



REVIEW

Housing flexibility problem: Review of recent limitations and solutions



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Abstract

The economic, technological, and cultural transformations of our present society influence various scales of our daily lives. In housing, these transformations include changes in the family nucleus and the activities performed in living spaces. Housing flexibility seeks to meet the multiple needs of users by changing their living spaces and functions. This study aims to explore housing flexibility through a review of relevant literature, discussion of valuable findings, and presentation of a contemporary panorama of the theme. Notions of flexibility are integrated to reinterpret the contemporary sense of dwelling. However, the lack of a well-defined concept of flexibility hinders the integration of methods and theories on the subject.

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1. Introduction

As populations concentrate in cities and exhaust available land, housing flexibility becomes a significant feature in the transformations of our daily lives. Associated with different typologies, housing flexibility offers the possibility of spatial or structural modification of buildings to meet user requirements by accommodating technological, cultural, and economic changes that occur over time. Housing flexibility is

based on extending construction lifespan (avoiding obsolescence) and sustainable consumption that conforms to recycling and waste management. Therefore, flexibility allows buildings to be useful for a long period by means of adaptations that guarantee continual utilization.

Examples of space flexibility are found throughout history; these include prehistoric tents, prefabricated catalog houses, and universal exhibition buildings (Clark, 1986; Wadel, 2009). In the 20th century, flexibility gained notoriety during the Modernist movement and resulted in the lively discussion of the “living machine” concept. Flexibility was an important resource for mass social housing, which sheltered the abundant working masses and their families (Leupen, 2004).

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Toward the end of the 20th century, in a time of rapid changes in dwelling culture and customs, the improvement of construction materials allowed a growing number of residents to purchase unfinished spaces with no partitions and participate in the configuration of their own homes (Friedman and Krawitz, 1998). Presently, flexibility is essential for adjustment in a mutating society in a century of enormous technological range. Flexibility strategies are combined to embrace daily activities and operate numerous procedures in accordance with habitat activities.

This study aims to investigate housing flexibility by reviewing relevant peer-reviewed papers published in the 21st century in international journals. The hypothesis is to analyze the contribution of flexibility to the development of a consistent perception of contemporary housing flexibility, which includes design, spatial organization, and the construction industry.

We began by reviewing housing flexibility concepts to establish the research object and structure the methodology clearly. Afterward, we surveyed studies on housing flexibility by using English digital editions of journals. This analysis of publication content led us to determine five categories after organizing the sub-topics of each publication.

The rest of this paper is organized as follows. Section 2 presents and defines housing flexibility. Section 3 introduces the surveyed studies, which are divided into five categories. Section 4 discusses the valuable findings, and Section 5 provides the conclusions.

2. Living space flexibility

Flexibility was widely discussed in the 1950s. Since then, its concepts and applications have been constantly renewed. Therefore, summarizing its definitions is essential. Flexibility can be considered the capability of a space to provide distinct choices, configurations, and customizations (Groak, 1992; Rabeneck et al., 1973); the generic purpose of an environment, where furniture and movable partitions symbolize its conversion (Venturi, 1977); the polyvalence of a space playing different functions without a change in the form itself, thus producing an optimal solution (Hertzberger, 1991); or the skill of creating margins where alternative interpretations can be implemented (Koolhaas and Mau, 1995).

Flexibility can be found in living spaces, offices, sports centers, and elderly/disability care centers (Cellucci and Di Sivo, 2015; Remøy and Voordt, 2014). Living spaces and elderly care centers have been emphasized in literature, indicating their scientific relevance. Housing flexibility, the field selected for this review, integrates contrasting

variables, such as structure and construction techniques, furniture, partitions, materials, and dynamics among rooms (Abdulpader et al., 2014; Živković and Jovanović, 2012). Flexibility exists in the details and at a large scale by combining procedures that vary the level of use.

This investigation reveals the singularities raised by each of the reviewed papers by collecting information pertinent to the proposed scenario. The research focuses on housing typology because frequent refurbishments exist in housing typology to accommodate technological, cultural, and economic changes (Dhar et al., 2013).

3. Research context

We compiled the main perspectives of the reviewed papers to comprehend their context. The aim was to provide an organizational structure focused on the analysis and discussion of issues. Considering the sectional division of the papers, we noticed that they dealt mostly with strategy application and construction techniques and were substantiated by the conceptual ideas of architects and projects, thus establishing a diversified universe conducive to the exploration of the scenarios surrounding the investigated theme.

3.1. Economic and budgetary aspects

By evaluating the influence of flexibility on building costs, the dissemination of its benefits can be reinforced, and the recycling of existent structures can be stimulated. Furthermore, optimization of available space is crucial in large cities, which become increasingly compacted and vertical. Regarding the construction of facilities, Slaughter (2001) argued that building equipment is not designed to accommodate changes over time, implying demolition costs (for the installation of new equipment) and waste of materials. She assumed that facilities experience changes in function (upgrading existing functions and incorporating new ones), capacity (changing loads/conditions and volume), and flow (changing the flow of the environment and people/things). In addition, interactions among facilities affect the versatility of components.

On the basis of these facility changes and interactions, Slaughter (2001) analyzed 48 projects in the United States by considering structures, exterior enclosure, services, and interior finish. The survey revealed that buildings require more renovations in their systems than previously assumed, especially when they are transformed to accommodate new purposes. Even if structures are independent and maintain

Table 1 Design strategies.

Source: Slaughter (2001).

Design Strategies

Reduce inter-system interactions	Dedicate specific area/volume for system zone
Reduce intra-system interactions	Enhance system access proximity
Use interchangeable system components	Improve flow
Increase layout predictability	Phase system installation
Improve physical access	Simplify partial/phased demolition

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