The Usage of Artificial Intelligence on Building Sustainable Park Design
(Technical Topic)

Community Understanding of Lack of Green Spaces
(STS Topic)

A Thesis Prospectus
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By
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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

Signed: _____

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Introduction

As the Industrial Revolution took the world by storm beginning in the 18th century, it had unprecedented urbanization and industrial growth effects, presenting the current issue of the lack of sustainable options for urban green spaces. According to the Library of Congress, "between 1880 and 1890, almost 40 percent of the townships in the United States lost population because of migration," (Don, 2017, City life in the late 19th century). The factories in urban areas needed workers to fuel their businesses, given that the importance of production was a top priority at the time. With the influx of individuals came the need of planning cities in a way to maximize the amount of usable space for businesses, often at the expense of parks and other greenery, more commonly known as green space. This poor urban planning by authorities has recently become a key factor for disastrous climate change in this world.

The awareness of the potential negative implications of poor urban planning has recently necessitated a shift to utilize green infrastructure while also using new artificial intelligence (AI) algorithms to innovate the process (Ghahramani et al., 2021). However, if the mindset is not changed quickly enough, climate change can and will increase at an alarming rate as heat islands and other urban effects will result in pollution skyrocketing uncontrollably, and the overall well being of citizens who live in the cities will degrade (Li et al, 2023).

This project proposes a two-headed approach to help with the crisis and pave the way for a sustainable urban future. The first is the technical aspect where the project aims to use AI technologies, such as generative adversarial networks (GANs) for park layout generation (Chen et al., 2023, p.1). The second is the socio-technical aspect where the project seeks to expand the actors by engaging public interest on the benefits of green spaces, making them more aware in the planning process. This involvement includes community engagement events that will help

everyday citizens understand the implications of poor urban design and, contrarily, help them comprehend the potential benefits that exist when there are more green spaces in an urban environment. This understanding will encourage citizens to take initiative in large scale urban planning processes (Scarano et al., 2021).

The Usage of Artificial Intelligence on Building Sustainable Park Design

The technical project will tackle the issues of modern day poor urban planning, specifically in park design. To put the issue into perspective, the elderly in our cities are finding summers increasingly unbearable. Research from Li et al. in 2023 points out that without enough parks and greenery, these seniors face heightened risk of heatstroke and even long-term cardiovascular problems. This is because natural, shady retreats are becoming more rare, and the concrete doesn't cool down quickly enough. The team's study reveals that green spaces can reduce surrounding temperatures by up to 4 degrees celsius, significantly mitigating these health risks. The usage of the GANs will find the best way to transform public parks so that cooler temperatures can be reached.

In order to fully grasp the workings of this project, one must understand the background of the tools being used. For the park design, the project uses Generative Adversarial Networks (GAN) which is a powerful AI tool that creates new images that meet certain criteria across different fields. GANs enable the autonomous generation of design options and bypasses traditional human limitations (Chen et al., 2023). The technical project will heavily build upon Chen et al.'s methodological research on "Generative Adversarial Networks on park generation to mimic real-world park designs". The methodology worked as follows: (1) Data Augmentation: The original dataset of 194 images was augmented to 4047 datasets to create a good foundation for training the neural networks of the GAN. (2) Model Training: the

experiment used two foundational models, Pix2pix and CycleGAN. Pix2pix learns to map input images to output images and CycleGAN uses image-to-image translation without needing paired images. This generation process can be visualized by examining Figure 1 below:

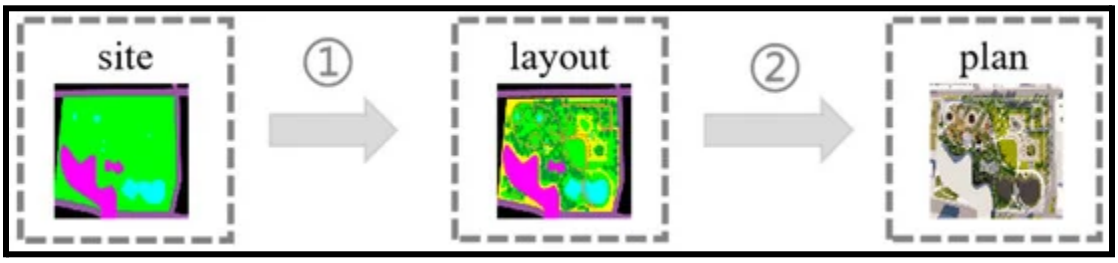

Figure 1. The iterative procedure of the models generating images (Chen et al., 2023, p.4).

(3) Evaluation: After the algorithm was able to generate the layout designs, the team conducted a comparative analysis between human designs and designs generated by AI. It was found that the augmented dataset was useful in the generation of layouts that closely match real park designs. It was also mentioned that the CycleGAN model had superior accuracy in generating results.

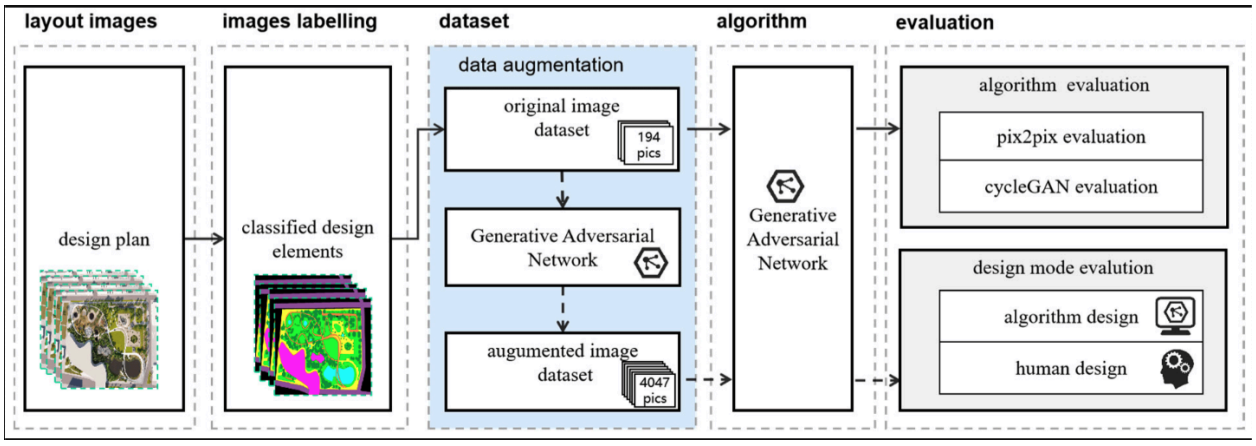

Figure 2. Research Framework of Chen et al.'s project on the usage of Generative Adversarial Networks on park design automation (Chen et al., 2023, p.4). This detailed description of the process will be similar to how my project will utilize the AI algorithm.

In the context of my own project, the process looks very similar to the one described above. It will take in a vast amount of data of current park designs and train the models of

Pix2pix and CycleGAN to output realistic designs based on the ones it learned from. The major difference, though, will be implementing specific labels to the algorithm such as native vegetation areas that are known to help environmental sustainability. This labeling will guide the GAN to generate designs that keeps this detail in mind so that more tree coverage can be obtained and in turn, more shade provided.

This generation of park designs is more important now than ever before. With the lack of sufficient and well-thought out parks, there has been an increase in urban temperature. Because of this increase, "higher temperatures compromise human health and comfort with an increased risk of respiratory illnesses, heat exhaustion, heat stroke, and heat related mortality" (Urban Heat Islands, 2022, Why should we care about urban heat?). I believe this project will work because as newer generations of individuals enter the government sector, there will be more policies enacted on these types of technologies that deal with sustainable energy designs.

Community Understanding of Lack of Green Spaces

Currently, public perceptions of green spaces in urban areas is at a really low level. Haq et al. mentions "we have a limited understanding of perceptions of UGSs (Urban Green Spaces) as well as a lack of scientific consensus on what factors affect perceptions of UGS" (Haq et al., 2021, p. 1). Due to this uncertainty, what needs to be addressed is the decline of physical and mental health in the individuals who live in widely urbanized areas. When considering the consequences that a lack of green space has on an individual living in an urban environment, it is important to understand the opportunities that are taken away from them. Opportunities such as physical activity locations, places for relaxation to alleviate stress, and a source of beautifying the landscape are taken away. Li et al.'s analysis in "The Impact of Urban Green Space on the Health of Middle-aged and Older Adults" further strengthens this argument by mentioning that "regular physical activities in green spaces can indirectly or directly benefit the physical and

mental health and happiness of residents, and the benefits to the older adults are more obvious." This is in part "because green spaces help residents get more exercise and relax. This significantly reduces not only cardiovascular disease, but also the health risk of respiratory disease, high blood pressure, paralysis, diabetes and other chronic diseases" (Li et al., 2023, p. 1). Looking at the technicality behind this, fundamental biophysical processes that aid the ecosystem, such as trees producing oxygen and absorbing CO_2, are taken away as detailed in Figure 2 below.

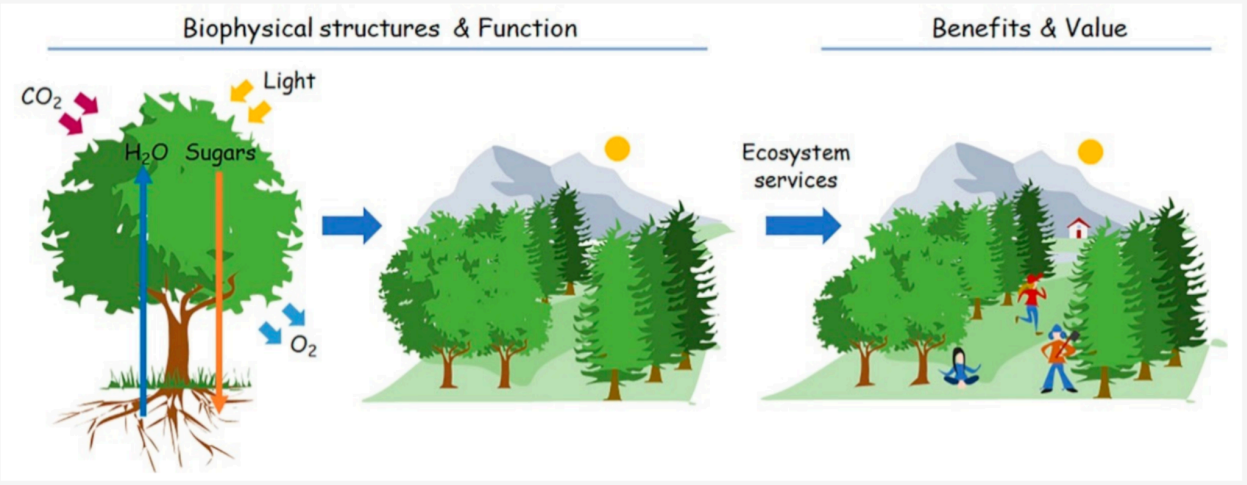

Figure 3. The illustration of the concept of ecosystem services that represent the benefits and values for human well being through the use of green spaces. (Scarano et al., 2021, p. 3)

The implications become more dire when the topic shifts to the development of children in these environments. Children are naturally inclined to engage in outdoor activities for both physical and social development. When the setting is urban landscapes with minimal greenery and places for a child to enjoy the outdoors, it becomes more complicated. A study conducted by Jarvis et al. investigated the impact of green spaces on the development of children and the effects on their brain growth. After analyzing 27,372 children born in Metro Vancouver between 2000 and 2005 using the Early Development Instrument (EDI), a tool that assesses children's

development in kindergarten, the group found a positive correlation between green space exposure and development. In particular, the interpretation of this result was that "increased exposure to residential green space might improve childhood development by reducing the adverse development effects of traffic-related exposure, especially NO_2 air pollution" (Jarvis et al., 2021, p. 1). The children in urban environments with a lack of green space, compared to other children, are more exposed to these pollutants and are less likely to have "increased physical activity, enhanced mental restoration, and improved social cohesion" (Jarvis et al., 2021, p. 1).

This lack of awareness on the implication of poor urban development with no regard to green space is a major reason why my STS project attempts to engage citizen participation in modern day urban planning. A reason why the public lacks participation in current urban planning is because of its complex nature which requires understanding of topics that are usually beyond the scope of their knowledge. According to the Analysis of Citizens' Motivation and Participation Intention in Urban Planning by Li et. al, another reason is because "the way the public should be involved in urban planning has been poorly understood, and that planning practice is highly deficient" (Li et al., 2020, p.1). The lack of confidence and uncertainty when it comes to this complex ordeal really pushes citizens back. Since citizens are the ones who are directly impacted by urban planning, the mindset when discussing involvement needs to shift. To directly influence this lack of knowledge, my plan is to build upon projects that have been implemented on educating the public on the effects of poor urban development and how it directly impacts sensitive topics such as their mental well being. I will use the concept of emphasizing problem definition in this context to help pinpoint what and where exactly the problem is. The deliverable will be community engagement events that will be catered to help

citizens become more aware of the ongoing issues. This will hopefully allow citizens to become better informed and more confident in their abilities to directly influence urban planning. The main challenges that this project will face will be the ability to see direct tangible results. Of course, it will take a lot of effort to educate the public and make them feel comfortable in engaging in major decisions such as urban development. However, this can be combated with impact evaluations through the usage of forms that gauges how citizens feel before and after these engagement events.

Conclusion

This prospectus proposes holistic solutions to the ongoing challenges of poor urban planning. It aims to implement AI algorithms such as Generative Adversarial Networks and Natural Language Processing to innovate park design generation and to gauge public sentiment on them. On the STS front, the project hopes to enhance public engagement in urban planning processes by teaching the crucial role green spaces play in urban health. If these projects can be implemented successfully, a more green approach will be taken when discussing the construction/changes of cities. Some challenges that the project will face are the slow process of tangible results in the STS portion and in the technical portion it is current government suspicion on the use of AI for the public sector. This fear of new technology is a major topic Mesthene discusses in his *Social Change in Technological Change: Its impact on Man and Society*. He comes to conclude that "isolating the opportunities (as the technological optimists do) or the problems (as the pessimistic critics are prone to) and construing one or the other as the whole answer is ultimately obstructive of rather than helpful to understanding" (Mesthene, 1970, 34). It is important to strike a balance between optimism and pessimism when it comes to modern day technological development, as an imbalance will likely cause the project to go astray. Therefore,

if both projects overcome these difficulties and are implemented in an applicable way, the project will lead to less negative environmental disruptions such as pollution and climate change, and the overall physical and mental health of the city dwellers will increase. (Roughly 2100 words + figure descriptions and citations)

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