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# Gestión de la Dimensión Social de la Sostenibilidad en los Códigos de Edificación. Building Codes and the Management of Sustainability's Social Dimension.

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*Resumen* — De acuerdo con la definición propuesta por las Naciones Unidas, el desarrollo sostenible se basa en tres dimensiones interrelacionadas: medio ambiente, economía y sociedad. A lo largo de las últimas tres décadas, la industria de la construcción ha adoptado esta definición centrándose principalmente en la dimensión medioambiental, descuidando la dimensión social. Al comparar ambas dimensiones, los parámetros medioambientales son medibles mediante unidades cuantitativas, lo que ha hecho posible su incorporación en los códigos de edificación a nivel internacional. Sin embargo, la dificultad para establecer valores cuantitativos adecuados a los parámetros sociales ha obstaculizado su incorporación en los códigos. Para facilitar la incorporación de factores sociales dentro de la industria de la edificación, se propone un enfoque teórico como base para desarrollar sistemas de valoración cuantitativos de los aspectos sociales en la edificación.

Palabras Clave-Sostenibilidad Social; Entornos Construidos; Edificación Regenerativa; Estándares; Salud.

*Abstract*— As defined by the United Nations, a sustainable development relies on three interrelated dimensions: environment, economy, and society. Throughout the last three decades, the building industry has adopted the philosophy of sustainable development by focusing on the environmental dimension, but neglecting the social dimension. When comparing both dimensions, environmental parameters are measurable by quantitative units, which have made their implementation in mandatory building codes feasible. However, the challenging nature to provide appropriate quantitative standards for social parameters prevented their incorporation in building codes. To promote the development of social sustainability within the building industry, this paper aimed to provide a preliminary approach to develop standards that addressed social aspects and health within indoor built environments, so that their incorporation in building codes may be feasible in the near future.

Index Terms— Social sustainability; built environments; regenerative; standards; health.

## I. INTRODUCTION

**S** INCE ITS EMERGENCE, the concept of sustainability has implied a balanced association of the following dimensions: environment, economy, and society (Dempsey et al., 2011; Hutchins and Sutherland, 2008; McKenzie, 2004). The building industry has mostly focused on the environmental dimension (Reed, 2007), where the concept of sustainable development, as defined by the Brundtland Commission Report (Brundtland et al., 1987), has been applied through design strategies aimed to reduce energy consumption, water usage, and gas emissions among many other strategies.

However, the social dimension of sustainability has been practically abandoned (Vallance et al., 2011), especially within the building industry. The diverse and contradictive definitions, and the difficulties to stablish valid objective qualitative measures (Weich et al., 2001) prevented its application in built environments (Dempsey et al., 2011; Hutchins and Sutherland, 2008; McKenzie, 2004).

#### II. SOCIAL DIMENSION OF SUSTAINABILITY

Within the varied definitions of social sustainability, there is a unified body of literature that addresses the concern to maintain social aspects throughout time and for future generations (Vallance et al., 2011). Polèse and Stren (2000) defined social sustainability in terms of a collective performance of society as well as the satisfaction of individual quality-of-life issues. In line with this trend, several authors highlighted the relevance of quality of life as central point of social sustainability (Colantonio, 2009; Hutchins and Sutherland, 2008; Vallance et al., 2011). Additional authors associated social sustainability with the adequate distribution of well-being in the present and the future (Mostafa and El-Gohary, 2014; Valdes-Vasquez and Klotz, 2013).

Based on this theoretical background, social sustainability and quality of life seem interrelated by focusing the attention on humans and their interaction with the surrounding environment, natural and built. However, human and social aspects seem intangible, abstract, within the building industry and, therefore, its application in a concrete and tangible industry was deemed difficult.

#### III. ANALYSIS

The general objective of this research was to find and propose an adequate approach to promote the practical application of social measurements in built environments. To that end, we focused on the quality of life and regenerative aspects described above.

According to (Bluyssen, 2010), quality of life is strongly related to well-being. To maintain or even improve people's quality of life, health factors should be addressed. Therefore, by promoting health and well-being in built environments, the occupants' quality of life may be sustained (Braubach and Power, 2011; Burton et al., 2011; Costa-Font, 2013; Oswald and Wu, 2010).

Research performed throughout the last two decades can be divided into two major groups: quantitative and qualitative studies. Quantitative studies focused on measuring the physical factors of indoor environments and their impact on the physical and psychological health of occupants (Liddell and Morris, 2010; Maidment et al., 2013; Sharpe et al., 2015). In contrast, qualitative studies focused on evaluating indoor environment features that influence occupants' health from a subjective perception approach (Evans and McCoy, 1998).

#### A. Quantitative studies

Quantitative studies focused on the impact of physical parameters such as thermal comfort, air quality, lighting, and noise, on occupants' health (Bluyssen, 2010). To judge the influence of those parameters on occupants' health, metrics or measures of performance were necessary (Hutchins and Sutherland, 2008).

Several studies highlighted the health issues related to poor indoor physical conditions. Deficient ventilation rates, or inadequate thermal and lighting conditions were identified as the cause of issues such as mould, damp, and infestations. Those issues were connected to occupants' illnesses such as increased blood pressure, asthma and other respiratory diseases (Evans et al., 2000; Liddell and Morris, 2010; Maidment et al., 2013) physical problems, and psychological distress (Evans et al., 2000; Halpern, 1995; Peat et al., 1998). Consequently, to promote occupants' health, several comfort models were developed as thermal and air quality indexes, light, noise, and ventilation scales (American Society of Heating, Refrigerating and Air-Conditioning Engineers, 2004; Bluyssen, 2009; Fanger, 1986).

#### B. Qualitative Studies

Qualitative studies explained the impact of indoor environment features on occupant's health through their subjective perception in the context of meeting their cognitive and emotional needs as well as their desires (Oswald et al., 2006; Wahl et al., 2009).

The influence of indoor qualitative factors on humans are mostly related to psychological processes. Through perception, human beings try to understand their surroundings. Depending on the environment's simplicity or complexity, users can experience a wide array of feelings such as confidence, relaxation, frustration or anxiety, depending on the way the information is processed (Kaplan and Kaplan, 2009). When indoor environment factors are inappropriately managed, detrimental effects arise in the form of stress, which derives in physical problems after a prolonged exposure. Stress significantly impacts physical health (Cohen et al., 1986) by affecting the endocrine, immune, and nervous systems (Bluyssen, 2009).

However, adequate indoor environment features promote residential satisfaction, which also exercises a significant impact on health and well-being. Inhabitants determine if a space suits them by perceiving tangible criteria that ranges from ergonomics to proxemics (Angel and Tienda 1982; Glick and Van Hook 2002). The fulfilment of the housing conditions in relation to inhabitants' needs and expectations has been defined as residential satisfaction (Amérigo, M., & Aragones 1997; Olmos and Haydeé 2008). Some of the housing characteristics that have been analyzed as determinant factors for residential satisfaction, were size, and quality of the indoor environment (Dekker et al. 2011; Li and Song 2009), and the ability to socialize (Basolo and Strong 2002; Dekker et al. 2011; Parkes, Kearns, and Atkinson 2002). Previous studies found strong positive relationships between psychological well-being and residential satisfaction (Levy-Leboyer and & Ratiu, 1993;

Brown, 1995, 1997; Siu and Phillips, 2002; Phillips et al., 2004, 2005; Fornara, Bonaiuto, and Bonnes 2010).

Summarizing, the subjective perception of indoor qualitative factors influences occupants' health, which ultimately affects their quality of life (Cohen et al., 1986; Evans and McCoy, 1998).

TABLE I Built Environment Health-Related Factors

Factor	Influence on Health	Authors
Crowding	-Overstimulation, difficulty to focus.	Aiello, 1987; Baum and Paulus, 1987.
	- Psychological distress, mental problems, and greater probability of depression.	Evans et al., 2003; Galea, et al., 2005; Honold, et al., 2012; Lederbogen et al., 2011.
	- Mental health problems, anxiety, insomnia, social dysfunction.	Migita et al., 2005; van Hoof et al., 2010.
Lack of control over environment	- Helplessness.	Cohen et al., 1986.
	- Psychological distress linked to physical disease.	Peterson et al., 1993.
	- Deficient space interaction.	Hedge, 1991; Sherrod and Cohen, 1979.
	- Social interaction obstruction.	Sommer, 1969.
Deficient Interior Layout	- Reduced space functionality.	Fadamiro, 2005; van der Voordt et al., 1997.
Luyour	- Limited physical accessibility.	Heywood, 2005; Imrie, 2003.
Privacy	- Proper social exchanges.	Coolen, 2006; Hartig et al., 2003; Scopelliti and Giuliani, 2004
	- Physical and psychological restoration.	Evans and McCoy, 1998.
Symbolic Environment	- Personal valence of dwelling elements.	Heft, 2001; Lewin et al., 1936.
	- Personal identity and space meaning.	Csikszentmihalyi and Halton, 1981; Moulaert et al., 2011.
Connection to nature	- Cognitive attention restoration, stress recovery.	Kaplan and Kaplan, 2009; Pfeiffer and Cloutier, 2016.
	- Improvements in overall mental health.	Alcock et al., 2015.
	- Promotion of physical, mental, and social wellbeing.	Abraham et al., 2010; Bratman et al., 2012; Carrus et al., 2015; Francis et al., 2012; Lachowycz and Jones, 2013:

#### C. Impact of qualitative features on health and well-being

As established by the scientific literature, built environment qualitative factors exercise their influence on occupants' health and well-being through subjective perception. Table 1 summarizes the factors and their influence on health as presented by the corresponding author.

According to the information presented in table 1, health factors are mainly related to the ability of the occupants to use the indoor space to its full extension. The space should provide enough opportunities for occupants to retreat and socialise comfortably, to access open or green spaces, to display personal and symbolic items, to circulate and use the internal spaces easily, and to adapt to personal and life circumstances. In order to incorporate social factors into building codes, we proposed to group them into the following categories: Accessibility; Flexibility; Regenerative and Unit size.

#### 1) Accessibility

Standards for accessibility within the dwelling unit are intended for any residential space to adapt to any user of any age, including those with permanent or temporary disabilities. These standards aim to minimize the physical barriers that reduce control and functionality of the interior environment, therefore mitigating, and even eliminating, the negative effects described in table 1, such as psychological distress, helplessness, and stress.

In line with Ulrich's Theory of Supportive Design (Ulrich, 1991), the built environment should offer physical accessibility to encourage a sense of control, and access to privacy. Regarding the physical accessibility, occupants should be able to circulate the interior space with minimal or no assistance (Heywood, 2005; Imrie, 2003). Housing design features that promote accessibility can include a toilet adapted to people with limited mobility on the main floor or near the main entrance, wider hallways, doorways and circulation spaces than required by the applicable code, and planned reinforced bathroom walls for potential grab rail installation (Saugeres, 2011; van der Voordt et al., 1997; Ward et al., 2014; Wright et al., 2017). As a dwelling is also a social space, accessibility should also be considered for visitors and, therefore, social areas of a residence should be properly dimensioned and accessible (Campagna, 2016; Rechavi, 2009; Wells and Harris, 2007).

#### 2) Flexibility

Flexibility standards aim to promote the versatility of interior spaces by facilitating the alteration of the physical conditions whenever necessary, according to the changing needs of users over time. The items of this section are intended to eliminate the incoherence, disorganization, dysfunctionality, and rigidity of interior layouts, which, according to table 1, may lead to anxiety, social dysfunction, depression, and, in general, psychological distress.

Flexibility has also been identified with functional design (Fakere et al., 2017), inclusive design (Milner and Madigan, 2004), and adaptability of the built environment to change (van

Scopelliti et al., 2016.

der Voordt, et al., 1997). The relationship between the psychological and sociological needs of occupants and the functionality of the space has also been stablished in previous research (Fadamiro, 2005).

Studies oriented to evaluate residential satisfaction considered flexibility as one of the attributes of the built environment to be assessed (Adriaanse, 2007; Chou et al., 2002; Mridha, 2015). In relation to symbolic aspects of the nvironment, flexibility promotes an adequate interaction with the space, and thus, the creation of meaning (Hedge, 1991; Moulaert et al., 2011; Sherrod and Cohen, 1979).

#### 3) Regenerative

Restorative standards are related to the environmental conditions that promote the recovery of users from excessive cognitive load, undesired or uncontrollable social interactions, and crowding. The items contained in this section promote the access to private and quiet spaces within the dwelling unit, daylighting, relaxing views, and contact to nature and greenery. As described in table 1, all these features are well-known for promoting health and well-being of occupants.

Private spaces in a dwelling unit offer retreat possibilities, provide a protection form ambient disturbances, temporary control over personal interactions, and stablish territoriality (Coolen, 2006; Giuliani and Scopelliti, 2009; Hartig et al., 2003; Scopelliti and Giuliani, 2004). Access to privacy within the dwelling must be considered for improved wellness results (Clark and Kearns, 2012; Heywood, 2005).

Regarding the connection with nature, there also is an extensive body of literature that highlights the benefits to human beings in general. Kaplan and Kaplan (2009) established the theoretical foundation for the restorative benefits of nature.

#### 4) Unit Size

Unit Size standards are intended to provide the minimum appropriate sizes of dwelling units in relation to the total number of inhabitants that the dwelling was intended to allocate. The floor area of a dwelling unit has an impact on every section described above as a certain amount of space is necessary to accommodate all the activities and functionalities that promote the health and well-being of occupants.

#### IV. DISCUSSION

When analysing the approaches of both quantitative and qualitative studies, we observed that the measurements applied on each dimension differed substantially. Quantitative studies measured indoor physical parameters such as air quality, ventilation, temperature, or lighting. Measurements provided objective and quantitative numerical values, so that precise metrics can be developed, and a correlation between health and indoor parameters can be determined. In addition, metrics lead to one of the most important factors within the building industry: standardization (Gibb and Isack, 2001), which promoted their incorporation as mandatory requirements into building codes. In contrast, qualitative studies analysed built environment features and their psychological implications on occupants' health. Measurements for perceived built environment features are provided via subjective and qualitative observations, which are non-numerical. Qualitative evaluations of environments were the base for previous studies, but objective and quantitative evaluations of environments are also needed (Winkel et al., 2009). Rating the characteristics of the built environment aside from the subjective perspectives of occupants is feasible, but stablishing the validity of objective measures is challenging, which has promoted the dearth of empirical research (Weich et al., 2001).

When analysing the practical implications of the theoretical background described on this section, the comfort models that derived from quantitative studies made a clear impact on mandatory building codes, regulations, and housing policies, at an international level. However, the conclusions yielded by qualitative studies has not been addressed, in general, by codes and standards.

Building codes are mainly developed to provide habitable spaces (Neilson, 2004), and to control the quality and safety of physical environments (Lawrence, 2002). To inhabit a residential space, basic standards are indispensable (Burdette et al., 2011; Clark and Kearns, 2012; Marsh et al., 2000; Newman and Garboden, 2013). However, in spite of establishing a baseline of habitable requirements, there seems to be an inconsistency between codes requirements and users' needs, and a disparity between users' expectations and actual materializations (Bluyssen et al., 2013). To avoid those discrepancies, and to promote occupants' health and wellbeing, housing policies and building codes should cover psychological and emotional needs of occupants (Suresh, 2007).

The objective of this research was to find and propose an adequate approach to promote social sustainability in built environments. We found a plausible approach in addressing health factors of indoor environments, and proposing a preliminary set of four categories of standards so that their incorporation into building codes may be feasible in the future.

#### V. CONCLUSIONS

Literature has shown that the social dimension of sustainability has been neglected in built environments. Within the building industry, energy efficiency measurements have received most of the attention at an international level (Reed, 2007). Many standards and rating systems have been developed over the last two decades, and their incorporation into mandatory building codes seemed the consequent trend. By their application, building occupants, and society in general, are involved in sustainability, but at the limited level of energy efficiency.

To materialize the evolution of sustainability towards society, the building industry needs to accommodate new standards that regulate health factors within built environments. As stated by Ward et al. (2014), the nature of the building industry, based on a high competition and the avoidance of any risk, is a major obstacle for adopting voluntary standards. Given the fact that the industry abides by mandatory regulations, building codes must address and incorporate social factors for the industry to apply them. In order to facilitate that incorporation, this paper also aimed to standardize qualitative features of residential environments.

The improvement of both theory and practice in the building industry is a necessary step for a shift in the current model of social sustainability, and standardization of built environment qualitative features seems an adequate preliminary approach.

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