

IB Subject(s): Design and Technology

Extended Essay

**Plants in modern architecture. The future of sustainability:**

**To what extent could the implementation of plants in modern building design be a feasible method for future construction, to fight pollution and improve well-being in and around the building environment?**

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**“If we want to do something about climate change we have to start doing something substantial, starting from architecture, that lays at the very base of our society.”**

- Stefano Boeri, Architect<sup>1</sup>

## **1. Introduction**

Architecture and urban design surround us perpetually. The buildings where we live, work, relax or do any other everyday activity are thoughtfully designed to make the most out of the available space. The main focus points of architecture throughout its development have been: Function, aesthetics and size. However, in recent decades, with the growing awareness of issues such as climate change and pollution, a new focus has been prioritised by architects across the globe, that of Sustainability.

The American Institute of Architects declared that a primary goal for the industry is to achieve carbon neutrality by 2030<sup>2</sup> which shows very well how architects are not simply focusing on aesthetics anymore but are now beginning to design buildings that are carbon neutral, to actively reduce global warming and pollution. A new design opportunity has been recognised by a number of architects and designers: the implementation of plants in modern building design, Stefano Boeri, Italian architect being the first of them. After he found a design opportunity, his team worked through a specific cycle of design ideas and progression. In developing a conceptual design, they initiated the construction of the first building in the world that organically implements plants in its design, “Bosco Verticale” which is now built and standing in the centre of Milan, Italy.

<sup>1</sup> Stefano Boeri (Architect), Interview in Milan by the writer, June 14, 2017

<sup>2</sup> Lance Hosey, “Why architects must lead on sustainable design”, GreenBiz website (2013), accessed on June 28, 2017  
<https://www.greenbiz.com/blog/2013/03/19/why-architects-must-lead-sustainable-design>

Fig.0 “Bosco Verticale”<sup>3</sup>

**Purpose of the essay and considerations:** The purpose of this essay is to undertake research strategies in order to gain a deeper understanding as to whether the implementation of plants within the specific brief and infrastructure in modern building design can be a useful, effective method for future construction, of fighting pollution, global warming and for improving the building environment for people who live inside and around and also whether it is feasible to adopt this technology in different cities and towns on a global basis. In order to explore this technology, I need to look at the elements of the *triple bottom line sustainability* concept which refers to social, economic, and environmental aspects of sustainability.

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Fig.1, Triple bottom line<sup>4</sup>

<sup>3</sup> “Bosco verticale” jpeg, stefano boeri architetti website, accessed on October 16, 2017, <https://www.stefano-boeri-architetti.net/wp-content/uploads/img-bosco1-1000x749.jpg>

<sup>4</sup> “Triple Bottom Line” jpeg, Aidgine website, accessed on October 16, 2017, <https://aidgine.com/wp-content/uploads/2015/04/TripleBottomLine.gif>

Various aspects will need to be taken into consideration such as costs including comparisons with other building options' costs differentiating in long-term and short-term, the advantages that it brings to the environment as well as the disadvantages, and most importantly the extent to which these types of buildings can improve the air quality and small suspended particles levels in the cities and areas where they are constructed. Finally, whether or not they can improve the overall wellbeing of inhabitants of the building itself and the surrounding areas starting from the thoroughly studied concept that "being around trees" can help people feel good starting from young age.<sup>5</sup> Specific topics that will be explored and evaluated are innovation, sustainability and the inclusion of a user-centred design approach in order to observe any effects.

**Methodology:** The methodology of research used for this essay will be as broad as possible. First of all, preliminary research will be undertaken, this includes the study of the context in which the topic falls, what are the current methods, materials used and what does the implementation of plants in architecture aim to achieve and resolve, this preliminary research will be based on sources found from website articles, books and TV programs. The actual explanation and investigation of how the implementation of plants can be put into practice, reduce pollution and improve the quality of air will be obtained from specific topic websites, this part will often refer to *user-centred design* approach which refers to the process of designing with the focus of user needs and requirements.<sup>6</sup>

Different interviews by various architects and constructors will be held and most importantly, information will be obtained from the official book of the Bosco Verticale "A Vertical Forest" written by the architect Stefano Boeri. In addition, a face to face interview with Stefano Boeri, head of Stefano Boeri Architects, the team that designed "A Vertical Forest" will be held in Milan. Thanks to this opportunity, the primary source will be used to gain a deeper understanding into the

<sup>5</sup> EarthTalks, "Does Being around Trees Help People Feel Good?", Scientific American Website, accessed on August 17, 2017, <https://www.scientificamerican.com/article/does-being-around-trees-help-people-feel-good/>

<sup>6</sup> "What is user-centred design?", The interaction Design Foundation website, accessed on October 16, 2017, <https://www.interaction-design.org/literature/topics/user-centered-design>



considerations that the main architect of the project thought of to start the project as well as some insight and more specific technicalities about the implementation of plants in architecture. Furthermore, I will interview inhabitants of “A Vertical Forest” to obtain opinions and non-technical thoughts regarding the claim of the project of having a positive impact on the overall wellbeing of the inhabitants, this will give value and help the evaluation of the *social sustainability* of this technology.

After this, in order to obtain information about the *economic sustainability*, economic and bureaucratic feasibility research into the various costs and permissions will be undertaken using sources such as official government regulations, construction costs taken by different websites and books and lastly the living costs of these building, for this section a simple market research will be undertaken using real estate agencies’ websites. This will allow me to gain a broad spectrum of information which can be used for the personal evaluation and critical thinking section, and eventually the conclusion will be based on all the claims and counter-claims and all the research and information previously obtained??

## 2. The context

**Plants as a material:** In modern architecture, the materials most frequently used are concrete, metal, bricks and glass<sup>7</sup>. These materials are well known and appreciated for their physical and cost effectiveness properties, nevertheless they do not bring any advantage to issues regarding global warming and pollution, in some cases, such as concrete, its manufacturing process actively emits

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<sup>7</sup> “Types of Building Materials, their Properties and Uses in Construction Works”, The constructor Website, accessed on August 9, 2017, <https://theconstructor.org/building/types-of-building-materials-construction/699/>

large quantities of CO<sub>2</sub> in the atmosphere<sup>8</sup> making it environmentally unsustainable. Furthermore, buildings are responsible for 38% of all human GHG emissions.<sup>9</sup> Another very important aspect in which the implementation of plants seems extremely promising is that this type of material can have a significant impact over the passage of time. Whereas other standard materials, concrete, metal, bricks and glass, do not produce any effect over time, the use of plants as a material claims that “The diverse vegetation will provide urban habitats for birds and insects, and will also create a humid micro-climate that produces oxygen whilst shading residences from harsh sunlight.”<sup>10</sup>

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Fig.2 One of the possible Implementations of plants<sup>11</sup>

**Aims and goals:** The implementation of plants in architecture has more goals. The first one is to look at disconnecting economics activity and environmental impact, which can be referred to as decoupling. Secondly, reducing the overall health-care costs not just by increasing the quality of the air of the surroundings and therefore of the urban environment but also by providing an exceptional amount of “green” which is proven to help the overall wellbeing of the people who experience it<sup>12</sup>. Thirdly, to have an impact on the biodiversity of the city in which the building is constructed, the

<sup>8</sup> “The Environmental Impacts of Concrete”, GreenSpec website, accessed on August 9, 2017, <http://www.greenspec.co.uk/building-design/environmental-impacts-of-concrete/>

<sup>9</sup> U.S. EPA. 2008. Inventory of U.S. Greenhouse Gases Emissions and Sinks: 1990-2006, p. ES8.

<sup>10</sup> “Stefano Boeri's “vertical forest” nears completion in Milan”, DeZeen website, accessed on September 4, 2017, <https://www.dezeen.com/2014/05/15/stefano-boeri-bosco-vertical-forest-milan-skyscrapers/>

<sup>11</sup> “benefits of plants in architecture” jpeg, treesaregood website, accessed on October 16, 2017, <https://www.treesaregood.org/portals/0/images/treeowner/benefits1.jpg>

<sup>12</sup> EarthTalks, “Does Being around Trees Help People Feel Good?”, Scientific American Website, accessed on August 17, 2017, <https://www.scientificamerican.com/article/does-being-around-trees-help-people-feel-good/>

claim is the selection of animals, insects and plants would increase drastically in diversity and overall quantity.<sup>13</sup> Another claim of the implementation of plants in architecture is to help with heat control in all seasons.

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Fig. 3 The benefits of “Bosco Verticale”<sup>14</sup>

Therefore, it is immediate to understand that this new type of technology can be a promising help for issues such as pollution and global warming not only in the short-term but more than everything in the long-term. Indeed, this type of technology will improve its quality with the passage of time, trees and plants will grow in size and therefore they will be more efficient in production of oxygen and absorption of CO<sub>2</sub> gases as well as reduction of other pollutants. It also provides a new perspective into the subject-specific term *planned obsolescence*, which refers to a strategy which is purposefully implemented to ensure that the current version of a given product will become out-of-date within a known time-period. This technology ensures that planned obsolescence is not possible, this type of building increases its benefits with the passage of time.

**Limitations of research:** However, it must be taken into consideration that these claims are strictly theoretical, as the technology has been adopted only in the last years, there is not enough evidence and research that the implementation of plants achieves the strong claims that architects, botanists and engineers, who work on this field make. It could be also considered that there is no scientific research on this specific topic and therefore these claims are extremely hard to prove or to prove

<sup>13</sup> Stefano Boeri, “Interview about “Bosco Verticale””, Interview by the Writer, June 14, 2017

<sup>14</sup> Stefano Boeri, *A Vertical Forest* (Milano, Corraini Edizioni, 2016), 120,121



wrong. Therefore, although there is some evidence that proves these claims and consequently some conclusions can be made on the existing material and research, it is passage of time that will reveal the full potential of such technology.

### 3. The technology

**Innovative technology:** This technology can be certainly identified as innovative. In order to gain a more thorough understanding of this technology, it is worth evaluating the type of innovation that this technology uses. It is the case of “*disruptive innovation*”, described as a process by which a product or service takes root initially in simple applications at the bottom of a market and then relentlessly moves up market, eventually displacing established competitors.”<sup>15</sup> It can be seen how the implementation of plants falls into this category, as it is a new, first-of-its-kind technology. The implementation of plants is the result of different *strategies for innovation*. Firstly, an *analogy*, defined as when an idea from one context is used to stimulate ideas for solving problems in another context, took place as the architects recognised how nature could be fundamentally helpful in an urban context. Secondly, the *technology push*, a phenomenon that occurs when scientific research leads to advances in technology lead the architects to the technology which is now used in buildings such as “Bosco Verticale”.

**Environmental benefits:** In order to evaluate the *environmental sustainability* of this technology, it is important to understand how this technology could be an effective help to improve the quality of air and to fight pollution. Trees and plants absorb CO<sub>2</sub> and emit oxygen during their life constantly, which means that the more trees we have in an area the less CO<sub>2</sub>, a gas that traps the heat in the atmosphere<sup>16</sup> contributing to global warming, besides being poisonous when present in high

<sup>15</sup> Clayton Christensen, “Disruptive innovation”, Clayton Christensen website, accessed on October 16, 2017, <http://www.claytonchristensen.com/key-concepts/>

concentrations<sup>17</sup>, is present in the area. Furthermore, the trees and plants capture small dust particles dissolved in the air improving the overall air quality.<sup>18</sup> This means that trees capture pollutants and prevent them from being dissolved in the air and entering the houses and apartments of the building that implements the technology.<sup>19</sup> This brings benefits for people who live inside the building as well as around the building environment, and in the longer term, and with a significant amount of buildings that implement this technology, to entire urban areas and cities.

**Limitations of trees in urban context:** There is however, recent research that claims that the presence of trees and plants in modern cities could have a *negative* impact on the quality of air<sup>20</sup>. The claim made by a report of the “National Institute for Health and Care Excellence” is that leaves and branches of trees would cause the slowing down of the air currents which causes pollutants to settle. “Their effect is dependent on factors including species, canopy density, time of year and wind direction. Ventilation [on streets] will vary according to the size, distribution and species of tree and their position.”<sup>21</sup> Therefore it is critical to select the appropriate species and position of plants and trees in an architectural project that implements the use of plants in its fundamental design concept.

**Effects on the individual:** Secondly in order to evaluate the *social sustainability* of the technology, it is also fundamental to take a look into how the implementation of plants in architecture can be a valuable help to improve overall well-being of people living in and around the building environment. Numerous scientific studies have shown that being around trees and plants, looking at them and

<sup>17</sup> Anne Marie Helmenstine, Ph.D., “Is CO2 Poisonous” Thought.Co website, accessed on September 12, 2017, <https://www.thoughtco.com/carbon-dioxide-poisonous-607545>

<sup>18</sup> Stefano Boeri, *A Vertical Forest* (Milano, Corraini Edizioni, 2016), 120-121

<sup>19</sup> Stefano Boeri, *A Vertical Forest* (Milano, Corraini Edizioni, 2016), 120-121

<sup>20</sup> John Vidal, “Trees may increase air pollution on city streets”, The Guardian Website, accessed on September 13, 2017, <https://www.theguardian.com/environment/2016/dec/01/trees-may-increase-air-pollution-on-city-streets>

<sup>21</sup> John Vidal, “Trees may increase air pollution on city streets”, The Guardian Website, accessed on September 13, 2017, <https://www.theguardian.com/environment/2016/dec/01/trees-may-increase-air-pollution-on-city-streets>

touching them has a strong positive effect on human's brain which include stress relief<sup>22</sup> as well as cognitive benefits such as improved memory and improved mental energy<sup>23</sup>. When some inhabitants of the "Bosco Verticale" were interviewed, the answers confirmed what the studies show. "Being in a skyscraper that feels just like a park, makes me feel connected with nature while living in the city I love" and "Looking at the trees when I wake up in the morning fills me with vital energy" are just two examples of the responses. Therefore, it can be stated with relative certainty, that implementing plants in architecture could be an effective method to improve well-being of people living in and around the building environment. Although there is the concern that the percentage of people who prefer living in cities rather than country-side, because of the many commodities and advantages<sup>24</sup>, would not be pleased with this technology, it is true to say that such technology does not affect in any way the normal commodities and functioning methods of a modern city.

**The construction:** As this essay also aims to investigate the extend of how feasible the implementation of plants in architecture as a future construction method could be, it is crucial to evaluate and consider the practical methods with which this technology can be implemented in cities. Basing the research once again on the "Bosco Verticale", which is the best example of today's world of the implementation of plants in architecture, the technology is relatively straightforward. The basic concept is to build a normal skyscraper, house or school that integrates in the design numerous terraces in which the plants, trees and bushes will be implanted in a future moment. Fig. 4 shows the initial stage of the building in which plants and trees are not implemented in the construction.

<sup>22</sup> Stephen Kaplan, "The restorative benefits of nature: Toward an integrative framework" *Journal of Environmental Psychology*, Volume 15, issue 3, September 1995, 169-182

<sup>23</sup> Marc Berman, Stephen Kaplan, "The Cognitive Benefits of Interacting with Nature", *SAGE Psychological Science*, volume 19, issue 12, December 2008, 1207-1212

<sup>24</sup> Angela Brisotti, "10 Reasons Living in The City Is Better Than Living in The Country", *NewsCult* website, accessed on September 14, 2017, <http://newscult.com/20-reasons-living-in-the-city-is-better-than-living-in-the-country/>

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Fig. 4<sup>25</sup>

At this point, one issue that could be raised is that, this method of implementation of plants does not focus on the construction of the building. There is no evidence that research for sustainable materials has been put in the initial stages of the project, before the plants and trees are actually implemented in the architecture. One could argue that no changes have been made into the construction technology which seems to be the same of previous “standard” buildings.

**The physical process of implementation:** The breaking-through technology begins to have a role in a later stage. After the initial construction is completed, different types and strains of plants and trees are implemented into the building. These are integrated in the architecture with an anchor system in the terraces of the building which have been previously filled with soil. “all medium and large trees are anchored to a horizontal frame of tubular elements fixed to the bottom of the terraces by means of security straps holding the turf, which prevents the tilting of the trunk away from its turf, they are

<sup>25</sup> “construction of Bosco Verticale” jpeg, il nuovo cantiere website (Italian Website), accessed on October 16, 2017, <http://www.ilnuovocantiere.it/files/2015/09/Clipboard03.jpg>

then fixed via three straps to an aerial steel restraining cable anchored to the floor of the terrace above.”<sup>26</sup> This method is shown in Fig.5 below. It could be considered that this method has been adopted by the architects and engineers after numerous tests which included a test with the wind tunnel using a 1:100 scale and winds up to 190 km\h at the Florida International University in Miami<sup>27</sup> as shown in Fig.6. Once the plants and trees are successfully implanted into the building, the rest of the soil can be put into the terraces and grass and bushes can be planted.

**Alternative methods of implementation:** Another method of using the technology mentioned above, is to construct structures that can be implanted in existing buildings such as bridges, rooftops and façades of buildings, this takes full advantage and implements the technology on structures that have otherwise no sustainability positive effects. It could be an extremely successful method in cities that have limited space to construct as well as areas that have issues with air quality and pollutants and have many structures already constructed. The latter method could be a working, innovative method as it extends the potential benefits and advantages of the technology to an extremely higher number of buildings and project. This could definitely mean an increase in the feasibility of the implementation of plants in architecture as a future construction method. This method is shown in Fig.7.

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Fig.5<sup>28</sup>

Fig.6<sup>29</sup>

<sup>26</sup> Stefano Boeri, *A Vertical Forest* (Milano, Corraini Edizioni, 2016), 50-51

<sup>27</sup> Stefano Boeri, *A Vertical Forest* (Milano, Corraini Edizioni, 2016) 102-103

<sup>28</sup> Stefano Boeri, *A Vertical Forest* (Milano, Corraini Edizioni, 2016), 51

<sup>29</sup> Stefano Boeri, *A Vertical Forest* (Milano, Corraini Edizioni, 2016), 103



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Fig.7<sup>30</sup>

**Maintenance:** Once the plants and trees have been integrated in the architecture, maintenance begins to play a fundamental role. In order to be preserved efficient and flourishing, the building needs specific methods of maintenance for the trees and plants on top of the standard building maintenance. Highly skilled gardeners and agronomists need constant supervision over the high number of trees and plants. Gardeners called “Flying Gardeners”, as shown below in Fig.8 need to climb along the building in order to carry out specific maintenance tasks.<sup>31</sup> This considerably increases costs of maintenance compared to a standard building.

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Fig.8<sup>32</sup>

<sup>30</sup> Stefano Boeri, *A Vertical Forest* (Milano, Corraini Edizioni, 2016), 141

<sup>31</sup> Stefano Boeri, *A Vertical Forest* (Milano, Corraini Edizioni, 2016) 151-152

<sup>32</sup> “Flying Gardeners” jpeg, repstatic website, accessed on October 16, 2017, <http://www.repstatic.it/content/localirep/img/rep-milano/2015/10/03/133822023-c495fd25-f250-4618-9c38-e536289d7e78.jpg>

#### 4. Issues and evaluation

In order to investigate the feasibility of this projects as a future construction method, economical and legislative feasibility, which are part of *economic sustainability*, must be taken into consideration.

**The costs:** Assuming that the costs of the initial stage of construction (when the plants and trees are not implemented in the architecture) are the same of a standard building which does not implement plants, the cost of the implementation of the technology is 5% of the total cost.<sup>33</sup> This data means that constructing a building that implements plants and trees is 5% more expensive than constructing a standard one. This is a relatively low cost, considering how much this type of technology could benefit to the air quality and overall wellbeing of people living in and around the building environment.

The cost of maintenance which must be taken into consideration, is considerably higher in a building that implements plants in its architecture, as mentioned before, this type of projects requires specific maintenance on top of standard one.<sup>34</sup> This increases the cost of living and house prices of such structure. Furthermore, a skyscraper such as “Bosco Verticale” only includes what could be considered “luxury apartments” of which prices are extremely high. This could be an issue for the feasibility of realizing entire cities that implement this technology as houses and apartments prices would be too high for a large percentage of the city population. However, with the passage of time, the costs of such buildings could be decreased considerably, and this technology could be implemented in other structures such as schools or council housing. This would bring the technology to a range of the population that has lower economic capabilities and could, in fact, bring the goal of making entire cities that implement this technology, to reality.

<sup>33</sup> “Bosco Verticale” Designbuild-network website, accessed on October 16, 2017, <http://www.designbuild-network.com/projects/bosco-verticale-vertical-forest-milan/>

<sup>34</sup> Helen Babbs, “High-rise gardening”, The Guardian website, accessed on October 16, 2017, <https://www.theguardian.com/lifeandstyle/gardening-blog/2013/feb/27/bosco-verticale-vertical-gardening>

**The economical comparison between old technology and new:** Following this last point, in order to evaluate the feasibility of this technology for future construction it is worth considering the difference in houses prices between a building such as “Bosco Verticale” and a similar building positioned in a similar area of the city that does not use this type of technology. The average price for a house or apartment in the “Bosco Verticale” is £6300/m<sup>2</sup><sup>35</sup> whereas the average price for a house or apartment in “Torre Solaria” a skyscraper right next to the “Bosco Verticale” with similar features is £6500/m<sup>2</sup><sup>36</sup>. This shows that “Bosco Verticale” achieves to implement such a revolutionary technology while keeping the house prices perfectly in the market.

**Urban planning and available space:** Another critical issue that definitely plays a role into the evaluation of the feasibility of such projects, is indeed the actual space that is available in a modern city. This method mainly focuses on the construction of new buildings and projects. Considering that in modern cities the space available to construct and build is extremely limited, building new constructions inevitably leads to the phenomenon of urban sprawl, which leads to numerous issues such as monetary problems and public transportation issues.<sup>37</sup> Regarding this issue the two main solutions that could increase the feasibility of this type of project are vertical constructions (skyscrapers and towers) and the already existing technology, mentioned above, of constructing structures that can be implemented on already existing buildings.

<sup>35</sup> “Alla scoperta del bosco verticale di Milano: pro e contro di un gioiello architettonico” Idealista.it website (Italian Website) accessed on September 13, 2017 <https://www.idealista.it/news/immobiliare/residenziale/2013/04/30/77546-alla-scoperta-del-bosco-verticale-di-milano-pro-e-contro-di-un-gioiello>

<sup>36</sup> “Milano: comprare casa in un grattacielo” MonitorImmobiliare website (Italian Website) accessed on September 13, 2017 [http://www.monitorimmobiliare.it/milano-comprare-casa-in-un-grattacielo-ecco-i-prezzi\\_201506261158](http://www.monitorimmobiliare.it/milano-comprare-casa-in-un-grattacielo-ecco-i-prezzi_201506261158)

<sup>37</sup> “Effects of Urban Sprawl: Costs, Health, Environment” Useful-Community-Development website, accessed on September 13, 2017 <http://www.useful-community-development.org/effects-of-urban-sprawl.html>

Nevertheless, in developing regions, such as China, India and many African countries, cities are being constructed from scratch in a fast rate. In such areas, the first technology analysed, implemented in “Bosco Verticale” could be put in practice with positive results. The technology can be used in Houses, Villas, Schools, Train stations etc. to give birth to a green city, which uses its building and structures to maintain control over the quality of air, small dust particles and greenhouse effect. Although this could be deemed a complicated and long process, it has already been put into practice in China where this model of city is being constructed, shown in Fig.9.<sup>38</sup>

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Fig.9 rendering of Liuzhou Forest City<sup>39</sup>

## 5. Conclusion

This topic, I believe, is extremely hard to analyse and evaluate. This is due to the relatively new technology that it explores. As said previously in the essay, research is still scarce. Many sources that attempt to analyse this type of technology are limited and in some cases biased, this means that throughout the research process I had to carefully select sources in order to give the least biased and most thorough explanation possible, and this restricted the valid sources I could use to a very limited number. Furthermore, I used many newspaper and magazine articles. The main problem with such sources is that they are prevalently written by single individuals and although I tried to use articles taken by the most respectable newspapers and magazines, I can see the limit that this involves. I

<sup>38</sup> “Liuzhou Forest City” Stefano Boeri Architetti website, accessed on September 13, 2017

<https://www.stefanoboeriarchitetti.net/en/portfolios/liuzhou-forest-city/>

<sup>39</sup> “Rendering of Liuzhou” jpeg, stefanoboeriarchitetti website, accessed on October 16, 2017, [https://www.stefanoboeriarchitetti.net/wp-content/uploads/Stefano-Boeri-Architetti\\_Liuzhou-Forest-city\\_view-3-3-1920x1066.jpg](https://www.stefanoboeriarchitetti.net/wp-content/uploads/Stefano-Boeri-Architetti_Liuzhou-Forest-city_view-3-3-1920x1066.jpg)

often found value judgments in these sources and this might have had an influence on my research and writing.

The essay question, which I deem to be extremely relevant to the subject and most importantly to the modern world, has been explored thoroughly and as I mentioned throughout the paper, basing on the research, the interviews, and the first-person exploration I made as well as personal opinion, I believe that the implementation of plants in architecture can absolutely be a method for future construction, of reducing pollution and improving wellbeing of people living in the building area. The extent is large, because as seen this is a cost-effective, revolutionary technology that uses a completely natural material such as plants to fight an urgent issue such as pollution and global warming, this claim is confirmed by the scientific characteristics of plants, which actively reduce pollution and small dust particles in the atmosphere. Besides, it effectively helps the wellbeing of people. On this last point, there is extensive research which I quoted and referenced in the previous pages and I feel confident in saying that this type of technology can improve the wellbeing of people without a doubt.

The aspect in which, I believe, the extent is the smallest is the use of this technology as a future method for construction. Although I presented sources and gave evidence, the rate with which innovative technologies are discovered is exponentially growing. This means that it is undeniably challenging to predict whether this technology can be an effective method for construction in the future as more advanced and more affective technologies could be discovered and implemented in its place. However, if no new technologies are developed, this can certainly be a valid method for future construction.

Therefore, although the future of the development of new technologies is uncertain, from my research I have concluded that the implementation of plants in architecture is a valid, effective technology which is ready to be adopted in any context. It is a promising help for future societies, it is now our responsibility to adopt it and improve it.



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