Implementing Walkable Infrastructure to Increase Urban Sustainability

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Introduction

In a world that is becoming increasingly vulnerable to the effects of climate change and damages associated with drastic shifts in planetary conditions, it has never been more crucial to prioritize sustainable development that builds resilience against climate disasters and works to reduce anthropogenic contributions to climate change. Especially as climate related disasters increase in frequency, investing in sustainable infrastructure such as pedestrian walkways, safe bike lanes, public transportation, natural areas, and mixed-use zoning will have compounding effects that reduce urban emissions. The purpose of this report is to investigate the advantages of implementing sustainable city design for community health and emissions reduction, as well as highlight the economic obstacles of investing in mass-scale infrastructure changes.

Currently, citizens of the US emit much more carbon dioxide annually than in any other country, with "the average American carbon footprint is estimated to around 16 tons per year," (Safdie, 2024) Much of this is a result of our dependence on automobiles, which are not only inefficient for mass transportation, but reduce available space for alternative methods of transportation through the sheer scale of space that roads, highways, and parking lots take up. Additionally, the transportation sector which is dominated by automobiles resulted in the emission of about 1,023 million metric tons (MMmt) of carbon dioxide," (EIA, 2023) in 2023 alone. Throughout human history prior to the invention of automated transportation, the cities we lived in were designed to prioritize pedestrian traffic and ensure that walkable infrastructure allowed people to accessibly meet their needs. Some of the most sought-after cities in our country and across the world prioritize walkability and mixed-use zoning in their design, like with "early American cities such as Boston…with its dense housing and extensive sidewalk networks." (Gama, 2023)

In my field, scholars primarily focus on optimizing and refining how we can develop our economies, construct our cities, and live our lives in a way that reduces our impact on the environment and promotes a more sustainable future. Combating the climate crisis is going to involve reforming all sectors of life, including how we develop our cities, and as major population hubs and sources of anthropogenic pollution, redesigning our cities with policies that target urban emissions will have widespread effects. In order to create climate solutions that are just and address inequalities, we have to recognize that low-income, disadvantaged communities "have been disproportionally affected by pollution, climate extremes, and lack of clean water and sanitation." (Vardoulakis, 2019) This climate racism "can create a "double burden" of communicable and non-communicable diseases for these disadvantaged urban populations," (Vardoulakis, 2019) that exacerbate urban inequalities, especially when coupled with other systemic inequalities like unaffordable housing. In order to create urban environments that encourage sustainable practices and human health we need to prioritize walkability, mixed-use zoning, and infrastructure that provides access to public transportation to reduce vehicle emissions.

Currently, there are a wide array of research and studies surrounding how sustainable city design can improve human health and happiness, and reduce anthropogenic emissions in urban centers. There is not much available research on the intersection between the human and environmental benefits in conjunction with each other, which is why I intend to bridge the gap and analyze how we can accommodate both human needs while improving sustainability in cities. When it comes to investing sustainable city infrastructure, the environmental and social implications of systemic changes include reduced emissions from utilization of alternative transportation and walkability, and improved human well-being and community ties.

Overhauling city infrastructure and redesigning our communities can be extremely expensive to implement though, and economic perspectives voice concerns over the added potential to displace already disadvantaged communities and exacerbate housing inequalities.

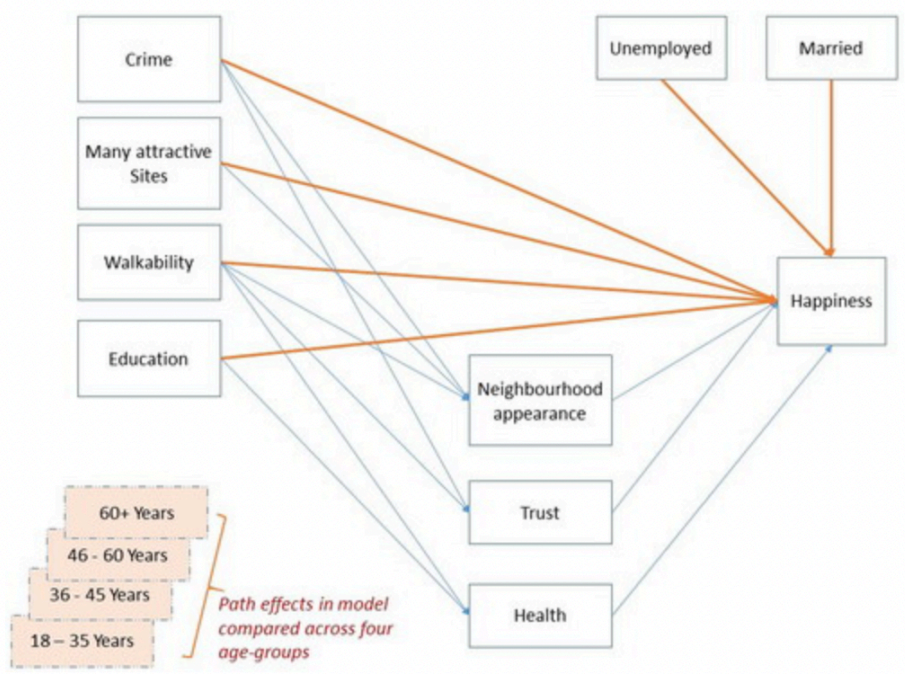
Overview of Perspectives

Side A: Environmental and Social Perspective

Cities and communities are becoming increasingly disconnected as urban development continues to prioritize designs that center automobiles instead of the residents of the city, causing a disintegration of social bonds and a dependence on carbon-emitting vehicles. In a 2023 study that surveyed resident perceptions of communities that highlighted walkability, respondents emphasized that "public transport was easier to use; they owned fewer cars and spent less on gasoline; they had more routes for walking from place to place; and there was a village feel to their neighborhood." (Leyden, 2023) When city design creates micro-communities that provide access to infrastructure to meets the needs of people within walking distance of their homes, such as shopping, transportation, third spaces, and public recreation, they inherent interact with those that live in the same area as them.

In figure 1, variables that influence the happiness of residents were identified, both direct and indirect, and it was discovered that walkability was not only directly related to happiness, but also to community trust and social bonds within the neighborhood. People feel more inclined to create bonds with those around them when they see each other on a regular basis and share common spaces, which can help to create more resilient communities that aid each other in times of crisis.

Figure 1 *Structural Happiness Model*



Note. This model was produced by Leyden et al. in 2023, and displays the direct and indirect effects of walkability and other control variables on happiness, measured for each age group.

Walkable communities can also have drastic effects on air quality and carbon emissions in urban centers, with a 2013 study conducted by the Department of Energy finding that "a walkable environment reduces greenhouse gas emissions by 4 tons a year, compared to living in an automobile-dependent suburb." (Porter, 2013) In relation to the 16 tons of carbon dioxide emitted on average by Americans, this would cause an approximate 25% decrease in yearly emissions for those living in urban areas that implement walkable infrastructure. This would not only reduce carbon emissions from the US as a whole, but also improve air quality conditions in cities and contribute to healthier communities.

Additionally, removing the need for extensive networks of roads and parking lot introduces useable areas for more green spaces to be included in urban areas, and when cities

"incorporate more trees and vegetation, they will inherently clean the air—17 trees can absorb enough $C0_2$ annually to offset 26,000 miles of driving." (Steuteville, 2024) In combination, the reduction of emissions within urban centers and the establishment of green infrastructure through implementing natural areas, parks, and increased tree cover will help to mitigate the effects of climate change such as air pollution and heatwaves.

When residents have access to reliable public transportation and amenities within walking distance of where they live, car-ownership isn't as much of a priority when compared to urban areas like suburbs that are designed to prioritize automobiles. Since traditional urban design implemented staring in the 1950's focuses on extensive networks of roads and highways that divide neighborhoods and reduce walkability in communities, "pedestrian needs would have to be prioritized over that of motor vehicles, and zoning codes would have to permit mixed-use pedestrian-oriented development with access to effective public transportation networks." (Leyden, 2023) Though this may seem like a radical change to our current infrastructure and how we interact with our cities, it has been implemented across the world with success.

Side B: Economic Perspective

Though sustainable urban development that prioritizes social and environmental aspects has impacts that help to reduce emissions from transportation, increase community ties, and have the potential to mitigate climate related risks, undertaking a task as grand as remodeling urban infrastructure in the US is a challenge. In a Forbes article detailing the price of implementing sustainable infrastructure according to a report released by one of the world's largest reinsurance companies, Ken Silverstein wrote that "Swiss Re estimated we need $270 trillion by 2050 or

$9.4 trillion annually," (Silverstein, 2024) which is an unprecedent amount to invest in infrastructural projects. Compared to the Department of Defense, which received $816.7 billion in funding in 2023 (Garamone, 2022), we would need roughly 11.5 times that allotted budget yearly to completely overhaul US infrastructure for a sustainable transition by 2050. This would not just require the implementation of sustainable infrastructure into future planning, but the removal or repurposing of current infrastructure such as roads, highways, and parking lots in exchange for walkability.

Figure 2 *Pedestrian Walkway in Denver, CO*

Note. This image is from a 2019 *Curbed* article by Patrick Sisson detailing the economic benefits and drawbacks of implementing walkable infrastructure.

Implementing a systemic change to our current infrastructure as significant as this would be difficult to execute, not just due to funding issues, but also because it would disrupt the lives of countless people. In order to transform streets intended for cars, you would have to close them temporarily, redesign the current street infrastructure with consideration for wider pedestrian walkways, bike lanes, and room for public transportation, and implement the design as demonstrated in Figure 2. This image presents a pedestrian walkway that takes priority over narrowed streets along the side, allowing walkers and bikers to move with greater freedom. Construction projects like this would have to potential to limit people's daily movement in the current car-centric infrastructure through street rerouting, sidewalk unavailability, and disruption of business traffic. The possible inconvenience and economic loss as a result of construction present a serious dilemma for the sustainable retrofitting of our current urban infrastructure.

Walkable neighborhoods that prioritize sustainability are also highly desirable due to their increased access to amenities like public transportation and natural areas, which can have impacts on the local cost of living. When compared to the rest of a city, "walkable urban places…demand roughly 75% higher rent over the metro average, a gap that is increasing," (Sisson, 2019) making it more difficult for low-income residents to find affordable housing. Especially if entire neighborhoods including building are retrofitted, displacement and the inability to return to affordable housing due to the increased costs associated with updated infrastructure could exacerbate pre-existing disadvantage.

Additionally, in cities "new housing developed in mixed-use zones in practice is often targeted to those who can afford the purchase of condominium apartments in amenity-rich downtown areas," (Moos, 2018) which can increase the effects of gentrification. Communities with rich history might be torn apart and their identify compromised by construction to increase

walkability and reduce the impacts of future climate related damages. Overall, the cost of implementing a project on a scale like this would be extremely expensive, possibly something we can even afford with current debates over budget halting mass scale infrastructure investments. The unintended cost of displacing residents, interruptions of life by construction and decrease in affordable housing further complicate the logistics and feasibility of implementing walkable infrastructure in cities.

Conclusion

In the fight against climate change, I believe that there is no better solution than wide-scale, systemic change. In order to mitigate the damage that has already been done and further reduce the risk of worsening the crisis through the status-quo, we have to take bold measures, such as reconsidering how to design our cities and utilize transportation. Solely the fact that "a walkable environment reduces greenhouse gas emissions by 4 tons a year," (Porter, 2013) has helped to convince me that drastic reformation of urban living is necessary to reduce our emissions as a nation and create resilient, long-lasting communities that are able withstand climate disasters.

Increasing the amount of information around this subject and further studying the effects of implementing sustainable, walkable infrastructure into our cities is crucial to better understanding how we can most effectively combat this crisis, which I think can be expanded in the realm of academic and industry research. The field exists currently, but I believe that sustainable urban design is the future of city design, and the field will grow in response to the need for systemic change. Though there are many facets to climate change solutions, targeting the root cause of a large section of emissions through reforming transportation and how we

design our cities around pedestrian mobility will have effects that ripple into changes in other sectors, which can be the difference between withstanding the impending crisis or not.

Though the potential benefits of further study and implementation around how walkable cities can transform how we live our lives and the effect on the climate crisis are immense, there are limitations for further study associated with the sheer cost of "$270 trillion by 2050 or $9.4 trillion annually." (Silverstein, 2024) Even if we don't reach this estimated expenditure, due to the current state of infrastructure investment, research is going to be limited until perceptions around sustainable urban design improve and become the mainstream city planning mindset. We won't reach results like this by 2050, or even 2100 at this point, so advocating for change at a local level is still one of the most effective ways to gradually gain ground in normalizing sustainable urban design.

Recommendation

In the case of implementing walkable infrastructure to increase urban sustainability, my recommendation is that we implement sustainable, walkable infrastructure in new development projects first, even though the changes won't be as significant as if mass-scale changes were implemented. Whether it be voting on pedestrian walkway designs, budget increases for public transportation, or approval for natural space protection, small, visible changes in cities can help to pioneer the implementation of these projects on a larger scale. Starting the conversation now within our own communities, doing what we can with the limited resources available, and pressing our government for increased involvement in funding infrastructure projects will help work towards a more sustainable future. Though climate change cannot be solved overnight, any

changes and policies that can be implemented now will help reduce the risk to communities and unite people in advocating for a livable future.

It is imperative that disadvantaged communities and low-income residents be included in these conversations, especially if construction would directly affect them, because progress would be impossible if you can't uplift those most vulnerable to the effects of this crisis. Safety nets and affordable housing subsidies to account for the impacts of mass-scale infrastructure changes would need to be prioritized to ensure that we aren't displacing those who don't have the resources to recover. Community discussion and involvement will only help to increase support for these projects and approval of the possible inconveniences or costs associated with changes to how they move around their cities. Though it is a daunting task, we can create more sustainable, resilient cities that minimize emissions and increase community bonds through the implementation of walkable infrastructure that changes how we interact with our urban environments.

References

EIA. (2024). *Frequently asked questions (FAQs) - U.S. energy information administration (EIA)*. Frequently Asked Questions (FAQs) - U.S. Energy Information Administration (EIA). https://www.eia.gov/tools/faqs/faq.php?id=307&t=10#:~:text=EIA%20estimates%20that%20in%202022,1%2C488%20MMmt%20of%20CO2.

Gama, Sarah. (2023) "The Impact of Pedestrian-Friendly Urban Planning on Communities." *Global Research and Consulting Group Insights*, insights.grcglobalgroup.com/the-impact-of-pedestrian-friendly-urban-planning-on-communities/.

Garamone, J. (2023, December 22). Biden signs national defense authorization act into law. *U.S. Department of Defense*. https://www.defense.gov/News/News-Stories/Article/Article/3252968/biden-signs-national-defense-authorization-act-into-law/

Howell, Nicholas A. et al. (2019). Interaction Between Neighborhood Walkability and Traffic-Related Air Pollution on Hypertension and Diabetes. *Environment International 132* https://doi.org/10.1016/j.envint.2019.04.070

Leyden, Kevin M. et al. (2023). Walkable Communities. *Journal of the American Planning Association 90* (101-104) https://doi.org/10.1080/01944363.2022.2123382

Moos, Markus et al. (2018). Planning for Mixed Use: Affordable for Who? *Journal of the American Planning Association 84* (7-20) https://doi.org/10.1080/01944363.2017.1406315

Porter, C.D. et al. (March 2013). Effects of Travel Reduction and Efficient Driving on Transportation: Energy Use and Greenhouse Gas Emissions. *Transportation Energy*

Futures Series. Prepared by the National Renewable Energy Laboratory (Golden, CO) and Cambridge Systematics, Inc. (Cambridge, MA), for the U.S. Department of Energy, Washington, DC. DOE/GO-102013-3704. 98 pp.

Roberts, D. (2017, June 27). Walkable urban areas can become playgrounds for the rich. is there any way to prevent that?. *Vox*. https://www.vox.com/2017/6/27/15716412/affordable-cities-playgrounds-rich-toderian

Safdie, S. (2024, January 16). What is the average American carbon footprint and how to reduce it?. *Greenly*. https://greenly.earth/en-us/blog/company-guide/what-is-the-average-american-carbon-footprint-and-how-to-reduce-it

Sisson, P. (2019, June 24). Why building walkable cities is the key to economic success. *Curbed*. https://archive.curbed.com/2019/6/24/18715939/real-estate-development-walkable-urbanism

Steuteville, Robert. Ten Environmental Benefits of Walkable Places. *CNU*, 4 Apr. 2023, www.cnu.org/publicsquare/2021/08/31/ten-environmental-benefits-walkable-places.

Vardoulakis, S and Kinney, P (2019) Grand Challenges in Sustainable Cities and Health. *Front. Sustain. Cities* 1:7. doi:10.3389/frse.2019.00007

Appendix

Figure 3 *Pedestrian-Centered Walkway in Publicly Owned Rental Neighborhood*

Note. Taken from a 2018 Vox article by David Roberts detailing why walkable urban areas can be subjected to increased gentrification.