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Relationship between Built Environment and Dementia. Evaluation of five Nursing Homes in Lombardy region, Italy

Silvia Mangili^{1*}, Andrea Brambilla¹ and Stefano Capolongo¹

¹ Politecnico di Milano, Department of Architecture, Built environment and Construction engineering (DABC), Design & Health Lab, Milan, Italy; silvia.mangili@polimi.it; andrea1.brambilla@polimi.it; stefano.capolongo@polimi.it

* Corresponding author.

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Abstract: Background: The relationship between Built Environment and Dementia is nowadays a fundamental theme to investigate in the healthcare field because the elderly population is growing worldwide. Epidemiological data show that Alzheimer's disease incidence is forecast to increase rapidly. Furthermore, the health and socio-sanitary structures for elderly patients represent a fundamental social infrastructure that collects significant investments but must be suitable to host people with dementia. This paper aims to describe the application of a tool able to evaluate architectural design features in facilities for patients with Dementia.

Methodology: The evaluation framework is based on a Systematic Literature Review on the relationship between the built environment and patients with dementia, different case studies, and existing evaluation tools analysis. The tool comprises four criteria (Quality, Spaces, Activities, and Wayfinding), 19 indicators, and 71 variables validated by recognized experts in the geriatric, psychiatry, and architecture field. The tool has been applied to five facilities, all accredited to the Italian National Health System and located in Lombardy that differ in period of construction and type.

Results: The maximum score is 100%, and results lower than 60% are considered inadequate, between 60 and 80% are sufficient, and more than 80 excellent. The results of the evaluation tool show that two are inadequate (47 and 54% of compliance), two sufficient (65 and 75%), and one excellent (92%). The newest building was evaluated as "excellent", while the structure with the lowest score was created by reusing existing structures. Future applications are needed to make the results more scalable.

Keywords: Dementia; Evaluation tool; Evidence-Based Design; Long Term Care; Users Centered Design.

1. Introduction

By 2050, it is expected that 1 in 6 people in the world will be over the age of 65, compared to 1 in 11 in 2019 (United Nations et al., 2020). In fact, in recent years, thanks to advances in medicine and the role of prevention that occupy more and more space in healthcare, life expectancy has risen rapidly from 77.6 to 81.3 years in Europe between 2002 and 2019 (eurostat, 2021). This has led to increased occurrence of Non-Communicable Diseases (NCDs) and years lived with disability (World Health Organization, 2017)

One of the most prevalent NCDs is Dementia, with about 7 million people affected in Europe and a forecast of 14 million for 2050 (Nichols et al., 2022).

Recent statistics shows that an average of 60-80% of people with dementia have Alzheimer's disease (Alzheimer's association, 2020). Alzheimer's disease is the most common

cause of dementia. Discovered for the first time in 1906 by Alois Alzheimer's, it predominantly affects people in their elderly years (over 65 years old) and the World Health Organization (WHO) estimates that about 60% affected by a state of dementia are affected by this disease. Alzheimer's affects all the parameters used by the WHO to define health status as "*a state of complete physical, mental and social wellbeing and not the physical, mental and social well-being and not merely the absence of the state of disease or infirmity*" (World Health Organization, 1946).

Many studies have been conducted to establish what are the criteria that an environment must meet in order to be dementia friendly. This is because many evidences have emerged of how an appropriate design of the built environment can influence the well-being, quality of life, independence and well-being of people with dementia (Fleming et al., 2008; Fleming & Purandare, 2010; Grey et al., 2019; Marquardt et al., 2014)

More and more studies allow understanding of how health is also related to people's environment. In this field the most popular approach is the Evidence-Based Design (EBD), the design based on evidence, born as an adaptation of Evidence-Based Medicine to the built environment. It demonstrates that, through measuring clinical outcomes, the built environment can have therapeutic effects on patients, both in a physically and psychologically, influencing the users' perception and wellbeing (Ulrich & Quan, 2004).

EBD breaks down the design process into research, evaluation, and analysis of contemporary literature before carrying out the actual design. What comes out of it is method that allows the designer to create spaces tailored to the user, ensuring both wellbeing of the patient, who finds space for treatment in the building, and of the staff, allowing them to work in a comfortable environment and relieve the burden of stress. (Brambilla, Morganti, et al., 2020)

This methodology was popularized by the studies of Ulrich (1984). He noted in 1984 that the healing of surgical patients varied according to the environmental conditions of the hospital rooms in which they were placed, those who had a view of nature were discharged before whom from the bed could only see a brick wall (Ulrich, 1984). This approach has been further adopted and implemented in research, education and dissemination worldwide (Gola et al., 2020).

The innovations introduced by the method are that it does not stop only at functional efficiency, sustainability, and cost reduction, but investigates the characteristics that the building, and the built environment must have to put the user first.

The users' wellbeing must become a priority in the design of every type of facility. This could be reached considering a plurality of aspects like green areas, wayfinding and spatial organization, soft qualities, security and privacy, flexibility, layout and management aspects (Capolongo, 2016).

Usually, the main aspects that are considered are related to economic issues and lack in considering the people's perception and experience within the space and users' needs (Buffoli et al., 2014).

The built environment can influence our health in several ways, directly, influencing environmental quality, or indirectly, influencing behaviors that impact disease transmission and healthy lifestyles (Fleming & Purandare, 2010; Pinter-Wollman et al., 2018).

It became clear that a more holistic approach is needed to evaluate structures that deal with health to create a healing environment where people social, cognitive, and perceptive aspects can integrate the design process.

1.1 Problem statement and research objectives

The space that surrounds us daily can not only influence daily life but helps to identify who we are. It can be said that the environment we live in defines who we are. (Capolongo, 2016)

We recognize the house, the neighborhood, all the spaces we live as something that belongs to us, a part of us. The patient, being neurodegenerative Alzheimer's disease, gradually loses knowledge of their places of life, of their neighborhood, of the house where he has lived for years. All of this contributes to the increase in the feelings of disorientation and anxiety typical of the disease.

Although many studies have been conducted and the evidence-based approach appears to be growing, many studies have been conducted in a limited way and on a small scale. For this reason, many aspects of dementia-friendly design have become very popular despite not having solid scientific evidence, as is the case with artificial intelligence. (Evans et al., 2022). This is the case with assessment tools, which, although there are many, applicable to residences as well as hospitals or nursing homes, most are poorly applied outside the testing period. In addition, there is no specific assessment tool for Italy. In Italy,

an increasing number of people with dementia are living within health care facilities, an estimated 70-75% of residents (Istat, 2020).

Italy now ranks second in dementia prevalence (22.5 people per 1000 of any age in 2017), preceded only by Japan (23.3 per 1000) (OECD, 2017). For this reason, there is an urgent need to evaluate the facilities in which these people with special needs live and create new facilities that promote the well-being and quality of life of older people with cognitive disorders and dementia.

2. Theories and Methods

The study evaluates facilities housing patients with dementia through the application of a previously validated checklist, a simple assessment tool for rapid evaluation of design features frequently used in several situations related to healthcare design studies (Brambilla, Lindahl, et al., 2021; Capolongo et al., 2021). The purpose is to understand how well the environments meet the space quality requirements highlighted in the literature.

The checklist has been created according to design guidelines and strategies (Brambilla, Maino, et al., 2020) derived by a systematic literature review, case studies, and tools already in use. This allowing to understand which the fundamental aspects are to be considered and implemented in a healthcare residence that can accommodate patients with dementia and Alzheimer's disease.

In particular, the literature was the initial push that provided a general and complete picture of the specific needs for the various areas of care and the ideal therapeutic environment. The case studies have confirmed and shaped the previously identified criteria, adding further details for each of them. This was made possible by highlighting the spaces and the percentages they occupy within the entire structures analyzed. The questionnaires have had a twofold usefulness. On the one hand, they have made it possible to understand in which way to put into effect the evaluative system, that is if to insert questions to multiple answer or to direct response.

The tool is composed by four macro areas and 19 criteria divided into:

- **Quality:** (visual quality, noise, smells, colors, safety, domesticity, small scale and perceptions) Patients with dementia need a place that allows them to live their lives in an environment designed specifically for their needs and adapted to the changes that the disease produces at sensory and perceptive level,
- **Spaces:** (room, garden, and common areas) understood as the spatial configuration of the environments needed by the patient, the staff and all those who participate in life in the facility,
- **Wayfinding:** (access control, paths and signage) Design attention must take into account the constant movement of the patients with dementia and cognitive diseases and their safety in being able to do so,
- **Activity:** (garden-ortho therapy, relationships, food, openness to community, and physical activity) The development of various activities during the day helps the Alzheimer's patient to have benefits both in the short term (they calm and engage the daily life), and long-term, helping the disease slow down.

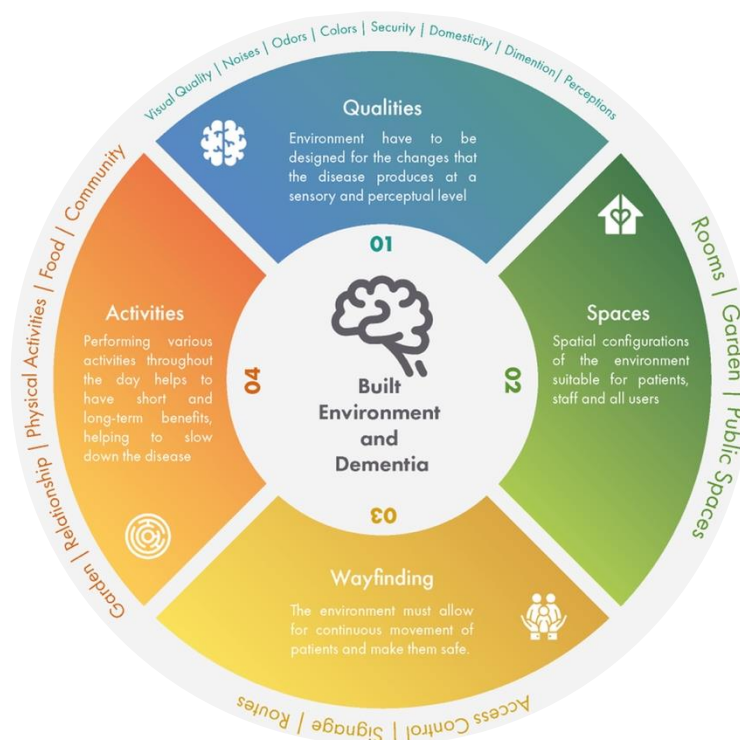


Figure 1 - The checklist's framework

These have emerged as the most important characteristics that make it possible to achieve an environment that adequately meets all the physical, environmental, and social needs of the person with Alzheimer's disease.

The purpose of creating the checklist was to provide a tool not currently present in the Italian care setting, where the demand for care facilities for dementia patients is at its highest in history (Alzheimer's association, 2020).

The tool is intended to provide facility managers with a basis for implementing small or large changes to make units more efficient and that promote the well-being of the dementia patient.

The tool consists of 71 binary answer questions (Yes, No, N/A - not applicable when the function/activity is not present in the facility). The maximum score is 100%, and results are divided into inadequate if less than 60%, sufficient between 60 and 80%, and excellent if above 80%.

Attached in Fig. 2 it's possible to understand how the checklist works, assesses not only the presence or absence of a criterion but how it is actually implemented in accordance with the patient's needs.

4.3 SIGNAGE	Are signs with signs and symbols that uniquely indicate the rooms placed along the routes? E.g. bathrooms with toilet/bedroom/common areas symbols	No 0 p	Yes 1p			1
	Is signage also present in outdoor spaces? Indications of routes to nearest restrooms and rest areas	N/A 0 p	No 0 p	Yes 1p		1
	Are rooms clearly identifiable to patients? For example, by the use of name plates, different colors, personal belongings posted outside the door	No 0 p	Yes, name 1p	Yes, color 1p	Yes personal things 1p	3

The criterion of objectivity was chosen in order to keep the instrument as objective as possible and to be more easily analyzable even from the point of view of the final meta-design indications. Moreover, the questionnaire can be filled in by the medical and administrative-managerial staff of the care facility, since it is based on a direct analysis of the facility and does not require prior knowledge. The administration of the questionnaire is done on paper and through direct compilation on site as it is necessary for the physical presence of the examiner inside the structure.

The tool has been introduced by a general statement that explains the choice of categories and describes them to provide the stakeholder with a clear and detailed picture of the reasons for the research. It is also indicated how to enter scores for each of the questions.

Each facility will have the option to decide whether to disclose its details or to remain anonymous within this study (to ensure the anonymity of information that could be sensitive from a commercial, managerial and economic point of view).

The tool has been applied to five (5) structures which are all accredited to the National Health System and located in Lombardy, Northern Italy, but differ in terms of the period of construction and types of nursing homes and long-term care facilities for people with dementia and cognitive impairments (Village or Special Care Unit (SCU), the typologies that host for people with dementia). The facilities also host patients with different levels of cognition and stage of dementia. Regarding access to service all of the facilities analyzed are accredited to the national health care system and therefore provide partial coverage of the fee by the region and part by the patients. The cost for patients ranges from 60 to 100 euros per day, depending on the type of facility.

3. Results

The **first** facility is a recently realized nursing home (a village type) following the latest innovations regarding the quality of the environments and the use of technological resources. The structure obtained a score almost completely excellent, with an overall evaluation of 138 points out of 150, equal to 92%.

The same assessment tool was applied to the **second** facility, a SCU, specifically for Alzheimer's patients, located in Lombardy. It was built a two decades ago (early 2000s). The analyzed structure obtained a good score but much lower than the previous one, with an overall evaluation of 98 points out of 150, equal to 65%.

The **third** structure was built in the first decade of the 2000s, by converting an existent department of a Nursing Home into a SCU. The analyzed structure obtained an overall sufficient evaluation with 113 points out of 150, equal to 75%.

The structure number **four** was recently built and is SCU in a Nursing home. The analyzed structure obtained 79,5 points out of 150, equal to 53%.

The last structure, **five**, is a SCU of a Nursing home built in 1970s. This structure obtained 70 points out of 150, equal to 47%.

Table 1. Area-based assessments of the various facilities

	CASE STUDIES SCORES				
Structure n°	1	2	3	4	5
Date	2018	2000	2010	2015	1970
Type	Village	SCU	SCU	SCU	SCU
New/renovation	new	new	renov	new	renov
Criteria scores					
Quality	89%	63%	83%	39%	43%
Spaces	100%	55%	61%	42%	48%
Activities	93%	67%	87%	47%	73%
Wayfinding	90%	83%	69%	31%	41%
Total score	92%	65%	75%	53%	47%

Since not all facilities adhered to the reporting of data and photographs, it was chosen to keep all five facilities anonymous.

The health structures analyzed with the evaluation questionnaire turn out to be a lot different from each other while sharing the same function of welfare residence for Alzheimer's patients. The SCU house people with varying levels of cognitive decline while the village is home to people with even very high residual ability and are in the early stages of dementia.

The results of the evaluation tool shows that 2 are inadequate (<60%) 2 sufficient (<80%) and 1 excellent (>80%). The best one is the newest and is conceived based on analysis of evidence in relationship between Alzheimer's and built environment and facts this scored the maximum (100%) in "Spaces". On the contrary, the older structures, made by the reuse of existing spaces, results as inadequate (every structure obtained <65%). The construction time difference of the buildings is evident both in size of the indoor and outdoor spaces, as well as lack of flexibility (Brambilla, Sun, et al., 2021).

The first case is an entirely dedicated building to the care of Alzheimer's patients and has very large outdoor spaces designed for host activities such as shops that reflect the characteristics of a country and become fundamental element in the treatment of dementias. The others present various types of outdoor spaces, like normal gardens, green spaces, patios and only the third structure has the access to an Alzheimer Garden, but it is located on a different level so it's difficult to reach for all the patients.

"Quality" in the first case study is the criterion that obtained the lowest value, with a score of 89% and 67 points out of 75 indicators met, due to the extensive use of natural light assisted by the use of artificial light controlled by home automation equipment. However, some areas of shade are present, the result of the high domesticity of the place, which is reminiscent of a large apartment. Safety is ensured by the use of correct materials, thanks to the masking of dangerous areas and the use of technology, with geo-location bracelets for patients that prevent escape and allow their location to be known in real time. The environment conveys a home-like warmth due to the possibility of customizing spaces, the use of personal furniture and the small number of patients, eight per apartment.

The second case study obtained the maximum score in the "Wayfinding" area, with 83%, thanks to the strategic use of signage, with the use of name, logos, and personal belongings which help the patient to identify their room.

The "Spaces" obtained the lowest score, with 55%, highlighting shortcomings within the room criterion, because all the rooms are double and not all are customizable by the patients. In this case, the number of patients per unit is very high, exceeding 20. From the point of view of perceptions, deficiencies in the visual are highlighted between living room and bedrooms.

The third facility obtained 83% in "Quality" indicator and excels in the criteria domesticity and odor control. Artificial light can be varied in intensity only in the rooms, the corridors have reflective surfaces. Also in this case, the call notices sound in the hospital rooms, the floors have color changes, no technology is used for the location of patients and there are deficiencies in the view between the area of the rooms and living room. There are 20 patients for this nucleus.

The facility number four lacks mostly in "Quality" and "Wayfinding" (respectively 39 and 31%). In this structure the major problem is the absence of an outdoor space, dedicated to patients. The nucleus is located at the third floor and the outdoor space consist by a small green area without covered areas and seats.

The last structure, same as the previous one, lacks in quality and wayfinding (43 and 41%) due to the high number of patients (more than 20), the absence of homelike strategies and technologies for safety control.

The preliminary results confirm and expand the knowledge in the field of healthcare architecture by defining a built environment quality assessment tool for evaluating territorial structures. This is the first study that use assessment methodologies for the quality evaluation of socio-sanitary facilities for Alzheimer in Italian context.

5. Discussion & Conclusion

The survey highlights that the design of community facilities needs to be based on evidence to create better spaces for the well-being of patients. It also shows that existing buildings are not meeting the needs of dementia patients.

This research is the first to use assessment methodologies to evaluate the quality of territorial facilities dedicated to Alzheimer's patients in the Italian context.

Assessing a facility and adapting it to the needs of the specific patient must become the practice in an ever-evolving field such as healthcare.

By comparing the results obtained in the case studies analyzed and analyzing the critical aspects of the specifications, some of the characteristics that an environment suitable for the dementia patient, and specifically Alzheimer's, must have in order to become a prosthetic and curative space and not just a place of residence that passively assists in the development of the disease emerged.

The aim of the analysis was therefore to outline a new assessment methodology, a tool absent in the Italian landscape and, consequently, a possible new strategy for adapting and modifying healthcare facilities. The research highlighted an extremely vivid and current problem in the field of healthcare infrastructure, namely the lack of knowledge of the issue from a regulatory point of view.

With the creation of the checklist, the importance of the built environment occupies within healthcare facilities dedicated to one of the most delicate and fragile categories of people, Alzheimer's patients, was highlighted.

Future applications to more facilities are needed to make the results more scientifically valid and to gather feedback from different types of facilities.

A revision of the checklist is currently underway to make it a real assessment tool, criteria and indicators weighted based on reviews with experts (architects, health care providers,).

For this reason, internal and external validity are currently being studied. A group of expert researchers from both Italy and abroad will evaluate the framework and test the usability of the tool in order to validate it before conducting future evaluations.

Contributor statement

Conceptualization, S.M.; methodology, A.B.; formal analysis, S.M.; validation, S.C.; investigation, S.M.; data curation, S.M.; writing—original draft preparation, S.M.; writing—review and editing, A.B., S.C.; visualization, S.M.; supervision, S.C.

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