Standardization in Construction as a Tool to Reduce Cost of Housing for the Low-Income Families in Jordan

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Abstract: Providing a decent housing is a major challenge for governments and development authorities in Jordan and Arab countries. Nevertheless, the growing number of population falling under poverty put more demand on low cost housing options. The goal of the research was to find ways of rationalizing the cost and determine the appropriate standards and models that achieve an acceptable equation between cost and performance, and that during design and construction phases. The study follows the method of investigation and analysis to get factors that reduce the cost of the house construction for poor families by means of the concept of standardization in traditional (popular) buildings system. The research confirms that the traditional system has many advantages that could strengthen towards development a low-cost building system by applying the principles of standardization through architectural, structural and electro-mechanical considerations of design. Research recommends taking on studies for low cost building system through comprehensive analytical study of local building experiences.

Key words: Housing, structural system, low cost.

1. Introduction

The problem of providing adequate houses has become one of the biggest challenges facing the government of Jordan and the Arab world. Over the past decades, many policies have been developed to counter the growing problems as a result of the high growth in population and the high cost of living and in bad economic conditions which affect the capability of the population to obtain suitable houses for a large proportion of the population as well as the conditions that led to the existence of a significant proportion of the poorest people whose, originally, not having a place to live. Jordanian State currently pay attention to this issue by creating a program to provide proper housing for this category of people, but this will increase the burden on the state in terms of the cost of that housing [1].

Most housing projects carried out by the sector oriented to middle-income and low-income, and rely on the principle of full cost recovery. The government had implemented an integrated package of structural reforms for the housing sector, to address the imbalances of the sector and enable it to meet the housing needs of all segments of the Jordanian society, and to redirect the investment in housing towards low-income and poor families, where the housing is needed. But these reforms and procedures have not been able to meet the housing needs of the poor population in Jordan. All this led to the launch of a new initiative designed to assess and meet the housing needs of poor households [2].

2. Research Objectives

The research aims to consider, in a holistic manner, the main components of the construction of the traditional Jordanian housing elements (architectural, structural, mechanical and electrical), and conduct detailed studies of these elements in an attempt to coordinate between all the measurements and the dimensions of these elements with each other and find ways of rationalizing the cost and determine the
necessary real quantities through the use of appropriate standards and models that achieve an acceptable equation between cost and performance, and that during design and construction phases.

3. Research Problems

The main problems and issues faced by the state in order to solve the problem of securing houses for poor families can be summarized by the following:

- The high cost of such housing projects, which pose a significant burden on the state budget;
- This cost is distributed to three main parts, the cost of land, the construction cost and the cost of the infrastructure services, such as electricity, water and other services that have become necessary and indispensable so that the construction cost has the largest percentage of the total cost;
- Until now, no guidelines are adopted for housing projects for needy families. A guideline is needed to define construction techniques, and materials specification to reduce cost and maintain high quality. Same construction methods are used, which may be costly and non-efficient;
- Beneficiary families try to impose their opinions during the construction to change original design. Adding to the difficulty is the desire of the family to build a separate house, which is the costliest style.

4. Research Hypothesis

This research assumes that construction of houses in the traditional manner is solid and safe, but it is not optimal. Likely, more materials are used due to the principle of standardization which increases the cost of the building, and therefore we must develop technique to support the use of standard/modular elements compatible and well thought out can alleviate the cost and can reduce the financial burden on the kingdom in order to secure the largest number of housing for poor families.

5. Research Methodology

This study follows the method of investigation and analysis to understand the problem to get factors that reduce the cost of the house construction for poor families by using the concept of standardization in traditional (popular) buildings system without reducing the efficiency and specifications of the construction, through the following methods:

- Identify the problems faced by the government apparatus in securing housing for poor families;
- Understand and analyze the style of traditional construction in Jordan and the mechanics of construction used locally;
- The use of personal interviews with engineers and technicians in site to get to the ways of reducing costs without resorting to drop the efficiency of housing and its specifications.

6. Discussion

According to the 2016 statistics and to the studies of the Ministry of Social Development, the number of families living in marginal and non-qualified houses in Jordan amounted to 12,000 families and estimated at about 0.13% of total population and at about 6% of the current housing stock in Jordan, with a total estimated cost 132 million Jordanian Dinars (JD), and they urgently need to improve these conditions by build some new houses for them. This is in addition to many families who live in crowded houses and substandard conditions, while the percentage of families whose breadwinner aged between 25-35 years is the dominant. We should take in our consideration that the average number of bedrooms per houses for poor families is less than the average number for non-poor families [3]. Fig. 1 shows some houses where the poorest families are living, while Table 1 shows the distribution of occupied houses, families and individuals, according to the type of housing for the Kingdom of Jordan [4].

Despite the limited economic resources of the state of Jordan, it focused attention to this aspect through launching many initiatives for housing as following:

- Based on the vision and directives of His Majesty
Table 1  The distribution of occupied houses, families and individuals according to the type of housing in Jordan 2015 [4].

<table>
<thead>
<tr>
<th></th>
<th>Buildings</th>
<th>Apartment</th>
<th>Villas</th>
<th>Caravan</th>
<th>Tent house</th>
<th>Temporary house</th>
<th>Work place</th>
<th>Under construction</th>
<th>Other</th>
<th>Not mentioned</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homes</td>
<td>228,503</td>
<td>1,514,637</td>
<td>10,601</td>
<td>29,547</td>
<td>3,857</td>
<td>2,678</td>
<td>2,660</td>
<td>317</td>
<td>224</td>
<td>268</td>
<td>1,793,292</td>
</tr>
<tr>
<td>Families</td>
<td>233,036</td>
<td>1,678,978</td>
<td>10,989</td>
<td>34,963</td>
<td>4,191</td>
<td>3,013</td>
<td>2,965</td>
<td>326</td>
<td>234</td>
<td>274</td>
<td>1,968,979</td>
</tr>
<tr>
<td>Individuals</td>
<td>1,226,295</td>
<td>7,948,470</td>
<td>55,271</td>
<td>167,283</td>
<td>21,082</td>
<td>16,724</td>
<td>14,295</td>
<td>1,401</td>
<td>1,011</td>
<td>1,292</td>
<td>9,453,124</td>
</tr>
</tbody>
</table>

King Abdullah II, a national initiative for housing under the name “Decent Housing for Decent Living” in an effort to promote social and economic security by providing a wide range of citizens appropriate housing in all the provinces within the five-year plan beginning in 2008;

- In November 2005, the “King Abdullah II poor families’ housing project” in Jordan [5];
- In November 2005, His Majesty King Abdullah II launched the “King Abdullah II poor families’ housing project” in Mafraq. The first phase of the project, which is overseen by the Royal Hashemite Court, included the construction of 600 houses for the poor in ten governorates, while the second phase includes the construction of 1,400 housing units in various governorates of the Kingdom, of which a great part has been completed and assigned [6];
- In 2004, the government embarked on the implementation of this initiative and completed the first phase including the construction of 481 houses for poor families at a cost of 2.6 million JD, followed by other stages of the construction of new housing with total cost of 3.5 million JD [7];

Referring to specific results that have been drawn from the analysis of the cost of projects that have been completed, we found that the cost of each housing unit was relatively high (about 23,000 JDs), which means that 200-230 JDs per square meter of construction. This is despite the reduction of the residential area of the unit and reducing some of its construction specifications. On the other side, we know that the different prices of building materials continue to rise, which means that we need to research to find ways that lead to reducing cost of building housing units in general and especially for poor families.

7. Traditional Building Construction System in Jordan

A popular practice in the traditional building construction system in Jordan is the use of reinforced concrete frame structures includes foundation, columns and ceilings with concrete bricks infill. Usually, they use a stone cladding for the exterior walls of the building (Figs. 1 and 2).

Although this system produces a solid and safe structure, however, there are several problems encountered by the construction process including the following [8]:

Fig. 1  The construction of foundations and columns of traditional house in Jordan.

Fig. 2  The construction of stone and brick walls in traditional house in Jordan.
Because of interlocking in the construction process, any delay in the implementation, at different stages, affects each other, and any difference in time may lead to work delay;

- There is a shortage of trained and qualified (local and non-local) laborers, which can affect the quality of the building and increase costs;
- The process of the development of this method of construction is slow and there is no mention of any actions to improve or modify it;
- A large amount of building materials used in construction (both in structural works or finishing) may be lost as a result of misuse and poor workmanship or during loading and storage operations (Figs. 3-5);
- Despite the fact that most of building materials, used in the construction, are prefabricated and available with different standards and specifications, but the application of using these substances methods, does not take into account the characteristics of these materials and the structural relationships to each other;
- Mostly, the construction process is dependent on the local contractors who are usually not licensed and not qualified. The contractor make agreement with the owner himself without adequate supervision of licensed site engineer or technicians.

There are several attempts that aimed to develop the prevailing traditional system in Jordan and to make improvements in terms of construction quality and reduction in time and cost that depend on the use of prefabricated typical structural elements, for example, the Building System No.5 [9], which was tested in the construction of a number of housing projects and in some administrative small buildings. In addition to all above, there are several factories that produced a structural precast elements, but these attempts were limited to construction in a certain projects and they stopped working at the end of the project works, or that they have not received adequate attention to developing them to fit with the popular characteristics of the traditional structural system in Jordan. Mostly, the production of typical standard elements in these factories were limited to main structural elements (foundations, walls, columns, roof slabs).

Therefore, there is a need to carry out studies for the development of a system for the application of the principles of standardization—as much as possible to all the structural and architectural elements of the house, especially, those have the most economic value such as: the main structural elements and finishing materials which can lead to the reduction of total cost of construction.
8. Measurement and Manufacturing in Construction

The scientists realized the importance of standardization, where the famous Mendeleev Russian scientist said, “Science begins where measurement begins” as Thompson said, “We know things as much as we can measure them” [10].

The use of manufactured building materials was expanded after the end of World War II, when the accelerating of construction process became as an urgent need, after that the manufacturing of construction elements became as a modern features in a series of historical development of the construction process, which depends on the principle of standardization and the principle of dimensional co-ordination [11]. The standardization is defined by the ISO (International Standards Organization) with the phrase “Formulation, publication, and implementation of guidelines, rules, and specifications for popular and repeated use, aimed at achieving optimum degree of order or uniformity in a given context, discipline, or field” [12]. Standardization can help to maximize compatibility, interoperability, safety, repeatability, or quality. It can also facilitate commoditization of formerly custom processes. In social sciences, including economics, the idea of standardization is close to the solution for a coordination problem, a situation in which all parties can realize mutual gains, but only by making mutually consistent decisions [13]. Figs. 6 and 7 show the practice of using standardization in manufacture of some construction components in Jordan.

In general, the concept of “standardization” is defined by adopting specific rules and solid fundamentals that are related to the humanitarian action, unanimity or to the conventional law. But either standardization in general is the adoption of specific rules and principles fixed to the order in matters of human activity that is determined, either by custom or consensus or law. As for construction, the standardization means the use of standard elements that produce an integrated system and closed through the pre-design of the process of production of these elements, whether assembled or single, in spite of the difference in function, type, measurements, method of production and other issues. The result is to achieve economy in the cost of construction [11].

The most important principles of standardization are the following:

1) Simplification is to determine the most important and popularly used sizes and models used in the production process;

2) Unification: by the means of unification of two specifications or more in one specification so as to be able to exchange the use of products by the adoption of optimal designs in terms of quality and production method;

3) Define specifications by the means of summarizing the requirements that should be achieved in a product with clarifications that the product is able to meet the requirements of this method of collection.
Standardization in general has many benefits, as well as the following:

- The overall savings in the labor efforts, materials and other during the production process;
- Maintain high quality standard for components;
- Protect the public health and safety;
- Increase production capacity, reduce costs and improve quality.

Since ancient times, different systems of standardization have been used in the construction and there are many evidences from different civilizations. The standardization methods have evolved over the centuries, depending on labor costs, on the specifications and on the characteristics of materials used. So researchers have found methods and structural systems which are compatible with some extent, with the nature of these materials in terms of manufacturing, installation, collection, construction and others.

In recent experiments, the use of the elements and normative components or standards for buildings, can lead to many important benefits, like quality control, price control, simplicity in installation and construction speed as well as reducing in materials waste and other things that can eventually lead to the desired goal, the results, of which, is the reduction in the construction cost.

9. Positive Characteristics of the Traditional System in Using the Principle of Standardization

This research found out that the traditional system has some positive characteristics and possibilities that can work on to develop a low-cost system through the following considerations:

9.1 Architectural Considerations

Most of the components of the structure or structural elements and finishing materials are characterized as pre-manufactured materials, and has the specific measurements and specifications and it can be manufactured according to the required specifications and dimensions of designed spaces.

Most of the materials used in the manufacture of building materials and construction elements are local materials and it is relatively cheap when compared to foreign materials and it primarily relies on natural materials such as: sand, cement, stone and iron as main building materials.

The building system can provide the possibility of repetition of selected structural elements for the implementation of the construction which means that there are cost savings and speed of achievement.

The system is suitable for small areas and it can achieve the highest efficiency at the lowest cost in the finishing works of the house, which contributes significantly to reducing the construction cost and in selection of finishing materials—either internal or external—on the basis of practical performance, efficiency and low cost, taking into account the operational side throughout the life of the construction.

9.2 Structural Considerations

Structural system in Jordan is characterized as a high quality system, in principle, and its suitable in all climatic regions of Jordan.

The quality of building materials is commensurate with the nature of the region, which helps to create the satisfaction of the occupants in terms of comfort and safety, as well as provide reduction in direct and indirect cost of the housing unit, which contributes to the quality.

Since the housing unit area would be relatively small and that its dimensions will be limited, the structural design is going to be simple in order to avoid the cost increasing low cost of general maintenance works in the future in all aspects.

9.3 Electro-mechanical Considerations

From all in the following, we can say that the traditional building system has many positives aspects that can contribute to helping poor families to build low-cost housing at a relatively short time, and for the
purposes of identifying such positives as a kind, it is necessary to conduct a detailed study on the model, showing all that positives:

- Ease of execution of the plumbing and sanitation whether it is a residential unit or in residential neighborhoods;
- The number and capacity of accessories and sanitary facilities are determined based on the number of users, which contributes to reducing costs;
- Sizes and dimensions of the water and sewage pipelines can be designed and determined based on the actual requirement of the pressure and the need of the population;
- The cost of finishing items like sanitary, electricity, painting, etc., varies depending upon the type and quality of products used in the building and its cost reduction can be left to the individual choice and liking;

Here we make the following recommendations where the cost can be reduced by using the principle of standardization:

- The design of the general dimensions of residential spaces (length, width and height) to be compatible with the dimensions of structural and architectural elements used and that are related to the walls, for example, brick dimensions and the dimensions of the openings and other;
- Columns dimensions: because of the room areas are relatively small, we can design one type of columns with specific standard specifications;
- Wall thickness: through determining the thickness of the bricks used in both exterior walls or internal, and after ending the finishing processes (plastering or tiles);
- The dimensions of the tiles: We must use the standard dimensions of the tiles that fit the dimensions of residential spaces in order to avoid shearing or crushing and waste, on the grounds that this element of the tiles could be replaced by less expensive concrete floor;
- Design openings dimensions, both for the doors or windows so that they are consistent with the dimensions of the raw material made available for them in the market (such as wood, aluminum, etc.);
- Scaffolding works could be skipped for some structural elements during construction process, for example, the columns can be casted within the spaces and openings between bricks;
- It can reduce the cost of construction so that we can cancel some of its clauses/elements and plastering, painting and replace it with other items cost less and so on.

10. Results

This study shows that the basic problem for poor families, in obtaining housing, is an economic problem, for their inability to provide the necessary funding amount, whether they are going to build a house or buy one. The basic problem for the housing construction is divided into three main parts, namely:

(1) cost of land suitable for construction (about 40% of total cost);
(2) the construction phase and to prepare for housing (about 50% of total cost) and this part is divided to two items: building material cost and labor cost;
(3) 10% services and miscellaneous.

The researcher assumes that a traditional structural system is suitable for the construction of housing in Jordan, but it needs some adjustments and development to reduce the final cost of construction, to make it easier for the government and secure the largest number of housing for poor families.

By planning each and every component of a house, the wastage of materials due to demolition of the unplanned component of the house can be avoided.

The main challenge for problem in access to housing is the economic cost mainly due to the high land prices. The basic problem in access to housing is limited in two phases: first, the cost of a land for construction; and second the construction phase. Most of construction workers do not abide by engineering code and regulations and do not consult engineers during construction phase. This often leads to structural errors...
and even failure. Also, some engineers may contribute to this problem by not doing full study of design and to calculating the customer need. To develop standardization approach in construction, information at various levels is needed:

- Information about properties of structural materials that will be used in construction;
- Information about used material dimensions (structural and architectural components);
- Information of the mechanisms of measurement and the calculation of cost of the structural elements (windows, doors, stone, plastering, tile, etc.);
- Develop appropriate dimensions of architectural spaces and openings to fit the building materials used to ensure that the waste use of materials will be minimized as well as to increase in costs of materials.

To obtain this information, extensive preparation market surveys are needed. This information can be only obtained by practicing engineers, technicians and construction contractors, who have a major involving in building process at all stages.

The benefits of standardization can be shown as reduction in cost when the units are produced at larger scale. Production costs are more likely to decrease and waste is minimized. Therefore, manufacturers are more willing to lower the unit price when larger quantities are purchased.

11. Recommendations

More researches and surveys need to be done on low cost building system through comprehensive analytical study of local experiments in the provision and construction of housing units for poor families in Jordan.

There is a need to conduct detailed studies to reach to a typical low-cost house design through the adoption of a comprehensive national project in which all the stakeholders involved.

The need to develop a comprehensive awareness and guiding program to help poor families in the design and construction of their houses fits with their financial and social requirements.

References