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Sustainability in Healthcare: Combining Organizational and Architectural Levers

Regular Paper

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Abstract Healthcare has been progressively required to improve its environmental performance as have other industries in recent years. In this regard, many new healthcare facilities have been built worldwide adopting sustainability-oriented approaches. However, results have been limited from an ecological and economic perspective, and many projects have rapidly become failures and then been abandoned.

A large part of these failures is grounded in the misalignment between the adoption of eco-friendly facilities and greening technologies and the persistence of outdated practices, mindsets and behaviours among healthcare professionals.

This study aims at furthering the current debate among leading practitioners and scholars of engineering business management about the combination of organizational and architectural levers for improving the sustainability of healthcare delivery.

By taking a socio-technical systems perspective, we developed a literature-grounded framework and relative propositions with respect to the improvement of sustainability-related performances in hospitals through the combination of organizational and architectural levers. Ten levers and their mutual relationships have been identified and described.

Keywords Sustainability, Greening, Healthcare, Hospital, Architecture

1. Introduction

Global warming emissions, local pollution and shortages of natural resources, such as water, are rising new concerns in societies, and these ultimately connect to the long-term sustainability of healthcare delivery as we know it today [1]. In this regard, there is a rising urgency in the most developed countries to implement new strategies and initiatives to reduce a healthcare-related climate footprint and move toward climate-neutrality. This is happening in a context that is globally characterized by high uncertainty, since information about environmental and economic changes is getting more and more difficult to collect, process and comprehend fully [2]. The debate surrounding the environmental performance of hospitals is attracting the interest of both leading practitioners and scholars of many disciplines such as engineering business management. Recent projects in Europe, US and Canada

confirm the relevance and urgency of this issue. For instance, Practice Greenhealth is a leading networking organization for institutions in the healthcare community that has made a commitment to sustainable, eco-friendly practices. Moreover, the Green Guide for Health Care is a best practice guide for healthy and sustainable building design and construction, and operations for the healthcare industry. Additionally, the European Commission has very recently recommended that hospitals should save energy and preserve the environment, and, in this regard, funded the construction/renovation of five European hospitals - i.e., Aabenraa/Haderslev Sygehus (DK), Fachkrankenhaus Nordfriesland (D), Meyer Children Hospital (I), Torun City Hospital (PL) and Deventer Hospital, (NL) - to promote examples of eco-friendly hospital building design. Finally, the World Healthcare Organization delivered a roadmap for sustainable (healthy) hospitals in which environment-related issues play a key role.

Despite these efforts, the real picture is different. Results have been limited from both an ecological and economic perspective, and many projects have rapidly become failures and then been abandoned. A large part of these failures is grounded in the misalignment between the adoption of eco-friendly facilities and greening technologies, and the persistence of outdated practices, mindsets and behaviours among healthcare professionals.

In fact, the innovation of hospital buildings is only one half of the challenge for eco-friendly hospitals. The other "half of the apple" is the aligned innovation of hospital organization, practices and behaviours [4]. According to the socio-technical systems theory, the *joint optimization* of the social and technical systems is necessary in order to achieve the desired organizational outcomes [5], the level of which depends on the "goodness of fit" between the two systems [6]. Therefore, when buildings are innovated without a coherent and synergistic change in the organizational realm, hospital professionals are more likely to replicate the practices and behaviours they engaged in in the previous layouts, nullifying the benefits and potentialities of the new buildings, or to be resistant to change [7, 8], since the new spatial organization is alien or unsuitable for them.

In this regard, past research has claimed that sustainability can be achieved only through a profound change that is not limited only to structural and architectural factors, but includes – and leverages on – organizational practice [8-13].

However, our current understanding of how architectural and organizational factors should be aligned in hospitals to promote and facilitate sustainability-oriented practice and performances is still very limited. The literature has developed along two parallel lines. The first stream dealt with architectural and structural factors, and their relative leverages. The second stream investigated the organizational factors and their relative leverages. At present, these two streams have no clear interconnections. The shortcomings of this limited understanding of the interplay between architectural and organizational factors have become very critical since many healthcare systems worldwide are implementing strategies and initiatives for making healthcare delivery sustainable by building new or renewing hospital buildings. Architects claim that their new projects promote and facilitate sustainability, but it is emerging that they lack clear guidance and indications on how to achieve these advantages. In particular, they are failing to take into account that hospitals and healthcare professionals also have to change their practices and behaviours in order to make the new architectural configuration work. In fact, the persistence of outmoded practices and behaviours might reduce any benefit. Additionally, despite hospital managers wanting state-of-art hospital buildings and new layouts for improving sustainability-performance, they are unable to provide architects with clear indications since they have no ideas on which architectural leverages might facilitate the organization, the practices and the behaviours they want to engage in in the new facilities.

Within this context, scholars of engineering business management have the possibility to advance both theory and practice by applying their multi-specialty approach to the study of the interplay between architectural and organizational factors.

This paper moves in this direction and aims to further the current debate by proposing a theoretical framework. By adopting a socio-technical systems perspective, as suggested by [11-13], we conciliate different bodies of literature with peculiar and often conflicting concepts, factors and leverages in a comprehensive framework. The list of new propositions that we have generated provides scholars of engineering business management with clear avenues for their further research. Their eventual confirmation (or not) will provide healthcare regulators, hospital managers, professionals and architects with clear indications about how to align the architectural and the organizational design of new or renewed hospitals.

2. Methods

Past research focused distinctly on the architectural or the organizational factors that might contribute to making a hospital sustainability-oriented and failed to crystallize the interplay between the two distinct bodies of factors. In order to narrow down this limitation, we carried out a literature review aimed at collecting the relevant studies that investigated the architectural or the organizational

factors and leverages that might be conducive to an increased sustainability in the peculiar context of new or renewed hospitals. Our review is not intended to provide an exhaustive analysis of such factors. Rather, it offers a survey of contributions that may help to improve our understanding of the most relevant interplays between the various factors.

We carried out an electronic literature search from January 1990 onwards covering Scopus, Ebsco and Pubmed to collect the relevant contributions. The references of the selected contributions were also reviewed. Both factors and leverages were limited to the architectural and organizational domains, and to the hospital setting. Potential contributions were identified through the use of the following keywords: "sustainability", "sustainable", "green", "environment" combined with "healthcare", "hospital", "design", "service", "workplace" and "facility".

The 81 identified contributions were reviewed for relevancy by the authors separately on the basis of the title and abstract. If at least one reviewer identified a contribution as being potentially relevant, the full paper was obtained. The 37 collected papers were then reviewed and a brief textual description was written for each factor or leverage, in particular concerning the interplays with other factors or leverages.

3. Findings from the Literature Review

The main findings from the literature review will be illustrated with respect to the two bodies of past research. Their mutual relationships will be illustrated in Section 4. In the following, we will illustrate formerly the main factors and leverages that refer to the architectural realm, and then the main factors and leverages that come from the organizational stream.

3.1 Architectural factors

Sustainable hospitals differentiate themselves from their conventional peers by their capability to achieve carbon neutrality or zero waste, and thus to minimize negative impacts on the natural environment and local communities [14,15]. Moreover, sustainable buildings are designed for flexibility, long-term use and high-performance [16].

Five design factors emerged from our literature review as salient for improving sustainability-related performances in hospitals. These factors are claimed to have not only a positive impact on environmental aspects, but also on staff well-being and productivity. They are: 1) ambient conditions, 2) spatial layout and functionality, 3) signs, symbols and artefacts, and 4) materials and technical systems.

In the following, they are detailed briefly.

3.1.1 Ambient conditions

Ambient conditions include the background characteristics of the environment such as temperature, lighting, noise and scent. As a general rule, ambient conditions affect the five senses [17].

Natural light and lighting in general have received a great amount of attention, because when taking advantage of natural light it is possible to minimize the need for electric lighting during the daytime, saving both energy and money [16, 18, 19, 20]. Additionally, the availability of natural light is cited as a major factor influencing the mood of patients and having a beneficial effect on the welfare and productivity of staff [21,22]. The ability to control the immediate environment, such as temperature, ventilation and light, is cited as one example of an important design feature affecting retention of nurses (for example, see [19]).

The exposure to nature views is appreciated by both patients and staff [1, 18, 24, 25, 30]. In this regard, past research found that hospitals that offer outside spaces, gardens and landscaping for rest and relaxation have an increased capability to attract both skilled professionals and patients [30]. They also contribute to balance the hospital carbon footprint, absorbing CO_2 and other air polluting emissions coming from the energy production necessary for medical equipment and heating.

Noise is also recognized as a distraction and stressor for staff, with reported emotional exhaustion or burnout among critical care nurses.

Finally, the traditional smell of hospitals as a consequence of outmoded organizational arrangements for managing chemicals and waste reduces the hospital's reputation and attractiveness for both professionals and local citizens [23].

3.1.2 Spatial layout and functionality

Spatial layout refers to the ways in which machinery, equipment and furnishings are arranged, the size and shape of those items, and the spatial relationships among them. On the other hand, functionality refers to the ability of the same items to facilitate performance and the accomplishment of goals [17].

Convenient layout increases professionals' productivity; reduces horizontal and vertical travel time and patient transfers, reduces energy consumption, and reduces costs of future layout modifications [14,15]. Moreover, an appropriate organization of supplies and equipment

saves nurses' time and limits time wasted on useless activities, providing more time for patient care, reducing job stress and increasing job satisfaction [28, 29]. Around 76% of respondents to the Director of Nursing survey [23] indicated that functionality is important to nurses as part of the recruitment process and 90% reported that it has a great impact on the performance of nursing staff.
Particularly critical is the concept of design for flexibility [26]. In fact, as changes in functional requirements emerge increasingly quickly, sustainable constructions will need to adapt their functions over time in order to save resources [24, 25]. Adaptability is particularly important for patient rooms. Adopting an acuity-adaptable room configuration, Clarian Health's Methodist campus was able to reduce the number of patient transfers by 90%, and thereby reduce the amount of nursing time expended on this "no-value adding" activity [28].

3.1.3 Signs, symbols and artefacts

Signs displayed on the exterior and interior of a structure are examples of explicit communicators.

They can be used to convey rules of behaviour and play an important part in communicating firm image. Quality materials used in construction, artwork, the presence of certificates and photographs on walls, floor coverings, and personal objects displayed in the environment can all disclose symbolic meaning and create an overall aesthetic impression [17].

Moreover, signage is important not only to patients and visitors, but also to staff, both to help them find their own way around the hospital and to avoid wasting time [24-26, 30]. In particular, signs, symbols and artefacts communicate the strategy and core values of an organization. Thus, hospitals that aim at reducing their impact on the environment might use this lever to promote and facilitate both patients and professionals' engagement in environmental-oriented behaviours.

3.1.4 Materials

Building materials and the products used to clean and maintain them can all be tremendous sources of volatile organic compounds and other indoor pollutants that affect indoor air quality and may cause the emergence of sick building syndrome and building-related illnesses.

Thus, sustainable strategies take advantage of eco-friendly and non-toxic materials both for buildings and furnishings [16, 18, 26, 30, 31]. Moreover, the use of outmoded and dangerous materials is recognized as a major source of environmental pollution and potential harm to health. Mercury, PVC latex and steel, which are present in many healthcare products, are recognized as threats to the health of both patients and workers, and this has led to many pollution prevention programmes [32].

3.1.5 Technical systems

Energy conservation is on the agenda of all programmes that have been undertaken by American hospitals in recent years to reduce their environmental impact and save money [18, 26].

The very recent Marginal Abatement Cost (MAC) Curve, developed by the NHS Sustainable Development Unit (UK), shows that hospitals can achieve the largest cut in CO_2 emissions by installing combined heat and power (CHP) systems, and introducing biomass boilers [33].

3.2 Organizational factors

With respect to the organizational factors, five main factors emerged from our literature review. They are: 1) organizational culture, 2) structures and roles, 3) human resource practices, 4) leadership, and 5) work process.

3.2.1 Organizational culture

The first factor is organizational culture, which has been defined as shared values, ideologies and beliefs [34]. It is often cited as the primary reason for the failure of implementing organizational change programmes [35].

Enforcing the employee perception that sustainability is entirely consistent with public value may in itself provide substantial motivation to pursue sustainability action [36]. Moreover, the healthcare professionals' oath "first, do no harm" is fully consistent with the search for behaviours that are more environment-oriented. Past research found that these kinds of altruistic social norms mediate environmentally friendly behaviour [37].

3.2.2 Organizational structures and roles

A second element is related to organizational structures and roles. Particularly important is the presence of a senior manager with specific responsibility for environmental sustainability, who has to communicate the need to change and prevent "green" actions from becoming marginalized [38, 39].

Facility managers and waste officer/managers are also important figures in promoting and maintaining low energy and resource consumption in the hospital's day-to-day operations, as highlighted in the case studies about NHS Trusts presented in [49]. However, usually these managers have to report to senior level

management and further direction by the CEO or a Board of Directors that oversees expenditures. If facility managers and waste officers are not able to shape the "business case for sustainability", this relation has the potential to create an imperfect decision making system, especially in the area of plant services, where the nature of business is highly technical [48]. Thus, the organizational performance can be improved by integrating facility management within the strategic management function and making the organizational structure more effective through a less restricted role for facility managers [50].

Organizations need also encourage staff to actively participate in sustainability initiatives and feel chartered and empowered to make decisions and take actions that represent green behaviours in their own practices [9, 10].

3.2.3 Human resources practices

Human resource practices are also salient for aligning all the organization members with the sustainability strategy.

The literature recognizes the fundamental role fulfilled by training and education. Training initiatives are useful to both managers and practitioners in order to raise awareness about the consequences of their decisions and actions [9, 10]. The NHS SDU suggests energy awareness campaigns as one of the most cost effective measures to reduce the level of energy consumption and CO_2 emissions of the healthcare sector. Moreover, information barriers on the nature of the environmental crisis in hospitals can be removed with the help of classes on energy conservation, recycling and other specific green products and climate change issues [1,37].

Hospital administrators often forget to train staff prior to a move to a new facility. Training on the appropriate use of building controls and procedures has to be provided also to non-technical building managers and staff to maintain efficient building operation and minimize operational environmental impacts [16]. Furthermore, if this education does not occur, staff are going to attempt to work in the new environment using old processes, and they frequently become frustrated [16].

Individuals or groups can also be incentivized to change their actions and break ingrained habits by offering rewards or incentives [26, 31]. They can be implemented in several forms, such as financial rewards and recognition awards, and these can function as reinforcement to motivate and increase commitment to the environment. Moreover, feedback on energy and resource consumption can increase awareness about the use of resources and maintain the enthusiasm and interest often associated with project initiation and the early stages of implementation of an environmental programme [26, 27, 31].

In addition, implementing sustainable and institutional environmental programmes requires participation from a wide variety of individuals and departments [40, 41]. Thus, cross-functional teams may be particularly helpful in achieving environmental improvement. However, to be effective, these teams must be well constructed, in particular diverse (related specifically to the issue at hand) and well facilitated [10]. In addition, managing the patient pathway through a multi-disciplinary approach enhances the sharing of professional competences and contributes to a definition of a more appropriate care that leads to the minimization of wastes and errors on one side and to the improvement of employees' satisfaction on the other [5].

3.2.4 Leadership

A fourth factor is represented by leadership. The right people at strategic level must be committed to sustainability [38, 39]. Leaders must approach green innovation with a firm commitment to investing in and responding to local innovation teams and their recommendations related to effective environmental transformation [10]. Thus, a participatory and transformational leadership style has been found to be essential to motivate workers and increase their commitment to sustainability [10, 23, 27, 41].

3.2.5 Work processes

Finally, work processes, namely the manner in which services are delivered, have been highlighted as one of the major organizational element that needs to be modified. Sustainable hospitals have to explore opportunities for sustainable models of care and avoid the ineffective ones. It is also necessary to increase investment to prevent illness, discourage unhealthy lifestyles and benefit from the natural environment [1, 42].

4. Conceptual framework

Past research from the architectural and design fields found that hospitals can improve their environmental performances leveraging on peculiar ambient conditions, spatial layout, signs, symbols and artefacts, materials and technical systems. Contributions from the organizational field found another five factors that can help hospitals in being environmental friendly, i.e., their culture, structure, human resource practices, management style and work processes.

Drawing on these findings, we come back to the selected papers to identify the relationships among them and thus define a comprehensive framework about the interplay between organizational and architectural factors. With this in mind, we were unable to connect three of the ten factors – i.e., ambient condition, materials, leadership – since past research did not offer enough evidence to state clear propositions about the interplay between these three factors and the other physical/organizational ones. This limitation to state a comprehensive framework provides scholars of engineering business management with a promising avenue for further research. We hope that in the near future, other contributions will be able to state and test the relationships between these factors and the others.

In the following, a set of propositions to be tested in further research will be argued.

Organizational culture has often been recognized as embedded within the built environment of health facilities [23]. As stated by a nurse during the focus groups reported in [23], "You get an impression when you walk in – for example, if it looks scruffy this may reflect the hospital culture". In fact, artefacts have been defined as the tangible aspects of culture shared by members of an organization [34]. Moreover, [43] suggest that ecologically sustainable organizations are characterized by numerous cultural artefacts, such as slogans, symbols, rituals and stories, which serve to articulate and reinforce for their members the importance of ecologically sustainable performance. Thus, hospital sustainability values can be shown to the staff through signs, symbols and artefacts. Furthermore, artefacts can serve as an easy method to give feedback about the organizational sustainability performance. For example, at Meyer Hospital in Italy in the hospital waiting room a screen is placed showing the amount of energy produced by photovoltaic panels and the amount of CO_2 saved.

Proposition 1: The alignment of signs, symbols and artefacts with organizational basic values and shared assumptions is positively related to sustainability performance.

Sustainable design needs to promote desired work processes [44]. Among the architectural variables, spatial layout and functionality have the strongest relation with processes.

In fact, physical relationships between the hospital functions (bed-related inpatient functions, outpatient-related functions, diagnostic and treatment, etc.) and flows of people, materials, and waste are extremely important to determine the most appropriate building configuration [45].

Furthermore, given the long lifetime of a hospital's physical structure, the design of a sustainable hospital needs to incorporate sufficient flexibility to accommodate the many changes in clinical care that are likely to occur over its lifetime.

Proposition 2: The alignment of spatial layout and desired work processes is positively related to sustainability performance.

Hospital layouts and work processes achieve a better alignment if human resource practices are set in such a way that healthcare professionals learn the appropriate use of buildings and the most adequate way of working in the new built environment. In fact, often employees attempt to work in new facilities using old practices and processes [16], thus generating different unintended consequences that could reduce the implemented changes [18]. Changing the current routines and behaviours requires specific training initiatives that challenge the status quo [9].

Proposition 3: Human resource practices moderate the relationship between aligned spatial layout and desired work processes with sustainability performance.

Advanced technical systems are particularly important to enhance sustainability performance, both in terms of energy and water conservation. However, their day-to-day operations and maintenance require advanced technical knowledge and capabilities that are usually held by managers, such as facility or waste managers, who do not necessarily hold positions of significant leadership and autonomy in hospitals. They are frequently under great pressure from senior levels and constrained in the extent to which they can meet the day-to-day demands [45]. Facility managers are very often undervalued and seen largely as a cost management role, rather than a strategic role for improving sustainability-related performances [47]. Thus, they advocate the integration of facility management within the strategic management function and a wider and less restricting role in more effective organizational structures [50].

For taking effective advantage of the technical systems that are part of sustainable buildings, decision making has to be delegated and technical managers have to be empowered by giving them the ability and responsibility to take active steps to identify and solve sustainability-related problems [51]. In the case of facility management groups viewed as significant partners in running an organization, the efforts required to develop sustainable practices are far easier and more readily achievable [48].

Proposition 4: The alignment of technical systems and organizational structure is positively related to sustainability performance.

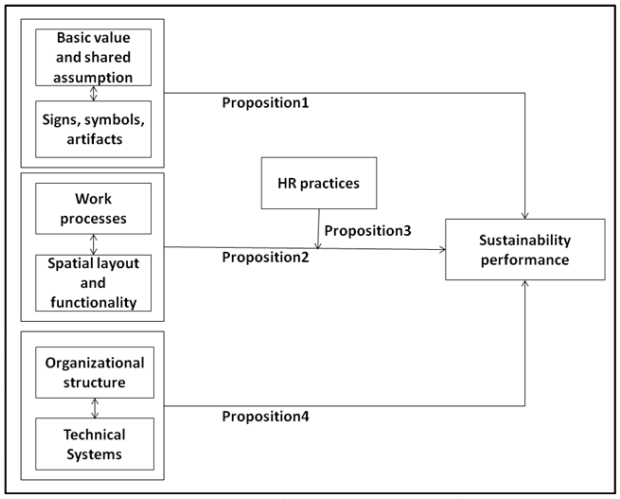

Figure 1. Conceptual framework

5. Conclusions

Citizens and politicians are requiring hospitals to meet challenging sustainability-oriented targets and to adopt mitigation practices to reduce the vulnerability of both the ecosystem and social system [52-54]. Hospitals have significant impact on the local community they serve in terms of pollution, energy and water consumption, and as employers. Moreover, events in the economic, political and ecological landscapes which surround healthcare are forcing hospital managers to promptly detect emerging drivers of change and risk [55, 56]. In particular, they have to understand the consequences of unsustainable practices [57, 58] on the capability to deliver high-quality care in the next 30–50 years [24, 25].

In this regard, synergic changes in both the physical structures and the organizational approaches are needed to meet the sustainability goals in the mid- to long-term [9, 10]. Unfortunately, the interplay between architectural and organizational elements in hospitals has been largely overlooked by past research on the sustainability issue in healthcare. Two bodies of contributions have developed separately over recent years. The architectural literature identified five factors that should be adopted or leveraged by a sustainable hospital, i.e., ambient conditions, space/function, signs, symbols and artefacts, materials and (technical) systems. The organizational literature, on the other side, argued for another five factors, i.e., culture, structures and roles, human resource practices, leadership, and work processes.

This paper sheds first light on the connections between seven of these ten factors – ambient condition, materials and leadership were not included since there was insufficient evidence to gain a full understanding of their role in conducing or moderating the other factors – and develops a panel of new propositions to be tested by scholars of engineering business management in their further research.

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