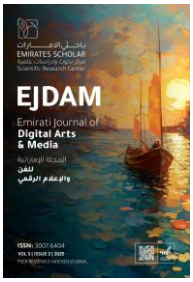

Emirati Journal of Digital Arts & Media
Vol 3 Issue 2 (2025)
Pages (17 - 29)

Available at
www.emiratesscholar.com

Printing an Arabic building in 3D, the expectations and aspirations for the success of the idea

Mohamed Abdelaziz[1], Mohamed Awad Allah[2]
Assistant Proffesor, KUTC[1]
mohamedabdelaziz12987@gmail.com[1]

ARTICLE HISTORY

Received: 10 September 2025.
Accepted: 17 November 2025.
Published: 29 December 2025.

PEER - REVIEW STATEMENT:

This article was reviewed under a double-blind process by three independent reviewers.

HOW TO CITE

Abdelaziz, M., & Allah, M. A. . (2025). Printing an Arabic building in 3D, the expectations and aspirations for the success of the idea. *Emirati Journal of Digital Arts & Media*, *3*(2), 17-29. https://doi.org/10.54878/9setfh90

ABSTRACT

Community awareness of the importance of 3D printing technology, which constitutes a promising future sector that provides billions of dollars in investment opportunities. It also constituted the first initiatives aimed at achieving the outcomes of the 3D Printing Strategy. The advent of the buildings that is printed by the 3D printing technology is revolutionize the construction industry by enabling the rapid, cost-effective creation of complex, customized architectural designs through the use of durable, eco-friendly materials, which not only reduces construction waste and labor costs but also allows for greater flexibility in design and the potential for creating sustainable, energy-efficient structures that can be rapidly deployed in response to housing shortages or disaster relief scenarios. The future of 3D printing technology is set to transform a multitude of industries by integrating advanced materials that offer unprecedented strength and flexibility, achieving faster and more precise fabrication processes, all while potentially reducing waste and optimizing supply chains. Today, with all this information, we are talking about the first and unique Arab experience in printing an entire building in 3D, and the impact of it on the future of construction in the Arab region, as well as its impact on many other sectors related to technology and its new ideas.

Keywords: *3D, Print, Technology, Humanity, Dubai, UAE*

The Research Problem:

The significant challenges in extending 3D-printed buildings lies in addressing the complexities of integrating new sections with existing structures, as this involves ensuring structural integrity and seamless transitions between printed and traditionally constructed elements, managing the compatibility of different materials and printing technologies, and overcoming logistical hurdles related to scaling up production while maintaining consistent quality and adhering to evolving building codes and regulations.

This research will focus on the near future after the first 3D building was built in 2016, why the idea did not lead to other similar projects in the Arab region, what could happen in the future based on the previous success of the idea, and the reasons for the delay in the results of the idea until now.

Research Objectives:

The future benefits of 3D printing span across various industries and aspects of life. As the technology continues to evolve, its potential impacts are becoming increasingly significant. Here's a look at some of the anticipated future benefits:

1 - On-Demand Manufacturing: Products can be created on-demand, reducing the need for large inventories and enabling rapid customization.

2 - Eco-Friendly Materials: Development of new, sustainable materials will enhance the environmental benefits of 3D printing, including biodegradable plastics and recycled materials.

3 - Waste Reduction: Improved processes will minimize material waste, and closed-loop systems could further enhance sustainability by recycling used materials.

4 - Affordable Housing: 3D printing could enable the construction of affordable, customized housing solutions, particularly in underserved or disaster-stricken areas.

5 - Innovative Structures: The ability to print complex geometries and integrate advanced materials will lead to innovative and efficient building designs.

6 - Reduced Launch Costs: Printing parts and components on-demand can reduce the need for transporting large quantities of materials from Earth.

7 - Rapid Prototyping: Accelerates the development of new ideas and innovations by enabling rapid prototyping and iterative design.

8 - Localized Production: Reduces the need for long supply chains by enabling localized production of goods, which can lower transportation costs and increase supply chain resilience.

9 - On-Demand Parts: Businesses can manufacture spare parts on-demand, reducing downtime and inventory costs.

10 - Pollution Reduction: The shift to more sustainable materials and efficient manufacturing processes can contribute to reducing overall pollution and resource consumption.

11 - Energy Efficiency: Improvements in 3D printing technology may lead to more energy-efficient production methods and products.

12 - New Markets and Jobs: The growth of the 3D printing industry will create new economic opportunities, including jobs in design, engineering, and manufacturing.

13 - Entrepreneurship: Lower barriers to entry for small businesses and startups in manufacturing and design will foster innovation and economic growth.

14 - Smart Materials: Future developments may lead to 3D printing with smart materials that can change properties in response to environmental conditions.

15 - Enhanced Performance: Research into new materials will result in products with superior performance characteristics, such as increased strength, flexibility, or thermal resistance.

Research Methodology:

The descriptive analytical approach, where models of 3D printed buildings will be presented historically, focusing on the building under the research study, to clarify the dimensions of the idea and its effects on large sectors and the ambitions that may follow the idea in the near future, and how to highlight the positive aspects of the idea.

We will also talk about the history of the industry and the chronology of the industry development, focusing on the construction of the building under study, so that we can develop a future vision of what the industry could be like in the near future.

Theoretical Side:

The Dubai Future Foundation is a visionary organization that shapes Dubai's future of building industry collaboration with general sector partners. they have a mission of making Dubai as one of the world's foremost future cities. They reimagine, inspire, and design innovative solutions, leveraging accelerator programs with incubators or labs that regulatory offers sandboxes and knowledge platforms. Through initiatives like the Dubai Program for Gaming 2033, which focuses on talent, content, and technology in gaming, and the Digital Courses offered by the Dubai Future Academy, they prepare future leaders and disrupters to navigate evolving technology landscapes. (Mohamad Kaddoura, 2020)

Dubai Future Foundation achieves a record for the first commercial building printed with 3D printing technology (guinnessworldrecords, 2020), the record-breaking building measures 250 square meters, which is 20 feet high and 120 feet long that was created using a 3D printer and a robotic arm that carried out the printing process (figure 1), the printing process was completed within 17 days, and the installation and construction process took two days, and after preparing the building externally, work was done on the interior design and building services within approximately three months.

Figure 1 : Dubai Future Academy which is made by 3D printing

Perhaps what most distinguishes the process of constructing the building is that it was completed using a workforce of less than 50 percent compared to traditional construction methods, and the construction process also produced construction waste at a rate of less than 60 percent.

The office complex centers around a tree-shaded café courtyard and features a partnership lounge and gallery for exhibitions, events, and workshops. It also includes a flexible space for team brainstorming and design work, as well as private meeting rooms for quiet tasks. Natural daylight is brought deep into the space through a series of openings, keeping occupants connected to the outdoors. The layout is thoughtfully designed to support a range of activities, including creative interactions, reflective work, and spontaneous meetings. (figure 2)

Figure 2 : Interior view of the 3D printed building of Dubai Future Academy

To support the broader initiative of engaging with cutting-edge and innovative projects, they utilized a super-insulated cladding system. This system, crafted through computer-controlled manufacturing techniques, shapes the building envelope with its unique and complex geometry.

In order to be able to know the speed of the development of the idea, so that we can predict what is coming, we must go back in history to some time when the idea was under development and what happened to it until the present time, so that we can develop a future vision of what the industry could be like in the future.

The History of 3D Printed Building:

First, this can be summarized in an important piece of information, before going into more detail. As the industry has gone through many steps and stages, here in the special research it is noted that not all of those stages included the current known form, whether in uses or materials, knowing that modern projects also sometimes resorted to the same old materials that will be discussed during the discussion in those specific points, with the emphasis that they are time stages that extend or differ according to the objectives of each stage alike.

The history of 3D printing dates back further than what we might think, The concept existed as early as 1945, and primitive 3D printing was attempted in 1971. It wasn't until 1984 that Charles "Chuck" Hull invented stereolithography, a method that uses UV light to create 3D objects layer by layer. Today, we see exciting advancements such as construction 3D printing, which employs additive techniques to fabricate buildings and components. Interestingly, in 1939, William Urschel developed the world's first 3D concrete-printed building behind a small warehouse in Indiana, United States. His "Wall Building Machine" featured an automatic ramming mechanism that compressed concrete between spinning disks, consolidating and smoothing each layer as the material was extruded.(figure 3).(Hart, K., 2022) What appears in the picture is the same idea of the current successive printing through different materials. However, the similarity of the idea and content makes us consider it to be almost the most important stage. Despite the development of technology up to our current era, the aforementioned form has been practically implemented in a way that is very similar to what is currently being done in construction. It will also be listed and the most important notes in it will be reviewed. The fundamental difference between the two methods is that this process used to be done by placing the raw materials manually, until this feature was developed to work automatically without human intervention, only by following up on what is being manufactured and examining its design before starting implementation.

Figure 3 : A photo from short video Filmed in Valparaiso, Indiana in the late 1930's, William Urschel demonstrates his "Wall Building" machine in this video.

Robotic bricklaying was conceptualized and explored in the 1950s, and the development of related automated construction technologies began in the 1960s with innovations like pumped concrete and isocyanate foams. In the 1980s and 1990s, Japan, through companies like Shimizu and Hitachi, pioneered the automated fabrication of entire buildings using slip forming techniques and robotic assembly, similar to 3D printing. These early approaches aimed to address the risks associated with high-rise construction but often struggled due to the construction "bubble," difficulties in adapting to new architectural designs, and challenges in material logistics in densely built areas.

Since 1995, research and development in construction 3D printing have been ongoing. Among the early innovations was a method developed by Joseph Pegna, which involved a sand/cement forming technique that used steam to selectively bond the material in layers or solid parts, though this technique was never demonstrated. (Montjoy, V., 2023)

The second technique, Contour Crafting, developed by Behrohk Khoshnevis, originally began as a novel method for ceramic extrusion and shaping. Patented in 1995, it was conceived as an alternative to emerging polymer and metal 3D printing techniques. Khoshnevis recognized that Contour Crafting could surpass these methods, which were limited to fabricating parts generally less than one meter in each dimension. Around 2000, Khoshnevis's team at USC Viterbi shifted their focus to construction-scale 3D printing of cementitious and ceramic pastes. They explored integrating modular reinforcement, built-in plumbing, and electrical services within a continuous build process. Although this technology has only been tested at the lab scale to date, it has been controversially alleged to have influenced recent efforts in China. The evolution of 3D printing continues to unfold, and its story remains ongoing.

Timeline of the development of 3D printed buildings:

- 1984: Charles Hull, an American engineer who would later become a co-founder of 3D Systems and a leading figure in the industry, invented stereolithography (SLA). This printing process creates tangible 3D models from simple images by directing a UV laser at liquid photopolymer. Additionally, the STL file format was introduced, which remains the most commonly used format in 3D printing software today.
- 1988: After the SLA process was patented, Charles Hull developed the first SLA 3D Printer (figure 4) (formlabs.com)

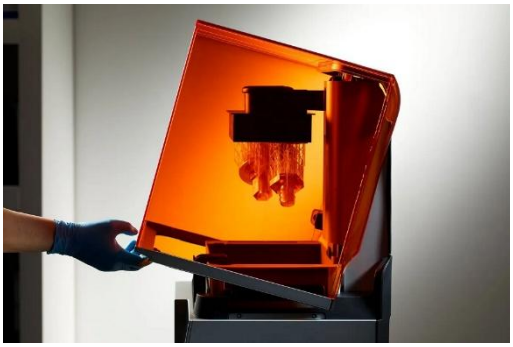

Figure 4 : a new example of Stereolithography (SLA) 3D Printer In its contemporary form

- 1989: Scott Trumo invented and patented Fused Deposition Modeling (FDM), a widely used 3D printing technique popular among consumers. FDM involves the layer-by-layer deposition of fused material, typically plastic, based on an STL file.
- 1990: In the same year, American-Israeli manufacturer Stratasys commercialized FDM 3D printers. Meanwhile, several organizations began experimenting with 3D printing to produce modular components for full-scale projects, setting the stage for future applications in the AEC industry.

- 1992: The Company 3D Systems introduced SLA printers to the market. Despite having some imperfections, it was already possible to create complex 3D objects overnight.
- 1993: MIT university developed its own patented 3D printing system, which evolved to create objects made of plastic, ceramic and metal guided by computer-assisted design (CAD) software.
- 2000: Italian engineer Enrico Dini developed the D-Shape 3D printer (figure 5), which uses a binder jetting technique to create large-scale structures from a mixture of sand and inorganic binding materials. This innovation marked a significant advancement in printing architectural elements. (Turney, D., 2021)

Figure 5 : an example of D-Shape 3D Printing Technology

- 2006: MIT researchers developed a large, highly controllable robotic arm capable of printing with materials ranging from concrete to recycled plastic using a conventional construction nozzle. In the same year, the first Selective Laser Sintering (SLS) machine became available. This technology allowed materials to be melted during the process, enabling the production of industrial parts from various materials.
- 2009: Increased research and experimentation by companies with 3D printing concrete opened new possibilities for architectural applications, leveraging the material's structural capabilities.
- 2014: The Chinese construction firm Winsun utilized a massive 3D printer to construct ten small-scale, cost-effective houses using glass fibers and cement. Later, they achieved a significant milestone by building the world's tallest 3D-printed building at that time—a five-story apartment block. (Russon, M., 2015)(figure 6).

Figure 6 : The highest building ever constructed using 3D printing technology, Jiangsu province, China (Photo by: WinSun Decoration Design Engineering Co)

- 2014: Several innovations came to light this year, including the first commercial 3D concrete printing robot, a 3D printing technique for structural steel and an earthquake-proof column built with 3D printed sand.
- 2016: Dubai's "Office of the Future" has been revealed as the world's first fully functional and permanently occupied office building made entirely of 3D-printed concrete. It was printed in just 17 days and installed on-site in only two days.(figure 7)

Figure 7 : Front view of Office of the Future, Which is considered part of the main interface related to the research.

It is worth noting that the stage of building the subject of the research was included among the steps because of its impact on the development of the industry, and also to clarify the purpose of listing the steps preceding it, and the steps following it, reaching the latest information available until writing this research, and in light of that, it is possible to develop an idea of what the industry can reach later. Although the building was not the first to be made entirely in 3D as mentioned in the research, many international sources point to its importance as a model for what new cities could be. Also, it is the first in the Arab world, and here we emphasize the importance of focusing on what this step could yield in repeating it on many levels, whether for environmental purposes or exploiting the positive aspects of the printing idea itself as mentioned in the text above.

- 2017: Additional architectural milestones include the creation of a complex concrete column using 3D-printed formwork and the opening of the world's first 3D-printed bridge in Spain.
- 2019: The Dubai Municipality has become the world's largest 3D-printed building, constructed on-site and standing 9.5 meters tall with a total area of 640 square meters. In the same year, construction commenced in Mexico on the world's first 3D-printed community.(figure 8). aiming to produce 50 homes using the Vulcan II 3D printer.

Figure 8 : World's First 3D Printed Community Minimises Homelessness in Mexico

In a remote area of Mexico, work is underway on the world's first 3D-printed community. This initiative aims to address homelessness by providing safe and adequate shelter through innovative printing technology. Here, in a remarkable development of using the idea for charitable purposes, where the building combines two very important elements in any modern construction, the first of which is the health element, which allows a larger space for construction from environmentally friendly materials, and the second important point is the low cost of these elements, which means the possibility of expanding them significantly to serve the community, as was done in that experiment, and this is also linked to the speed of implementing the project as urgent assistance to those affected if the housing is to shelter displaced persons from areas of natural disasters such as earthquakes and volcanoes.(Grace, K., 2019)

- 2020: Germany's first 3D printed two-story home entered the market (figure 9), and two months later, Construction company PERI has successfully printed Europe's largest 3D-printed apartment building.

Figure 9 : Germany's first 3D-printed house From outside, the 3D-printed facade stands out with its rounded edges. Source: PERI

The prototype model in Beckum, Germany costs a value of about 450,000 €. (HEIDELBERGCEMENT) including luxurious furnishing and high-end smart devices. Returning to that building, it is clear that it was primarily concerned with its health value, in terms of the material it was printed from, of course, in addition to the distribution of windows and external spaces and its total area that allows movement and comfort in distributing any elements inside it. As for the aesthetic form, there was not much interest in it, as the printing lines appeared clearly on the external facade of the building, and it was not designed to contain many decorations or inclinations except in its basic edges only, but the colored lines in it still have a good effect on the final shape, this may be due to the user's taste, as the information has not been confirmed. This may be due to a desire to complete the building faster, and as is known in 3D printing, the speed of the printing process may be linked to the quality of the final shape, and the reason for this may be the materials used.(Gira Magazine editorial team, 2022)

- 2021: 3D printed metal bridge emerged in Amsterdam, Netherlands, which was started in 2015 (figure 10) - a result of innovative 3D printing technology, generative design and topology optimization techniques.

Figure 10 : Joris Laarman's 3D-printed stainless steel bridge in Amsterdam

A 12-meter pedestrian bridge, designed by Joris Laarman and built by the Dutch robotics company MX3D, has been unveiled in Amsterdam, six years after the project's initiation. The bridge, which spans the Oudezijds Achterburgwal in the Red Light District, was crafted from stainless steel rods using six-axis robotic arms with welding gear. The structure utilized 4,500 kilograms of stainless steel, which was 3D-printed by robots in a factory over six months before being craned into position over the canal this year. However, architect Philip Oldfield calculated that the stainless steel in the structure contains 27.7 tonnes of embodied carbon. The bridge features a curving S-shaped form and balustrades with lattice-style perforations, designed using parametric modeling software. The team behind the project claimed that this technique demonstrates how 3D-printing technology can create more efficient structures with reduced material usage. The Alan Turing Institute and Arup equipped the structure with a network of sensors that enables the bridge to collect data and create a digital twin. This digital twin will track the bridge's performance and health by monitoring corrosion, load changes, environmental conditions, and pedestrian usage, aiming to advance data-centric design. (Parkes, J., 2021)

- 2021: Architects and industry specialist WASP build the first fully natural 3D printed construction made of raw earth (figure 11). The sustainable housing prototypes used multiple printers synchronized to work at the same time for 200 hours.

Figure 11 : World's first 3D printed house made of local raw earth by Italian architecture studio Mario Cucinella Architects and Italy's pioneering specialists in 3D printing, Massa Lombarda, Italy

Addressing today's climate change and urgent needs, the team developed a small-scale housing model that can be replicated worldwide using a 3D printer and local soil. The project involved 200 hours of printing with 7,000 machine codes (G-code) to create a structure made of 350 stacked layers of 3D-printed local clay, each 12 mm thick. This process required 150 km of extrusion and utilized 60 cubic meters of natural materials. The team highlighted that this construction technique uses an average of less than 6 kW of energy, significantly reducing waste compared to traditional methods. Each printer unit has a printing area of 50 square meters, allowing for the construction of independent housing modules within a few days. The layers are clearly visible upon closer inspection, providing both structural stability and thermal insulation. (Italy Architecture News, 2021)

- 2021: BIG, Lennar, and ICON have embarked on a project to construct the world's largest 3D-printed neighborhood, featuring 100 homes in Austin, Texas.(figure 12)

Figure 12 : BIG, ICON, and Lennar 3D-printed Homes in Texas, USA

ICON, a pioneer in large-scale 3D printing, announced the construction of a 100-home 3D-printed community. This project, co-designed by BIG - Bjarke Ingels Group and developed by Lennar, will be located in Georgetown, north of Austin., "The Genesis Collection at Wolf Ranch" will become the first and largest house estate in the world built by a fleet of robots integrating additive construction techniques. The project aims to address the housing crisis in Austin, one of the U.S.'s most dynamic and rapidly growing cities. The homes will feature 3D-printed walls made from Lavacrete, a cementitious-based material. The walls are created layer by layer through a nozzle, eliminating the need for additional support or finishes, which reduces waste and construction time. Based on previous prototypes, printing a house ranging from 90 to 200 square meters takes approximately 5 to 7 days, a significant reduction compared to traditional methods like timber framing, which can require up to 16 weeks for the same area.(Cano, P., 2022)

- 2023: Researchers at ETH Zurich, exploring large-scale robotic 3D printing applications, developed a lightweight insulated wall system using cement-free mineral foam made from recycled waste. This innovative system aims to reduce building materials, labor, and costs.

Today, the potential of 3D printing in architecture is virtually limitless. Once used primarily for creating tabletop models, the technology has now expanded to large-scale production, enabling the construction of homes and entire communities using various materials, from common concrete to readily available raw earth. The future holds even more promise, with potential applications extending to temporary shelters, affordable housing, living buildings, expansive urban areas, and even outer space colonies. To fully grasp how we reached this point and to prepare for what lies ahead, it's essential to revisit the origins of this technology.

General Benefits of 3D Printing:

3D printing offers many benefits that make it a powerful tool in many fields. Here are some of the main benefits:

1. On-demand production: 3D printers can produce parts and components on demand, reducing the need to stock large quantities of finished products.

2. Custom design: They provide the ability to create customized and detailed designs, making it easier to meet specific needs, whether in the furniture industry, medicine, or other industries.

3. Innovation and experimentation: They enable companies and designers to test new ideas and experiment with innovative models quickly and at a relatively low cost.

4. Reducing waste: Parts are produced directly from raw materials, which reduces waste and reduces the impact of the traditional manufacturing process on the environment.

5. Production of complex parts: 3D printers can produce complex shapes and structures that cannot be achieved using traditional manufacturing methods.

6. Low initial production costs: Prototypes and experimental parts can be produced at a low cost compared to traditional methods, making it easier to develop new products.

7. On-site manufacturing capability: 3D printers can be useful in locations where large materials are difficult to transport or manufacture, such as construction sites or disaster areas.

Conclusion:

The experiment was not the first of its kind. The idea of designing similar houses printed used already before. But the idea is still under observation and analysis.

1. The first axis: Viewpoints:

Differences of viewpoint between supporters and opponents of this advanced technology, they are divided into two groups:

- The first party: claims that the technology helps save a lot of the resources used in construction, in addition to the speed and accuracy of its completion, and the percentage of errors in it is almost non-existent because it was done under observation, inspection, experimentation and modification on computers before starting to print it. To present it as a final product.
- The other team: imposes its bias towards nature, reality and its products, as the industry, although it provides a lot of money, loses many workers and intermediaries such as contractors and others for many traditional construction opportunities, and it may also lead to an increase in the unemployment rate in general as a result marginalization of that group.

However, the two groups remain present when any new technology or event is released at all levels and fields, and those ideas that support staying in the safe zone that fears the

use of modern technologies remain present throughout the ages, but in most cases they cannot stand in the face of development. The rapid pace imposed by the pace of the times.

2. The second axis: Abundance of raw materials:

Studying of the materials that make up 3D prints, their availability in nature, and their environmental interactions with the surrounding atmosphere, whether in cold climates such as those found in Europe, or when they are found in hot countries such as the Arab world, for example, we know the extent of human sensitivity to these materials and dealing with it professionally, and being reassured that limiting these materials does not lead to a violation of the quality of the environmental balance around us, the idea of printing is still a good idea, even though all current studies confirm that it is economical in terms of raw materials as well as in terms of surrounding services.

3 - The third axis: Financial aspect:

The cost-effectiveness of 3D-printed homes is a major advantage. This technology can lower construction costs by 30-50% and greatly reduce construction time, potentially leading to a new era of affordable housing and helping to address the widespread housing challenges faced by many cities.

In general, The cost of 3D-printed houses is lower compared to average wood-framed homes. This is partly because 3D printing reduces labor needs, eliminating the requirement to hire skilled workers such as bricklayers, framers, and sometimes even roofers. Additionally, the faster construction process further lowers labor costs.

4 - The fourth axis: Expectations:

Therefore, based on our knowledge of modern technology and its inherent role in everything that surrounds us, welcoming new ideas and proposals for architecture and construction is a good nucleus for other major projects, and entering into new fields and providing centers specialized in studying and creating them gives us a good idea of what should be done, so that the Arab world has its own product in sync with global development at the same time.

5. The fivth axis: Positive points:

In the end, any project needs a sufficient period of time to fully evaluate the experience, and in the context of our research, it is necessary to review the results and from them an evaluation will be made, even though the experience is encouraging, as until the time of writing the research, no negative comments or damages were issued to the aforementioned building that is the subject of the research.

And to refer to the most positive point, It is valuable that the Arab world has entered into this technology, through the city of Dubai and that academy that was built using three-dimensional technology, because it puts the Arab world on the same edge with the world to experiment and judge everything new without the need to wait for results abroad, but rather On the contrary, the fact that the Arab world shares the technology immediately after its release provides the opportunity for more Arab analysts to express their opinions and perhaps have a role in developing technical activity later.

References:

Books and Researches:

1- Aranda, S., 2017, 3D Printing Failures: How to Diagnose and Repair All 3D Printing Issues, Texas, USA: Sean Aranda
2- Diamandis, P., Kotler, S., 2020, The Future Is Faster Than You Think: How Converging Technologies Are Transforming Business, Industries, and Our Lives, New York, USA: Simon and Schuster
3- Dougherty, D., 2022, Make: Volume 83, California, USA:Maker Media

4- Hamad Aljassmi, "Large-Scale 3D Printing: The Way Forward", IOP Conference Series Materials Science and Engineering 324(1):012088324(1):012088, 2018.
5- Hourcade, Juan Pablo, Natasha E. Bullock-Rest, Janet C. Read, and Yoram Chisik. "HCI for peace: Promoting peace and preventing war through computing technology." In Human-Computer Interaction-INTERACT 2011: 13th IFIP TC 13 International Conference, Lisbon, Portugal, September 5-9, 2011, Proceedings, Part IV 13, pp. 689-690. Springer Berlin Heidelberg, 2011.
6- John, M., 2019, 3D Printing: The MIT Press Essential Knowledge series, Massachusetts, USA: MIT Press
7- Saras, A., 2019, 3D Printing Made Simple: Exciting & Innovative Technology, New Delhi, India: BPB Publications
8- Segerman, H., 2016, Visualizing Mathematics with 3D Printing, Maryland, USA: Johns Hopkins University Press

Websites:

1- ArchDaily, Office of the Future / Killa Design, accessed 16 March 2024, <https://www.archdaily.com/875642/office-of-the-future-killa-design>
2- Cano, P., 2022, BIG, ICON, and Lennar Announce Community of 3D-printed Homes in Texas, USA, accessed 16 March 2024, <https://www.archdaily.com/992081/big-icon-and-lennar-announce-community-of-3d-printed-homes-in-texas-usa>
3- Dubai Future Foundation, About, accessed 21 July 2024, <https://www.dubaifuture.ae/about>
4- formlabs.com, Guide to Stereolithography (SLA) 3D Printing, accessed 21 July 2024, <https://formlabs.com/asia/blog/ultimate-guide-to-stereolithography-sla-3d-printing/>
5- Gira Magazine editorial team, 2022, Paving the way for future living: Germany's first 3D-printed house, accessed 21 July 2024, <https://www.gira.com/en/en/g-pulse-magazine/building/3d-house-germany>
6- Grace, K., 2019, World's First 3D Printed Community Minimises Homelessness in Mexico, accessed 16 March 2024, <https://www.archdaily.com/930556/worlds-first-3d-printed-community-minimises-homelessness-in-mexico>
7- guinnessworldrecords, 2020, First 3D printed commercial building, accessed 21 July 2024, <https://www.guinnessworldrecords.com/world-records/585284-first-3d-printed-commercial-building>
8- Hart, K., 2022, William Urschel Demonstrates his Wall Building Machine, accessed 21 July 2024, <https://naturalbuildingblog.com/william-urschel-demonstrates-his-wall-building-machine/>
9- HEIDELBERGCEMENT, German Innovation Award for first 3D-printed house, accessed 21 July 2024, <https://www.bft-international.com/en/artikel/bft_German_Innovation_Award_for_first_3D-printed_house-3661715.html>
10- Italy Architecture News, 2021, Mario Cucinella Architects and WASP built world's first 3D printed house made of local raw earth, accessed 16 March 2024, <https://worldarchitecture.org/article-links/evpeh/mario-cucinella-architects-and-wasp-built-world-s-first-3d-printed-house-made-of-local-raw-earth.html#google_vignette>
11- Marquardt, T., Zheng, E., accessed 16 March 2024, <https://blogs.lawrence.edu/makerspace/history/>
12- Mohamad Kaddoura, 2020, Learn about the world's first 3D-printed commercial building, accessed 16 March 2024, <https://www.guinnessworldrecords.ae/news/commercial/2020/2/discover-the-worlds-first-3d-printed-commercial-building-in-dubai>

13- Montjoy, V., 2023, Infographic: The Evolution of 3D Printing in Architecture: Since 1939, accessed 16 March 2024, <https://www.re-thinkingthefuture.com/technology-architecture/a11860-the-evolution-of-3d-printing-in-architecture/>
14- Parkes, J., 2021, Joris Laarman's 3D-printed stainless steel bridge finally opens in Amsterdam, accessed 16 March 2024, <https://www.dezeen.com/2021/07/19/mx3d-3d-printed-bridge-stainless-steel-amsterdam/>
15- re-thinkingthefuture.com, The Evolution of 3D Printing in Architecture, accessed 16 March 2024, <https://www.re-thinkingthefuture.com/technology-architecture/a11860-the-evolution-of-3d-printing-in-architecture/>
16- Russon, M., 2015, Chinese man creates world's tallest 3D-printed building and a villa in just 10 months, accessed 16 March 2024, <https://www.ibtimes.co.uk/chinese-man-creates-worlds-tallest-3d-printed-building-villa-just-10-months-1485354>
17- Turney, D., 2021, History of 3D printing: It's older than you think, accessed 16 March 2024, <https://www.autodesk.com/design-make/articles/history-of-3d-printing>
18- Wikipedia, Construction 3D printing, accessed 16 March 2024, <https://en.wikipedia.org/wiki/Construction_3D_printing>
19- Xinyu, D., Yi, L., Song, M., Lei, Z., Minhui, H., Lin, F., Yuliang, W., Wei, Z., Gong, W., 2024, 3D printed sequence-controlled copolyimides with high thermal and mechanical performance, accessed 21 July 2024, <https://www.sciencedirect.com/science/article/abs/pii/S1359836824000738>