variable that is not to be underestimated in hospital settings because it is able to influence both patients' and users' physical parameters with consequences on staff performance. Some studies have also endorsed the theory that occupational stress is closely linked between the psycho-physiological parameters of the user and this environment [32]. This relationship is affected by the image, the sensory conditions, the ability to exercise control over the environment and the orientation difficulties. All the elements, as already said, can sometimes be in their favour [33]. When it comes to State-of-the-Art, a hospital is classified for its sound insulation and soundproofing through specific values.

Comfort weighting system

Comfort, in relation to the two hospital typologies, has a considerable impact on the total score of social sustainability. In the case of operative hospitals, it is evident that comfort and humanisation have a similar weight which is enough to influence the result of the macro-area (Figure 4 and Figure 5). However, in new generation hospitals, comfort has greater influence within the social macro-area and its result is due, in particular, to the resulting scores of daylighting, thermal comfort and IAQ, whose sum is equal to half of the entire score.

As illustrated in Figure 7, daylighting has the greatest weight from among the indicators, since it is the only one that permits non-invasive changes on the structure: several operative and new construction healthcare facilities apply a uniform lighting design, including in several underground spaces, and study diurnal cycles of working spaces. It is important to guarantee a dynamic design of the artificial lighting system which attempts to integrate available daylight.

With regard to thermal comfort, the influence of the result is not so predominant because it must respond to some regulatory requirements. Since some aspects are evaluated in the user questionnaires under the humanisation criterion, it is important to apply strategies that guarantee a good perception of hospital environments.

It is only possible to calculate the IAQ indicator by studying the dynamic calculations of people flows, or sizing the system for a constant coverage of needs and leaving the most adverse situations managed through passive systems. For obtaining good IAQ performances, it is important to use finishing and furniture materials that absorb pollutants, or high quality materials, and with a reduced presence of formaldehyde [31].

In the rating tool, the acoustics indicator is not very influential but it should be taken into consideration in the design to achieve user's well-being. The use of sound-absorbing materials that can respond positively to user needs is recommended.

DISTRIBUTION

The Distribution criterion evaluates the efficiency of the access paths and distribution. The criterion is then characterised by four indicators: access and paths, space flexibility, hospitalisation blocks and departmental doctors' offices.

A hospital project requires a layout that ensures a good organisation of the departments, the several functions and all the distribution networks. The accesses, in particular the main reception area, become the starting-point of a user's experience and, therefore, all the routes must be designed properly [26]. Several international research works have shown that people's physical and mental states are greatly determined by the hospital, service efficiency and quality, its distribution, etc. [34]; distribution has the function of optimising the flow and the access of users and resources, especially in the design phase and construction. Resource optimisation in the design phase, in fact, allows more flexibility in the use of space to fulfil different functions during the course of its life and permitting its transformation

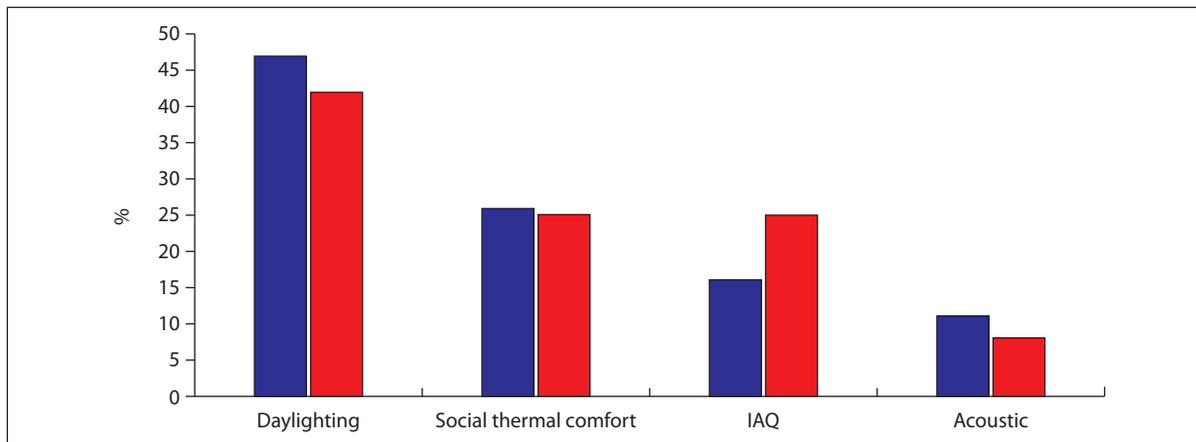


Figure 7

The weighing system of the comfort issues for each indicator, the blue one represents the existing hospitals' weights, the red the in-design ones.

through a low use of resources. This requisite is much more difficult, and therefore much more complex, in operative healthcare facilities because the paths are quite constrained by the layout.

It is necessary to ensure good organisation based on system processes and distribution planning for the different requirements, users and functions of the entire complex, together with different accesses for first aid, logistics, researchers and students. The project must meet the hospital's needs and its functions. This criterion is strongly influenced by management aspects, analysed in an economic sphere. As several case studies demonstrate, such as that of the Humanitas Clinical Institute of Rozzano in Milan, healthcare facilities are designed with a flexible layout which facilitates strong management that can be changed quite simply [35].

The criterion also assesses the functionality and flexibility of hospitalisation blocks through their typologies subdivided into: inpatient rooms on the front and naturally-lit corridor; a central corridor and inpatient rooms on both sides; inpatient rooms on both sides, double corridors and nurses' station in the middle of the block. Respecting the typologies, the indicator is also affected by the distance between the rooms and the vertical connections [36].

Within the distribution criterion, flexibility and functionality are also evaluated: firstly, with a view to transforming some parts of the building or hospital or research environments [37] with the least amount of human and physical resources; secondly, to re-arrange the departments which, in turn, can be divided into delocalised areas or areas in proximity of outpatients' clinics and inpatient wards with a common distribution or an innovative one, such as open spaces and the presence of comfortable and relaxation areas [38].

Distribution weighting system

Referring to the whole rating system, in the social sustainability sphere, distribution for both systems has very little influence on the total score. The values, in fact, are so limited, especially in operative hospitals, because of

difficult processing and change over time (Figure 4 and Figure 5).

As illustrated in Figure 8, accesses and paths have a strong weight on the criterion because it is evident that the size of the structure has a cascading influence on the other indicators which characterise the structure. The structure must be easily accessible with clear directions; the user must be able to move easily within the structure and without any discomfort.

On the subject of new hospitals under construction, space flexibility is the most important requirement for guaranteeing flexibility to the building in all its complexity. Nowadays, there are several case studies with very flexible solutions for responding to hospital and medical requirements such as the INO-hospital in Bern (SW) and the Martini hospital in Groningen (NL), European case studies that guarantee, through different strategies, a good conversion of the building.

CONCLUSIONS

After several studies and the application of the tools on a number of hospitals, today the research work demonstrates that it is able to measure social sustainability in healthcare facilities and, consequently, capable of suggesting some appropriate improvements. The rating system is very susceptible to users' perception in operative hospitals and to the best theories and practices on well-being in the new ones. Therefore, the results were very consistent with reality [39]. In the case of in-design structures, the tool is indispensable because the connection between the psycho-physical state of a person and the environment is an important well-known issue. It is, therefore, fundamental to involve users in order to understand their needs and create a structure that is able to respond them [39]. On the other hand, with regard to the already-built structure, social sustainability is frequently undermined. This rating system really aims to pinpoint the weak factors in this field and to propose new policies and strategies to improve it. Therefore, the tool is equally important for the two types of healthcare buildings.

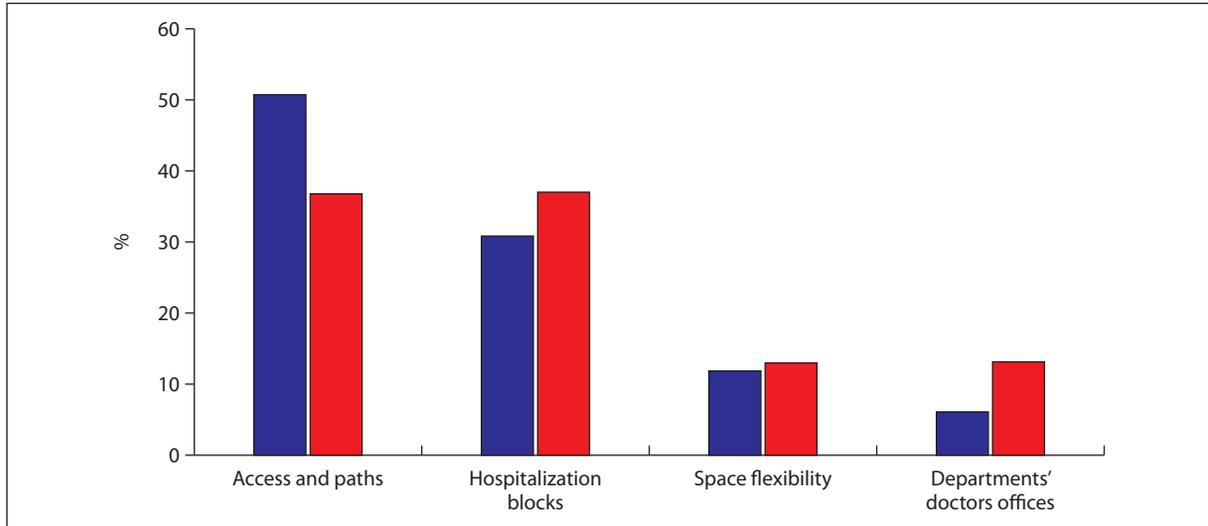


Figure 8

The weighing system of the distribution issues for each indicator, the blu one represents the existing hospitals' weights, the red the in-design ones.

As the application revealed, some factors are somehow more important than others and this is the reason why they have major weight in the evaluation process. Moreover, for the actual assessment, some indicators require a relatively long period of time and participation, which later helps to create statistics and shape the result. This is the reason why the instrument is so rich and useful: it is focused on several areas of social sustainability and tries to catch all the possible nuances of perception. It is, therefore, objective and omni-comprehensive. To this end, the rating tool should be implemented as much as possible before construction, and later, when making decisions for new modifications or for regular monitoring.

Modern hospital science and medicine have already demonstrated that the human body is not a complex machine that needs to be repaired, but a person who has to be respected and assisted in order to live healthily. For this reason, every new hospital (as well as existing ones where possible) must strive to be fully focused on the person, becoming a true social place which does not imply exclusion, but rather inclusion and well-being, with the motto "The Patient always comes first".

Nevertheless, this tool has its own limits: for instance, it presents difficulties in comparing hospitals of the same type but of a different size or functions; consequently, in the future, an adjustment of the method may be developed to also consider these irregular circumstances. Instruments, such as questionnaires, have to be introduced with a clearer focus on specific patient categories such as elderly people or paediatrics.

This tool varies from other existing tools because it is easy to operate and assesses social sustainability particularly in the way it interacts with the rest. Furthermore, it is also very reliable because of the scientific weighting method employed to compare the different criteria. A major advantage is that it is a wide-perspective tool that is not just based on a single point of view and it is easy to measure. In this way, the rating system reflects

what experts really sustain. In addition, the tool which has been developed provides guidelines which can be consulted by hospital planners during the design phase, and offers a measure to understand the field in which to work further in order to efficiently improve overall sustainability. It also provides techniques and modifications to create operative structures that are more human and socially-friendly [27].

A further development of the evaluation system outcome should aim to create an international standard for sustainable hospitals which takes into consideration the differences and peculiarities of each alternate type of building, as well as differences on the regional scale [40]. Up to now, it has been proved that this evaluation tool provides a better basis for evaluating buildings than other rating systems, mainly because of the consideration of all the three aspects of sustainability: environmental, social and economic.

What is really innovative is the fact that the tool not only evaluates the degree of sustainability of a project as a static tool, but it also has a dynamic nature. This is, due to the design aid it provides after the appraisal for a new hospital and improvement strategies for operative ones. In fact, the system developed in this research work measures overall social sustainability; it finds the weak points and, finally, provides possible solutions for design and management teams. These are the reasons why this tool seems to be a very helpful and valuable monitoring instrument when trying to deliver the best results in a reasonable period of time.

Conflict of interest statement

There are no potential conflicts of interest or any financial or personal relationships with other people or organizations that could inappropriately bias conduct and findings of this study.

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REFERENCES

1. World Health Organization. *Preamble to the constitution of the world health organization*. New York: Official records of the WHO; 1946.
2. Spinelli F, Bellini E, Fossati R, Bocci P. *Lo spazio terapeutico*. Firenze: Alinea Editrice; 1994.
3. Graban M. *Lean hospitals*. Florida: CRC Press; 2012.
4. Capolongo S, Buffoli M, Oppio A, Petronio M. Sustainability and hygiene of building: future perspectives. *Epidemiol Prev* 2014;38(6):46-50.
5. Capolongo S, Buffoli M, Oppio A, Nachiero D, Barletta M.G. Healthy indoor environments: how to assess health performances of construction projects. *Environ Eng Manag J* 2013;12(S11):209-12.
6. Alfonsi E, Capolongo S, Buffoli M. Evidence based design and healthcare: an unconventional approach to hospital design. *Ann Ig* 2014;26(2):137-43. DOI: 10.7416/ai.2014.1968
7. Capolongo S. *Edilizia ospedaliera*. Milano: Hoepli; 2006.
8. Capolongo S, Buffoli M, Oppio A, Rizzitiello S. Measuring hygiene and health performance of buildings: a multidimensional approach. *Ann Ig* 2013;25(2):151-7. DOI: 10.7416/ai.2013.1917
9. Capolongo S, Buffoli M, Riva MG, Tognolo C, Oppio A. Hygiene and emergency: considerations and proposals for improving hygiene and health features of Advanced Medical Post. *Ann Ig* 2012;24(5):389-96.
10. Capolongo S, Bottero MC, Lettieri E, Buffoli M, Bellagarda A, Birocchi M, et al. Healthcare sustainability challenge. In: Capolongo S, Bottero MC, Buffoli M, Lettieri E (Eds). *Improving sustainability during hospital design and operation: A multidisciplinary evaluation tool*. Cham: Springer; 2015. 1-10. DOI: 10.1007/978-3-319-14036-0_1
11. Buffoli M, Capolongo S, di Noia M, Gherardi G, Gola M. Healthcare sustainability evaluation systems. In: Capolongo S, Bottero MC, Buffoli M, Lettieri E (Eds). *Improving sustainability during hospital design and operation: A multidisciplinary evaluation tool*. Cham: Springer; 2015. p. 23-30. DOI: 10.1007/978-3-319-14036-0_3
12. Buffoli M, Capolongo S, Bottero M, Cavagliato E, Speranza S, Volpatti L. Sustainable Healthcare: how to assess and improve healthcare structures' sustainability. *Ann Ig* 2013;25(5):411-8. DOI: 10.7416/ai.2013.1942
13. Bottero MC, Buffoli M, Capolongo S, Cavagliato E, di Noia M, Gola M, et al. A multidisciplinary sustainability evaluation system for operative and in-design hospitals. In: Capolongo S, Bottero MC, Buffoli M, Lettieri E (Eds). *Improving sustainability during hospital design and operation: A multidisciplinary evaluation tool*. Cham: Springer; 2015. p. 31-114. DOI:10.1007/978-3-319-14036-0_4
14. Doran G. There's a S.M.A.R.T. way to write management's goals and objectives. *Manag Rev* 1981;70(11):35-6.
15. Bottero MC. *Indicators assessment systems*. Berlin: Springer; 2011. p. 15-29. DOI: 10.1007/978-94-007-0366-7_2
16. Saaty T. *Theory and applications of the analytic network process*. Pittsburgh: RWS Publications; 2005.
17. Capolongo S, Buffoli M, di Noia M, Gola M, Rostagno M. Current scenario analysis. In: Capolongo S, Bottero MC, Buffoli M, Lettieri E (Eds). *Improving sustainability during hospital design and operation: A multidisciplinary evaluation tool*. Cham: Springer; 2015. p. 11-22. DOI: 10.1007/978-3-319-14036-0_2
18. Buffoli M, Gola M, Rostagno M, Capolongo S, Nachiero D. Making hospitals healthier: how to improve sustainability in healthcare facilities. *Ann Ig* 2014;26(5):418-25. DOI: 10.7416/ai.2014.2001
19. Buffoli M, Bellini E, Bellagarda A, di Noia M, Nickolova M, Capolongo S. Listening to people to cure people: The LpCp – tool, an instrument to evaluate hospital humanization. *Ann Ig* 2014;26(5):447-55. DOI: 10.7416/ai.2014.2004
20. Office of the Deputy Prime Minister, Audit Commission, Department of Environment, Food and Rural Affairs. *Local quality of life indicators, supporting local communities to become sustainable. A guide to local monitoring to complement the indicators in the UK Government sustainable development strategy*. UK: Office of the Deputy Prime Minister; 2005.
21. Ambiente Italia. *Indicatori Comuni Europei. Verso un profilo di sostenibilità locale*. Roma: Ambiente Italia; 2003.
22. Del Nord R, Peretti G. *Lumanizzazione degli spazi di cura*. Firenze: Centro di ricerca Tesis sistemi e tecnologie per le strutture sanitarie; 2012.
23. Maiocchi M. *Design e comunicazione per la sanità*. Rimini: Maggioli Editore; 2008.
24. Capolongo S, Bellini E, Nachiero D, Rebecchi A, Buffoli M. Soft qualities in healthcare. Method and tools for soft qualities design in hospitals' built environments. *Ann Ig* 2014;26(4):391-9. DOI: 10.7416/ai.2014.1998
25. D'Alessandro D, Buffoli M, Capasso L, Fara GM, Rebecchi A, Capolongo S. Green areas and public health: improving wellbeing and physical activity in the urban context. *Epidemiol Prev* 2015;39(5):8-13.
26. Trabacchi V, Pasquarella C, Signorelli C. Evolution and practical application of the concept of clinical governance in Italy. *Ann Ig* 2008;20(5):509-15.
27. Guenther R, Vittori G. *Sustainable healthcare architecture*. Hoboken: John Wiley & Sons; 2014.
28. Origgi L, Buffoli M, Capolongo S, Signorelli C. Light wellbeing in hospital: research, development and indications. *Ann Ig* 2011;23(1):55-62.
29. Buffoli M, Capolongo S, Cattaneo M, Signorelli C. Project, natural lighting and comfort indoor. *Ann Ig* 2007;19(5):429-41.
30. Signorelli C, D'Alessandro D, Capolongo C. *Igiene edilizia e ambientale*. Roma: Società Editrice Universo; 2001.
31. Settimo G. Residential indoor air quality: significant parameters in light of the new trends. *Ig Sanita Pubbl* 2012;68(1):136-8.
32. Baglioni A, Capolongo S. Ergonomics in planning and reconstruction. *G Ital Med Lav Ergon* 2002;24(4):405-9.
33. Cook N, Hayashi T. The psychoacoustic of harmony perception. *American Scientist* 2008;311-9.
34. Simeone D, Kalay Y, Schaumann D. Using game-like narrative to simulate human behaviour in built environments Open Systems. In: Proceedings of the 18th International Conference on Computer-Aided Architectural Design Research in Asia, CAADRIA 2013, p. 99-208.
35. Bohmer R, Pisano G, Tang N. Istituto Clinico Humanitas (A). *Harvard Business School Case* 2002.
36. Nickl-Weller C, Nickl H. *Hospital architecture*. Berlin: Braun; 2007.
37. Buffoli M, Nachiero D, Capolongo S. Flexible healthcare structures: analysis and evaluation of possible strategies and technologies. *Ann Ig* 2012;24(6):543-52.
38. Cavagliato E, di Noia M, Gherardi G, Gola M, Nickolova M, Rostagno M, Speranza S, Volpatti L. *Testing the susthealth evaluation system*. Cham: Springer; 2015. p. 115-29. DOI: 10.1007/978-3-319-14036-0_5
39. Casati C. *Architectural design of hospitals*. Milano: Hoepli; 1980.
40. Cantlupe J. *Hospital sustainability gets executives' attention*. Brentwood: Health Leaders Media; 2010.