

Investigating the Difficulties Arising from Changes in Residential Buildings in their Lifetime and Available Solutions to Remove them

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Abstract: Rapid advancement in human society and changes in lifestyle in short periods of time has increased the severity of alterations in using buildings. Disregarding changes in behavioral patterns, fashion, and aesthetics has resulted in the inadequacy or omission of some spaces in buildings. Flexibility and variability of a building can respond to transition and transformation in population and lifestyle of residents. Building's incompatibility with recent functions may result in huge waste of national money and energy, in addition to its instability, within the realm of construction which plays significant role in the infra-structure of a country. Spatial design with high level of flexibility and variability regarding formation and level arrangement plays multiple functions such as higher customer satisfaction. Buildings constructed flexible and adaptable will last longer in the course of time. Investigating and determining factors and criteria for building and internal space flexibility to increase adequacy and building stability through time are the main concerns of the present study. Therefore, this research which is descriptive-analytical in method leaves no stone unturned to, in addition to revealing challenges on the way to higher building lifespan which is considered influential in internal space flexibility, investigate the effects of flexibility on building stability and internal space flexibility parameters and, finally, present solutions to enhance building flexibility.

Key words: Flexibility, internal space, building permanency, building lifespan

INTRODUCTION

Population and its related factors are among the most crucial ones in determining the policy of each society. Population growth and transformation affect construction field most because all societies, no matter small or big, can not help design man-made structures for accommodating its members. "Population transformation affects building tendencies of societies, because population is composed of individual and public behavioral patterns which necessitate various space structures through time" (1). Incompatibility of a building with requirements and behavior patterns through time can bring about instability of a building or its abandonment by residents.

"Many buildings with different functions after construction go through physical changes made to them by users; changes which, sometimes, consider the building itself an obstacle and make the building an entirely novel; architectural entity; on the other hand, due to inevitable transformations which are constantly carried out by users (internal change) and technical and value discipline (external change), user have to make these changes to satisfy their needs based on new developments" (2). These changes might range from simple redecoration of furniture to drastic physical alterations in residential building. Designing for the purpose of spatial change and flexibility is an integral construction principle with the observation of which there will be buildings with long lifespan and high output, appropriate for next generation use and away from undue destruction and turning into construction debris which has become a major environmental issue in large cities. This research attempts to find the answers to the following questions:

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- How does flexibility affect building design?
- What are the advantages of flexible designing?
- What are some spatial opportunities created out of flexible design in residence arrangement?
- How does building flexibility affect its lifespan and respond to coming requirements?

RESEARCH METHOD

Research method is descriptive-analytical and it has tried to investigate the topic based on library documents and available proofs. The logical trajectory of this study is examining prior researches and findings, data gathering, analysis, and coming to a conclusion and respond to research questions.

DEFINITION AND ESSENCE OF FLEXIBILITY

Broadly speaking, flexibility can be defined as *the tendency and willingness of material to change*. However, in architecture and residence designing which is the main research topic, it is defined as “designing and arranging man-made space to fulfill new functions, necessities, and conditions”.

Flexibility and adaptability are usually considered synonym concepts in residence design. However, despite noticeable common grounds, these two are different issues: “Most human behavioral patterns emerge in a physical context; adaptable spatial design is a plan which makes behavioral patterns possible in different times regardless of physical changes; such a space is called stabilized, multi-functional space” (3). Present study introduces adaptability as one of the sub-categories of flexibility.

“Flexibility is an approach in which the designer, consciously or unconsciously, changes the functional pattern of the project and presents a design adaptable to various functions to satisfy the customers’ needs. Some interpret this procedure as annexing new parts to a building; another group considers spatial changes prerequisite to functional changes in the buildings; and a final group introduces the use of multi-functional spaces. In fact, flexibility is an inclusive term and covers annexation and development, change, and multi-functionalism”. (4)

HISTORY OF FLEXIBILITY IN IRAN AND THE WORLD

Iran

House, as an example of Iran traditional architecture, has been most influenced by life pattern of people and represented needs, beliefs, and thoughts; it, as an important dimension of life, has always been in mutual give and take with human life. The pivotal point in Iranian houses is their spatial organization which has made utmost spatial use possible, a sort of intelligence which provides highest use without applying modern technologies. “The frame of the house is thoroughly saturated in human activities and it is the human that plays central role. In this context, human attempt to reform environmental issues interact with climate transformations and overcome architectural weaknesses as human activities which react to changes”. (5)

World

Modernism introduced I free plan, which is the result of drastic changes in overall structures and includes several situations, into architecture. Lokorbozie and Vandrohe were the groundbreakers in modern architecture and free plan. Lokorbozie’s contributions were regular building structure and non-load bearing curtain wall, while metal building and mobile inert-column bearing wall were presented by Vandroh both of whose works were portrayed in Stuttgart exhibition which was a momentous event in European architecture. Frank Loid Wright’s work was also different in using extensive open space and accommodating curtains between spaces instead of walls and doors; instead of designing a box, he unboxes the plan and

humanizes the space through keeping least possible divisions.; “actually his work presents another version of Lokorbozie and Vandrohe’s idea of intact, extensive open space” (5). He, even, tries to mix house facilities with the structure itself and create a space with unlimited variety and unexpected points on small scale through minimizing the number of rooms and making all parts of the building spatially coherent.

This perspective towards flexibility continues in next periods. Deconstruction presents world as a texture of differences whose oppositions are to be displayed; Folding considers these differences as mobile flexible layers which, while keeping individual characteristics, merge into each other. This explanation makes it clear that modern architecture aims at creating unlimited various spaces in which there are different and special relationships between open and close spaces in proportion to the needs of the users. However, one of the main reasons for the failure of modern architecture was its disregard of environmental capabilities and socio-cultural characteristics; it did not integrate various space construction models. Therefore, its view was mainly functional and technological. Ignoring ideological tendencies of the community and integrating predictable functions cannot guarantee necessary flexibility in space in environmental capabilities.

Problems of Residential Buildings Resulting form Inflexibility

“Residential buildings have long complicated lifespan during which their functional parameters change drastically; although they are constructed in fixed cite their environment changes, develop, and are replaced like all other buildings. Flexibility and compatibility are necessary because of the demands of economy and new requirements” (6). Peoples’ cooperation, in this process, facilitates building’s adjustment and enhances public satisfaction. Creating the possibility of change, space adjustment capability, and change of life space based on personal taste are characteristics of an ideal house.

Table 1
Changes which necessitate architectural alteration on large scale

	<i>Financial need change</i>	<i>Increase in the number of users</i>	<i>Change in users</i>	<i>Change in activities (special occasions)</i>	<i>Change in user taste</i>
Cultural-religious space	★	★			
Educational space		★		★	
Residential space		★	★		★
Business space		★	★		

Change in Populationstructure, Regulations and Standards, and Values

Architecture cannot help change to adjust to alterations and save space quality, a change which moves towards flexibility. History of architecture embeds countless examples of buildings which right after construction had been changed to respond to new conditions; cultural-religious spaces and mosques which experienced physical change to make money are explicit instances. Increase in the number of users has resulted in annexing new parts to cultural space to accommodate the population.

Increase in the number of students has necessitated more and bigger classes in educational spaces. Expansion of branches and educational levels at universities made educational buildings vertically or horizontally larger; actually, the essence of educational space demands changes through time. Residential buildings change, too, based on personal taste, space preservation, and emerging needs. Factors like childbirth, change in residents, and independence of children bring about residential space segregation or association; aging and change of taste, as well, may result in physical changes to the building. Generally, factors influential on physical change can be categorized in four groups:

- Change of the habitants in residential buildings

- Population growth through time
- Physical changes
- Change in lifestyle, fashion, and aesthetics

Table 2
The advantages of flexible buildings from the perspective of users

<i>Eco-environmental stability</i>	<i>Social stability</i>	<i>Economic stability</i>
<ul style="list-style-type: none"> • Reduction in the use of fossil energies • Reduction in pollution 	<ul style="list-style-type: none"> • Social and cultural stability of districts • Stability despite change of family form • Appropriateness with various physical conditions • Stability in proportion to technology use • Cultural harmony 	<ul style="list-style-type: none"> • Reduction of transportation costs • Reduction of consumable energies costs • Reduction of reconstruction costs

Change of the habitants in residential buildings

Residential spaces are mostly used in rental or ownership form. If they are rented, yearly changes, based on the needs of the new inhabitants, are inevitable, and since most buildings are not constructed flexibly, these changes bring about users’ dissatisfaction. In the ownership form, a building, from construction to destruction, is resided buy a single owner. There might be fewer problems; however, if the building is sold and does not accord to the needs of the new user and is not flexible enough to accommodate segregation, association, or development, it will result in serious dissatisfaction of new inhabitants.

Population growth through time

Change in the structure of family is inseparable from change of residential buildings. Nowadays, aging of family members and emergence of new needs determine life in kernel families and new buildings. Marriage, independence of children, presence of grandpa and grandma necessitate a more flexible house.

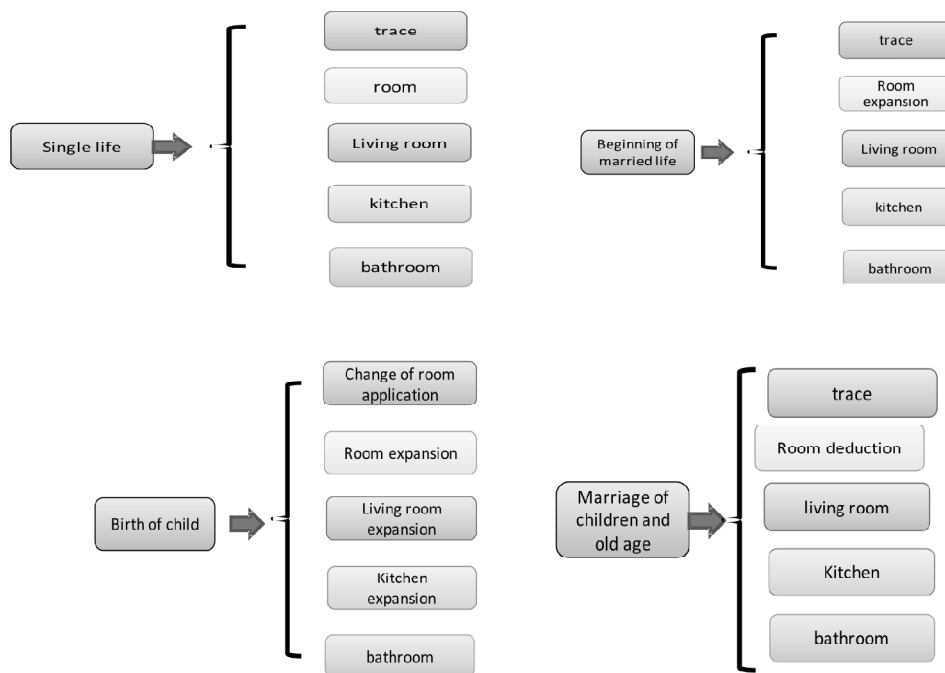


Figure 1: Population changes of family through time

Traditional houses, which accommodated three following generations, experienced these changes more severely and response to new needs was made possible through using various available spaces at home.

Seasonal Changes

A building's environment is under constant seasonal and daily changes which people taken benefit from for developing internal space. "Climate and environmental necessities, and making best use of natural conditions, provide users with advantages by which they can plan constructing flexible spaces" (7). Through flexible house designing, solutions can be predicted to confront unfavorable climate change and move towards stable architecture of residential buildings.

Functional requirements emerge according to change in family structure and size, life style, activities, gradual growing of family members and house facility applications. Therefore, houses need to be more flexible due to psychological and social impacts of these changes. Ownership and financial facilities can result in flexibility only if their functional, psychological, and social effects are truly recognized.

"Every historical era and social life incorporates certain architectural patterns used by majority of people. Aesthetically speaking, these short lived patterns are called 'fashion'; patterns which last longer and have wider spatial favor are called 'style'. Fashion lasts shorter and changes more; style lasts longer and changes less; aesthetic principles last longest and change least.

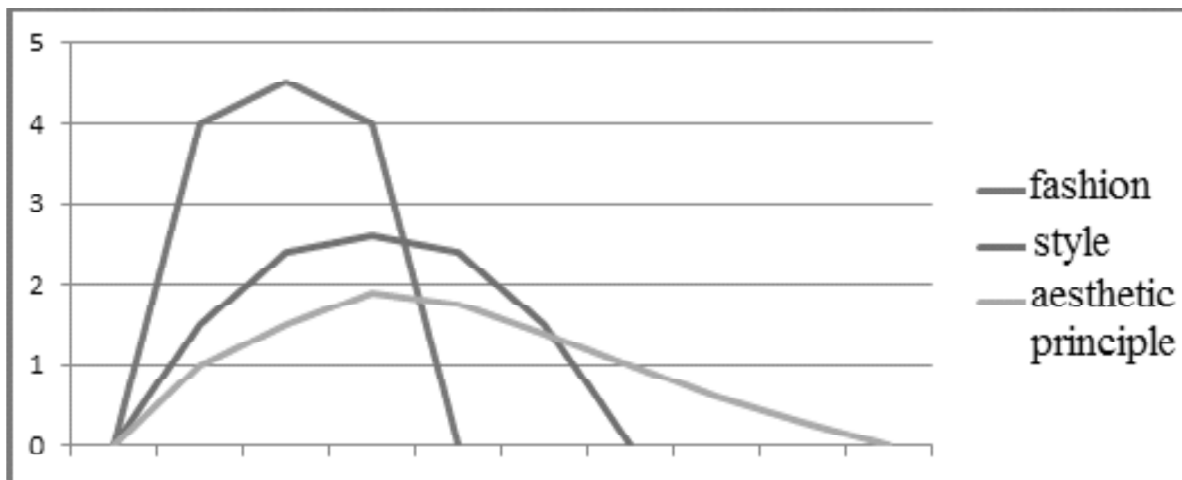


Figure 2: Fundamental aesthetic principles, style, and fashion

The more a building is constructed according to the fashion of the era, the sooner it expires visually and aesthetically, some even lasting less than 10 years. Applying fundamental aesthetic principles not only reduces the risk in architectural patterns, but also makes building simpler, more luxurious, and aesthetically older.

Solutions and Design Innovations towards Building and Internal Space Flexibility

Flexibility in architectural design presents the possibility of residential unit's adjustment and compatibility through time and, finally, results in the flourishing of hidden perspectives of the building. In order to provide flexibility, architects must prioritize the needs of the users in designing and think in long term necessities. "One of the fundamental principles of flexible designing is avoiding inflexibility; the structural system and service providing spaces are permanent members. In structural system, the walls are preferred to be non-load bearing so that they can be moved between spaces in the unit and provide the necessary space for presenting services in all available sections of the unit" (9). Buildings belong to users and their

adjustment section. Thus it can be said that in general designing building is dependent on environment and user and since human beings are in search of variety and stability of environment seems monotonous to them, they are in favor of facilities by which they can do physical and spatial changes. These changes can range from simple resorting to drastic alterations, even of the whole building.

Main issues in flexible buildings are as the followings:

- Structural system
- Availability of service providing spaces
- Architectural design
- Internal space mobilization for flexible use of space
- Application of structural elements and furniture for smart and flexible changes

Structural System

Many buildings with different functions after construction go through physical changes made to them by users; changes which, sometimes, consider the building itself an obstacle and make the building an entirely novel; architectural entity; on the other hand, due to inevitable transformations which are constantly carried out by users (internal change) and technical and value discipline (external change), user have to make these changes to satisfy their needs based on new developments.

“If structural system is considered to cover architecture as well, meaning that they are the same, then the stability of the building minimizes flexibility of space and possibility of change; bearing walls which are stable parts of building are clear instances of this fixedness. In buildings with bearing walls, the possibility of change is minimized; therefore, in buildings which are designed fixed and immobile, construction is divergent from architecture” (2). Historically speaking, with the occurrence of industrial revolution and outstanding advancements in building and construction technology, there came plans with highly complicated structural calculations which necessitated a spatiality called structural engineering; on the other hand, rapid advancements in building technologies expanded the gap between architecture and structure engineering increasingly; from then structure and architecture had to be united with each other again. At the beginning of 20th century the first steps were taken for this unification. Therefore, structure came to be accepted as bearing member of architecture system. To satisfy the needs of the users, both have to follow the same direction because their divergence will result in serious dissatisfaction.

Service Providing Spaces

The location of service providing spaces can be considered as an influential factor in spatial fragmentation; actually, service units are either parts of fixed structural system, or they are designed separately. Placing wet spaces in separate sections of dry spaces provides the mobility of kitchen and bathroom in definite areas without being fixed. Therefore, service providing spaces remain intact within the boundary of main spaces through association.

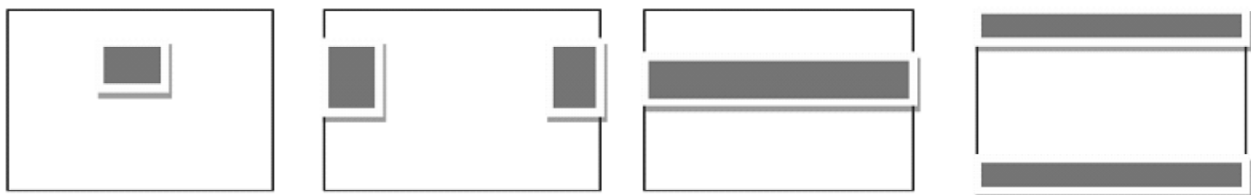


Figure 3: Placing service providing spaces in a part of plan with the least interference in main spaces

“The designers tend to ascribe definite places for particular activities within buildings. Specification of spaces, for further satisfaction of the users, complicates and makes difficult the fulfillment of other processes and activities” (3). Multi-functional spaces present more opportunities in comparison with task-based designed spaces; such spaces, which provide various services, are called flexible.

Architecture Design

Fragmentation of permanent parts is a degree of flexibility in buildings. Flexibility of architectural designs depends on the fragmentation of permanent members so that it can respond to emergent needs of the inhabitants. In the following example, architectural design can be responsive to population requirements on both soft and hard scale. Soft and hard are two terms to evaluate the flexibility of structural system in which soft provides more freedom of action compared to the hard form.

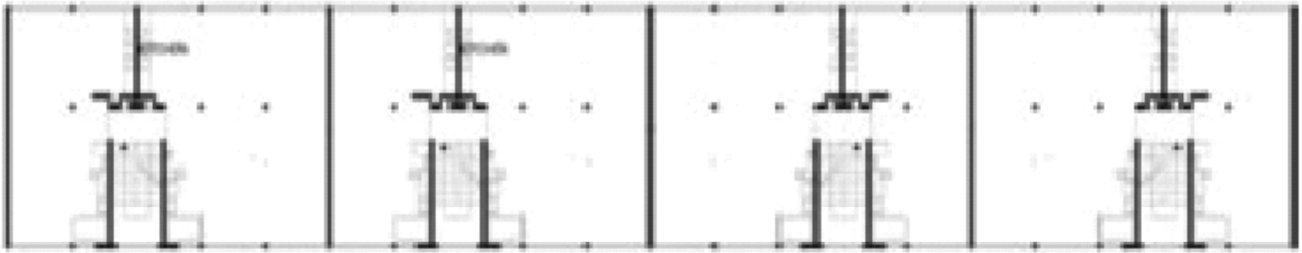


Figure 4: This plan does not specify space fragmentation (soft form)

“Hard form refers to developed forms which are designed specifically to be flexible; i.e. the structure of the building is consciously designed to be flexible. In soft form, building has limitless opportunities in designing and attributing spaces which make change and adjustment application possible through time. For example, apartment blocks in figure 4 are designed in soft form; the whole space is vacant and it is left to the users to use the space available as they wish”. (9)

Internal Space Mobilization for Flexible use of Space

Elements used as separators or partitions are very influential in spatial organization. Sliding and transitional elements and bending and folding walls, as mobilization elements, are labeled ‘spatial flexibility equipment’.



Figure 5: Flexible furniture

Separation through these elements and partitions is an opportunity for users; using furniture is a level or functional unit; folding furniture is preferable in buildings. As it was stated earlier, furniture is one of the fundamental factors the smart application of which helps attain flexibility in internal designing; multi-functional and flexible facilities have come always helpful to and preferred by users.

“In this type of architecture, sorting of available furniture in an eclectic form not only facilitates possible changes, but also is a manifestation of flexibility in furniture fragmentation; choosing the color, material, form, and size is open to the users. These innovative equipment which have plastic or wooden coverings have more flexibility and durability”. (10)

Application of Structural Elements and Furniture for Smart and Flexible Changes

Though designing structures which are flexible in shape and form is not a new idea, it has remained embryonic due to lack of necessary technologies and materials. However, the last two decades has experienced rapid growth of such structures because of advancements in man-made facilities and technologies.

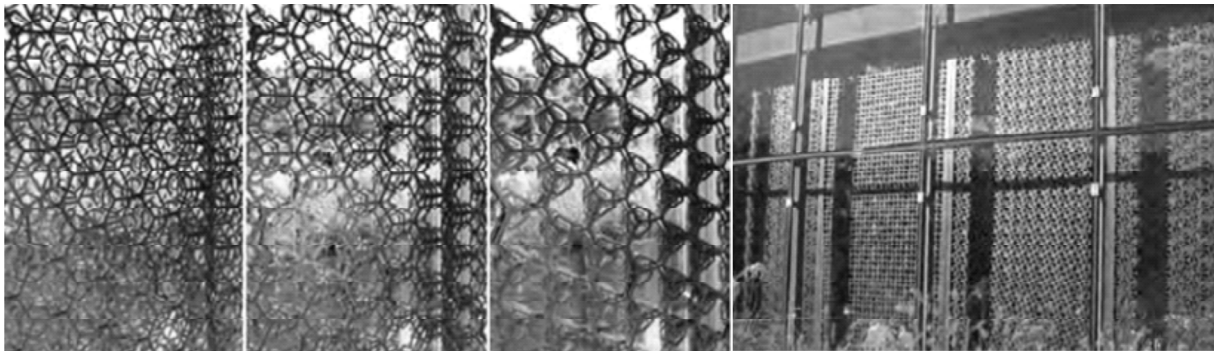


Figure 6: Tessellate system. Simons center: Stony Brock University

“Applying flexible materials and structures has greatly influenced and revolutionized architectural spaces in buildings; it can also be said that these structures, in addition to enhancing the quality of architectural spaces, play the main role in the production of buildings. The most important advantages of flexible structures are: installation and transition mobility, creation of symbolic elements, and application of civil or internal spaces”. (11)

Tessellate system, produced in an American company, is an example. It is made of framed, netted sheets which can change automatically based on climate, environmental necessity, and internal space application.

CONCLUSION

Life and requirements of human beings change through time. Not only space users are not fixed and changes in population, space application, family size, and life patterns necessitate adjusting to time, but also residential building design evolves. Therefore, buildings must incorporate opportunities to meet emerging needs of users, and this defines permanent flexibility. Flexibility refers to an endless approach in designing which permits infinite changes. Cooperation of architecture and time through applying flexibility, which can be cheaply done, can help buildings last longer and better. Some advices regarding flexibility in residential buildings are the ultimate part of this study:

- The extent of flexibility is closely related to the size of space. The smaller a space, the more difficult it becomes flexible because that limited space is expected to satisfy all needs of the users.
- Construction: there is a relationship between construction techniques and flexibility

- Appropriate space fragmentation in designs: ascribing suitable spaces to places like stairs, entrances, and service units make the building flexible for possible changes with little cost.
- Layer: explicit recognition of construction layers, such as structure, crust, and service units, helps increase control.

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