

Research Article

Technology and Construction Techniques Development in Jordanian Building Sector

Zaid A.O. Aldeek

Department of Architecture, Hijjawi Faculty of Engineering Technology, Yarmouk University,
Irbid, Jordan

Abstract: The aim of this study is to provide evidence on how rigidity in architectural design processes is the major cause of the confused situation in Jordanian building and architectural development. The Jordanian construction sector has developed in a manner that does not adhere to normal processes of building to global construction procedures. Specifically, many construction process technologies adopted in recent times are not designed to meet the country's needs. Thus, this sector is characterized by anomalous development characterized by an accelerated and increased evolution. Many factors distort these processes and technologies without any concern for local considerations; for instance, the erecting of buildings without future planning, such as by using imported materials and techniques with minimal analysis of whether they will be suitable for local conditions. At other times, builders use traditional materials and technologies in a nostalgic fashion without considering their clients' needs for modernization. Disconnected urban planning and the separation between architecture and urban design further contribute to this issue. Therefore, in this study, we focus on the importance of technological reading of the design process, as it provides valid tools to support the designer in his complex work. This is particularly essential in underdeveloped urban sectors where the industry is characterized by unpredictable variables and unexpected factors. A crucial part of this study is to determine the role of technology in design process by examining local and regional examples. By using real-life cases rather than theoretical studies, we demonstrate how the current design process is not flexible and inappropriate for the general conditions in Jordan.

Keywords: Compatible and appropriate technology, local and vernacular architecture, regional architecture, Technology and techniques, technology as language of design, the energy management in traditional buildings

INTRODUCTION

By understanding 'technology', we can develop easily adoptable solutions that respect the factors that influence process design. Every civilization has linked its expansion to its ability to use environmental resources and to the development of processing technology (Abrami, 1987). These words highlight the importance of the transformation of technologies in the development of societies. This supports the hypothesis that rigidity in design process is incompatible with natural evolution and that it could lead to adverse or regressive conditions (Congdon, 1977).

The aim of this study is to prove that architectural technology is an important element of design process. The purpose of design is to solve problems by introducing new artifacts (Ratti and Claudel, 2015). This leads us to make active technology choices that can be shared or opposed.

In addition to form and function, architectural technology also touches upon other practical considerations; first, it provides insights into the

historical index of the development of architecture and second, it can help to identify the instruments that would give the most value to regional and local characteristics. In fact, it highlights the importance of historical memory as a producer of territorial changes and new cultural contexts in collective consciousness. Continuity with the past means retaining the intangible heritage of traditional knowledge and wisdom, which are considered to be the true capital of human society (Musotto, 2010). Therefore, it takes into consideration the universal questions that influence the mode of thinking in the Arab countries, i.e., the theme of 'Muslim and Arab Style Discussion'. In order to understand this theme, local architects need to study it in-depth. For example, the use of stone in modern facades in Jordan is different from that in traditional buildings. First, it is just a heavy use of stone characterized use by wasting of the resources, while in traditional facades it is a combination of weight, light and respond to genuine principles. The use of stone in traditional facades proves its high capacity to be combined with other building materials.

It is not enough for this to be treated superficially and in isolation, as architectural elements, materials and construction techniques are being used incorrectly in the construction projects of various local architects. The study of the development conditions of construction techniques and technologies in the Jordanian construction sector has an objective: to analyze the settlement patterns and technologies used in residential buildings and to emphasize the forms of development and related problems in this area at various levels. In the development of the discussion on 'Arab and Muslim Architecture', the focus is usually on studies of monumental aspects, ignoring the regional and local side of the discussion (Al Sayyed, 2011). This characterizes the observations on the evolution of this sector in this study: The Jordanian building sector is disconnected from its reality.

MATERIALS AND METHODS

The previous chapter demonstrated the role of architectural technology in design process, in particular, its importance in regional and vernacular studies over philosophical studies, which is what is normally discussed in Arab and Muslim architecture studies. Generally, architectural technology originates from the immediate territory and it is characterized by regional and local aspects.

Regional studies describe the use of construction materials and techniques of construction. They do not disregard traditions and valuable knowledge on the use of local materials and genuine building elements. Still, it is beneficial to evaluate regional knowledge in light of a global vision. In the United States, for example, despite the great variety of climatic conditions, the buildings often have a careless uniformity. Building types and construction materials are too often used in a variety of environments with little or no attention given to their effect on human comfort; surely, these materials do not reflect regional characteristics (Olgyay, 1981).

Tugan (Moukanzah, 2012), one of the most famous architects in Jordan, commented on the traditional regional systemic crisis in Arab architecture, particularly in Jordan: 'Although there are valid reasons to [both] resist and preserve the local, regional and Islamic architectural character, this character is in a global context, which is used by a force of an action for many reasons in various levels'. The use of techniques and construction materials has little influence on the market system. In fact, local architects tend to imitate the construction technologies and styles used in developed countries. In this study, we show how this aspect influences most types of architecture in the Arab World and raises the crucial question of how to develop Arab and Muslim architecture in the actual, complex environment of languages and styles. With Jordan being a young country with little experience in the building sector, we must understand the difficulty of achieving

development on all levels. For this, it is necessary to look at possibilities to make valid contributions to develop the Jordanian construction sector. The use of traditional models is not adequate for the country's current requirements; therefore, there is a need to identify which traditional techniques and technologies can be adapted to modern parameters and requirements.

Hassan Fathy was a noted Egyptian architect who pioneered technologies for construction in Egypt, especially by working to re-establish the use of mud brick (or Adobe) as an alternative to the current western building design and layouts. He was against any change in traditional methods and models of life. However, his commitment to using only traditional models and methodologies in his constructions had negative results; for example, in Qarna village, people opted not to continue to live there because their homes were not compatible with their hopes. This was a result of rigidity in design process. This rigidity can be reduced by considering certain factors, such as the social maturation, the level of development and the readiness of the sector operators. These words reflect this situation perfectly: 'the development of poorer regions is not a question of investments or high-tech applications, but [a question of] the capacity of the local population to take part in the development process' (Bottero, 2005). This statement highlights the importance of using local technologies in development and the process controls that influence architecture, the importance of participation of local people, the use of traditional environmental control systems and local knowledge of building processes.

In his translation of Vitruvius's 'The Ten Books on Architecture', Pollio and Morgan (1960) writes about the importance of the education of architects, that the architect must be educated in a wide range of matters; technical, social, natural and other sciences, in addition to the history of architecture. This gives him the right tools for reflection and a clear vision of the problems to be solved, which is the essence of the concept of technology.

The vernacular architecture and technological approaches used by Fathy and Gourni (1973), as per my personal interpretation, prove that the exclusive use of traditional models cannot be enough. Considered to be among the highest ranks of technical architects, Fathy's creativity has been described by critics to arise from the interaction of his intelligence with his environment. He dedicated his life to improving the lives of poor people and their homes, with a keen eye on the local environment and heritage. He built beautifully designed domed houses using mud bricks, but he did not build them like a traditional architect, dictated by standards and techniques, but with the artist's spirit, with a strong link to the environment of these buildings and by using local materials. His goal was not only the preservation of traditions, but also their recovery.

At this point, with paradox, we note the causes of the rigidity of his design process; the revelation of other

traditions was more radical in every cost. In his architecture, Fathy and Gourna (1973) incorporated domes inspired by classical architecture from times when simple building materials were used. By using sludge and mud bricks in his constructions, he utilized a simple method to provide habitation. His methods initially met with opposition because these techniques were thought to not be appropriate. However, he had proved on a technical level that when the methods were used in rural Egypt, they were not used correctly, but with the right design and the correct use of these techniques, the procedures could be well adapted to the needs of the present. In the planning stages for Qarna village, Fathy and Gourna (1973) proved that mud bricks can support high compression forces provided the right methods are used for construction. He built domes with progressive inclinations, thus providing the ability to have relatively large spaces; this also solved the rural inhabitants' problem of precarious roofs.

Fathy's works bear witness to his great ability to design the right technology for rural populations in Egypt and this concept has presented excellent theories that are recognized by international academia. However, in practical terms, it did not provide a model for developing social housing: the fact that technology should not only be appropriate but also compatible with human needs, social matters and the needs for modernization. Compatible technology balances many factors and has a control system: it defines the relationship between the technologies used and the its level of development and diffusion.

This study seeks to re-evaluate local technology in light of modern considerations and to find effective solutions to the problems faced by the construction sector in Jordan. By studying this sector, we found that the first problem was born from difficulties in the use and comprehension of imported technology; in many cases, such technologies are appropriate for our conditions. After studying the local construction technologies used in the past, we noticed the capacity of builders to manage with limited resources. In the use of imported technologies, this principle cannot be easily applied.

Another problem faced by many underdeveloped or developing countries is that strategies are orientated to providing solutions for new constructions; they often do not take into account that existing buildings must be also be rebuilt and reintegrated in modern and functional cities. The construction sector in Jordan is increasingly dependent on international companies, which provide specialized expertise, introduce modern construction technologies; including precast concrete and environmental control systems and building management systems, while local companies play a limited role and gradually lose the capacity to be a partner in the country's development.

A particular technology could be considered to be compatible if it uses natural principles and controls its

use of energy resources (both traditional and alternative). Some of these principles are very simple and can be adapted without any cost; they only require the comprehension of the design process (Johansson *et al.*, 2009).

Traditional architecture in Arab and Muslim countries largely incorporates these principles. In particular, this type of architecture has a high capacity in managing energy consumption. Energy management in such buildings is the major theme that many researchers are pursuing; the consumption in this sector has a high incidence that contrasts the concept of sustainability (Lavagna, 2005).

Upon analyzing the commonly used sustainable elements in traditional architecture, we observed the use of available local resources and materials, the multiple use of building materials and techniques of construction in the same building; this is the use the 'multi-layers' of techniques, vertically and horizontally.

Another aspect in the compatibility of technology is the sustainable urban design in traditional cities. Protection and better performances of buildings were also guaranteed by urban form; in the desert, compact and enclosed houses give the city a sense of being a grand courtyard. The courtyard house is one of the most enduring architectural forms, transcending regional, historical and cultural boundaries. 'Its balance of simple, appropriate construction, environmental control, social and familial structures and continues to engage architects and architectural historians' (Zein Alabidin, 2014). This is the fundamental element of urban design for all weather conditions; it gives protection against heat, cold, winds and direct solar insulation. Thus, it guarantees sustainability and a comfortable life for its inhabitants.

Sustainability in architecture means the possibility of a good and continuous performance as well as a durable lifecycle; this indicates that one of the most important elements is low energy consumption. One of the focal points of this study is to prove the capacity of traditional buildings, in many countries, to focus on the problem of energy management and to show how this culture was gradually lost. The awareness, the correct use of resources and adaptability in the solutions characterize the local and traditional architecture, while these elements have been lost in the current architecture of Jordan.

Control in the design process means the capacity of the designer to strike a good balance between the performance of the building and the necessity of the user to have a habitation that reflects his potential, hopes and desired lifestyle. It is not possible to achieve this if the designer lacks the technical preparation that would allow him to understand these problems. Technical preparation permits the architect to control the phases of construction design and to use the adapted solutions and the technology's design applications. Also, the knowledge of social and cultural matters

allows his technical preparation to be appropriate and compatible with the local context, thus providing compatible technology and construction techniques. The role of control in construction and environmental technology in the overall design process is more significant than using regional and traditional architectural values.

Speaking about technology in the Jordanian building sector requires the identification of all conditions that determine technical development, so as to analyze the traditional, current and actual methodologies to propose alternative technologies. The fundamental aspect of this operation is to seek reasons for the present situation; one must understand the traditional construction process and the modern necessity of people to have a good habitation and to understand the role of technology. This requires us to study the complex problem of the construction sector in Jordan.

Another factor of complexity is regional architectural value, as previously mentioned; it forms the important basis for appropriate and compatible technology studies. The importance of regional architecture has been highlighted by several famous researchers. Gropius, talking about regional expression, writes: 'a genuine regional character cannot be found through a sentimental or imitative approach, but [by] studying the fundamental differences of architectural design in different climatic conditions' (Olgyay, 1981).

The importance of the regional aspect in the Jordanian building sector is evident because there exists a typical situation that differentiates it from other countries; the complex urban problems in cities such as Amman and Irbid (Tarrad, 2014), for example and the different technological development conditions. In such situations, any standard cannot be adapted if it is designed for other areas; it must reflect a central role in the relationships between technologies and used techniques always. The identification of policies and strategies, finding ways for technological development to solve the problems in the country, re-evaluation of the historical methods used by the local culture and establishing criteria of future use are some of the goals of this study.

The search for these criteria is carried out through the study of the economic and technical mechanisms that maintain materials, techniques and management of the space in use a specificity and a complexity that gives a complete picture and a clear index of development. This requires the identification of the parameters of compatibility in the choices of innovative interventions, such as the relationship between cost and functionality, the degree of flexibility, the degree of technological maturity, the relationship between place and its technical culture and the design choices that characterize the stages of development and serve as a clear indicator of social maturity to accept changes (Congdon, 1982).

RESULTS AND DISCUSSION

The analysis carried out in this study confirms the seriousness of the current problems in the construction sector of Jordan: the detachment of the local technological culture and the adoption of rigid and unsuitable design processes. In this analysis, the used criterion consistently has a critical position versus the current policies, not to challenge certain methods in favor of others, but to evaluate them rationally and to provide a complete picture of the problems without bias.

To this end, we examined the design methodologies of regional and local architects, such as Hassan Fathy and Rasem Badran, whose works are based on a methodological approach in defining architecture as a continuous dialogue between contemporary, historical and inherited cultural values (Al Sayyed, 2011), along with the stages of development and consequences of using such techniques, highlighting the salient concepts of these experiences and considering the intellectual matrix of local technology.

In the construction sector, the complexity arises from social unrest against decisions to use mature technologies. This highlights the importance of re-evaluating local technological research to reduce the inappropriate use of resources. The standard of living of the low-income population is affected by the sharp rise in the cost of housing and in most cases, involves the renunciation of many vital services to offset the increase. In such circumstances, a majority of the people seek to secure the primary housing needs; however, many of the homes do not have even the basic facilities and services.

The collected considerations demonstrate the linked difficulties and the importance of appropriate solutions; the path choices made may not have an immediate effect if they a strategy of comprehensive planning is not used. As in the case of developing countries, building strategies concentrate on the search for new solutions with no regard to the problems related to the redevelopment of existing buildings.

This implies the absence of a policy of urban renewal due to interventions that favor certain areas over rural areas. Urban and renewal building begins with the policies of a country; in Jordan, the general trend is, for several reasons, to focus on the capital city of Amman. The results of this strategy are evident: a gradual impoverishment of the less central zones and a drastic increase in living costs. As a result of this speculative strategy that exploits the country's resources to favor a few people, there is an increase in the range of the marginal population and increased migration from inner peripheral cities to the capital city and other major cities. This process increases the marginal population and endangers the natural development of the market system.

The conclusion is clear: the deterioration in the Jordanian building sector is related primarily to the adopted strategies, which have produced urban hardships and led to the birth of illegal practices and the degradation of the citizens' quality of life.

These issues call out for solutions that involve implementing policies to close the gap between the wild development of the city centers and the death of the smaller cities. Legislation and policy measures should encourage the development of rural areas with a strategy to enter these areas with conscious planning, in the medium and long term, indicating that these areas are a potential and vital resource of the country. The deepening of these elements is critical to the definition and study of residential strategies under various aspects: economic, social and technological. Generally, strategies tend to produce studies that can lead to lower overall costs and that maintain a certain quality at least in theory. These strategies on the issue of the cost have their goals: the creation of a new way of conceiving the building sector planning, as well as the management of urban spaces. John P. White, one of the important researchers of philosophy of technology of architecture, writes that there are many ways to help the development of rural areas, including the promotion of small and medium building material production centers, the simplification of phases of production that should have future development plans and increasing the use of local technologies among sector operators (Congdon, 1982). This points to a total agreement with the aims of this study and traces the deadlines and criteria to be used.

This study includes the definition of the criteria and paradigms that make studying the feasibility of the strategies used compatible with the local reality. It also explores the motivation of the abandonment of traditional methodologies and the motivations to retain traditional methods and adapt them to suit several conditions of the present.

This concept can be summarized in the words of Fathy and Gourna (1973) 'whenever the architect introduces an innovation, [he] has contributed to the creation of a new tradition, a synthesis that connects the new with traditional and characterizes the search for compatibility'. It is clear that the attempt in this case in the study of design and building production through the identification of procedures and used techniques results in our definition of the optimal conditions for the implementation of strategies to develop urban and architectural design.

This factor is important for the identification of the conditions and constraints that characterize housing demand, the intervention procedures, the necessary conditions to reorganize the building process, the importance of local culture in the conception of new building technologies and the repercussions that a forced process can have on a fragile sector.

The reorganization of the entire building process within a regeneration policy that invests in the field of knowledge and practical. For this purpose, we took into account the actual conditions of building production in Jordan; the architectural origins, the rural architecture with its technology and technical matrix, the social and urban evolution to identify the potential of the techniques employed and to eventually elevate them to their current versions.

It should be noted that the analysis carried out on the traditional building process is not driven by nostalgia, but as a reminder that building is not an operation that has no history; instead, it is the result of knowledge acquired over many generations, mutating over time in terms of its aspects and procedures.

The study of traditional architectural highlights how inappropriate the current methods of building are and leads to potential solutions. Rarely were traditional constructions built using a single material and rarely were they built according to strict procedures that did not allow a margin of flexibility; this is the fundamental criterion in the search for effective solutions. Besides the aspect related to 'self-taught', the traditional buildings improved over time by virtue of implementing the knowledge and experiences gained by builders of the past.

The necessity for comparison implies that the study of traditional methods must be followed by a deepening of the conventional methods, procedures, techniques and solutions adopted in construction, highlighting the characteristics of such procedures. Conventional methods of construction in Jordan are characterized by the use of a single type of material; the derivatives of cement and aggregates.

The result, as expected, reflects the initial hypothesis: the need to reorganize the complete process of building. It is not difficult to demonstrate that the procedures and techniques currently used do not meet current requirements. These deficiencies are presented in different aspects: the performance of buildings are reduced, continuous renovation of buildings and wasteful energy consumption. Existing buildings comply with only the formal and expressive aspects, setting aside the requirements of functionality and highlighting the inadequacy of the current ways of building.

Efforts in this study are aimed at dealing with various themes that characterize development in the construction sector and identifying the important aspects of potential development scenarios based on the criteria of appropriateness and compatibility. As mentioned above, there are many elements that lead to the appreciation of traditional technological methods, from which we can benefit. The criteria used to this end is the comparative analysis between the current situation and those of the past. This criterion is necessary because we do not have many examples to analyze technological developments in the construction

sector in Jordan. However, international cases provided us with similar situations to obtain information that helped us in this study. In all cases, the major problems lie in the urbanization process and in the use of techniques of construction that have a low level of development and nonexistent planning.

The individuation of technological and typological solutions will not be easy without the development of human preparation. This factor will be fundamental in the process of development. In the analysis done to prepare this study, we observed that the level of comprehension of the operators of new technologies is not enough and that their comprehension of traditional technologies is gradually lost. The result is that the building and architecture sector is underdeveloped and significant steps must be taken to further its development.

In this investigation, we see the marginal role of the architects in this process; the marginal role is not because they have no legal role to act, but because of their weakness in being a part of the process. The deterioration of this relationship is derived from the strangeness of the modern figure of the local architect, who took over the role of the building master in past who would engage in a dialogue with the use to understand his various needs. Thus, we sought to individuate the conditions that transform technology and those who study technology to reflect the social and cultural needs.

Throughout this study, we kept in mind the experiences of Hassan Fathy, which stress the importance of understanding social factors. Derived from these experiences is an important line: the social aspect of the technology of architecture is the base of technical innovation.

There are many authors who support the line of thought (Schumacher, 1973) that indicates that technological choices should be appropriate not only to economic conditions, but also to social conditions. In his studies, Schumacher (1973) often used the expression 'socially appropriate' to indicate that the development of a technological matrix of a society must have its roots in its conditions and in their modes of life; this calls for the individuation of conditions for a mediation between technological development and moderation. The adoption of rigid positions will damage this process of development.

CONCLUSION

This study sought to demonstrate that rigid positions in making design process and technology choices have a negative effect. It is among the major problems that characterize this theme at an academic or professional level. To demonstrate this, we conducted many analyses on constructions by several important local architects, which showed how radical positions can damage the development process. Upon analysis, we found that the implementation of the concept of

technology returns could contribute greatly to architectural design processes.

To define the compatibility parameters of technologies, techniques and methodologies of usable building materials, we must consider the various elements that influence the country's technological development. These elements can be summarized in terms of how they are impacted by the introduction of new technologies in this sector. In this study, we verified the conditions of compatibility on both the theoretical and practical levels:

- Methods and processes used in design approaches in order to determine which technological innovations should be introduced and which should not.
- Possibilities of recovering some traditional techniques and how they should be employed.
- The performance of local resources and materials and their potential to combine new and traditional techniques.

The techniques and technologies proposed must use all the available resources in the country. This encourages builders to gradually grow beyond using only one building material or technique. The proposed techniques must also offer a good cost-to-performance ratio and they must be controlled by regulations.

In terms of materials, the main local raw materials; concrete, stone, calcium silicates and clay, showed significant potential for use. Proposals for new techniques and new construction procedures must consider the use of these elements in a combination of traditional and innovative procedures. With regard to the methods for improving the quality of concrete, we observed that local cement can be made to achieve excellent quality for relatively low costs. Further, the proposed improvements must consider the aggregates that are currently used, which are characterized by excessive weight and low performance on various levels. Finally, any improvements must also take into account the multiple construction materials and technologies used, which can complicate building design processes.

RECOMMENDATIONS

Future works can focus on experimental studies on the real-life applications of combining materials and techniques in the construction sector. The students of my department will participate in studying and verifying which methods should be appropriated and their effects on architectural design in Jordan.

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