International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-8, Issue-6, November 2021
https://doi.org/10.55524/ijirem.2021.8.6.88
www.ijirem.org

An Overview of 3D Printing In Construction

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ABSTRACT
Building is generally of the largest employment businesses in the globe, as well as one of most significant providers of jobs. For years, the industry has been plagued by low production and limited technological advancements. The building sector has lately been more interested in different automation, like 3D printing. printing in architecture has demonstrated to be incredibly promise in regards of automation construction procedures, and it has the capacity to save time, money, and potentially risky people activities, among other things. A lot of research has gone into better understanding present advances, future prospects, and challenges related with large-scale usage of 3D printing in construction projects. Since building is an employment business, this study examines the impact of increased 3D printing adoption on the labor market. It has been revealed that 3D printers may reduce the quantity of labor necessary, which might assist to alleviate the labor shortages problem, especially in countries where building is heavily dependent on immigrants. In countries where construction is a big employment and labour is lower expensive, however, 3D printing may not be beneficial. Furthermore, professionals with specific understanding of this novel technique will be required to employ 3D structure manufacturing.

Keywords
3D Printing, Additive Manufacturing, Construction, Workforce, Construction Labor.

1. INTRODUCTION
3D printing is the desktop serial layering of elements to make three-dimensional forms. It comes particularly handy for developing and constructing mathematically complex elements [1]. It was created in the 1980s, although it were a complicated and expensive method with limited applications at the moment. It has recently been relatively easy and inexpensive since 2000, allowing it to be used in a wide range of applications including item development, component and tool production, retail devices, polymers, metals, aviation construction, dental and medicinal applications, and footwear. The appeal of AM machines, sometimes called as "3D printing," has skyrocketed, and home use of 3D printers has become possible since 2005. Building
Construction 3D printers are 3D printed equipment that are particularly built for the construction industry[2].
A 3D electronic model of the thing is created using desktop designing (CAD) or a 3D scanning. After reading the design, the printer adds consecutive layers of printing media to the image, that are then melted or mixed to produce the item. Although the process is moment, it enables for the creation of nearly any shape. Based on the technique employed, printing may make many parts at an identical moment, use different materials, and use multiple colors. A high-resolution subtractive approach for removing material from a massive printed object might increase precision. Solubilized polymers are employed in several production procedures to support overhanging parts. Because printing metals may be expensive, it might be better expense to print a mould and then use it to manufacture the thing. Another of the most essential drivers to a nation's financial prosperity is the building industry, accounting for 9% of global GDP (gross domestic product) and 78.5 percent of total employment.
In 2018, global construction expenditure By 2025, this value is expected to reach USD 14 billion [3]. Despite its importance to the economy, the industry is plagued by low efficiency owing to a dearth of technological developments, limited digitization, and the usage of robotics, among other factors. Building operations are often dispersed and person, that thwarts the automated procedure in the sector. Furthermore, as stated in the construction sector gets very little investment in technology, which slows productivity development even further there is a significant connection between a sector's degree of digitalization and its productivity gains.
The construction business in the United States has invested just 1.5 % contributed in technologies, compared to 3.6 percent for the industrial industry and the total industry. Construction production has remained nearly unchanged over the last several decades, according to various studies, while industry production has approximately tripled. According to current research, the building industry is gradually incorporating automation technologies and robotics technologies, with the majority of those technology remaining in the study and development stage and just a few real implementation [4]. Virtual reality, enhanced truth, blended actuality, robots, robot hands, laser searching, 3D printers (3DP), and other sorts of automating are been researched and used in development. Nonetheless, the majority of these automated technologies are utilized only for a few specialized projects. These technologies, unlike industrial processes, are not easily adaptable or repeatable to numerous construction projects due to the unique character of building projects.
In order to apply automation technologies on a large scale, further research is required. 3D printers, also called as incremental manufacture, is a mechanized technology for creating complex form shapes level by level using a 3D modeling (laptop designing (CAD) models using a series of pass slices. Materials wastage, labour expenses, and production time may all be reduced. It has been continuously rising in several industrial areas, such as vehicles, airplanes, medical equipment, and so on, for decades [5]. Because of the huge disparities amongst structure development and industry operations that can make multiple duplicates of a single product, the buildings and construction industries were the last to adopt 3DP technology [6]. The use of additive technology to print concrete for houses and villas has a better probability of success than the construction of large structures. This is due to a variety of disadvantages, such as a

3D printer's restricted capability for high-rise structures, inadequate printing substances (particularly for pile parts), a low degree of customisation, the sophistication of communication transmission from plan to physical item, and so on.

Apart from printing buildings, 3DCP has being utilized to printing walking footbridge, in situ repairs when person entry is impossible or risky, speedy building of disaster relief bunkers, army shelters, creating steel framing, architectural and non-structural parts with complicated geometry, and more, printing molds for load bearing components, and replicating historic structures. 3DP is a new There is a lot of discussion about the benefits of technologies in the development business, as well as the challenges it confronts. Development costs are lower, materials are used less, there is more security, there is less reliance on human resources, there is more branding and marketing dominance, and the buildings is more lasting and ecological, and other benefits of 3DCP have been extensively addressed in the literature. One of the key advantages of 3DCP has been recognized as labor reductions. Given the reality that building has historically been a labor-intensive business, the impact of 3DP on the labour pool has yet to be fully investigated. Labor is very important in the construction industry. Based to the World Rescue Committee, the construction industry employs around 8.4% of the worldwide workforce. The construction industry, on the other hand, has been attempting to enhance efficiency for years because it is primarily dependent on people labour and uses little technologies or industrialisation. [7]

This workforce accounts for at least a quarter of the project's overall cost. Unskilled employees and/or a labor scarcity sometimes stymie construction progress. Increased use of technologies, such as the 3DCP, will surely minimize reliance on human resources, potentially boosting production and improving employee security and wellness by removing dangerous tasks [7]. As a consequence, broad usage of 3DP in the construction industry may be beneficial to the industry while simultaneously presenting the potential of significant job losses for many people throughout the world. This is a thorny problem that requires to be looked at more. As a consequence, this study looks at the impact of 3DP in the building industry on the labor market. A deeper review of the research and case example studies will be used to examine how 3DCP may replace conventional building operations in terms of labor demands, labour, efficiency improvements, workplace security and wellness, and job marketplace consequences [9]. The research is especially relevant for nations where construction employs a large number of people.

1.1 Scope of 3D Printing in Construction

In the architecture industry, 3D printers might be utilized to create building parts or to 'print' full buildings. Architecture is an excellent match for 3D printers because the majority of the data required to manufacture an item is produced during the design process, and the industry is already experienced with computer-aided manufacturing. Buildings info modelling (BIM), a relatively new concept, might make 3D printers better available. Manufacturing 3D printing may allow for the faster and more exact manufacturing of complex or bespoke items, as well as a reduction in labor costs and waste. It may also enable construction in challenging or dangerous environments where human labor is ineffective, such as space. 3D printing is an old technology that dates back to the 1980s. Many industries have embraced the process of creating a 3 - dimensional prototype, or prototypes, from a desktop design by layering consecutive layers, ranging from aviation and architectural to healthcare and high-end manufacture. In practice, cement is sprayed in consecutive slices, layer upon layer, from a nozzle connected to a laptop cyborg arm, which is whether static or moves along rails, to generate the preferred construction framework, other than an facade or decor wall, or element, like as an archway or void.

The approach, according to proponents, is quicker, cheaper, and more ecologically friendly than conventional construction techniques. They point to faster home delivery, more design freedom, lower building costs, more efficient material usage, and better levels of sustainability through minimizing construction waste, as well as less noise pollution. Industry experts point to the seamless manufacturing of things from a numerical design and access to a broad variety of geometries for the finished object, both of which are difficult or prohibitively costly to do using conventional processing methods. Big builders seem to find the business attraction compelling[9]. The 3D-printed construction sector will be worth $40 billion by 2027, according to industry prognosticator SmarTech Publications. Concrete 3d printer reduces time, labour, and materials in the development industry as contrasted to traditional methods. It's important to note, though, that 3D printing aren't yet capable of constructing a fully functional house. Only the framework and walls of the home are built; other features like window, lighting, and drainage must be installed later. On the other side, concrete 3D printers may be used to make bridges, benches, and just basic garden ornaments [3].

1.2 Advantages of 3D Printing in Construction

- Injury Prevention: Some of the more important benefits that printers has brought to construction employees is the possibility of fewer workplace injuries. Considering how difficult sometimes dangerous—concrete construction is, this may be a welcome shift. Workers benefit from a healthier workplace atmosphere, while companies benefit from fewer worker 's insurance claims as a consequence of occupational accidents.
- Material Costs are lower: Another benefit may be a significant decrease in fabric waste. 3D printers utilize just the right quantity of concrete for the wall, floor, or anything else you want to make. Builders and general contractors will not need to purchase in bulk since they would know precisely how much material they have.
- Construction Time Reduction: Solid 3D printers really distinguish themselves from traditional development methods in this area. While a project can require days or years to finish, 3D printing can often finish a work in minutes or days. According to reports, a house was erected in under 24 hours! This enables subcontractors to go on to other jobs more quickly. and complete more requests. For the contractor, this equals more money.
- Less Expensive Construction Overall: 3D printing is less costly than traditional construction techniques and processes. As labor and materials expenses are decreased, organizations will see a huge rise in their advantages. While many people would almost certainly be fired off, various will remain since all of the pieces must be put together by someone. Workers may improve their employment safety by learning about technology. They'll earn more money, and the firm as a whole will as well.
- Emerging Markets: Construction organizations may also reach regions that were previously unavailable to them by utilizing a 3D printing. Having a 3D printers on standby might help new constructions companies stand out from companies that have been around for years and are averse to change. Similarly, conventional and well-established construction firms may make use of 3D printers to stay

relevant in the market. Essentially, 3D printers are often utilized to join a new market as well as to provide a competitive advantage to an already existing business.

- Increased Durability: While concrete testing will still be required in the early phases of construction, 3D printing has proven found to increase the durability of architectural elements. This is typically due to the substances utilized, as well as other factors, as a result, the way they're put together. Construction firms may concentrate their efforts elsewhere to generate profit since more durable structures need fewer maintenance. Clients, too, have a strong preference for a structure that will endure longer.
- Enhancement: Finally, increasing brand recognition is one of the most significant effects that the 3D printer has had and will continue to have on the development business. Construction companies are frequently portrayed as wastage and untenable. 3D printer is a great way for a business to enhance its picture between those concerned about the climate change impact of concrete construction has on the globe since it minimizes waste. Contractors that want to add a personal touch to their branding might consider purchasing and using a 3D printer.

2. LITERATURE REVIEW

A. Nadal [10] proposed that Construction 3D printing is still in its early stages of development, particularly in terms of material optimization and procedural problems. These constraints stem from the specialized expertise that these technologies need, as well as the total expense of the gear needed, as well as the lack of well defined procedural requirements This article explains how to overcome these limitations by developing a procedure that makes it straightforward to use 6-axis robotic arms. There is a way for optimizing the usage of materials. A test scenario depicts the convergence of the architecture process utilizing Integrated Robotics Devices (IRS) and Asymmetric Layered Manufacture (ALM) technologies. Materials optimisation and intelligent filler patterns are discussed in this research using a framework technique. A 0.4 0.4 1.5 m test element is given as a technological example.

M. Sakin [4]proposed that the innovative 3D printing of structures technology for future sustainable homes. 3D printing-based construction technique is a new constructing process that started with the invention of the 3D printers. The most recent innovations were discussed in this article, with Contour Crafting being highlighted as a promising method that has the potential to transform the construction sector in the near future. There are many benefits to this technique, including cost and time savings, less contamination of the environment, and a reduction in On construction sites, there are a lot of accidents and deaths. The combination of Buildings Data Modelling with 3D printed buildings technologies is emphasized in comparison to traditional constructing techniques. Even though this new technology offers numerous advantages and benefits, we still have some worries, which are described in the conclusions, since the technology still has several limits. A short overview of 3D printing applications in the construction sector is provided. Many modeling software packages allow you to create a 3D model of a building that will work with 3D printers. The STL format is one of the most widely used formats for exchanging such models, and it is supported by a wide range of proprietary applications. Furthermore, combining the BIM technique with 3D printing modeling will improve energy efficiency, design, cost reduction, and structural isolation.

I. Hager [5] Proposed that This article presents the existing condition in the field of 3D manufacturing of buildings and construction parts. In compared to traditional building processes, 3D printing is an ecologically benign alternative that allows for almost infinite geometrical complex realizations. Contour Carving is emphasized as a potential technology that has the ability to alter the building industry in the distant years in this article, which discusses two sorts of techniques. Numerous benefits of this technique may be mentioned, including cost and time savings, reduced pollutants, and a reduction in accidents and deaths on building sites. Despite the numerous benefits and aspirations, the findings highlight certain worries, since the technology currently has significant limits. A short overview of a few instances of cutting-edge 3D printing applications in the construction sector is given. Many different modeling applications allow you to create a model that is suitable for 3D printers.

3. DISCUSSION

While 3DCP is expected to require fewer people labor, it will also require the employment of personnel with specific skills who are knowledgeable with either brick and electronic technologies in order to detect errors in the electronic models throughout brick construction. In order to operate with 3D printers, they need be able to mix robotic and civil activities. With the expanded usage of 3DCP, present workers will either need additional training to cope with the new 3DCP working processes or may be compelled to look for other job. If 3DCP were extensively adopted, many building employees' lives will be destroyed, particularly those in low-skilled occupations. Companies who depend significantly on foreign workers and are worried about labor shortages may benefit from this. On the opposite side, in countries where labour is abundant and the constructions industry is one of the most significant sources of jobs, these job cutbacks may be an issue. Workers in the building industry are often are compensated higher than other professionals. For illustrate, the average wage in Kazakhstan's construction industry is higher than the average wage in other occupations. Building workers are paid less that workers in other industries, stated to, since workers are often hired on an ad hoc basis would little or no social protection.

Industrial employees might be harmed by job losses, but other elements of technology growth must be handled as well. As robots take over low-skilled positions, for example, it may be possible to expand and improve the lists of occupations with more sophisticated tasks, such as 3D layout, 3D printing monitoring, materials purity control, study and innovation, and legal advice. Moreover, it has been shown that using the 3DCP protects personnel from potentially dangerous construction settings. Engineering is 1 of the most dangerous industries in terms of worker security and healthcare, with the highest number of fatalities in the US. 3DCP may eliminate or minimize the quantity of human needs for dangerous activities throughout the construction process.

4. CONCLUSION

Architecture is 1 of the more employment industries, with low efficiency and a lack of technological innovation. In the development business, 3DP, like robotics and various automated technology, is gaining acceptance. This study looked at the current status of printing in construction as much as its future prospects. Because 3DCP has the potential to be widely used, this research looked at how it may affect the

building labor market. According to the literature, 3DCP has a lot of possibilities to benefit the architecture industry, such as quicker construction, reduced materials wastage, less intense labor demands, improved occupational security, and so on. While the usage of 3DP in development is yet in its initial phases, with just a couple buildings and modest bridges identified for actual use throughout the world, the literature suggests that greater and larger initiatives would be completed utilizing 3DCP in the next years. The industry for 3DCP is expected to grow in other countries as soon, with Dubai promising that by 2030, 25% of its structures would be created using this groundbreaking technology. According to the study, 3DCP reduces the amount of labourers required in the construction procedure and may save up to 80% on labor costs. As a consequence, the 3DCP is expected to alleviate the labour shortages problem, especially in countries where construction is heavily dependent on migrant workers, such as the American Kingdom, the United Arab Emirate, Doha, Malaysian, and Singapore.

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