

Building Our Communities Better - How Housing Can Be Sustainable

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring 2024

Introduction

As the world's population grows to a projected 10 billion people by 2050, 6.3 billion of them are expected to be living in an urban environment – an increase from 3.6 billion in 2011 (Gan et al., 2017). As the urban population grows, it'll be increasingly important to have housing capacity for all these people, especially for it to be affordable and sustainably built in a way to reduce resource consumption. For our uses, affordable housing is defined as “when rent or mortgage, plus utilities, costs no more than 30% of a household's pre-tax income” (Affordable Housing | Albemarle County, VA, n.d.), while sustainable housing is defined as “meeting the needs of the present generation without compromising the ability of future generations to meet their own needs” (Gan et al., 2017).

In this paper, I will explore sustainable urban development with a focus on affordable housing. I will first present the problem at hand and then ask, “How can the design and implementation of a new residential development promote environmental sustainability, community integration, and affordability while meeting regulatory requirements?” I will consider the topic from the Science, Technology, and Society (STS) framework of the Actor-Network Theory (ANT) before analyzing it from both an international perspective, as well as on a more national scale, here in the United States, and finally in the local area of Charlottesville, Virginia.

As a case study, I will present the proposed design of a mixed-used residential development in Albemarle County, and how it looks to be a sustainable model for the future. In this paper, I hope to illustrate how building better communities is a matter of organizing the resources we have at our disposal to make the lives of people better.

Background and Significance

How the Affordable Housing Crisis Has Affected Housing Instability

There must be more research done on how the design and implementation of residential developments can promote environmental sustainability, community integration, and affordability within the framework of regulations. The rapid increase in human population, especially in urban areas highlights the need to find effective solutions to the crisis that is unaffordable housing which is threatening the financial stability, along with the physical and mental health of so many around the world. The sheer change in dynamics of the human population, as it increases and takes up residence in urban areas, will strain any current residential capacity to the point where housing becomes an untenable burden for many. In the United States, housing costs have been an increasingly worrying issue since the Great Recession. Over 40% of renters spend more than 30% of their income on housing costs and housing prices are rising faster than wage growth in 80% of U.S. markets (Ghent, 2023). It was estimated in 2022 that four to five million more houses are needed on the market to tackle this issue. More recently, the COVID-19 pandemic and the insufficient housing supply, caused by a combination of labor and building material shortages, have made the issue even worse. In developing countries, this can take the form of living in slums and sub-standard housing of which 828 million people in 2011 live in (Gan et al., 2017) and is expected to rise with the increased urban population.

Housing instability, which includes homelessness, high cost of housing in proportion to income, overcrowding, poor housing quality, and multiple moves, can negatively affect the

education of children and how successful they are in school. There tends to be greater stress and difficulty learning, which can lead to disrupted school attendance which ultimately leads to poorer school performance. Of the 1.1 million school children who experienced homelessness in 2011-12, “These children are more likely than their peers to drop out of school, repeat grades, perform poorly in school, disengage in the classroom, and suffer from learning disabilities and behavior problems. (Enterprise Community Partners, 2014)”

Instability in housing, which includes a high cost of housing in proportion to income, overcrowding, poor housing quality, and multiple moves can negatively affect child and adult health. Access to proper nutrition for children is not present typically, leading to life-long health problems. Researchers found that “For every \$500 that average annual rents increase in a region, there is a 10 percent increase in food insecurity rates among low-income families. (Enterprise Community Partners, 2014)”. Looking at a local example, 16.7% of residents in Charlottesville are food insecure, compared to the national average of 12.3% (Shook, 2019). The common theory goes that if housing costs increase, households will have less money for purchasing food and if there is a lack of personal vehicles or adequate public transportation, reaching grocery stores will be more difficult.

From a sustainable standpoint, it is just as important to integrate members of the community with their surroundings as the people who have the most to gain from more sustainable housing are the most disadvantaged, who typically live in communities that possess “detrimental environmental conditions that negatively affect their mental and physical health” (Pattison & Kawall, 2018). Development which includes greenspaces and parks is seen to be associated with greater social cohesion and sense of community, which along with living in a less noise and dust polluted environment would empower communities and residents. In Australia,

they have a strong emphasis on limiting the physical extent of cities, preventing urban sprawl, by “intensifying development in inner areas and limiting the conversion of rural land on the urban fringe” (Gurran, 2008). This is also known as ‘urban consolidation’ or ‘containment’ and is touted to “cause less air pollution, have lower energy and water demands, result in lower biodiversity loss, and promote more efficient and equitable use of urban infrastructure” (Gurran, 2008). It’s important to have housing near services and urban amenities such as efficient transportation which will promote further economic growth but lead to more housing demand for new workers. While housing might be more expensive due to ‘good’ planning, the social and environmental impacts are more positive.

Therefore, it’s important to understand how new housing can be built in a way that makes it financially accessible but is created in a way that is in congruence with environmental standards so that the communities that inhabit it can live more equitably. How will these parameters be met in a way that is acceptable to all stakeholders at play?

Methodology

As with any kind of community, the issue of building more sustainable housing has many different parties at play - we need to consider all relevant stakeholders and how they interact with each other. Actor-Network Theory (ANT), developed by sociologist Bruno Latour, offers a unique lens through which to understand complex socio-technical systems like the design and implementation of a new residential development. ANT states that “human and non-human actors form shifting networks of relationships that define situations and determine

outcomes”(Nickerson, 2024). We can use the ANT framework as a methodology for how to design and implement the kind of residential development that we’re looking for.

As hinted by its name, the most important part of ANT is identifying all human and non-human actors, also referred to as actants, involved. According to ANT, every actant in the network is regarded as having equal value, human or non-human. This includes individuals (e.g., residents, architects, engineers), organizations (e.g., owners, contractors, regulatory bodies), materials(e.g., sourced concrete, engineered timber), technologies (e.g., renewable energy systems, AR/VR, BIM), and concepts(e.g., sustainability, community, affordability).

ANT also looks at how these actants interact and influence each other as they exist within a network. These networks are given a technical term, *an assemblage*, which is the total sum of all these actants. For instance, how do building materials affect sustainability, or how do regulations impact affordability? While all actants are regarded as having equal value, certain actants have more influence on the outcome, how livable a community is, and must be balanced to meet goals. Goals in this case would include environmental sustainability, community integration, and affordability.

A key concept in ANT is *translation*, which “is the process of establishing the identities and conditions of interaction, and of characterizing representations (Nickerson, 2024).”

Translation in this context means transforming various elements of the development process, such as materials, designs, and policies, to achieve these goals while navigating the complex network of stakeholders and regulations.

For example, when it comes to promoting community integration, translation might incorporate involving local residents and community organizations in the design process. This could entail holding community meetings to gather input and feedback, incorporating features like public green spaces or community centers into the development plan, and ensuring that the design reflects the cultural and social needs of the community. Using the ANT framework, developers can navigate the complex network of stakeholders, regulations, and interests involved in residential development projects to achieve a sustainable, integrated, and affordable community. This paper looks to understand the relationship between these actants to understand how they can be harmoniously integrated to meet the given goals.

This can best be accomplished by looking at literary sources from various perspectives around the world. I'll be exploring an international perspective through the lens of the Chinese economy, a national perspective from an American public policy figure, and a local perspective through the recommendations of Albemarle County. I will also be looking at a case study of a proposed mixed use residential development in Albemarle County which seeks to be a model of the ideals set forth in this paper. By piecing these stories together, I will attempt to make a case for how we can make the lives of people better through the places in which they live.

Literature Review

Part I: An International Perspective

Affordable housing is not a national issue, but an international one which plagues every society in the world. This is very much the case in China, the country with the world's second-largest economy and population. *"How affordable housing becomes more sustainable? A*

stakeholder study”, by Gan, X., Zuo, J., Wu, P., Wang, J., Chang, R., & Wen, T. gave a glimpse at how China is trying to handle their affordable issue – particularly by incorporating sustainability.

While sustainability is a great buzzword to be used in the development of new housing, there needs to be a framework to guide policy towards affordable housing. The paper looks to identify key sustainability performance indicators (KSPIs) that guide the development of affordable housing, focusing on environmental, social, and economic performances. These KSPIs can be used by policymakers and developers in the planning and feasibility analysis for a housing project so “ -a systematic integration of sustainability into affording housing programs can be achieved.”(Gan et al., 2017)

This framework can only be established by seeking input from key stakeholders as their engagement and expertise is vital throughout the project planning process. These stakeholders include government agencies, developers, and academics who can achieve a consensus on the criticality of sustainability issues and incorporate their perspectives into the project. While a limitation of the study conducted in this paper is that it focuses on parties involved in or supporting the decision-making process in the construction industry in China, other stakeholders would need to include future residents, the existing community, and other relevant actors who might be affected by development.

However, there is reference to the requirements of the community as the paper speaks on ensuring that the project aligns with the local context and economic and social situations. In China, a country with many regional variations, this involves considering local cultural preferences and aesthetics when designing housing. For instance, the size and style of dwellings should align with what's accepted and valued by the surrounding community and local

authorities. Diversifying the types of housing available can also promote interaction and strengthen social ties within the community. Getting input from residents and encouraging their participation in the housing program not only fosters better relationships but also ensures that their current and future needs are met. Additionally, ensuring secure tenure and effective property maintenance and management is vital for creating a sense of ownership and stability within the community. This helps residents feel a stronger connection to their homes and fosters a sense of belonging.

Developers have neglected sustainability to maximize short-term gains, but in the long term, life cycle cost and performance are hampered, causing further issues down the line. A consensus can be reached by establishing effective lines of communication between all relevant stakeholders on what KSPIs are most important in the development of an affordable housing project.

Part II: The American Perspective

There is no one simple solution to the issues of sustainable and affordable housing so it's important to consider a wide range of possibilities. *“To improve housing affordability, we need better alignment of zoning, taxes, and subsidies.”* by Schuetz, J. presents their solutions as a “three-legged stool” – zoning reform, a land value tax, and more housing subsidies.

The first leg of zoning is regulatory barriers that limit the building of small, lower-cost housing on high-value land as the single largest issue in the improvement of housing affordability. In most US cities, “local zoning regulations prohibit building anything other than single-family detached houses on three-quarters of land”(Schuetz, 2020), including apartments, duplexes, and townhouses. Additionally, zoning rules limiting building heights and minimum lot

sizes hinder how feasible affordable housing is in an area. To solve this problem, cooperation will be needed across federal, state, and local governments. In the technical portion of my project, the site being used for the proposed residential development at Old Ivy Road was rezoned by Albemarle County so that it would be easier for the developers to have both commercial and dense residential housing in the same area.

The second leg of a land value tax proposes that taxes be increased on expensive, underused land and lowered on structures to encourage landowners to build more intensively. Typically, a landowner in an expensive city, would incur more taxes if an apartment building was built on their lot, but a land value tax would have them foot the same tax bill whether the land was being used for parking, apartments, or anything else. This would further incentivize the building of more dense development.

The third and final leg of housing subsidies discusses how expanding market-rate housing alone won't sufficiently address housing affordability for the poorest families who often struggle to afford even minimum-quality apartments. Public subsidies, such as housing vouchers or the National Housing Trust Fund, are essential for bridging the gap between low incomes and high housing costs. This doesn't act independently of zoning changes like upzoning and land value taxes, which may inadvertently exacerbate affordability issues by prompting the redevelopment of low-rent apartments into unaffordable units. Therefore, expanding housing vouchers alongside zoning reform can protect low-income renters from displacement and prevent rent increases in certain markets.

Part III: The Local Perspective

Albemarle County presents “Housing Albemarle: Recommendations for a New Housing Policy” which gives solutions by a local jurisdiction that struggles with affordable housing. There are 12 objectives and multiple strategies given for each one. In my view, the most important ones by far are the ones that discuss increasing the overall housing supply – in particular, the supply of long-term affordable and workforce rental housing. This is denser housing that is close to job centers, community amenities, and public transit – further reducing costs of living.

Albemarle County aims to increase the housing supply to meet the diverse needs of residents by implementing various strategies. These include incentivizing a variety of housing types close to job centers and public transit, ensuring a percentage of new developments include affordable housing, and exploring options for permanent affordable housing communities on county-owned land. Additionally, they seek to promote long-term affordable and workforce rental housing through incentives, such as density bonuses and reductions in parking requirements, and by developing programs that establish minimum periods of affordability. Furthermore, the county plans to improve access to affordable homeownership opportunities by supporting shared equity models and enforcing occupancy and sales price restrictions. Collaborating with local organizations will be crucial in promoting access to affordable housing opportunities and maintaining publicly accessible data on available units.

The county knows that regulatory barriers are hindering the production of affordable and workforce housing and looks to reduce them. This involves reviewing the County's Comprehensive Plan and ordinances to identify and remove obstacles. Action steps include examining all chapters of the Comprehensive Plan and Master Plans, analyzing land use designations, and collaborating with the community to find solutions. Specific strategies entail

revising zoning ordinances, such as reducing minimum lot sizes and setback requirements to enable more affordable housing, allowing small-scale residential structures in single-family neighborhoods, permitting external accessory dwelling units, and evaluating the effectiveness of density bonus ordinances. Additionally, future zoning text and map amendments should support innovative housing types and infill development projects to increase density in development areas.

Part IV: A Case Study at the Old Ivy Road Residential Development

The case study that I would like to look at is that of the design of a mixed-use residential and commercial development for a 35.8-acre parcel along Old Ivy Road in Albemarle County, Virginia. The client requested 250 to 300 housing units divided into single-family homes (10-15%), townhomes (20-30%), and apartment units (60-70%) with adequate parking. A minimum of two commercial buildings were required for the lot, as well as amenities for the housing developments. The design and implementation of this residential development sought to effectively promote environmental sustainability, community integration, and affordability while meeting regulatory requirements through several key strategies.

The site design seeks to address the affordable housing shortage in Albemarle County by increasing the housing supply by demonstrating a sustainable approach to mixed-use residential development. By creating 250-300 additional housing units alongside community amenities such as parks and green spaces, the development becomes an attractive living space for future residents. Effectively using an unused parcel, this project “-is economically accessible to all socio-economic groups as it meets the Albemarle County requirement of a minimum of 20% of the total number of housing being provided as affordable housing due to its dense nature.”(Gurung et al., 2024) Furthermore, by integrating green transportation options like

sidewalks, walking trails, and bus stops, the site looks to promote sustainable mobility and enhance connectivity within the community and the surrounding area.

The project's careful consideration of community concerns, such as traffic management and environmental preservation, underscores its commitment to inclusive development. Thoughtful road design, including innovative roundabouts instead of traditional intersections, regulates traffic flow while minimizing congestion, ensuring seamless transportation both within the site and its surroundings. By minimizing potential crash points and facilitating smoother traffic movement, such design choices not only comply with regulations but also contribute to a safer and more efficient environment. Additionally, maintaining the integrity of natural assets like the Rivanna Trail through coordination with local environmental groups demonstrates environmental stewardship. The site designers also sought to engage in town hall discussions with the local community, to ensure that the commercial spaces meet their needs without contributing to gentrification.

The design and implementation of the new residential development at Old Ivy Road showcases a holistic approach that balances regulatory compliance with environmental sustainability, community integration, and affordability. By prioritizing safety, efficiency, affordability, and community engagement, the project sets a precedent for future developments to follow suit in fostering sustainable and inclusive communities.

Discussion and Results

This study explores how the design and implementation of a new residential development can promote environmental sustainability, community integration, and affordability while meeting regulatory requirements. By analyzing a diverse range of literary sources along with

looking at a local case study, this research aims to provide insights into what solutions have been proposed and are available. The literature review highlighted the global significance of affordable housing and its impacts, along with proposed solutions such as zoning reform, land value taxes, and housing subsidies.

Being a global challenge, it was important to look at international insights that emphasize the crucial role of sustainability in affordable housing initiatives. A stakeholder study in China identified key sustainability performance indicators (KSPIs), providing a framework for policymakers and developers to systematically integrate sustainability into housing projects. This underscores the importance of stakeholder engagement in aligning housing development with environmental, social, and economic imperatives. From an American standpoint, we looked at a multifaceted approach to addressing housing affordability issues. This approach likened to a “three-legged stool,” incorporates zoning reforms, land value taxes, and housing subsidies. By addressing regulatory barriers and providing economic incentives, such strategies aim to foster affordable housing amidst market pressures. At the local level, jurisdictions like Albemarle County exemplify efforts to overcome regulatory hurdles and promote inclusive housing development. Through housing policy recommendations, the county outlines strategies to increase housing supply, incentivize affordable housing, streamline regulatory processes, and collaborate with local stakeholders while revising zoning ordinances as key components of these efforts.

When analyzed through the lens of Actor-Network Theory (ANT), these initiatives reveal the intricate network of actors and factors shaping housing development. In the international context, stakeholders like government agencies, developers, and academics form a dynamic network influencing sustainability initiatives. By engaging diverse actors, housing policies can

incorporate varied perspectives, aligning with ANT's emphasis on actor interactions. Similarly, in the American context, zoning regulations, tax policies, and housing subsidies work through translation to shape housing markets toward objective needs. These policies intertwine with actors such as developers, landowners, and policymakers, constituting an actor-network that influences housing affordability. ANT highlights the interconnectedness of these actors and policies, emphasizing the need for collaborative efforts to address housing challenges.

Locally, Albemarle County's housing initiatives illustrate the role of governmental actors in shaping housing policies through collaboration with community stakeholders and revising zoning ordinances. In forming an actor-network aimed at overcoming regulatory barriers and promoting affordable housing, the county emphasizes ongoing collaboration and adaptation in housing policy implementation, as underscored by ANT's dynamic nature.

The design and implementation of sustainable, integrated, and affordable residential developments require multifaceted strategies that address regulatory, economic, and social factors. There is no one set strategy to tackle the issues at hand. Still, by incorporating insights from international, American, and local perspectives, along with theoretical frameworks like Actor-Network Theory, stakeholders can navigate the complexities of housing development, fostering inclusive communities and sustainable environments.

Conclusion

This research endeavor has shed light on the critical intersection of affordable housing, environmental sustainability, and community integration in the context of residential development. Safe and comfortable housing is one of the core tenets of an equitable society that all citizens deserve to have. Through a comprehensive literature review and analysis, it has

become evident that the affordable housing crisis is a multifaceted issue with far-reaching social, economic, and environmental implications. From the global scale to local jurisdictions like Albemarle County, the need for innovative solutions to address housing affordability while promoting sustainability and inclusivity is paramount.

For decision-makers and influencers such as researchers, policymakers, and practitioners, the next steps involve translating the findings of this research into actionable policies, projects, and initiatives. We must continue exploring innovative approaches to housing affordability, integrating sustainability principles into urban planning and development processes, and fostering community engagement and collaboration. This is an evolving challenge as the global population ebbs and flows, causing greater needs in varied areas. Moreover, ongoing monitoring and evaluation of implemented strategies are crucial to ensuring their effectiveness and identifying areas for improvement.

Ultimately, addressing the affordable housing crisis requires a collective effort and a long-term commitment to creating inclusive, sustainable communities where all residents have access to safe, affordable housing. By building upon the insights generated by this research and leveraging the expertise and resources of diverse stakeholders, we can move closer to achieving this vision and creating a more equitable and sustainable future for all.

References

Albemarle County. (2021, July 7). HOUSING ALBEMARLE: RECOMMENDATIONS FOR A NEW HOUSING POLICY. Albemarle.

<https://www.albemarle.org/home/showpublisheddocument/10130/637637566155230000>

Affordable Housing | Albemarle County, VA. (n.d.). Retrieved October 23, 2023, from <https://www.albemarle.org/government/community-development/learn-more-about/housing/affordable-housing>

Enterprise Community Partners. (2014).

Impact-of-Affordable-Housing-on-Families-and-Communities.pdf. Home For All SMC.

<https://homeforallsmc.org/wp-content/uploads/2017/05/Impact-of-Affordable-Housing-on-Families-and-Communities.pdf>

Gan, X., Zuo, J., Wu, P., Wang, J., Chang, R., & Wen, T. (2017). How affordable housing becomes more sustainable? A stakeholder study. *Journal of Cleaner Production*, 162, 427–437.

<https://doi.org/10.1016/j.jclepro.2017.06.048>

Ghent, A. (2023, January 24). The Affordable Housing Crisis in 2023: Where Do We Stand, and What are the Solutions? Kenaninstitute.Unc.Edu.

<https://kenaninstitute.unc.edu/commentary/the-affordable-housing-crisis-in-2023-where-do-we-stand-and-what-are-the-solutions/>

GURRAN, N. (2008). Affordable Housing: A Dilemma for Metropolitan Planning? *Urban Policy and Research*, 26(1), 101–110. <https://doi.org/10.1080/08111140701851985>

Gurung, S., Hertel, R., Lindsay, A., Taylor, M., & Webbert, G. (2024). Old Ivy Road Mixed-Use Development (p. 79) [Technical]. University of Virginia.

https://docs.google.com/document/d/1JVe4EMOuDJ_CZVcojKQILjSTxgs0G2CIPYXITBzuMm8/edit?usp=sharing

Nickerson, C. (2024, February 13). Latour's actor network theory. Simply Psychology.

<https://www.simplypsychology.org/actor-network-theory.html>

Pattison, A., & Kawall, J. (2018). Equitable Local Climate Action Planning: Sustainable & Affordable Housing. *Ethics, Policy & Environment*, 21(1), 17–20.

<https://doi.org/10.1080/21550085.2018.1447900>

Schuetz, J. (2020). To improve housing affordability, we need better alignment of zoning, taxes, and subsidies.

https://www.brookings.edu/wp-content/uploads/2019/12/Schuetz_Policy2020_BigIdea_Improving-Housing-Afforability.pdf