Complex Projects Assessment. The Impact of Built Environment on Healthcare Staff Wellbeing

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Abstract. Projects, plans and programmes for complex environments such as healthcare facilities need to be designed with specific consideration of the multitude of users, technologies and policies in order to address a sustainable and resilient development. Several Evidence Based Design (EBD) studies highlight the deep interrelation between built and natural systems with human or organizations-related outcomes, but the effect on healthcare staff such as Medical Doctors (MD) is still underexplored. The paper investigates the assessment of self-reported satisfaction and wellbeing of MDs in healthcare facilities. A multidimensional assessment model composed of 53 Likert scale questions has been developed from literature review and existing tools, and submitted to a statistically significant sample of workers in 2 different office settings of an Italian hospital. Since MDs spend a considerable amount of their working time in offices, the qualities of such space are very important. The study highlights and confirms that localization, indoor environment, natural and artificial light are relevant drivers for staff satisfaction and wellbeing. Further investigations on a wider and diverse sample are encouraged.

Keywords: Evaluation survey · Hospital staff · User satisfaction

1 Background

1.1 Complex Environments and Unexplored Areas of Research

Projects, plans, and programs for complex environments such as healthcare facilities need to be designed with specific consideration of the multitude of users, technologies and policies in order to address sustainable and resilient development. In complex building types, such as hospitals, there is the demand for overall quality and several

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theories, tools and methodologies have been developed to assess the qualities of the physical environment [1–4]. Since 1980 s scholars and researchers conducted multiple studies in order to demonstrate how the built environment has a significant effect on the final users, including and with a specific focus on patients and their families, clinicians, nurses and the entire medical staff. Environmental psychology theories and Evidence Based Design (EBD) have focused on explaining the influence of natural and built environment on human health [5, 6]. Recent literature in the field from environmental psychology, architecture and public health, highlights that environmental conditions i.e. acoustics, temperature, safety and security and layout issues are never neutral, yet they have an either positive or negative impact on occupant's outcome and performances [6–9]. This relationship is considered as fundamental for the concept of "usability", that consider buildings as support medium of their occupant activities [10]. Literature reviews show adequately which are the gaps and open points that should be investigated to evaluate in a more accurate way healthcare qualities, highlighting the deep interrelation between built and natural systems with human and organizational outcomes [11]. To the best of our knowledge the effect of the built environment on healthcare staff such as Medical Doctors (MD) is still an underexplored field of study, since many researches just focus on patients [12]. Nevertheless, in the medical field, several researches highlight how clinical work is actually very stressful for the medical staff, and how this can lead to bad health conditions. There is also evidence that clinicians who suffer from work-related stress are more prone to relational problems, anxiety, burnout, substance abuse, to develop depression syndrome and assume antidepressant drugs, or even get to suicide [13]. In literature it is also showed how burnout and depressive syndrome have an indirect bad influence on healthcare systems and on patient's care [14, 15]. All these effects can have consequences on patients, such as higher wrong diagnosis rates, wrong drug prescriptions and many other medical errors, that can then pass on the satisfaction and the wellbeing both of patients, about their care path, both of clinicians about the overall clinical results they obtained. MDs are indeed considered as a fundamental part of the hospital workforce and therefore their workplace should be adequately designed in order to improve satisfaction, productivity and so a consequent benefit for patients. Two principal typologies of support spaces are identified for the MD such as the examination room, where the medical doctor evaluates the patients, and the medical office, meant as the administrative work station, on which this study is focused [16]. The activities carried out in the medical office can concern the clinical report update, the setting of the therapeutic plan or the radiology exams request for the patient, and where clinicians usually meet patients and their parents to discuss the therapeutic plan. It is reasonable to conclude that these offices can be considered the physician workplace [17]. Nevertheless, when focusing on MD workplaces in healthcare facilities and the impact on their wellbeing and health outcomes, emerges an uncovered research area [12]. As different studies, reviews and workplace regulations show, the use of a comfortable and customizable work environment can contribute to maximize productivity, reduce fatigue and discomfort, limiting the risk of occupational illnesses. In healthcare settings this means an increased security level of services provided to the patient, directly and indirectly influencing the healthcare system's performances. At the same time, the

workplace physical environment can provide many stressing factors, such as annoying lighting, undue noises, inappropriate equipment location or space overcrowding. The scientific literature on workplaces largely shows the benefits that specific layouts and physical features have on workers' wellbeing [18, 19], laying the foundations of systematic evaluation tools adopted by quality certifications for these specific spaces. This knowledge is rarely transferred to healthcare workplaces, despite the deep impact it could have on both medical staff and patients. Starting from these bases, the gap is calling for qualitative and quantitative studies that investigate the impact of the hospital environment as enhancer or reducer of MDs performances and wellbeing, and this research proposes a comprehensive methodology to tackle it.

1.2 Aim of the Study

The aim of this study is to assess and compare two different medical office settings from the same hospital, evaluate the perceived wellbeing and relate impacts that these environments have on MDs that regularly use them. This study identifies specific features to care about when designing, refurbishing or operating medical office spaces within the overall hospital facility management. These selected features could be also proposed as criteria for a systematic evaluation of healthcare workplaces, that is now lacking.

2 Methodology

The research methodology has been structured into three phases: survey development, empirical phase and data analysis as shown in Fig. 1.

2.1 Survey Development

Starting from some existing and validated assessment tools, commonly used in organizational and architectural fields, and the available literature on the topic, an assessment survey has been developed. Six evaluation tools from excellence certifications that are considered the gold standards for qualitative analysis have been selected: three from the environmental field (Leed, Breeam, Casbee) and three from the managerial field (JCI, CQC, ACSQHC). In parallel, it has been conducted a literature review about the quality evaluation of hospital spaces, sorting all the publications in the macro-areas described by Ulrich et al. in 2008. Among these few articles, only the ones that focus on medical offices were selected and analyzed. From the critical integration between elements considered in the literature and the ones considered in the tools analyzed, this research proposes an assessment model for the evaluation of medical staff support areas in hospitals. The tool is structured as a questionnaire and is described in the following paragraphs.

Assessment Model Structure

A specific survey has been elaborated in order to evaluate the qualities of medical offices. The anonymous survey has been submitted to the selected sample, both as paper and as digital version. The questionnaire is composed by 53 items: 45 items are issued as multiple-choice questions, 8 items are issued as open-ended questions. The questions are structured in order to explore the impact of eight built environment variables on four psychological and physical wellbeing outcomes domains (Table 1).

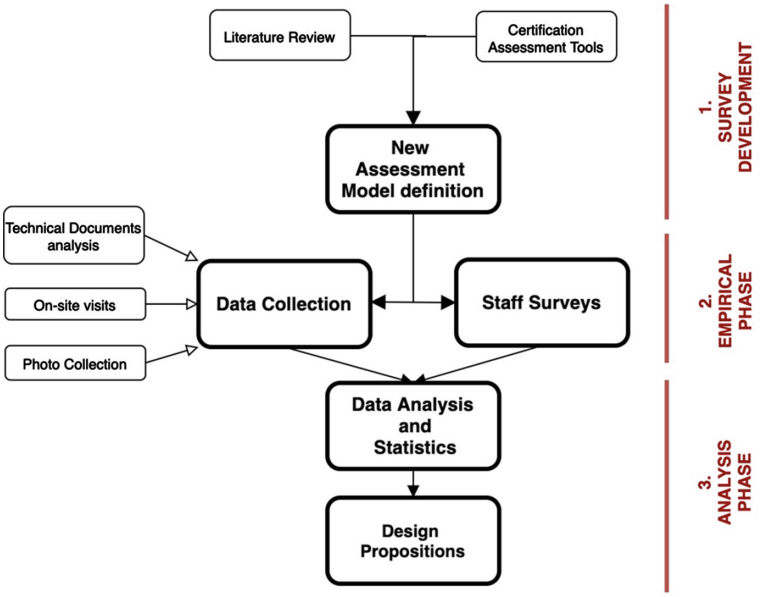


Fig. 1. Flow chart of the methodological process followed

Table 1. Assessment framework of environmental features and MD wellbeing domains

Environmental features	Wellbeing domains
1. Localization	a. Overall satisfaction
2. Indoor environment	b. Work performances
3. Natural light	c. Daily fatigue
4. Artificial light	d. Stress
5. Temperature	
6. Humidity	
7. Acoustics	
8. Ventilation	

The questions are structured as a Likert scale model: each item is a question to whom the user can answer stating their agreement/disagreement degree. The interviewer can choose a value from 1 to 5, declaring how much he/she agrees that the built environment feature has an impact on his/her wellbeing domain. Value 1 stands for "I completely disagree" and value 5 stands for "I completely agree" [20].

2.2 Empirical Phase

The empirical phase has been developed into two sub-phases: an observational phase and an experimental phase. During the observational phase the support areas selected were analyzed, considering the daily activities that are carried out in those spaces. The

experimental phase was applied to two main typologies of medical offices. The data collection was carried on through the analysis of technical documents, on-site visits and photo collection. The on-site visits were conducted in weekly working-days during the daily activities. During the experimental phase the assessment model was proposed to medical staff through a questionnaire, in order to collect feedback from users about the quality of the medical offices considered.

Site and Settings
The tool was applied in selected hospital wards from a medium-large size University Hospital in Lombardy Region, Italy. The choice of the structure was motivated by the presence of two different typologies of medical offices, that differ in terms of localization, spatial layout and indoor settings. The structure derives from the union of a monobloc building (divided into three principal sectors A, B and C) and some foreparts located behind it, named "the diamonds" because of their shape. In this study the medical offices located in sectors A and C have been included. The choice of these two sectors was due to the different characteristics they have in terms of layout distribution and physical elements we can find in medical offices. Offices in sector A are hereafter called Type-A offices, and offices in sector C are hereafter called Type-C offices. A detailed description of the two settings is provided in Table 2.

2.3 Analysis Phase

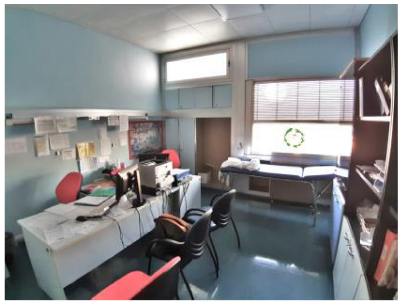
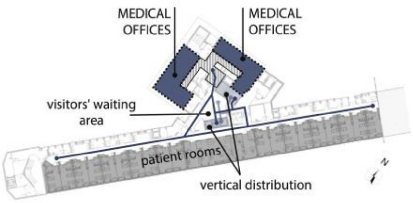
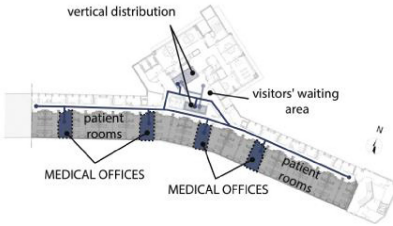
Data collected during on-site visits and through the questionnaire have been analyzed, extracting descriptive statistics that led to qualitative considerations.

Data collection and sample size
The sample has been calculated with the Creative Research Systems online tool "Sample Size Calculator" (https://www.surveysystem.com/sscalc.htm) promoted by the Italian Public Health and Epidemiology portal. Considering the total staff population in the hospital counting 670 individuals (2017 data), 149 Medical Doctors have been included in the survey, since 75 of them were allocated in sector A, and 74 in sector C. Data have been collected between 18 and 28 February 2019 through direct interviews to the staff and online forms.

Data Analysis
Data gathered through the questionnaire have been analyzed with the software IBM SPSS Statistics v.25. Firstly the data collected have been submitted to descriptive analysis through frequencies observation, to detect the number of occurrences of each answer chosen by the respondents calculated as average, median and standard deviation. Secondly, the T-Student statistical test was applied, which allowed to compare the obtained average values from each item for type-A and type-C medical offices, and to highlight only the results where a significant difference between the two setting was present. This approach allowed to focus the analysis only on the parameters that had a significant difference in values between the two groups, looking at the averages obtained. Therefore, just the results related to Localization; Indoor environment; Natural light; Artificial light will

Table 2. Characteristics of the two office typologies included in the study

Type-A OFFICES	Type-C OFFICES
• Located in the foreparts, filtered from patients corridor; • Single and multiple workstations (3-4 MDs); • Absence of art or natural elements; • North or West orientation; • Neon lights from ceiling; • Limited control of the temperature by the users • Standard acoustic insulation	• Located inside the wards, within the patients′ corridor; • Multiple workstations (3-4 MDs); • Absence of art or natural elements; • South orientation; • Neon lights from the ceiling; • Limited control of the temperature by the users • Standard acoustic insulation

Type-A OFFICES	Type-C OFFICES
	
	

be discussed. The remaining four built environment parameters (Temperature; Humidity; Acoustics; Ventilation) have not been considered, because no significant differences between the two office settings emerged.

3 Results and Discussion

3.1 Demographic and Job-Related Data

58,1% of the sample is represented by female MD while 41,9% is male. In terms of age, the population is homogeneously distributed with a minority of over 50 (20,9%) while

under 30 (most likely resident doctors) and 31–50 years old practitioners are respectively 39,2% and 39,9%. More than half of the sample (53,4%) stated that in average he/she spend more than 30 h per week inside the medical offices, 31,1% spend between 11 and 29 h and only 15,5% spend 10 h or less. Most of MDs spend up to 75% of their working-week time in offices, therefore the quality of built environment where they stay should be seriously taken into account.

3.2 Indoor Environment

Several data suggest a great impact of indoor built environment on MD's wellbeing. Indeed, from the data collected, only 12% of the respondents from type-A medical offices are satisfied with the current indoor quality characteristics of the workspaces; equally, in type-C medical offices only 19% are satisfied with the spaces they use every day. The current characteristics of both medical offices A and C do not contribute to improving work performance, according to 89.3% of the respondents from type-A medical offices and 87.8% from type-C medical offices, respectively. The same environments seem to have a bad influence on daily fatigue in 60% of the interviews for A-offices and in 55.4% for C-offices. 66 out of 75 physicians say that the indoor environment of type-A workplaces does not help in reducing stress levels, and 68 physicians affirm the same for type-C workplaces. The low overall satisfaction in both offices about the indoor environment and his influences on work activities could be related to office settings. Both type-A and type-C offices have a net surface between 14 and 18 m^2, and are organized to host between 2 and 3 doctors, and in some cases an examination bed. These office dimensions could be inadequate and undersized for hosting both medical consultations and workstations for more than one doctor. This study confirms that the current characteristics of the workspace and the type of furniture in both medical offices do not help, or even worsen overall work quality and the wellbeing of doctors that have been interviewed. Size, furniture, colors, the possibility of customize the space are all characteristics to be taken into account in such healthcare workplaces.

3.3 Localization

More than half of the physicians interviewed (65.3%) believe that the location of type-A medical offices ensures adequate visual privacy, while the situation is opposite for type-C medical offices, where 60.8% of physicians point it as a missing quality. Similarly, the localization of type-A studies helps improving work performance in 41.4% of cases and reducing stress levels in 34.6%, while the localization of type-C offices does not improve work performance in 77% of cases and does not reduce work stress in 83.7% physicians' opinion. The analysis shows that the specific localization of workspaces has a negative impact on privacy levels, work performance, daily fatigue, stress and personal satisfaction in Type-C settings which are located inside the ward, in opposition to Type-A settings which, although very close to the ward are more protected. These results underline that an effective study of layouts, with a correct functional distribution of public spaces and healthcare flows, can significantly influence the working wellbeing of medical staff, improving their efficiency and decreasing negative consequences related to the daily workload. These design choices are fundamental to ensure adequate visual

privacy for conversations between medical staff and patients or their family members. An adequate location of medical offices ensures a greater level of visual privacy for healthcare professionals, that can perform certain activities without being interrupted, thus improving work performances.

3.4 Natural Lighting

Only 17.3% of physicians are satisfied with natural lighting provided in Type-A offices, while almost half (47.3%) of them are satisfied with natural lighting in Type C offices. This seems to have a negative impact on daily fatigue (60%) and stress (65.3%) in Type A studies, while a degree of indifference on effects of natural light in Type-C offices prevails. The analysis strongly shows a very low satisfaction about natural lighting in type-A medical offices, in opposition to a good satisfaction in type-C offices. In addition to a different facade orientation (north and west for the Type-A and south for the Type C), the results for natural light satisfaction are also due to the design of the windows. Indeed, the presence of ribbon-like windows in type-A offices does not allow an outward vision or direct enlightenment of workstations, unlike the vertical ones that are present in type-C offices. The lack of adequate natural lighting has a negative impact on visual comfort and wellbeing of medical staff and their activities [21]. As can be seen from the data analysis, window type and door frames with vertical development are therefore preferable to horizontal ones (ribbon). The indoor natural lighting conditions are influenced not only by the orientation of the façade but also by the window size as well as by other parameters such as the relationship between the window and the floor surface, the furniture position, the colors, etc.

3.5 Artificial Lighting

Artificial lighting in type-A offices is considered qualitatively and quantitatively unsatisfactory by 41.4% of physicians, while it is the opposite for type-C offices where satisfaction for artificial lighting is found in 39.2% of respondents. For both type A and type C workplaces, in most cases artificial lighting seems to have no impact on daily fatigue (48% for type A and 45.9% for type C) or on work performance (48% type A and 52.7% type C). On the contrary, it has a negative impact on stress in both type A (53.4%) and type C (46%) settings. Under the same conditions of artificial lighting, the level of satisfaction is opposite for the two medical offices, in favor of type-C ones: this is probably linked to the fact that the presence of a greater source of natural light contributes to medical staff satisfaction.

4 Conclusions and Further Development

The study highlights and confirms that built environment characteristics are very important for MDs satisfaction, productivity and wellbeing. In particular localization, natural and artificial light and the indoor environment emerged as driving factors able to positively or negatively influence indoor wellbeing. The research could lead to some design propositions able to support designers or hospital technical managers in the project

phase, refurbishing or renovating MD workspaces prioritizing the most influent parameters, in order to improve overall satisfaction and performance. Further investigations are encouraged on a wider sample of healthcare professionals, including nurses and socio-sanitary workers, analyzing other typologies of workspaces that support different healthcare daily activities.

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