The business case for 3D printable buildings: An approach to growth-positive low-emission cities

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Introduction

- Renotech established in 1994
- Finnish SME with global ambitions
- Member of Smart Chemistry Park
- Bob Talling MD and owner

- Extensive experience in construction industry
- Pioneering experience in circular economy R&D
- We have built the interiors of all the cruise ships in Finland
- Geopolymer tiles for roofing since 30 years
- Innovative fireproofing solutions for houses and ships since 25 years
- Circular economy solutions provider
Global change brings new opportunities

- As per a study by Yale University, there are 150 million homeless people in the world and 1.6 billion living in inadequate accommodation.
- As per the OECD, the global population is projected to reach 10 billion by 2050.
- Increasingly middle class & younger generation can’t afford to buy houses.
- As per HSBC bank, global real estate market is worth $28.3 trillion.
- There is rapid shift towards “sustainable investing.”
- The shift towards “Impact investing.”
- So given these trends we need to rethink traditional methods of manufacturing and ideologies.
- One such transformative technology is 3D printing of buildings.
Different problems 3D Printing can solve

- We are solving the housing crisis problem (mass production)
- Housing affordability problem
- The carbon sink problem
- Complex design problem (freedom of choice)
- Efficient housing problem (eco-design)
The Benefit of 3D printing tech

• Its cheaper and faster, consider this as per (Source WEF, Dubai) it is **90% cheaper** to 3D Print part of a building
• It is upto 80% faster to build
• There is less risk involved
• Creative structures can be constructed
• Green building materials can be used to help battle climate change
Construction 3D printing market in brief

• A conservative estimate of 1% of global real estate markets have a value of $0.28 trillion. So the opportunities are immense
• Market research suggest construction 3D printing will grow at CAGR of 245% until 2024
• Most of the technology and equipment providers are based in Europe and USA. With Europe having the most companies
• Dubai has a target of 25% of all buildings to be 3D printed by 2025
• In general APAC region is leader in application market
• Europe is second with increasing focus on novel 3D printable binders
What is 3D printing?

• “3D printing” or “Additive Manufacturing” is a form of manufacturing process which is “additive in nature” i.e a kind of “bottom up approach”

• As this is a vast area we will stick to methods relevant to building industry. In this area “extrusion” is the dominant approach to 3D print.

• Here the building materials are deposited layer-by-layer on top of each other. We can deposit concrete as well as fire proofing materials.
3D printing steps

• The commonly used steps includes the use of a computer, 3D modelling software (Computer Aided Design or CAD), machine equipment and layering material.

• Once a CAD model is produced, the file is then transferred to the 3D printer and the machine reads the data from the CAD file and starts to lay down the material in layers on top each other forming the object.
3D Printing development

• An active area of development is the nozzle design and arm configuration.
• From the chemistry side, development of recipes with right flow and setting properties with novel materials is an active area of development.
• 3D printing can be done on-site or off-site. When done off-site, the structures are just locked into right places and assembled on site. The 3D printed office called “Office of Future” in Dubai was constructed that way.
• Another method to 3D print which has found application is the powder based technique. It involves depositing binder liquid selectively on a powder filled bed. This hardens in time and is more suitable as an offsite technique.
What can be commercially 3D printed?

• A whole building structure cannot be 3D printed
• The most commonly 3D printed parts are the Walls
• Other 3D parts involve: The foundation, Spray insulation
• Novel building materials: Green cements, Geopolymers etc
• In future: Finishing (paints), Roofing, Surface tile laying
Examples

These 3D-printed homes can be built for less than $4,000 in just 24 hours

- Last March, the 3D printing company Icon produced a 350-square-foot tiny home that cost $10,000 and took just 48 hours to build.

- The company was confident that it could print a larger structure in just 24 hours for even less — around $4,000 — since the printer wasn’t running at full speed.

- A year after its prototype was released, Icon is now selling an upgraded version of its 3D printer.

Print time 24h, Cost $10,134, Size 37m2 (pic by Apis Cor)
3D printed community building in Mexico by ICON

3D Printed office building in Dubai by Apis Cor
3D printed building in Denmark by COBOD

3D printed castle by TotalKustom
BOD 2 modular printer from COBOD

Gantry based printer
- Material extrusion

On site/Off site
- 8 hr for first time set up
- Total operation hours:
  - 46.3 hr for 50 m^2 house

Multiple size options:
→ Various print areas possible
  - From 1,9 x 2,1 x 1,5 m
  - to 12 x 27,8 x 10,1 m
→ 3 storey buildings are possible

Price: 180000 - 595000€

Advantages:
- Curved shapes are not a problem
- Less workers and workhours
Cost Benefit Analysis

• Our detailed calculation shows that printing the walls can save costs upto 70% when compared to established manual method

• The printer under consideration is the BOD 2 by COBOD Denmark

• The possibility exists to print industrial side streams derived materials. Specifically ashes, slags, flue gas desulpharization (Gypsum), magnesium based materials etc

• Using novel materials brings down CO$_2$ emissions in various ways. Some of these materials even absorb CO$_2$ during their setting period
New value concept

**Revenue from:**
- 3D printing structures
- Creative design assignments
- Carbon credits business
- Data business
- Maintenance and consulting services

**Customers profit from:**
- Lower cost of housing
- Less construction time
- New revenue streams leading to quicker ROI
- IoT and digitalization enabled solutions leading to low energy waste and greater savings
- Green subsidies
Future vision

• 3D printed buildings to suite personality
• 3D printed Eko buildings using novel green building materials
• Each building is design optimized to capture maximum possible light, water, wind etc
• Each building generate at least part of their own energy, water
• In conclusion each building act as a net producer of resources and energy rather than consumer
Key takeaways

Providing buildings at 90% cheaper and 80% faster → Providing affordable housing, jobs and new carbon sink

Catering to a 282€ billion market → A brand new business model

Use of green materials as required → First mover advantage in Finland

Collaboration with big brands, cities and EU → Last but not the least it is impact investing
We need you to make a green inclusive future