

# Evaluation of 3D Printing Technology in Rapid Build Processes For slums and affected areas

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**ABSTRACT:**This thesis deals with the technique of three-dimensional printing and its impact on housing in the Arab Republic of Egypt, and the theoretical study contains the first chapter and deals with a background on some of the traditional construction systems and modern systems, including the technology of three-dimensional printing, and in the second chapter the traditional structural system in construction is studied as building is studied Using 3D printing technology with an analytical study of a model of housing projects in Egypt that is not applied to 3D printing technology and comparing it to housing buildings that are similar in size and height. 3D printing technology is used in construction. It results in the benefit of the owner, the contractor and the customer, and the third chapter deals with a study of the 3D printing technology and the types and dimensions of the machines used so far and the study of projects around the world implemented using modern technology and knowing why this technology has not started so far in Egypt, and in the fourth chapter the concept of slums, the reasons for their appearance and types will be studied. Slums in Egypt and Classifying them and knowing the locations of slums. The concept of popular participation in improving and developing slums, studying the concept of resettlement, studying some development experiences locally and internationally, and comparing the development process between if the method used in building is a traditional system or if the method used in construction is a system of 3D printing technology and then it is concluded Message with results and recommendations.

**KEYWORDS:**3D printing of concrete, building in Egypt ,Slum development in Egypt, Building technology

## I. INTRODUCTION

The technological progress of our present age in all areas of daily life is nothing but the result of man's ideas and constant effort towards his comfort and the service of his purposes and the requirements of his life first and foremost. And if some claim that modern technology has dominated man and made him subject to it, life can not be without it except that we can say that A person with his ideas is the one who created this technology and controlled it, directing and running it to serve his various purposes<sup>1</sup>, and therefore there will be attempts to solve the main problems of research, namely:

- Compensation for those affected by the removal of their homes by rapidly developing informal settlements projects that prevent them from forming new slums as a result of not providing them with fast housing suitable for their living and human life

- The prolonged implementation period and the instability of economic conditions in Egypt in the current period, which hinders the course of work as a result of permanent price change

To reach the main goal of research , which is:

Access to a modern, advanced system that is better than traditional systems for building housing projects in Egypt.

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<sup>1</sup>Dr. Muhammad MahoudAweidah , Modern Technology in Building , Dar Al-Nahda Al-Arabiya , Beirut ,January 1984, pp. 20-40

## II. RELATED WORK

### A - Future Office project in Dubai:<sup>2</sup>

A 3D printed office for the UAE National Committee was designed as the headquarters of the Dubai Futures Corporation.

The so-called "Office of the Future" primarily serves as a meeting place for parties from all over the world. The 3D printed office is a fully functional building with all services such as electricity, water, telecommunications, and air conditioning systems.

Some parts were produced from the printed office in China and shipped to Dubai. The project eventually reduced labor costs by 50% to 80% and construction waste by 30% to 60%. It is considered as the catalyst behind the 3D printing revolution



### B - Apiscor prints an entire house in Russia:<sup>3</sup>

Only a single Russian company built a 400-square-foot house from scratch in just 24 hours in Moscow. The cost of the building is \$ 10,000, highlighting the potential of 3D printing technology for the future.

The entire house is built on site with a portable 3D printer, this is a home that is sure to be inhabitable and with little space. The fact that it was produced at such a low cost in 24 hours all the walls and foundations of this structure were imprinted with a concrete mixture and other parts such as windows, fixtures and furniture added after construction. The house is finished with a fresh coat of paint

The final cost for the entire project was \$ 10,134 total



## III. METHODOLOGY

To achieve the goal of the research, the research will follow a set of methodological stages, and it includes the research on the following scientific approaches:

### • Inductive Approach:

To study the concepts, ideas, data and information that represent the knowledge base for research with the aim of gathering information to conclude and extract realistic and real indicators of the pros and cons of working in these construction systems in Egypt.

To achieve this, reliance will be placed on books, scientific references and research related to the research topic.

<sup>2</sup> [www.dubaifuture.gov.ae/our-initiatives/office-of-the-future/](http://www.dubaifuture.gov.ae/our-initiatives/office-of-the-future/)

<sup>3</sup> Mehmet Sakin\*, Yusuf Caner Kiroglu , 3D Printing of Buildings: Construction of the Sustainable Houses of the Future by BIM , 9th International Conference on Sustainability in Energy and Buildings, SEB-17, pp3-4 , july 2017



**•Analytical and Analytical Comparative Approach:**

To analyze global and Arab experiences in modern construction systems in general and 3D printing technology especially in residential projects to identify the most important features and features of these experiences, compare them, draw lessons learned from them and how to benefit from them at the local level

Then the existing projects abroad are monitored and analyzed and compared if they are used in Egypt in order to extract the benefits from the use of these technologies.

**•Applied Approach:**

Carrying out a study of the existing projects that have been built and knowing the total cost of each project and with regard to the systems that need machines or machines to be imported, the total cost of purchasing those machines and machines, the cost of shipping them to Egypt and their maintenance, and all matters related to the work of those machines and machines and how much the cost will be saved so that we can know Feasibility of using these technologies in Egypt

To study a local area that was developed using traditional methods and systems in construction and to apply the use of modern technology in the process of developing it and to come up with results that benefit the feasibility of using technology in developing slums

<b>Research introduction</b>		
<b>Building methods</b>		
<b>Chapter one summary</b>	<ul style="list-style-type: none"> <li>• Study of traditional building systems:                             <ul style="list-style-type: none"> <li>- Bearing walls</li> <li>- Beam and column</li> <li>- Lack of Bishop</li> <li>- Precast concrete installations</li> </ul> </li> <li>• Study of modern building systems:                             <ul style="list-style-type: none"> <li>- Backing diagonal grid</li> <li>- Rastra</li> <li>- 3D printing technology</li> </ul> </li> </ul>	<b>Chapter 1</b>
<b>A comparison between the traditional structural building method and the modern construction method using the 3D printer</b>		
<b>Chapter two summary</b>	<p>Study the traditional structural implementation method in detail and learn:</p> <ul style="list-style-type: none"> <li>- Types</li> <li>- Load distribution methods</li> <li>- Its component (modules, columns, etc.)</li> </ul> <p>Studying and analyzing a housing model in the traditional way in terms of:</p> <ul style="list-style-type: none"> <li>- plans</li> <li>- elevations</li> <li>- A full explanation and analysis of the property, its pricing and design</li> </ul> <p>Studying the modern implementation method with 3D printing technology and knowing:</p> <ul style="list-style-type: none"> <li>- About the machine</li> <li>- Technology development</li> </ul> <p>Study and analysis of a housing model using the modern method in terms of:</p> <ul style="list-style-type: none"> <li>- plans</li> <li>- Interfaces</li> <li>- A full explanation and analysis of the property, its pricing and design</li> </ul>	<b>Chapter 2</b>
<b>Slums (reasons for their appearance - methods of solutions - global development experiences)</b>		



### 3D printing technology and machine working method

Chapter  
three  
summary

- Study of 3D printing technology in detail
- Study of most of the machines that have been reached
- Knowing the capabilities of each machine, its scope of work and its selling price
- Study of some projects that were implemented using the machine
- Access to the advantages of 3D printing technology for concrete
- Access to the defects of the technique of 3D printing concrete
- Reasons for not using 3D printing technology in construction in Egypt

Chapter  
3

Chapter  
4  
summary

- Studying the concept of slums
- Studying the methods of classifying slums
- Studying how to classify slums
- Studying the reasons for the emergence of slums
- Study the types of slums in Egypt and classify them
- Know the whereabouts of slums
- Study the concept of popular participation in improving and developing slums
- Study the concept of resettlement
- Study of some global experiences of slum development

Chapter  
4

### The application of 3D printing technology in slum development projects in Egypt

Chapter  
5  
summary

- Study the experience of developing the Zeinhom housing area locally
- Making a comparison between the traditional method and the construction technology of the 3D printer on the local study model (Zeinhom housing)

Chapter  
5

### Results and recommendations

### References

#### IV. EXPERIMENTAL RESULTS

- Access to the advantages and disadvantages of traditional building systems that have been studied
- Access to the advantages and disadvantages of the modern building systems that have been studied

Access to knowledge of a modern building system called 3D printing technology enables:

Reducing labor costs by 50% to 80% and construction waste by 30% to 60% in the Dubai Future Office project.

- To build a house on an area of 400 square feet from scratch in just 24 hours in Moscow. The cost of the building is \$ 10,000, highlighting the potential of 3D printing technology for the future.

The first house in the Kingdom of Saudi Arabia was built in just 25 hours by only 4 Saudis and 2 foreign experts.

Modern technology was not used internationally in housing projects and administrative buildings only, but was also used in the development of public streets (making public benches - public bathrooms - flower walls) and was also used in drainage work and building private and public manholes.

• Reaching an evaluation of the modern construction system and the usefulness of using that system or not in housing projects in Egypt compared to using the traditional system and coming out with a result:

3D printing construction saves from 50 - 60% of construction cost

• Scholars have found that technology can save the construction cost by 50-70%, and the labor cost by 50-80%.

• Building with 3D printing technology reduces the cost of building the largest 3D building in the world as an area of Dubai by up to 60%.

Modern technology is environmentally friendly and more sustainable, as it can reduce the percentage of waste resulting from construction operations by up to 60%.

• It is not necessary to use concrete only in construction using 3D printing technology. Houses in Italy were printed using a mixture of natural clay made from soil taken from the surrounding site, in addition to waste from rice production such as chopped straw and rice husks.

• Building with 3D printing technology completes the project in a time that is approximately one third of the time used in the traditional construction method.

• The success of "resettlement of slum areas" policies of all three types, and solving the problem from its various aspects is closely related and depends on more than one factor:

- Residents' participation in options

The ability of the government and local administration to manage and implement a project and provide the resources available to them

Providing adequate housing for this segment of the population to meet their needs

Providing socio-economic programs aimed at training on work and employment and increasing income. The research recommends the necessity of developing a plan for post-occupancy evaluation and project follow-up to avoid deficiencies.

• If 3D printing technology is used in the development of slums, the time taken for the development process can reach a quarter of the time spent during the development process using traditional methods of construction.

• If 3D printing technology is used in the development of slums, the cost of the development process can reach nearly half the cost of the development process using traditional methods of construction.

• Being able to assist investors in establishing tourist resorts and luxury residential complexes in less time and at lower cost, with a modern construction system

• To be able to assist the state in solving the housing problem and to enable very fast projects at a lower cost to bridge the deficit

• Being able to assist the state in developing informal areas by finding a way to compensate those affected by the rapid removal of their homes and houses that are structurally and architecturally better than the ones in which they lived.

• Controlling project schedules in a very large way due to the fact that these systems are not dependent on the element of manpower and also because of the speed of construction in these systems. There will be no time difference between the beginning and the end of the project, which does not give the opportunity to delay the project due to changing economic conditions, and this is what Egypt witnesses in the last period.

#### V. RECOMMENDATIONS

- The need for the state to facilitate the import of these machines and remove obstacles facing importers
- Holding conferences and seminars for contracting companies and investors and educating investors and contracting companies about modern technology and its advantages
- The state started using technology to encourage companies to import and use the machine because of its many benefits, as it was presented in the research

- Begin to study the application of technology to housing projects, especially low-income housing, because it will enable the state to solve a big problem, which is the housing problem
- To start studying the application of technology to medium and upper middle housing projects to speed up reconstruction of new cities and save time and cost
- Begin to study the application of technology to premium or luxury housing projects to encourage construction companies and investors to use modern technology because of its great advantages in the return cycle and the speed of project completion at a rate of more than 300% over the use of traditional methods of construction
- Begin to study the application of 3D printing technology to hospital projects, as the construction speed may benefit by using it in the face of disasters and crises, such as the recent Covid 19 (Corona) epidemic.

## VI. CONCLUSION

The process of manufacturing building materials usually produces huge carbon emissions, as for this printer, it can recycle building materials, and workers are not exposed to toxic substances during the processing process, and there are many advantages to using it, such as saving time and cost, as the printer is a robot that pumps cement or building materials continuously recycled without fatigue, stopping or assistance

As for the ceilings, of course, it is not completed yet and there is a lot of development. Ceilings that are slightly tilted up can be printed. As for completely flat and flat roofs, their supports are placed from wooden panels or the ceiling is printed on the ground and then raised and installed. This is if we do not use wooden ceilings and on the bases of the house, the iron support is manually installed and then the printing is resumed again. As for the openings such as water and electricity pipes and vital connections, they are placed during printing easily, so the cement is still wet

The 3D printing process of concrete can:

- reduce construction cost by up to 60%.
- Reducing labor costs by up to 80%.
- completion of construction tasks in a third of the time it takes to build by traditional methods

## REFERENCES

- [1] Dr. Muhammad MahoudAweidah , Modern Technology in Building , Dar Al-Nahda Al-Arabiya , Beirut , January 1984, pp. 20-40
- [2] [www.dubaifuture.gov.ae/our-initiatives/office-of-the-future/](http://www.dubaifuture.gov.ae/our-initiatives/office-of-the-future/)
- [3] Mehmet Sakin\*, Yusuf Caner Kiroglu , 3D Printing of Buildings: Construction of the Sustainable Houses of the Future by BIM , 9th International Conference on Sustainability in Energy and Buildings, SEB-17, pp3-4 , july 2017