RURAL REVITALIZATION WITH SYSTEM DYNAMICS USING KINSTON, NC AS A CASE STUDY

by

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Introduction

This paper gives a detailed account of the adaptation of system dynamics modeling to rural revitalization efforts in Kinston, NC. System Dynamics (SD) is a methodology used in engineering to simulate complex interactions with stocks and flows. Simulations are based on data inputs of stocks and equations that represent flows between stocks. Using balancing (negative) and reinforcing (positive) feedback loops to represent interactions between system components. SD methodology has been used extensively to describe engineering, environmental, and health systems, including the epidemiology and dynamics of the spread of infectious disease (Bordehore, 2020). Recently, SD was used to study the prevention and response to COVID-19, including infection modeling, health system capacities, and the social and economic system reactions to different policies and behavioral modifications (Bradley, 2020).

In urban planning, SD modeling has been used for traffic management, housing development, and strategic plans in relatively large cities. Simulations enable policy makers and stakeholders to identify effective system levers to yield desirable outcomes by incorporating both expected and unintended outcomes within the model. SD modeling is appropriate in a rural revitalization assessment because these communities often have multiple stakeholders operating within their target areas which are complicated by community attributes outside their spheres of influence. For example, private sector retail investment can only be effective with public sector infrastructure support. Public sector spending maybe absorbed by programs to address poverty, crime, and underperforming schools. By incorporating public and private initiatives, community members' information sets, with community challenges and initiatives within a SD model, stakeholders can see how they are part of a broader system. Community leaders can experiment with system levers to develop more strategic and effective investments. The system approach recognizes that rural revitalization requires broad collaboration, institutional change, and time. An effective SD model enables stakeholders to alter system levers to examine consequences before investing in potentially ineffective programs.

In his seminal book "Urban Dynamics," Jay Forrester (1969) develops the system dynamic intuition by applying system thinking into the complexity of urban planning. For example, one area of interest Forrester researched was low-cost housing construction. His SD approach demonstrated the counterintuitive nature of these complex social systems. The construction of low-cost housing adversely affected the very problem it was designed to alleviate in his simulations. The construction of low-cost housing brings additional pressure to the city. The new construction actually attracts people that are underemployed, making the population proportions more unfavorable than the original conditions. Intuitively sensible policies such as low-cost housing construction can still produce undesired outcomes. By creating a model that encompasses intentional and unintentional outcomes, the complex interaction modeling enables planners to alter model scopes, time horizons, agents, and institutions to models appropriate to the community attributes and stakeholders' interests.

The accuracy of an agent-based SD model is built on the knowledge of the community gleaned from stakeholders. For this study, leaders and community members in Kinston contributed their time, knowledge, and insights to inform the creation of this SD model as a tool for economic development. As stakeholders contribute to the modeling of a system, they begin to see how each part of the system affects one another. The model can then be used as a tool for decision makers using simulations to envision how system components are interconnected systems can react.

SD economic modeling has been applied to economic development and urban planning such as the IBM-sponsored 25-year plan for the City of Portland (Yasin, 2011). Their model simulated how the core systems of the city, including housing, education, public safety, transportation, and the economy are interconnected. This study is similar but on a much smaller scale. In 2017, Portland had a population of 647,800; Kinston's population was only 20,500.

What has been done for Rural Revitalization

Nobel Prize winning economist, Paul Krugman wrote in a NY Times Opinion piece in March of 2019 that "reviving declining regions is really hard." He was referring to the weakening economies of rural America. According to the U.S. Department of Agriculture, Economic Research Service, poverty rates in nonmetro areas have exceeded metro poverty rates since poverty rates were first reported in the 1960's. These differences still hold true today, in the South poverty rates were 6.1% higher in nonmetro areas over the 2014-2018 period. In *Rural Children at a Glance*, Carolyn Rogers documents that children in these areas are more likely to receive food stamps and free and reduced lunches at school. Living in rural poverty as a child increases the likelihood that he/she will remain in poverty as an adult. She recommends that health, education, and nutrition programs be targeted to areas with concentrated child-poverty rates in the South. Rural poverty is persistent and intergenerational.

Why is rural economic growth "really hard"? When communities have poverty, geographic isolation, joblessness, poor health, education, and industrial infrastructure, how do members of these thrive? Research by the Community Research Connections has focused on factors that contribute to rural revitalization and community resiliency. My research uses the knowledge of community stakeholders to inform the SD model for the Kinston context. Relying on community stakeholders to inform policy and analysis has broad acceptance in the literature. For example, many community case studies that examine the impacts of programs or initiatives in education, arts and culture, crime reduction, or housing infrastructure investments rely on community input.

Education has long been viewed as a key component of a healthy community. Education impacts employment, pay, and potentially family size. The lower education attainment in rural areas undermines quality of life metrics and the resiliency of rural communities. In New Mexico, 13 school districts engaged members of their communities to augment the state-developed curriculum. In their 2007 study, Gerald Pitzel, Alicia Benavidez, Barbara Bianchi, Linda Croom, Brandy R. de la Riva, Donna Grein, James Holloway, and Andrew Rendon found that the holistic, community engaged program enhanced the connection between community and schools. This led to enhanced funding for schools, allowed schools to begin programs they before could not afford, and in some instances sparks creative initiatives that students were able to run such as a senior-run tactile blanket business (Pitzel, 2007).

According to the U.S. Department of Education, another important discrepancy between urban and rural education is in access to art education. Students attending schools in high poverty, rural communities have less access to art education which has been linked to development of critical thinking skills. In their 2015 study, Lisa Donovan and Maren Brown found that increasing access to arts education in rural areas such as Harlan County, Kentucky improved students' understanding of issues of economic development and equity within their own communities according to education specialists participating in the survey research. (Brown and Donovan, 2015).

Research has shown that community-enhanced curriculum improved student outcomes in rural communities across the U.S. This work is confirmed by studies in other countries. Nancy Duxbury and Heather Campbell in 2011 found that arts education improved student retention, engaged learners, and enhanced community outcomes by attracting new residents and businesses in rural Canada. The rural revitalization literature includes several studies that highlight both education and the arts industry as engines of economic growth. In particular, communities with well-developed expressions of visual and performing arts have enhanced tourism and have demonstrated resilience through economic, political, and cultural transitions (Duxbury and Campbell, 2011).

In 2016, Caroline Ross started investigating how arts, culture, and creative placemaking affect public safety. A survey of artists and community leaders found that projects at the intersection of creative placemaking and public safety (1) promote empathy and understanding, (2) influence law and policy, (3) provide career opportunities, (4) support well-being, and (5) advance quality of place. The survey also showed that collaborations between creative placemaking and public safety initiatives reduce violence and criminal activity (Ross, 2016).

Other research has found a negative correlation between crime rates and revitalization efforts. In a 2011 study of Seattle, Washington, Derek Kreager, Christopher Lyons, and Zachary Hays found that community revitalization initially increased crime within a community as institutional changes were enacted. The reorganization of community systems sparked criminal activity through an adjustment period. As revitalization programs progress, crime rates begin to drop. Kreager, Lyons, and Hays were able to identify development efforts as the cause for changes in criminal behaviors. However, there may be bi-directional feedback; lower crime rates may contribute to economic growth. When people feel safe, they are more likely to engage in economic activities that support local businesses. Interactions between crime and economic development are considered feedback loops within the SD methodology thus the direction of causality does not have to be resolved, rather incorporated into the model. (Kreagor, 2011).

In his book *Urban Dynamics* (1969), Jay Forrester demonstrated how to use systems thinking in urban planning. He simulated a life cycle of an urban area. As economic activity in a region concentrates into an industrial hub, infrastructure develops, workers are employed, their income supports other businesses. A complex web of economic interactions develops within a physical infrastructure designed to support the social and economic interactions. Over time, the physical infrastructure depreciates and deteriorates. Vibrant communities stagnate and decline as new infrastructure moves centralized activities to the less developed, less expensive perimeters around the urban centers. The deteriorated central core then becomes the focus of urban planning and revitalization efforts. Infrastructure investment can ignite economic activities and the complex systems of economic interactions is reestablished, setting the cycle in motion again.

In his book, Forrester traces reinforcing and balancing feedback loops in urban job training programs, social net financing, and low-cost residential construction. In modeling these initiatives within complex, interactive system he finds both intended and unintended effects that can inform policymakers and community stakeholders. His assessment of the urban built environment is particularly relevant to the Kinston context. When buildings deteriorate, which happens when depreciation rates exceed maintenance and re-investment rates, dilapidated buildings begin to define the built environment and the community is identified by that deteriorated state. When older buildings dominate

the business and/or residential landscape, the economic conditions of the inhabitants' decline. Low profit businesses occupy older buildings. These businesses cannot afford building maintenance and the conditions worsen. The cycle of deterioration of deliberated buildings is reinforced by financial inability of the low-profits occupants to reverse the cycle. This same relationship exists for residential structures. When houses deteriorate, they are less desirable for higher income households. As dilapidated houses are occupied by low income residents who cannot afford maintenance, the deterioration cycle is reinforced. He simulates the cycle of built environment with socio-economic conditions within a system dynamics framework. His model indicates that community revitalization that replaces older buildings and homes upends the deterioration cycle and can spark economic development and community revitalization. Extending the lifecycle of the infrastructure with new construction invites new economic activity and sparks the rehabilitation of deteriorating urban centers attracting businesses and employment (Forrester, 1969).

In 2016, Skobba and Tinsley examined the impact of the Georgia Initiative for Community Housing program which was designed to address housing and community development needs of low-income residents in 25 rural communities across the state. The needs-assessment portion of their research indicated that the financial requirements to maintain and improve deteriorated housing stock were beyond the residents' abilities to pay. The Georgia initiative program trained residents to fix and maintain the housing stock. Through instruction on construction, electrical, and plumbing, residents were empowered to provide the labor to maintain and improve their homes. While the program provided the knowledge and training, in many cases, skills alone were not sufficient to maintain and rebuild the housing stock. The found that residents needed more specialized training and in other cases, residents needed inputs and tools for residential maintenance that were still beyond their abilities to pay. This research recognized that the rehabilitation of aging housing stock is a complex system that involves knowledge, skills, abilities, motivation, tools, inputs and resources. The needs of residents within the different communities varied, thus engaging community stakeholders was key to the successful implementation of training programs. This program and Skobba and Tinsley's assessment reinforce that revitalization of houses, neighborhoods, and communities require long time horizons and are part of complex systems of reinforcing and balancing feedback loops (Skobba, 2016).

Economist Specific Research

Gladwin, Long, Babb, Beaulieu, Moseley, Mulkey, and Zimet (1989) examined the importance of entrepreneurship to rural revitalization in Northern Florida. Their study included questionnaires and open-ended interviews of local entrepreneurs. Responses were compared across survey-type for consistency. They found that there were attributes specific to rural entrepreneurship that were necessary for rural communities to thrive. However, much like other features of economic development, entrepreneurship is a necessary but not sufficient condition. Economic development requires a system of individuals and activities working synergistically. Without sufficient economic activity, household income, and local spending, entrepreneurial businesses cannot survive in rural communities.(Gladwin, 1989).

Rural revitalization is complex and involves many different interactive factors. Research has identified many factors that inhibit economic development in rural communities including systemic poverty, unemployment, crime, and deteriorating infrastructure. Case studies and stakeholder-informed assessments have identified several potential areas for investment—investment in education, infrastructure and arts or programs that incentivize entrepreneurship or training of specific skills.

Programs and initiatives have been implemented, outcomes have been measured, and recommendations have been made. However, the research is consistent in identifying that context matters; the success or failure or programs is often linked to the attributes and institutions in individual communities. Programs and initiatives operate within a dynamic system and can only be successful within a limited context (sphere of influence or time horizon). This study takes a step back and looks at this body of work broadly and attempts to describe how a community is a compilation of many subsystems working in tandem—reinforcing or offsetting the actions and outcomes of other components of the system. In particular, this study applies the system dynamic methodology developed by Jay Forrester to consider economic development and community revitalization of one rural southern town. SD methodology is based on non-linear, system assessment using stocks and flows, incorporating stakeholder knowledge, calibrated with data, to create a system to simulated different policy levers. The outcome of this study will be a visual representation of the institutional interactions within the community that can identify opportunities and challenges of rural revitalization within the Kinston, NC context.

Systems Dynamic Methodology

This paper adapts system dynamic modeling to a rural context. SD modelling is particularly appropriate as an initial step in community planning because it is designed to look at the major composite parts of a community and consider how the different pieces interact through reinforcing and balancing feedback loops. This type of assessment is necessarily nonlinear, when a system has feedback loops, SD is a useful tool. When a system is linear, SD modeling is not informative. As an example, linear modeling to lower crime might be to increase police officers. Within an SD model, lowering crime could include police officers, improved educational system, greater employment opportunities, and an effective social net system. The SD set-up enables bi-directional feedback, interactions between sub-systems, and time lags. For example, students in a better school system, may have better academic performance and higher graduation rates. However, it might take several years for the improved student performance to affect crime rates or quality of employment. SD modeling can incorporate these lags and interactions in a simulated environment.

R.L. Ackoff explains, “In an environment in which complexity was also growing at an increasing rate, the ability to forecast and predict deteriorated in an alarming way. As a result, the one thing that is certain about almost any prediction beyond the immediate future is that it will turn out to be wrong. Thus, any method of planning that was critically dependent on the accuracy of forecasting was doomed to failure. Furthermore, there were contexts within which we had found very good alternatives to forecasting. …Planning should be about controlling, creating a desired future, not preparing for one that has been predicted. This led to the realization that one could deal with the future through assumptions rather than predictions. …Assumptions are about possibilities; predictions and forecasts are about probabilities. With multiple assumptions, we can do contingency planning. We can control much of the future and prepare for what we can’t control” (Ackoff, 1997).

In describing SD methodology, I begin with some basic terminology. A system is a set of things interconnected in a way that produces a pattern of behavior over time. It consists of three parts: elements, interconnections, and a function. Elements physically make up a system. They can be tangible like a car or intangible like school pride. Interconnections are the relationships that hold these elements together. Many interconnections are simply flows of information. Information holds systems together and determines how they operate. Finally, functions are why the system exists. It is important to note

that functions are deduced from behavior, not from rhetoric or stated goals. A systems function is both the least obvious part of a system and often the most crucial determinant for behavior. A system is more than the sum of its parts. Systems are adaptive, dynamic, goal-seeking, self-preserving, and constantly evolving. Dynamics is simply behavior over time (Meadows, 2015).

System Dynamics is a method to understanding the nonlinear behavior of complex systems over time using stocks, flows, feedback loops, and time delays. Stocks are accumulations or stores of material or information overtime. Flows are the rate of change of this stock. Imagine a bathtub full of water. The stock is the water that is sitting in the bathtub. As water is added to the bathtub the stock increases. This increase in the stock is a flow.

A dynamic system model does not predict the future. It creates realistic simulations of possible system behaviors under a given range of conditions. It is important to note that structure is the source of behavior. Behavior reveals itself as events over time. The structure is the key to why things are happening, not a prediction of what will happen.

System Dynamics was originally used by Jay Forrester in Urban Dynamics to analyze the reasons for urban decay and how to reverse the trend. Forrester examined how 3 subsystems: housing, business, and population, affected the relative health of an urban area over a 250-year period. It has since been used for a diversity of issues such as sustaining quality improvement efforts in corporations, diabetes in men, the savings and loans crisis, river basin resource planning, sustainable development, and recently a tool for urban planning in Portland, Oregon. Another interesting study based in the Haaglanden region in the Netherlands uses System Dynamics to examine the impact of new housing construction and the transformation of outdated dwellings on the regional social housing market.

A rural community has many individual parts that make up the community. They are complex. When thinking of revitalization in an area, one must consider the education system, transportation, local economy, the local art scene, housing stock, and countless other parts that make up the whole. Each individual piece to the puzzle tells a different story about what should be done to improve community wellness. By looking at each part collectively, we may get a better understanding of how the system works we identify synergies that can yield more effective solutions. However, interactions between components of the system can yield unexpected or even counter intuitive outcomes. Forrester (1969) demonstrated how program that assist people who are underemployed, re-train workers, provide financial aid and low-cost housing can yield unexpected dependencies or worsen economic conditions of the people they are designed to help.

System Dynamics is a tool to simulate system complexities by modeling interconnections. By looking at the issue as a whole, one better understands how each part affects one another. This widened view of the situation helps prevent unintentionally damaging the community. This methodology is particularly relevant for city planners who have to think through how different parts of the community are related, introduce programs, and anticipate realistic time horizons between implementation and results. For example, an education intervention for middle schoolers likely would not alter retention or graduation rates immediately, but rather with a 4-year (or more) lag. Using SD modeling, planners in Kinston will be able to better think about the consequences of a proposed strategy and see the consequences, both intended and unintended, of the proposed course of action.

An important feature of SD is the construction of the model itself and running simulations to analyze how the system would perform in different situations. SD models are presented as causal loop diagrams. A causal loop diagram shows a systems parts and how these parts interact with one another. For example, one important component of our final model is population size. Figure 1 is a simplified example of a causal loop diagram with two feedback loops. The left loop is a reinforcing feedback loop which shows the more people in Kinson there are, the more births, which inevitably leads to more citizens of Kinston. The right loop is a balancing feedback loop. This shows how the more people there are, the more deaths, which decreases the amount of people in the community. Starting with the construction of a causal loop diagram helps to identify the major components of a system and the interactions that exists between them.

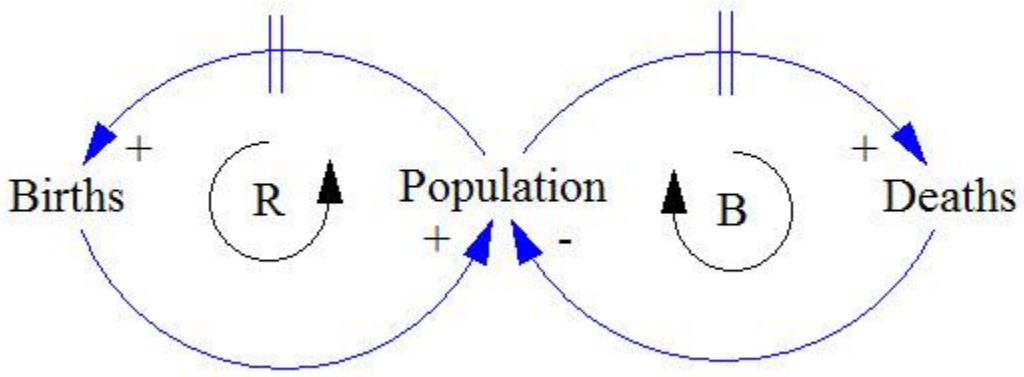

Figure 1. Causal Loop Diagram

Rural revitalization is a complex issue comprised of many unique pieces. System Dynamics is a tool that can be used to simulate and describe how each piece interacts with one another to produce a specific result. Understanding how each component affects one another will help to reduce unexpected outcomes and allow contingency planning.

One of the most important outcomes of SD is the advanced understanding of the system present. Because of this, a process that incorporates community stakeholders is vital to the long-term success of the revitalization at hand. Community agents or stakeholders vested interests in the success of the community and firsthand knowledge that can contribute to the accuracy of the SD model for rural revitalization. One advantage of SD causal-loop diagrams is that it provides a tool that captures the feedback from stakeholders and can be communicated back to them in a visual way that invites feedback and critique that can inform revision to the model before it is finalized for simulations.

If stakeholders are present from beginning to end, they will obtain a far greater understanding of how the system they are a part of works. Also, chances of buy in and continued operations after the modeling of the system is complete increase if community agents are included. Rural revitalization will not occur if a plan is accepted but then discarded due to lack of community support or understanding. Stakeholder involvement combats these issues and provides the best chance of incorporation and ultimately success.

Why Kinston

This case study is being conducted to act as a blueprint for Rural Revitalization. The selected site is Kinston, a small rural city in Eastern North Carolina with a population of 21,393. Kinston, like a lot of rural areas, at one time had a thriving local economy. Due to many macroeconomic shifts, Kinston now represents a community whose economic boom has passed. Community leaders are struggling to revitalize the city and return to prosperity. Kinston offers an illustrative case study for rural communities trying to get back to where they once were.

Kinston was formed in December of 1762 as Kingston, in honor of King George III. It became Kinston in 1784 at the conclusion of the American Revolution. In December of 1791, Lenoir County was formed. Kinston has been the county head ever since inception. The period after the Civil War is when Kinston really started to develop. By 1870, the population was estimated at 1100 and by the end of the decade sat at nearly 1700. Located right on the Neuse River, Kinston also started to thrive in industry. Kinston was a major tobacco and cotton trading center. By the early 1900's, more than 5 million pounds of tobacco were sold annually from Kinston's warehouses. During this 30-year period, property values in Kinston increased roughly 500%.

Kinston's economy stayed hot in the first half of the 20th century. New industries traveled to Kinston, including lumber and cotton mills. A minor league baseball team decided to settle in town. DuPont, a plant for the manufacturing of polyester fibers and pharmaceuticals brought job opportunities. As the local economy boomed, a vibrant downtown business district developed with Romanesque and Art Deco styled architecture. Tourists came to Kinston to shop downtown which also contributed to their thriving economy.

Things finally began to shift in the late 1960's due to a series of unfortunate economic shifts. One major blow was textile production shifted overseas. Also, production processes for important areas like tobacco and cotton become more capital intensive, leading workers migrating to more urban areas. The shift away from using rivers and railroads as intranational transportation also greatly impacted Kinston's economy. The railroad line in downtown Kinston runs down the center of the city. Once a thing of vital importance had now become a non-factor for the local community. Due to this unavoidable mid-century economic decline, Kinston's downtown area, housing stock, infrastructure, education system, and retail production began to deteriorate. The city tried to revive the declining economy but were met with limited success. Today the city is fighting to return to the prosperity enjoyed just a few decades before.

These shifts were not all unique to Kinston. Many rural communities have had economic booms come and go with community leaders struggling to revitalize the town and return it the prosperity once enjoyed by the city. This sets up Kinston to be a very intriguing as well as informative case study for the revitalization of rural communities.

Momentum is gathering in many different sectors of Kinston's economy. Improvements are being seen in their local crime rates, real estate market, job opportunities, and the establishment of a culture for art. Due to the many interconnected parts, SD proves to be an appropriate tool to help navigate potential pathways to this revitalization.

According to police officials, the idea of people being seen downtown at night 10 years ago would have been impossible. Over the last decade, significant strides have been made downtown.

Today, people feel comfortable eating at local restaurants, drinking at the brewery downtown, and staying in the hotel next door. This reduction in fear continues to play a large role in the revitalization project of downtown Kinston.

The real estate market has also begun to shift. According to a local real estate agent, the housing supply has drastically dropped over the last couple of years from 600 available homes to now approximately 90 listed. As Kinston becomes a more attractive location to live, demand will continue to increase. This can lead to the appreciation of property values, the construction of new properties, and an increase in tax revenue for the city.

Job opportunities are beginning to come back to Kinston. The Global Transpark, a multimodal industrial park and airport supporting the manufacturing and logistics needs of the aviation, aerospace, defense, emergency response, and advanced materials industry, is continuing to grow and supply the area with above average area wage positions. This growth has also contributed to the creation of the new Aerospace and Advanced Manufacturing Center at Lenoir Community College. New businesses sprouting up downtown such as the Mother Earth Brewery and Mother Earth Motor Lodge also supplement opportunities both directly and indirectly. As they continue to find success, more businesses will be willing to locate nearby.

Kinston has also made it a priority to establish an art scene downtown. One private investor has found success acquiring properties downtown, renovating them, and offering subsidized housing and studio spaced to up and coming artists. The hope is to reverse the negative perceptions of Kinston by offering a safe space for non-locals to come and participate. Following models of other revitalized communities, Kinston is hoping that an arts-focused downtown area will increase tourism.

There are many moving parts to any revitalization project. An agent-based SD approach allows for holistic analysis. This provides a mechanism for planning process to help simulate the fact that as one factor of the community is affected, they all are. For example, rather than looking at real estate by itself, the model put real estate as one aspect of the community that is impacted by the success of the arts scene and the art scene is impacted by the availability of residential property using feedback loops.

My Research Approach

This project applies the tool of SD to rural revitalization research. This requires adapting a modeling technique, SD, that was developed by engineers and has been adapted to environmental research and health care. Kinston, North Carolina will be the case study. Similar to a SD modeling project based in the Haaglanden region of the Netherlands, community stakeholders play a major role. Community stakeholders (agents) are vital to the success of any rural revitalization research. This group model building approach is more beneficial for a rural revitalization approach than the formulation of a technical system like typical engineering or environmental applications of SD would be.

The incorporation of stakeholders in the model's construction serves many purposes. First, their involvement in the model's beginning stages will allow them to better understand the end result. Second, their involvement allows the model to more accurately reflect the actual system of the city of Kinston. These stakeholders have a much better understanding of how things in Kinston function. Third, it increases the likelihood that this research is incorporated upon completion of the model. Allowing stakeholders to invest time and energy into the model boosts commitment to the insights gained.

The central purpose of this research is to start a conversation. Towns like Kinston are doing their best to revitalize the local community and are always looking for more tools to be successful. SD facilitates conversations that increase understanding, helps recognize interconnections among system parts, and promotes community engagement. It enables community stakeholders to begin working as one instead of working individually towards the same goal.

This SD modeling project was divided into four steps. First, ten local stakeholders were chosen to participate in building the model. Each individual was hand-selected based on their extensive knowledge of Kinston and their community involvement. Before engaging with those selected, IRB certification was obtained. To do so, there was an in-person meeting to get the process started, followed by an official application including the research questions for human subject review. After a series of queries and responses, IRB-endorsed approval for the interview data collection was obtained. Stakeholder participation consisted of a 10-question interview to gather data about the city of Kinston. Each stakeholder contributes a unique view of what Kinston is actually like and what it could be. Their vision is then recorded and used in step two.

In step two, a basic model was derived based off of their responses. The stakeholders were responsible for the major pieces of the model. The interconnections, time gaps, and feedback loops were also based off their responses along with basic modeling principles learned from Thinking in Systems and Urban Dynamics. This stage was about getting all of their thoughts on paper. This provided a basic model for experimentation and running rough simulations to ensure the model was viable.

Due to Covid-19 interference, the project was interrupted before reaching step three. Step 3 would have included further stakeholder involvement. The rough model would be returned to the community stakeholders to receive feedback on what was misunderstood, what seemed accurate, and what other pieces may be missing. This step is crucial for System Dynamic success using stakeholder engagement. This allows community stakeholders to take a step back from their initial viewpoint and see Kinston as a whole. Each stakeholder specializes in one area. For example, some were successful local entrepreneurs, others experts in local education, and some were local government officials. Here the interconnections of each part are visual, and work can begin on how each part is vital to the success of rural revitalization instead of picking one to work with exclusively. The hope is to build a more representative model using the individual mental models provided by each individual. We are going from a collection of limited mental model to one true model of how Kinston actually behaves.

Step three begins the conversation of how stakeholders can work together to achieve the end goal of revitalization. As it becomes more visible how education, crime, housing, entrepreneurship, etc. affect one another, local efforts will become more thoughtful, surprises will come less often, and more contingencies can be in place when something does not go as planned.

Step four would be the construction of the final SD model for Kinston. Now that stakeholders have had a chance to see the basic model, they are able to contribute feedback on its accuracy. It is much easier to fix a model that has already been constructed than to completely build one from scratch. Their feedback in step 4 is more specific to the accuracy of the model. A fine-tuned model is then constructed incorporating improvements to the basic model as well as parts that are missed in the general interview portion of the research.

The modeling team consisted of three people. One was responsible for coordinating and conducting interviews with community stakeholders. All three contributed to the construction of both the basic and the final SD model. One member is an expert in SD and was responsible with teaching how to operate vensim, the software used to construct both models. The final member of the modeling team is an expert economist and was responsible for helping understand how each piece fit together and the impact of these interactions.

SD Model

The model presented below is the culmination of the stakeholder feedback interpreted through the perspective of the research team and modeled within Vensim software.

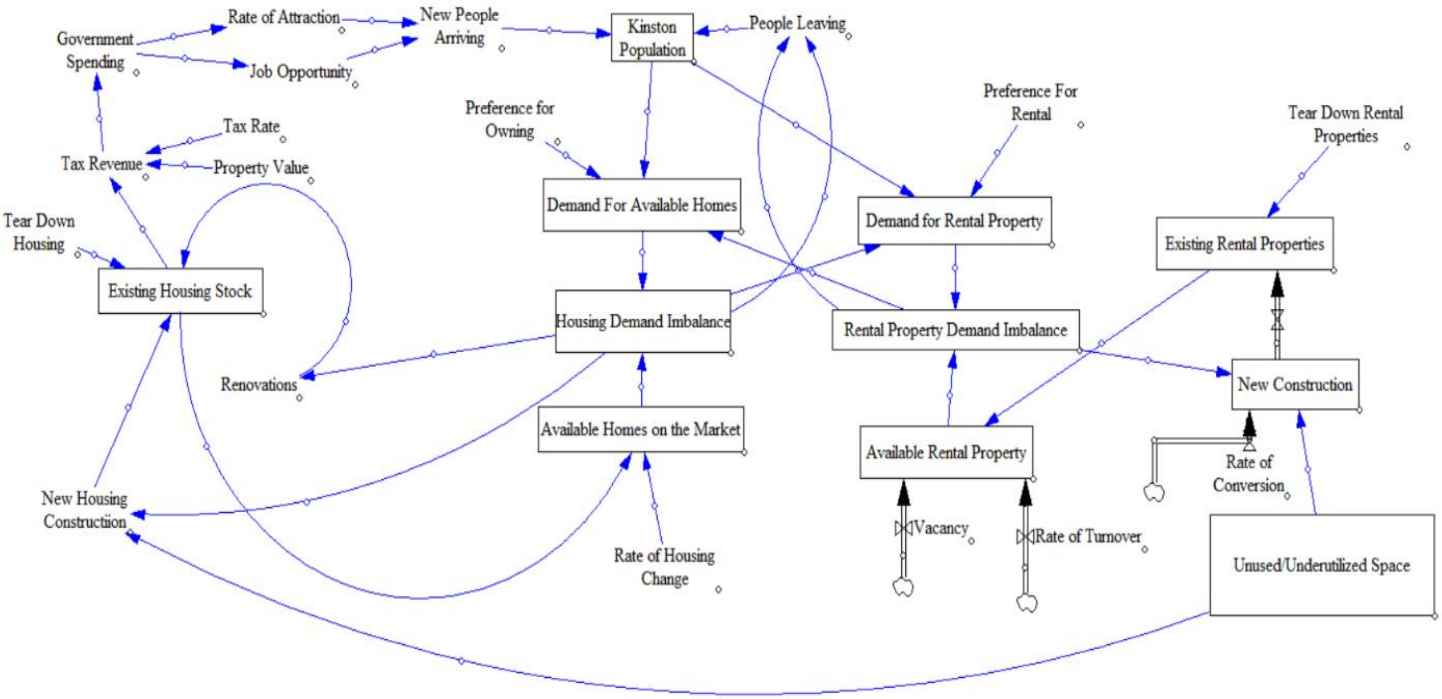

Figure 2 SD Model of Kinston

Major stocks included in the SD model of Kinston include Kinston's population, existing housing stock, and existing rental properties. Also, Kinston's emerging art culture and training programs would have also been considered had it not been for COVID-19 interference.

To ensure understanding, it is important to break down the above model into smaller parts and see where it leads. Kinston's population is at the top center of the model. This is a stock, or accumulation of Kinston's citizens. The population is affected by the amount of new people arriving and the number of existing citizens that leave. These two rates of change are flows. New people arriving is directly attributed to both the rate of attraction for Kinston and the job opportunities present to support this incoming population. As Kinston becomes more attractive than surrounding areas, new people will begin to migrate to Kinston. This cycle will continue until the increased amount of people decrease the

area's attraction for other potential incoming residents as job opportunities are taken and residential space reaches capacity and prices rise.

Existing housing stock is a major concern for any rural area. Housing stock directly contributes to real estate tax revenue which is determined by property value and the tax rate charged in that area. As new homes are constructed, this existing housing stock increases which in turn increases tax revenue. However, as homes are torn down, the amount of homes available decreases which can negatively impact tax revenue. Both the construction and demolition of homes are flows that affect the stock of homes. At the same time, the renovation of homes that already exist is another way that revenue can be affected without changing the housing stock. While renovations do change the quality of housing, this model only counts the housing stock; therefore, renovations are not included as flows within this model.

The population of Kinston affects both the demand for owning homes and the demand for renting properties. The preference of owning and the preference for renting will, in theory, equal 1. If demand for home ownership does not equal the available homes on the market, there will be a gap. In the model, this gap will be referred to as a housing demand imbalance. This housing demand imbalance has multiple impacts. The disparity between homes available and demand can lead to an increase in the renovation of existing homes. This will indirectly lead to a positive feedback as the increase in property value will then increase the demand for available homes thus increasing the imbalance further.

Another potential consequence of this housing demand imbalance is an increase in demand for rental properties. If people are unable to purchase a home, they can turn to the rental market to obtain housing. Similar to the disparity between demand for owning a house and the available homes on the market, a discrepancy may exist between the demand for rental property and the available rental property. This second gap will be referred to as a rental property demand imbalance in the model. As demand for rental property increases due to the housing demand imbalance, the rental property demand imbalance begins to widen as well. This second imbalance thus contributes to the demand for owning homes as rental units fill up.

A third potential consequence of the housing demand imbalance is an increase in the construction of new homes. A limiting factor on this new construction is the amount of available or underutilized land. The amount of land available in the present affects the amount of construction that can occur. As demand for homes increases, public or private money will react to increase supply. If the amount of available land becomes an issue, demolition of existing properties may also increase to make room for new construction.

Existing rental properties are another major stock that must be examined. Similar to existing housing stock, existing rental properties increase when new construction takes place and decreases when existing stock is torn down. Available rental properties are the existing rental properties after considering rate of turnover and vacancy rates in Kinston. As described earlier, a discrepancy may exist between the demand for rental property and the available rental property. This discrepancy is illustrated by rental property demand imbalance.

This rental property demand imbalance has many potential consequences. There is a positive relationship between the change in rental property demand imbalance and the amount of new construction. As the imbalance between demand and available rental property widens, new

construction of rental properties will take place. This construction will take up unused or underutilized space thus affecting the amount of new construction for new homes or businesses.

Briefly explained earlier, the rental property demand imbalance will also directly affect the demand for available homes. If Kinston's population is not able to rent, they may look to purchase homes. This increase in demand for owning property will then widen the housing demand imbalance and accelerate the consequences explained earlier.

Together, both imbalances contribute to the amount of people who have to leave Kinston. If there are no available places to live, they must locate in a different area. There is a direct positive relationship between the imbalances and the people who leave. As both the rental property demand imbalance and the housing demand imbalance increase, the amount of departures will also increase.

Kinston's desire to attract artist would have played an interesting role in the model. The incoming artists require a place to live, thus increasing demand for available homes and rental properties. Also, the presence of an artistic community would increase the rate of attraction for Kinston as well as tourism. As artists contribute to the aesthetics downtown, the area becomes physically more attractive. Tourists are drawn to the new artistic community and are willing to spend money downtown thus increasing city revenue. This injection of revenue allows for an increase in government spending which leads to an increase in the rate of attraction as well as job opportunities.

Another interesting impactor of this model would have been the presence of training programs in Kinston. Earlier, the Global Transpark was mentioned as a positive for Kinston as a case study. The presence of this Transpark has led to Lenoir Community College creating training programs to help supply available, qualified workers. This training program potentially will affect many areas such as demand for home ownership and rental property, area attractiveness, job opportunity, and the renovation of already existing homes.

What does this mean for Kinston?

In interviews with community stakeholders, optimism is high for continuing revitalization in the downtown area. This model presents a concrete way to test potential policy initiatives and weed out ineffective ideas.

The model will improve the odds that Kinston achieves desired outcomes. As previously explained, one common problem with city planning are unexpected consequences of policies that may actually be counterproductive. This model provides an in-depth analysis by providing examples of things that can occur if a policy is initiated. Although SD does not provide an end destination for the town of Kinston, it does help give a roadmap to aid in their achievement of Rural Revitalization.

The hope is to provide a resource for Kinston to accelerate their journey. This model will help enhance their thinking to ensure that all interconnections are considered and accounted for before making a policy decision. Although not giving a concrete finalized plan, it will help increase efficiency by reducing the number of ineffective projects set in place.

It also can be used to pinpoint current initiatives that should be scrapped or modified. Instead of Kinston having to wait 3-5 years to realize a policy is not achieving desired results, they can run the policy through this model to ensure they have the best idea in place to achieve that outcome.

How it can be used in other communities

Overall, Kinston provides an informative case study of how SD can be used to promote Rural Revitalization anywhere. Not all rural communities will share the same priorities as Kinston. Kinston has a unique goal of becoming a tourist location in Eastern North Carolina. Other communities may value education, art, etc. to a higher degree. Although this study included Kinston's specific resources, opportunities, and deficiencies, the modeling process can be replicated anywhere.

Recruiting and interviewing stakeholders in a community is a powerful way to promote change. The increased collaboration between influential individuals promotes a more interconnected urban planning process which can accelerate and possibly improve outcomes. The possible introduction of key personnel to one another is in itself valuable. SD allows this to go a step further by illustrating the whole picture to each member involved. As the interconnections between system parts become more visible, new ideas and initiatives begin to formulate.

The fostering of new creative ideas is not the end, however. Community stakeholder buy-in is essential for any area that wishes to undergo Rural Revitalization. One or two motivated individuals is usually not sufficient when undergoing such a daunting task. Forming a group of highly motivated, influential stakeholders increases the probability of success due to the additional resources, connections, and differing points of view based on each person's personal expertise.

Being able to understand how differing initiatives are interconnected provides an invaluable perspective to future policy initiatives. Treating the city like one huge community project will yield differing results than each individual working separately on just one potential subsystem of the larger picture.

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