Efficient planning and management of determinants in Iraqi residential projects

Ahmed Mohammed Teen Ahmed, Ana Maria Gramescu

Abstract—It is important to focus on the role of modern technology in planning and managing residential projects by studying the impact of that technology on the performance determinants of projects (time, cost, and quality), especially large investment projects that contribute effectively and directly to providing appropriate solutions to the housing crisis. Legislation and laws related to determinants of performance improvement in projects must be done in a way that can improve results during the implementation of those projects. The economic and environmental impacts on the performance of projects are the main factors through which all investment institutions and companies seek to achieve them to reach the goals related to achieving high marketing value and improving social goals for implementing those projects. The main determinants in project performance are quality management through several major axes related to building sustainability and improving facility management when the project is completed in addition to ease of maintenance. The safety and security of projects must be achieved in the life cycle stages of the project, starting from the start of the project and ending with the phase of removal at the end of the project life cycle, which is what modern technology will achieve and choose appropriate patterns for construction. In addition to the importance of quality on the sustainability of the construction, it is important to focus on studying the costs related to the project over the life cycle of the project, that the majority of investors and companies focus on direct costs and the importance is not given to the operational costs of the building, since the costs related to implementation constitute only a percentage if we take that most of the buildings have a life cycle of more than 40 years, especially residential buildings. Striking a balance between project constraints is very important not to prejudice any of the main constraints.

Index Terms— determinants, time, environment, projects management

I. INTRODUCTION

The main determinants of construction projects must be adapted to each other in the manner in which the main objectives of the project can be achieved by committing to achieving the project scope, table in below shows the main constraints of construction project

<table>
<thead>
<tr>
<th>No.</th>
<th>constraint</th>
<th>Impact 1</th>
<th>Impact 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low cost</td>
<td>High implementation time</td>
<td>Low quality</td>
</tr>
<tr>
<td>2</td>
<td>Low implementation time</td>
<td>High cost</td>
<td>Low quality</td>
</tr>
<tr>
<td>3</td>
<td>High quality</td>
<td>High cost</td>
<td>High implementation time</td>
</tr>
</tbody>
</table>

Efficient management during planning and implementation of any construction project must find balance between the main project determinants, that all investment institutions and companies undertake preliminary studies and then deep and detailed studies of the impact of the technology used to improve and balance the main determinants of the project. Usually, the financial and human resources are among the most important determinants that must be managed in an appropriate manner because most investment companies have limited resources, and therefore, taking the final decisions to choose the project must be within the process of filtering for the proposed projects after preparing documents for the project and conducting studies related to feasibility and other effects related to environmental determinants and legislations Legal in order to secure access to the main objectives of the project through several factors determined by the higher authorities that will take final decisions through the principle of priority and according to the following main determinants:

- A study that provides the resources required to implement the project and includes financial and human resources
- Examine the project-related risks by identifying potential risks and a response plan for those risks
- Priority study for projects with low costs and low human resources
- Study the priority of projects with a low implementation period
- Study high-quality projects by choosing the appropriate and modern method for construction in order to achieve high marketing value that guarantees the success of the project

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- Examine the projects that are expected to ensure that the project framework is implemented in an integrated manner

In the figure below, the main determinants through which to study them are choosing the optimal project, which is part of the knowledge making of the foundations of project management in addition to the remaining four determinants, including: portfolio management, communications management, integration management, and procurement management

II. THE ACTUAL NEEDS OF HOUSING UNITS IN IRAQ

With the increase in population in Iraq, as the population for 2020 exceeded 40,000,000, according to the latest estimates [1], the shortage in a residential units exceeds 4,000,000 residential unit according to latest of iraqi ministry of construction and housing [2]. The wars that went through Iraq made him lose a lot of infrastructure, and among the great losses resulting from the wars is the great destruction in housing complexes, which greatly exacerbates the housing crisis in addition to the extinction value of 5%, according to the statistics of the Ministry of Construction and Housing for housing units due to the end of a life cycle. Iraq needs to build residential unit every 40 seconds [3]. Since the problem is large and deep, solutions must be unconventional [4]. And because Baghdad is the capital of Iraq, most of the commercial centers and most of the main government departments are in them, and therefore the population density is very high compared to other cities in Iraq, as the population of the capital Baghdad is estimated at 8,000,000 [5], and this makes the prices of housing units very high.

III. CRITERIA FOR CHOOSING A SUITABLE TECHNOLOGY FOR CONSTRUCTION

The main determinants in the planning and management stages of the implementation of residential complexes must take into account the main factors in studying each proposed project, namely that the project be of good marketing value with the presence of great competition between companies and investment institutions, and this requires reducing the price of units sold to improve competition in the real estate market in addition to improving the quality through which the building life is calculated and the costs of operation and maintenance. With the increase in global warming and increasing temperatures, the environmental determinants of the legislating laws must focus on sustainable buildings that take into account environmental standards through technological methods and building materials that reduce toxic gas emissions as well as reduce pollutants resulting from energy consumption at all stages of the building life cycle by increasing Thermal insulation, reduce water and electrical consumption, and increase green areas to improve the surrounding environment. Safety and safety requirements must be a priority in the preparation of project documents and the outputs of the project implementation plan at all stages (implementation, operation, maintenance, and demolition phase at the end of the building’s design life)

A. Costs optimization of residential units in Iraq

The main determinants of choosing the type of technology used must be compatible with technical and environmental requirements. The most important factor that is determined by the strategy of managing housing projects is to reduce the cost to the lowest possible level to obtain radical solutions that help support the poor classes in society. The price of housing units is relatively high in the capital, Baghdad, where the price of construction depends on the method of construction used and the degree of quality of the materials as the cost is divided into three categories and on this basis it depends on the cost per square meter, as shown in the table below:
In addition to the purchase price of the land to be constructed, it is the most prominent element, as its price ranges between 1000 - 1700 USD/m², and therefore the total cost of the housing unit will be as shown in the table below.

<table>
<thead>
<tr>
<th>No.</th>
<th>Construction style</th>
<th>Land cost (USD/m²)</th>
<th>Construction cost of residential unit (USD/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Class A</td>
</tr>
<tr>
<td>1</td>
<td>Vertical (4-10 floors)</td>
<td>50</td>
<td>550</td>
</tr>
<tr>
<td>2</td>
<td>Vertical (2-4 floors)</td>
<td>150</td>
<td>650</td>
</tr>
<tr>
<td>3</td>
<td>Horizontal (Separated units)</td>
<td>1000</td>
<td>1800</td>
</tr>
</tbody>
</table>

Table (3) cost of residential unit per square meter (cost of construction +cost of land)

The costs calculated in the above table include direct costs for construction that include the purchase of materials, transportation, installation and manpower costs in addition to the indirect costs represented by taxes, insurance, security and guard, but consideration must be given to the cost of the operation and maintenance (M&C costs) of the building, as planning for the construction pattern and the technology used has a major impact that will determine the cost of operation and maintenance over the design life of the building. The predominant material in building housing units in Iraq is clay bricks, and it is represent more than 60% from all used materials, which cost between $ 100 and $ 120 per cubic meter, and it is one of the main materials in the construction industry in Iraq, and it is very expensive compared to modern alternatives, such as lightweight concrete (cellular concrete block) or foam concrete, the price of which is Less and better advantages compared to regular concrete or brick. In addition to the high thermal insulation, which is 12 times the brick insulation [6], also the absorption rate 22-29 [7] compare with 65-70% in case of traditional bricks, therefor in case of using light concrete block rather than traditional block we can to save 47 $/m³ of total construction cost as same as the table in below

<table>
<thead>
<tr>
<th>No.</th>
<th>Masonry Materials</th>
<th>Direct construction cost per m³ (USD)</th>
<th>Total cost (USD) per m³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Materials</td>
<td>manpower</td>
</tr>
<tr>
<td>1</td>
<td>Bricks</td>
<td>98</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>cellular block</td>
<td>61</td>
<td>15</td>
</tr>
</tbody>
</table>

Table (4) Direct cost comparison between traditional and modern masonry materials

Assuming that each housing unit contains walls with a length of 100 m and a height of 3 m, the ratio of the total construction size will be up to 75 m³ considering that the thickness of the two types is 25 cm, and therefore the savings in the total cost of construction including the direct and indirect file will be $ 4230. And if we take into consideration that the building area is 100 m² and we apply this fact to Table No. (2) To calculate the total cost of the housing unit, we will notice the percentage reduction in the total cost of construction through the use of modern alternatives to one item of the construction materials.

<table>
<thead>
<tr>
<th>No.</th>
<th>Construction style</th>
<th>Total construction cost of residential unit (USD)</th>
<th>Reducing amount (USD)</th>
<th>Reducing rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Class A</td>
<td>Class B</td>
<td>Class C</td>
</tr>
<tr>
<td>1</td>
<td>Vertical (4-10 floors)</td>
<td>5000</td>
<td>4500</td>
<td>3000</td>
</tr>
<tr>
<td>2</td>
<td>Vertical (2-4 floors)</td>
<td>5000</td>
<td>4500</td>
<td>3000</td>
</tr>
<tr>
<td>3</td>
<td>Horizontal (Separated units)</td>
<td>8000</td>
<td>7200</td>
<td>4000</td>
</tr>
</tbody>
</table>

B. Optimization of quality

Quality in projects is one of the most important determinants upon which it determines the type of project that will be chosen based on technical studies. The quality of projects determines their market value through the main elements through which the customer is attracted to these types of projects. The use of modern technological alternatives in housing projects enhances the quality of those projects, which in turn are one of the main decisive factors in solving the housing problem by increasing the design life of the building and thus this will reduce the percentage of extinction in residential buildings, which is about 5% for one year. The most important elements that modern materials and technology must contribute to are to increase the thermal and acoustic insulation in addition to reducing energy consumption and increasing the design life of the building through high performance concrete. The quality of the materials that lead to the permanence of the building and reduce the cost of operation and maintenance of the building. The use of the wall and glass insulation method reduces the consumption of electrical energy, which was unable to supply it to about 50% of the total required energy. As the
requirements for air conditioning, especially in hot climates in
Iraq, which extend for about 8 months, amount to about
72-78% of the energy used.

C. Optimization of environmental reality

The construction sector is one of the most important and most
contributing sectors to pollution and heat emissions, as it
contributes significantly to climate changes and pollution to
water and air sources due to the many stages the construction
industry is going through. According to the U.K. Green
Building council, the consumption of building materials
exceeds 400 million tons /year [8]. World Green Building
council mentioned that 39% from all emissions caused by
construction process[9][10]. The consumption of raw
materials included in the construction industry is not used in
the construction materials industry, but there is a loss rate in
those materials that exceeds 10% in the form of waste in the
factory and in the work sites. construction within
pre-fabricated production plants leads to a reduction in losses
of waste materials by 12% [11]. Hence the importance of
managing raw materials in a way that reduces emissions and
pollution. According to the U.S. Green Building council, the
contribution of the construction industry to the environment is
very large, as shown in the countries below:

<table>
<thead>
<tr>
<th>No.</th>
<th>Issues</th>
<th>Contribution rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pollution</td>
<td>23</td>
</tr>
<tr>
<td>2</td>
<td>Climatic change</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Drinking water rate</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>Landfill waste</td>
<td>50</td>
</tr>
</tbody>
</table>

Table (7) contribution of construction in global pollution
according to USGBC

The rate of pollution passes in many stages, starting with the
extraction of the raw materials involved in the construction
industry, through the processes of transporting raw materials
to the factory and then transportation to the work site and
implementation of the project, which are many stages that
must be managed in an efficient manner that guarantees
reducing pollution and emissions resulting from construction
processes. The manufacturing and construction procedures
must be improved during the 7 stages to reduce the pollution
rate, as shown in the figure below:

The use of modern construction technology reduces emissions
and pollution from construction operations. The use of
prefabricated building technology can reduce pollution and
emissions significantly through its contribution to reduce the
consumption of raw materials, reduce waste in reality, reduce
emissions from energy consumption, in addition to reducing
noise during the implementation of the project and at the
operation period due to high sound insulation which is In line
with achieving the principles of building sustainability. 10 %
or more saved by using prefabricated construction
technology. fabrication processes deals with all waste
material that caused by prefabricated construction and recycle
all waste material to reduce the impacts of waste materials on
the environment and to reduce

D. Optimization of security

Among the most important requirements for planning for
efficient project management are the safety and security
standards for the facility and the residents of those complexes,
in addition to workers during the period of implementation
and maintenance. According to HSE 40% of fatal injuries are
caused by falling from high [12] as shown in figure below:

![Figure (4) Main kinds of fatal accident for workers, Source: RIDDOR, 2018/19](image)

From here, the effects related to the materials and technology
proposed for the implementation of housing projects should be
studied to ensure a reduction in work-related accidents, as
well as a decrease in accidents related to accidents during the
operation and maintenance period because the technology
used in Iraq uses traditional methods in which activities related
to site construction are large and use heavy blocks, and many
activities of external and internal finishes (internal and external
plastering) as well as the local casting of many activities
related to reinforced concrete work (foundations, columns,
beams, and roofs) then thus activities need many numbers of
site workers, and therefore one of the most important
solutions related to reducing accidents at the site must ensure
the change of the traditional technology used in construction.
Prefabricated construction technology may be contributes to
reduce accidents in all stages of building lifecycle as shown in
the table below:

![Figure (3) pollution reducing stages in construction fabrication](image)
Table (8) contribution of construction in global pollution according to USGBC

<table>
<thead>
<tr>
<th>No</th>
<th>Life cycle phase</th>
<th>Potential accidents</th>
<th>Accidents reducing by using prefabricated technology</th>
<th>Impact of proposed technology on accidents reducing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excavation</td>
<td>Many lifting times of masonry materials</td>
<td>Low lifting times</td>
<td>Low lifting time lead to reduce accidents rate.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Many workers in site</td>
<td>Low workers at site (50- 400%)</td>
<td>Reducing of accidents by reducing workers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Many scaffolding</td>
<td>Low cost of scaffolding</td>
<td>Low accident because of low scaffolding cost.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High implementation</td>
<td>Low implementation</td>
<td>Low implementation time lead to reduce accidents rate.</td>
</tr>
<tr>
<td>2</td>
<td>Operational and maintenance</td>
<td>Low quality</td>
<td>High quality (99-99.5% of defects)</td>
<td>Low maintenance lead to low accidents.</td>
</tr>
<tr>
<td>3</td>
<td>Decon and recycling</td>
<td>Solid waste materials caused by demolition</td>
<td>Low waste materials</td>
<td>Deconstructed site demolished to reduce accidents.</td>
</tr>
</tbody>
</table>

IV. CONCLUSION

The impact of the main units of the projects is closely related to the technology used that helps in improving the management of housing projects and finding economic alternatives that reduce the cost as found in prefabricated constructions and the use of cellular concrete, which contributes to reducing the cost up to (5-10) % of the total cost in addition to improving quality and reducing environmental damage by reducing energy consumption and reducing construction waste. The feasibility of the proposed technology is not limited to initial impacts during the planning and implementation period, but the integration of the feasibility is to improve the management of project determinations during the Operation and Maintenance period as well as the effects associated with the operations of removal and recycling of waste from buildings.

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