

Article

# Using a System Dynamics Simulation Model to Identify Leverage Points for Reducing Youth Homelessness in Connecticut

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**Abstract:** Youth homelessness is a significant problem in most United States communities. Health problems are both a contributor to and a consequence of homelessness. Responses to youth homelessness are typically fragmentary. Different agencies deal with various causes and consequences of the problem. Stakeholders in Connecticut sought a more coherent approach. This article describes the development and use of a system dynamics simulation model as a decision-support tool that: (1) brings stakeholders together from diverse service sectors and allows them to see the system as a whole, (2) enables them to explore how delivery systems interact to affect homeless and unstably housed youth, (3) lets them test the impact of different intervention alternatives on reducing the problem, and (4) helps develop insights about coherent approaches to youth homelessness. The model's development is described as a phased process including stakeholder engagement, causal mapping, and creation of the quantitative simulation model. The resulting model is presented along with an interface that enables stakeholders to use the model in a Learning Lab setting. Results of an initial set of Learning Labs are presented, including types of insights gained by participants from using the simulation model. Conclusions include limitations of the model and plans for its future use.

**Keywords:** youth homelessness; system dynamics; child welfare; juvenile justice; mental health



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## 1. Introduction

### 1.1. Magnitude of Youth Homelessness as a Problem

Most communities across the United States are struggling to address the complex and persistent problem of youth homelessness. In 2017, an estimated 4.3% of teens (13–17 years old) and 12.5% of young adults (18–25 years old) experienced some form of homelessness [1]. Homelessness among youth is typically defined as unaccompanied youth between 14- and 24-years old who are living apart from parents/guardians and who lack a fixed, regular, and adequate residence (e.g., living in shelters, on the streets, in cars or vacant buildings, or who are “couch surfing” or living in other unstable circumstances) [2]. Young people find themselves without homes for many reasons, including family conflicts, mental health and substance use problems, early pregnancy and parenting, coping with the effects of sexual and/or gender minority status, fleeing domestic or sexual violence, and leaving child welfare or juvenile justice systems without adequate skills or support [3–5]. The impact of homelessness on youth and society is extensive. Evidence suggests that periods of homelessness lead to higher rates of substance use, sexual risk behaviors, early parenthood, unemployment, incarceration, mental illness, suicide, injury due to physical violence, and poor educational and health outcomes [6–16].

Young people experiencing homelessness have histories of contact with multiple systems—education, child welfare, mental health, and juvenile/criminal justice—yet no entity has ongoing responsibility for them. For example, approximately 44% of homeless

youth in a national study indicated that they had been in foster care [17]. A study following a sample of adolescents who left the foster care system two years prior found that 43% endured housing instability since their exit from foster care, and 20% experienced chronic homelessness [18]. These young people experiencing housing instability reported having spent time in foster care, inpatient mental health settings, juvenile detention, or jail [18]. Effective solutions to addressing youth homelessness will involve coordination and collaboration among multiple system stakeholders and a holistic understanding of the factors and dynamics that influence the issue.

### *1.2. Case Study: Connecticut's Mission to Address Youth Homelessness*

This article describes a system dynamics simulation model developed in partnership with a cross-sector coalition of youth-serving providers and young people with lived experience of homelessness in Connecticut (CT). The coalition has been meeting since 2012 with the mission to end youth homelessness across the state. At the time of model development, the total population projection by 2015 in CT was nearly 3.6 million people, with 191,056 minors (ages 14–17) and 348,167 young adults (ages 18–24) [19]. In 2019, an estimated 28.7% of young people (ages 14–24) had reported experiencing a form of homelessness in CT, which is greater than the national prevalence estimate [1,20]. Of those who were experiencing housing instability or homelessness, approximately half had experienced literal homelessness (e.g., sleeping outside, in a shelter, or other places not meant for human habitation) while the remaining individuals had been living in precarious housing situations, such as staying with others and moving frequently from place to place while unaccompanied by a parent [20]. Over half of the young adults experiencing housing instability and homelessness had a history of criminal justice involvement (56.7%), and over 80% had been involved in foster care [20]. To prevent this ongoing cycle between homelessness and involvement in state systems, the coalition hoped to develop a coordinated response that would address the varied and unique needs of young people who are at risk of or experiencing homelessness.

Connecticut's goals aligned with the United States Interagency Council on Homelessness (USICH) national strategic plan to prevent and end homelessness by making youth homelessness rare, brief and non-recurring [21,22]. This means: (a) driving down the number of youth experiencing housing instability/homelessness to as close to zero as possible; (b) enhancing and coordinating systems and interventions to prevent new youth from entering into housing instability/homelessness; (c) quickly identifying and rapidly providing necessary assistance when a youth does fall into housing instability/homelessness; and (d) ensuring formerly homeless youth have the tools to remain in stable housing.

A number of problems interfered with developing a coherent approach to youth homelessness in CT. One was simply a lack of consensus about definitions of homelessness, complicated by different definitions used by Federal programs. Another was the lack of compatible data systems and protocols which prevented sharing of data needed to provide a complete picture of youth homelessness. There also was not a history of coordination among agencies that were dealing with the same population of at-risk and housing-unstable youth. Finally, there was an acknowledged shortage of housing and other resources that resulted in too many youths not receiving the help they needed and suffering more serious and long-lasting consequences as a result. It was hoped that the modeling effort would highlight these problems and point the way to practical solutions.

### *1.3. Role of System Dynamics in Addressing Youth Homelessness in Connecticut*

Connecticut stakeholders sought the use of a system dynamics simulation model as a decision-making tool that would bring stakeholders together from diverse service sectors and allow them to see the system as a whole, explore how intervention delivery systems interact, and determine the impact that state policy might have on solving the problem. The aims were to help stakeholders develop and use the simulation model to identify the best combination of interventions and avoid unintended impacts, coordinate services

across systems, and garner support for resource allocation and policy change. Due to the geographic diversity (urban, rural, and suburban) and differences in available resources across the state, stakeholder planning and coordination occurred both at the regional and statewide levels. Therefore, a model was needed that can be used in planning statewide efforts and also adapted to particular regions.

Prior to initiating the modeling process, the coalition had been using an Excel spreadsheet to estimate the number of housing resources that would be needed based on a population of young people with diverse needs. However, they expressed a desire for a tool that would allow them to project the dynamics of movement into and out of homelessness for young people, visually map the intersections between systems of care (e.g., child welfare, justice, mental health), and assess how specific policies and prevention strategies could reduce the inflow of young people into homelessness and result in a reduced need for housing resources. The purpose of this paper is to describe the processes by which stakeholders came together and formed a core modeling and data team (CMDT), developed an initial causal map that embodied their understanding of the system of forces responsible for youth homelessness, created a simulation model based on that understanding along with an interface that enabled stakeholders to use the model themselves, and derived insights from using the simulation model in a series of Learning Labs.

## 2. Methodology

Solving a complex problem such as youth homelessness requires collaboration in a community setting and across multiple sectors. We used a community-based group model building (GMB) approach to engage diverse stakeholders in the process of systems thinking and developing system dynamics models [23,24]. GMB is an intentional approach to model building that is participatory and embedded in the community, involving stakeholders as partners in the modeling process from defining the problem to developing and using models to implement changes [25]. This direct involvement leads to a better model as well as enhanced capacity for the use of systems thinking, more effective collaborations, and increased ability to implement changes based on system insights gained through the process. We also used the Typology of Youth Participation and Empowerment (TYPE) Pyramid framework for effective youth–adult partnerships in the modeling process [26]. The TYPE Pyramid articulates different configurations of youth–adult control that reflect optimal participation for youth empowerment and positive youth development. Youth–adult partnerships are crucial to creating solutions that are effective, relevant, and responsive to youth needs.

The project was divided into four major phases to support the involvement of a large number of stakeholders, providing the broadest perspectives possible from many vantage points. The four phases involved: (1) forming a core modeling team to co-design a modeling process; (2) mapping the causal factors and the relationships between them; (3) co-developing a simulation model; and (4) building stakeholders' capacity to use the model for gaining system insights. The project was implemented between March 2017 to March 2023. Overall, 126 system stakeholders participated in the modeling process. Each stakeholder was selected based on their expertise with different systems that touch the lives of young people who experience homelessness. A total of 97 front-line service providers, service directors, and policymakers participated. Young people ( $n = 29$ ) with lived expertise of youth homelessness and the service systems were involved in all phases of the project, including on the core modeling team.

### 2.1. Forming a Core Modeling Team and Engaging Stakeholders (Phase 1)

The Youth Homelessness System Dynamics Modeling project was initiated by the community, specifically, a statewide taskforce focused on addressing youth homelessness in CT. The second author, as a member of this taskforce, was approached by coalition partners to lead and facilitate the system dynamics modeling (SDM) process. All decisions regarding the SDM process were made in collaboration with taskforce members which

consisted of 30–40 representatives of youth-serving institutions, community-based service providers, policymakers, and advocates.

Twelve individuals from the taskforce formed the “core modeling and data team” (CMDT) responsible for designing the causal mapping process. The CMDT consisted of four young people (17–24 years old) with lived experience of youth homelessness, a senior-level representative from the CT Department of Housing and one from the CT Department of Children and Families, a director of a social service organization, a director of a community-based organization, two housing/homelessness policy analysts, an attorney/legislative advocate for homeless youth, and a researcher/system scientist (second author HM). The CMDT met six times between March and July 2017 to select stakeholders to participate in all phases of the modeling process, to plan, design, and co-facilitate the GMB workshops and to review synthesized causal maps. The CMDT defined the goals of phase 1 as: (a) build strong collaborations across systems, (b) develop a shared problem definition and language, (c) build systems thinking, and (d) create a shared understanding of causal pathways driving youth homelessness by using causal mapping.

As an initial step in identifying stakeholders to participate in the modeling process (e.g., GMB workshops, model review sessions, simulation model workshops), the team identified seven areas of stakeholder expertise needed for creating a holistic understanding of the causal pathways involved in youth homelessness and for building confidence in the model. These areas of expertise included: housing, health/mental health, education, employment, child welfare, juvenile/criminal justice, and parenting as a teen/young adult. The group carried out stakeholder analysis using a power/interest grid stakeholder mapping tool [27] to strategically plan who and how different stakeholders were to be meaningfully engaged in the project and modeling process. To increase diversity, additional factors were considered in the selection process, including stakeholder demographics (race, ethnicity, gender, and sexual orientation), geographic expertise within CT, and role/perspective (e.g., service-user, front-line service providers, director/management, policymakers, data expert).

## 2.2. Causal Mapping (Phase 2)

Over a hundred ( $n = 108$ ) system stakeholders from across the state—including 29 young people (14–24 years old) who had experienced housing instability/homelessness—participated in the causal mapping process. The process involved thirteen separate GMB workshops (with different stakeholders) and three model review sessions (same stakeholders across the three sessions) to map and validate the structural dynamics that drive the problem of youth homelessness in CT, and to build systems thinking and collaboration among stakeholders. Professionals did not receive monetary incentives for participating in the modeling process. However, service users (young adults who had experienced homelessness) received \$50 each to participate in a GMB session.

Each GMB workshop was 4 h long and consisted of short orientation presentations and a sequence of structured small group activities called “scripts” [28] that focus on different goals of the modeling process and support team decision making that results in useful products and insights for community stakeholders by the end of the workshop. The workshop sequence started with a “Hopes and Fears” activity to understand group expectations for the GMB sessions and products [29] and then a variable elicitation activity called “Connection Circles” to elicit information about the factors that affect or are affected by youth homelessness. These variables were used in “Causal Mapping in Small Groups” where subgroups worked together to map key causal factors and their relationships in a causal loop diagram. Time was set aside for breaks, discussion, and model reflections between scripted activities to identify and understand the main feedback loops in the diagrams. The “Action Ideas” and “Dots” activities were used at the end of the workshop to brainstorm, prioritize potential actions to impact variables, and emphasize connections between variables. Detailed procedures for executing each script can be viewed online from Scriptapedia [30].

During the GMB sessions, the CMDT served as presenters, reflectors, runners, and wall-builders. HM functioned as a community facilitator and three staff researchers at the Institute for Community Research served as ethnographers/notetakers. GMB experts from Washington University in St. Louis supported HM and the CMDT in the design and facilitation of the GMB workshops and in developing systematic procedures for model synthesis and review/refinement.

Raw data (small group causal maps) from GMB sessions were synthesized by HM into a causal map that integrated key variables and feedback relationships found in participants' maps. The synthesis involved transferring individual hand-drawn causal maps into STELLA Architect [31], identifying the most common variables and links among variables across the maps using content analysis [32], and then creating a synthesized causal diagram that included the variables in common that had the most links [24]. Validation occurred iteratively in stakeholder model review sessions [33], which were used to seek participant feedback on synthesized maps, insights and stories, and to check researcher interpretation. The review involved stakeholder feedback on a synthesized map created by HM, discussing each variable and causal link to ensure it had face validity and was supported by stakeholders' knowledge and the literature. Synthesized maps were revised through feedback from subsequent GMB and model review sessions, and consultation with the existing literature. The process resulted in 12 interconnected causal maps that visually described "stories" of stakeholders' shared understanding of what is driving the youth homelessness problem. The rich qualitative information collected through this process was used in the next phase of modeling as well as in CT's HUD Youth Homelessness Demonstration Project (YHDP) planning phase to develop collective goals, objectives, and action steps in the Coordinated Community Plan.

### *2.3. Developing the Simulation Model (Phase 3)*

To initiate this next phase, the CMDT invited an additional six members to replace one representative of the CT Department of Children and Families, who transitioned jobs, and to address gaps in expertise. New members included a data expert at the CT Department of Mental Health and Addiction Services/Young Adult Services, a policy expert in juvenile justice systems, a researcher/scholar from the University of New Haven with expertise in justice systems, a senior-level representative from CT Court Support Services Division, and a senior level expert from the youth and adult employment sector. (See Appendix A for CMDT members' organizations.) This phase began with the co-authors facilitating a 4 h workshop with the CMDT to orient new members to the project and system dynamics concepts, practice systems thinking, and refine and expand on an initial stock-and-flow diagram seed structure. Stocks and flows in the initial diagram were identified through the co-authors' initial content analysis of the stories depicted in the qualitative maps from the previous phase that described the factors and relationships that led to youth homelessness and caused it to remain a serious problem. The workshop ended with a number of products: a parallel stock-and-flow structure that separated young people based on their age grouping (minors and young adults), shared definitions of the different stocks, and an initial list of the most important causal factors affecting each of the flows. Follow-up interviews with eight members of the CMDT were conducted to elicit more in-depth feedback on the model structure. Changes were critiqued, discussed, and refined in several subsequent CMDT meetings before settling on a final set that formed the "backbone" of the model. The causal factors determining the rates of flow were identified first by the CMDT and through analysis of the causal maps in the previous phase. Then, these factors were compared and prioritized based on an extensive review of the youth homelessness literature and feedback from our CMDT that included young people who had experienced housing instability. The estimates on the effects of these factors were extensively reviewed with the CMDT and other experts and adjusted as necessary.

The research team requested secondary quantitative data from institutions participating in the modeling process. The specific data needed for modeling was identified by

stakeholders. The co-authors met with data experts from eight different institutions and submitted data sharing requests to obtain data in aggregate form with no identifying information. CMDT members helped facilitate the data request process within their agencies. Data were collected from: The Department of Housing, The Department of Corrections, The Court Support Services Division, The Department of Mental Health and Addiction Services, The Department of Education, The Department of Labor, The Department of Children and Families, and the United Way (2-1-1 helpline data).

The next task was to quantify the relationships in the model so that it could be used to simulate the impact of various interventions, by themselves and in various combinations. Some of the data assumptions in the model include:

1. Initial populations in various statuses, corresponding with stocks in the model. These come from various data sources or estimation procedures carried out by respected authorities. Some of these are further adjusted based on estimates derived from the youth homelessness literature, for example, dividing the initial population of homeless young adults into groups of those experiencing homelessness for the first time and those that endure repeated homelessness. These are presented in Table S1 in the Supplementary Materials.
2. Assumptions based on the youth homelessness literature and discussions of our CMDT that assign numerical values to concepts in the literature. Some of these numerical assumptions are not based on particular values derived from the literature as much as a sense of the relative strength of the causal relationships they represent, based on those discussions with the CMDT. These are presented in Table S2A–E in the Supplementary Materials.
3. An additional set of model parameters came from calibrating the model to produce what we believed was a reasonable baseline simulation, one that projects current trends and assumes no major new initiatives to prevent or remediate youth homelessness. We considered a number of trends in unstable housing and homelessness in youth, both locally and nationally. Some were growing, others declining. There was no definitive trend apparent. The CMDT confirmed that a stable trend going into the future was the most likely scenario. Therefore, we decided to settle on a baseline simulation that projected constant levels of unstable housing and homelessness for youth. The calibration process then consisted of calculating the fractions of minors and young adults flowing from one status to the next (e.g., from At Risk to Unstably Housed) over a given period that would maintain (relatively) stable numbers in each status as the simulation progressed over a ten-year period. These are presented in Table S3 in the Supplementary Materials for each section of the model. Table S3 also contains data derived from the CT CAN (Coordinated Access Network) Data Dashboards ([ctcandata.org](http://ctcandata.org)) on Temporary and Supportive Housing programs, the average lengths of time youth spend in those programs, and the fractions of various outcomes upon leaving those programs.
4. Data on the costs of homelessness and of various interventions to reduce homelessness, taken from various studies and used to calculate social costs and program costs, both on a monthly and cumulative basis. These are presented in Table S4 in the Supplementary Materials. Calculating these costs and resultant savings due to various interventions enables the model to project resources that can be freed up and reinvested in those interventions.

The simulation model was validated through an iterative process of model review sessions and interviews with additional experts. Data and assumptions used to quantify the model were critiqued by the CMDT over several group sessions and through member-checking with content and data experts to verify the credibility of parameters in the model. For example, we consulted with six experts outside of the CMDT to verify model assumptions related to child welfare service populations. Through these consultations, we were able to build consensus on parameters such as the proportions and relative risks of unaccompanied homelessness for minors receiving in-home services as compared to that

of minors receiving out-of-home care and the proportion of out-of-home youth who have a history of behavioral health needs, among others. Validation of the model against historical data was not possible due to a lack of reliable longitudinal data on youth experiencing unstable housing and homelessness. The point-in-time counts of homeless youth most often cited significantly undercount their numbers. Estimates of actual numbers of homeless and unstably housed youth came from a methodology derived by Dr. Stephen Adair for the Connecticut Coalition to End Homelessness [20]. The CMDT and other experts supported the assumption that those numbers going forward would remain relatively constant in the absence of any additional or stronger interventions. Interventions represented in the model were tested to assure that their effects were realistic and, in the process, also indicated that the model was responding appropriately to various inputs.

#### 2.4. Building Stakeholders' Capacity to Use the Model (Phase 4)

The CMDT hosted five virtual 1.5 h workshops, or Learning Labs, with key stakeholders via Zoom to build the stakeholders' capacity to use the model for testing and analyzing different combinations of strategies and to plan for implementing model insights. The workshop series began with an orientation on the model structure, a simulation demonstration, and time for individual hands-on play and practice with the model. Subsequent workshops involved an iterative process of structured activities for stakeholders to explore testing different scenarios and then refining strategies based on insights. The results of simulation runs were recorded by stakeholders using an intervention impact summary matrix that allowed stakeholders to analyze results by easily comparing across scenarios and creating higher order metrics to understand how different strategies performed on key objectives. Stakeholders' feedback and insights were recorded on a whiteboard and through detailed ethnographic field notes during the Learning Lab, then discussed by stakeholders to build a shared understanding of the underlying dynamics generating the observed behavior. The large number and varied simulations run during these labs provided additional opportunities to test the model and make adjustments when the results seemed questionable.

### 3. Results

#### 3.1. Model Structure

Figure 1 depicts the basic flow structure of the Youth Homelessness Model. The population represented is for the entire state of Connecticut and is divided into minors (ages 14–17) and young adults (ages 18–24). Additional versions specific to regions of the state are currently being implemented using the same model structure and region-specific data. The boxes represent statuses with respect to stable housing (Stably Housed), risk (At Risk), unstable housing and homelessness (Unstably Housed and Homeless), and recovering from instability/homelessness (Stably Housed Formerly Homeless).

Horizontal arrows indicate flows among statuses as minors and young adults become at risk, become unstably housed or homeless, and potentially become stably housed again. Formerly homeless minors and young adults can also fall back into unstable housing and homelessness. Vertical arrows simply represent aging as minors reach age 18 and become young adults. Young adults age out of the youth-serving homelessness system as they reach age 25.

The majority of minors and young adults are in the two left-hand boxes and are either living with family or other guardians or are on their own in stable housing situations and considered not at risk of becoming unstably housed or homeless. These numbers come from state population data. How do we consider someone at risk of unstable housing and homelessness? How large a group do we assign to this status? There are many ways of determining risk. One that seemed appropriate was based on the experience of Adverse Childhood Experiences (ACEs). The connection between ACEs and homelessness is supported by a number of citations from the literature [34,35]. Examples of ACEs include experiencing violence within the family and living with someone who has had mental

health or substance abuse problems [34]. An extensive body of literature shows that individual ACEs can impact young people's development in a dose–response manner. For example, the higher number of ACEs experienced, the greater the likelihood of poor physical and mental health outcomes, less successful educational attainment, and reduced workforce success [36–43]. Research also shows a relationship between ACEs and unstable housing and homelessness, suggesting that young people who have had three or more ACEs are at more chronic risk and have a greater likelihood of homelessness [44–49]. National prevalence research suggests that about 17% of young people in the US meet this criterion [45,46]. We applied this percentage to estimate the total number of minors and young adults at risk.

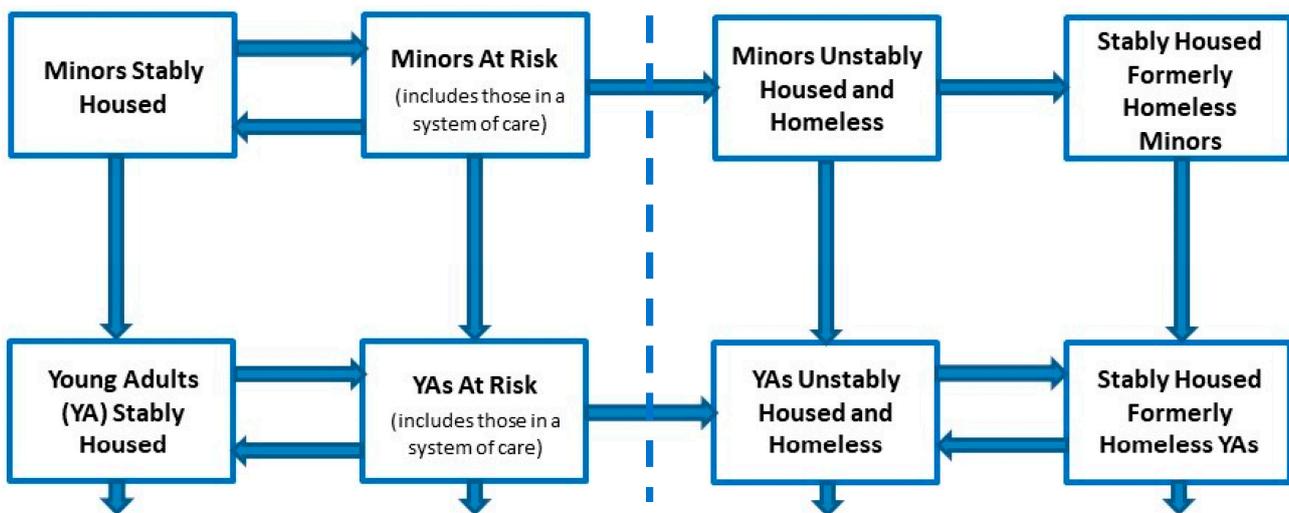


Figure 1. Overview of Model Flow Structure.

Minors and young adults at risk of housing instability or homelessness fall into two categories. One category consists of those at home with their families who are not part of an organized System of Care (SOC). An SOC is a system/institution that coherently provides services with case management or other oversight that can provide or refer clients to the services that they need (e.g., child welfare). These young people at home with their families are deemed at risk of becoming unstably housed or homeless due to family conflict, potential physical, emotional, or sexual abuse, and/or mental health and substance abuse problems suffered by themselves, their parents, or other family members. Evidence supports that these risk factors are strong predictors of youth and young adult homelessness [50–54].

The remainder of at-risk youth are in some form of SOC. Two of these SOCs are represented for minors: The Department of Children and Families (DCF) and the Juvenile Justice System. Four are represented for Young Adults: DCF, Criminal Justice, Department of Mental Health, and Department of Labor (Job Training). The numbers of minors and young adults were provided by the relevant SOCs and were subtracted from the total numbers assumed to be at risk to obtain the number of those not in an SOC. Some of the young people in SOCs may remain at home with their families, but they remain connected to the SOC under the supervision of a caseworker or probation officer; others are in residential settings. Remaining connected to an SOC with case management can serve as a protective factor for young people who are at risk of homelessness. However, these young people can become at greater risk when discharged from SOCs. Without teaching them the necessary skills and offering careful discharge planning, young people leaving systems of care can “fall through the cracks” and become unstably housed or homeless once they leave [55].

The model represents two types of housing instability for minors and three for young adults. Being unstably housed means that a young person is nominally off the street and living in a domicile fit for human habitation but is not in a secure situation and can be

ejected at any time. This status is sometimes referred to as “couch surfing.” While typically viewed as less dangerous than homelessness, those who are unstably housed are often at risk of abuse and exploitation from people with whom they are staying [56–60]. For minors especially, the lack of adult supervision leaves them vulnerable to additional risks.

Homelessness means having no domicile designed for human habitation (e.g., living under a bridge or in a park). This naturally exposes a young person to additional risk of harm and exploitation as well as being injurious to their physical and mental health. The impacts of homelessness feed on themselves and make it even more difficult to help a young person find stable housing [61].

A third status for young adults is repeated homelessness, which is more than one episode of homelessness. People in this status typically have accumulated more trauma and are at risk of more serious drug abuse and mental health issues and can require more extensive housing and wrap-around services [62,63].

The vertical dashed line and unidirectional arrows between at-risk and unstably housed statuses in Figure 1 indicate that young people remain at risk if they have experienced housing instability or homelessness in the past. This assumption came from a large body of literature and consensus among the CMDT. Experiencing housing instability/homelessness has long-term effects on young people’s mental health, physical health, and financial and future housing stability [64–72]. These young people cannot return to the At-Risk and Stably Housed statuses that represent individuals who have not experienced housing instability. They are a different population of youth who might need a different set of interventions. As someone continues to experience homelessness, they accumulate trauma and stabilization becomes more difficult. Young people who have experienced homelessness can still become housed but remain chronically at risk due to cumulative trauma resulting from experiencing homelessness [36].

Estimating the number of youth experiencing unstable housing and homelessness is difficult [73]. “Point-in-Time (PIT) counts” are a method of trying to rigorously count numbers of people experiencing homelessness on a particular day, but are generally recognized to be undercounted because of the limited ability to accurately identify youth experiencing homelessness and unstable housing, as this population experiences more hidden forms of homelessness and tends to avoid shelters [14,74,75]. These counts also would miss many of those young people who are unstably housed. We relied instead on a Youth Outreach and Count methodology in Connecticut that added a robust element of data that addressed some of the limitations of the PIT Count by including youth from a wide variety of community contexts (e.g., schools, popular gathering spots, and youth programs) and executing the Youth Outreach and Count for a full week.

Even this more rigorous method of counting could miss some youth facing housing instability. As indicated earlier, further refinement and extension of these enhanced Point in Time Counts was based on a methodology developed by Professor Stephen Adair of Central Connecticut State University. Professor Adair started with the number of people reporting at least one night in a shelter, developed estimates of the numbers who were unstably housed and homeless for each city and town in Connecticut, and aggregated upward for the state as a whole. Detailed information on the Youth Outreach and Count and estimation methodology can be found in the 2019 PIT report on the Connecticut Coalition to End Homelessness website [20].

Formerly homeless young people who are stably housed may be placed in housing designated specifically for this population on a temporary or permanent basis or in a regular apartment with some supportive services. As suggested in Figure 1, they continue to be at risk of future homelessness and may fall back into housing instability and homelessness.

The behavior of the model is determined by the stock-and-flow structure shown in Figure 1, the model’s causal structure, the magnitude of interventions applied by model users, and the places in which those interventions impact the flows of youth through the system. An overview of the causal structure affecting young adults is shown in Figure 2. It indicates that the trajectory of housing instability and homelessness is determined by a

set of reinforcing loops that can worsen the problem and balancing loops that can limit or reduce its magnitude.

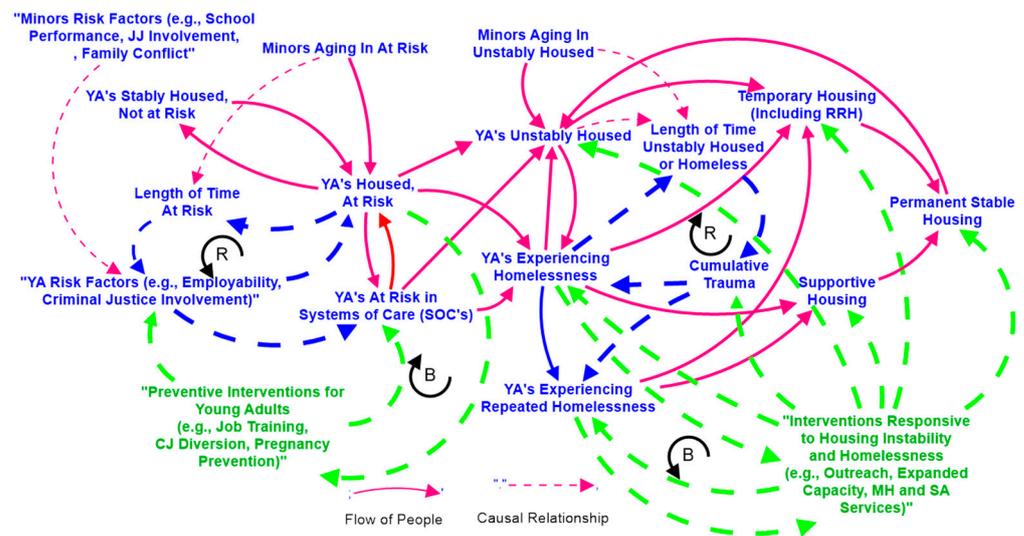


Figure 2. Overview of Model Causal Structure for Young Adults.

One set of reinforcing loops (represented by blue dotted lines) involves the numbers of young adults at risk of housing instability and the length of time they remain at risk. Longer times spent at risk increase the likelihood and severity of risk factors, such as involvement in the criminal justice system, and further lengthen the time at risk and maintain a greater at-risk number. The other set of reinforcing loops acts on young adults once they become unstably housed or homeless. Longer times spent unstably housed make it more likely that they will be exposed to risks such as mental illness and substance abuse disorders that cause them to become homeless. Once homeless, longer times on the street expose them to additional risks and increase the cumulative trauma of homelessness that can result in repeated episodes of homelessness and additional trauma. As with any reinforcing loops, efforts that reduce the lengths of time unstably housed or homeless and cumulative trauma can lead to further improvements and reductions in the number of youths dealing with these problems.

Working against these reinforcing loops are balancing loops, which reduce the risks of homelessness, the numbers of youth unstably housed and homeless, and the trauma arising from homelessness. One set of balancing loops (represented by the green dotted lines) includes interventions designed to reduce risks such as diverting young adults from criminal justice, better preparing them for jobs, or helping them deal with mental health or substance abuse conditions. These interventions can reduce the length of time and number of young adults who remain at risk. The other set of balancing loops includes services directed at young adults who have already become unstably housed or homeless. These services can reduce the number and length of time that they experience housing instability or homelessness by finding them temporary or supportive housing, or reducing cumulative trauma through care for mental health and substance abuse problems. Model users, working through an interface described below, can increase the intensity of these interventions and observe their impact on the number of youths experiencing unstable housing and homelessness. They can investigate what combinations will yield the best overall result in reducing the burden of youth housing instability. The effects of more intense interventions can be amplified by the reinforcing loops diagrammed in Figure 2 and have a greater impact.

Figure 3 indicates the full set of interventions that can be used in different combinations, where in the model they have their effect, and the assumed strength of those effects. Assumptions about the impact of various interventions were not based on single quanti-

ties derived from the literature, since there were usually multiple studies that indicated different impacts. Instead, they were estimates based on a sense of the relative impacts suggested by multiple studies. These are described further in the document “Intervention Descriptions” (Appendix B).

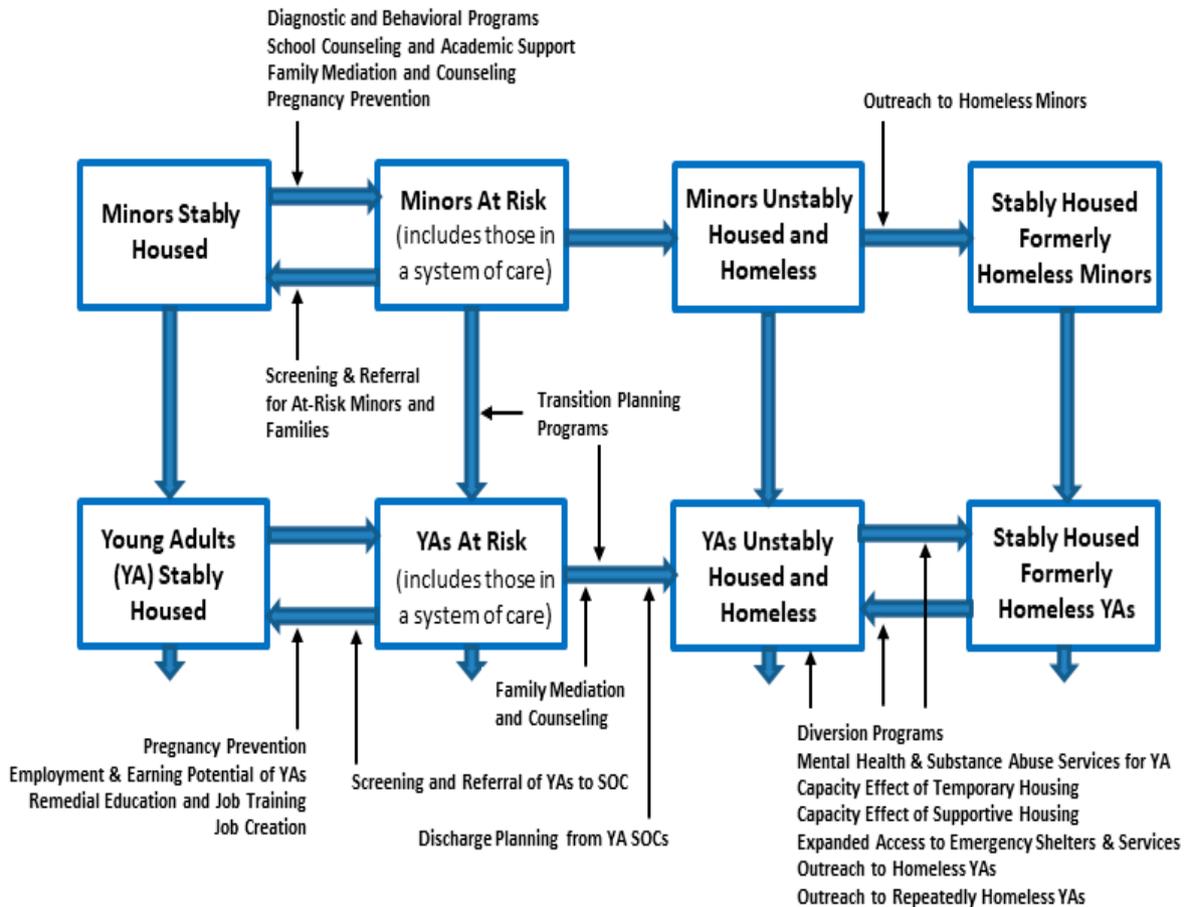


Figure 3. Interventions Available to Model Users and Their Assumed Points of Impact.

### 3.2. Model Interface

An interface was created to enable users to directly access the model without being familiar with the Stella modeling language. Figure 4 displays the Simulator Dashboard screen on which users can select initiatives to include in simulated strategies and compare high-level results achieved with different strategies. Figure 5 displays one of the screens with more detailed simulation results, on which users can “drill down” to better understand what is going on in the different simulations. That screen features specific results related to young adults’ housing instability.

### 3.3. Using the Simulator

Users work from the simulator’s Dashboard to set up and run scenarios with various interventions selected. They typically start by generating a baseline run to serve as a basis for comparison. As indicated earlier, the baseline simulation reflects an underlying set of assumptions that the number of minors and young adults experiencing housing instability and homelessness in Connecticut is likely to remain stable for the foreseeable future. As indicated earlier, this was supported by the CMDT and other various experts we spoke with based on recent trends and limited expected changes in exogenous factors that affect youth homelessness. This work was completed just before COVID-19 struck. COVID-19 had some immediate effects such as delays in receiving services (which was also true of a whole range of other services) and reduced access to shelters and temporary housing. The

Department of Children and Families also held off on discharging clients when they turned 18 during the quarantine. Our impression is that these effects were transitory and expect that the policy conclusions based on the types of results reported below would remain the same despite COVID-19's impacts.

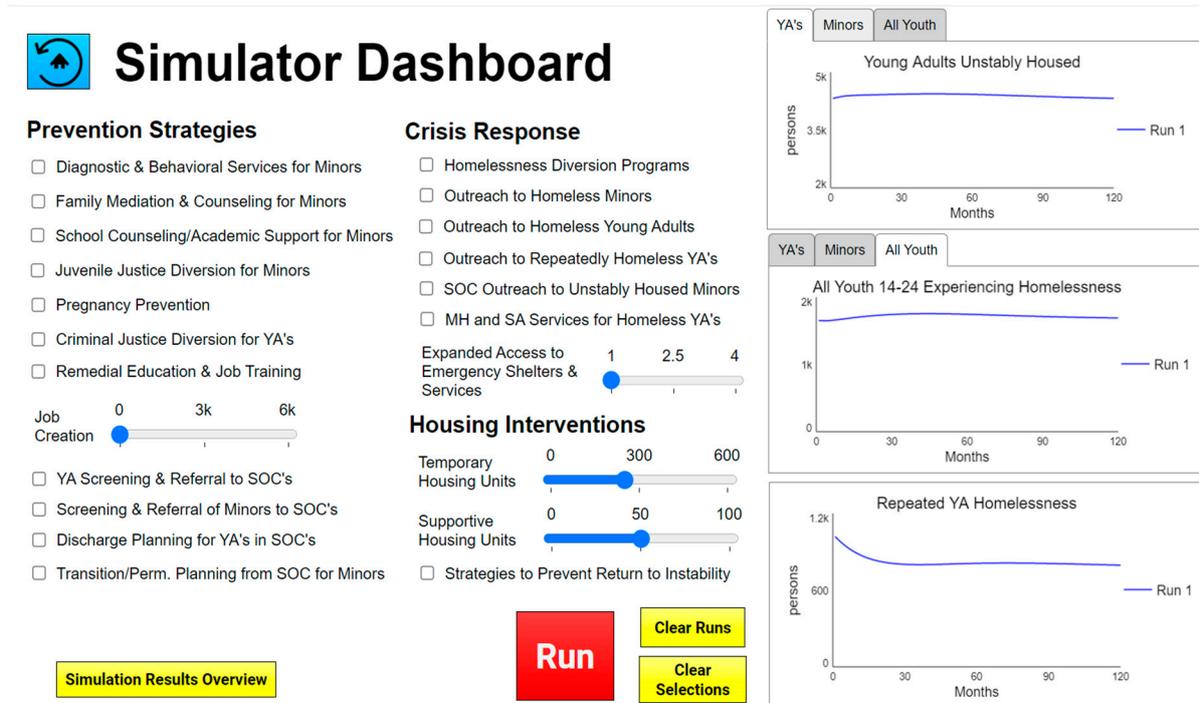


Figure 4. Simulator Dashboard Screen.

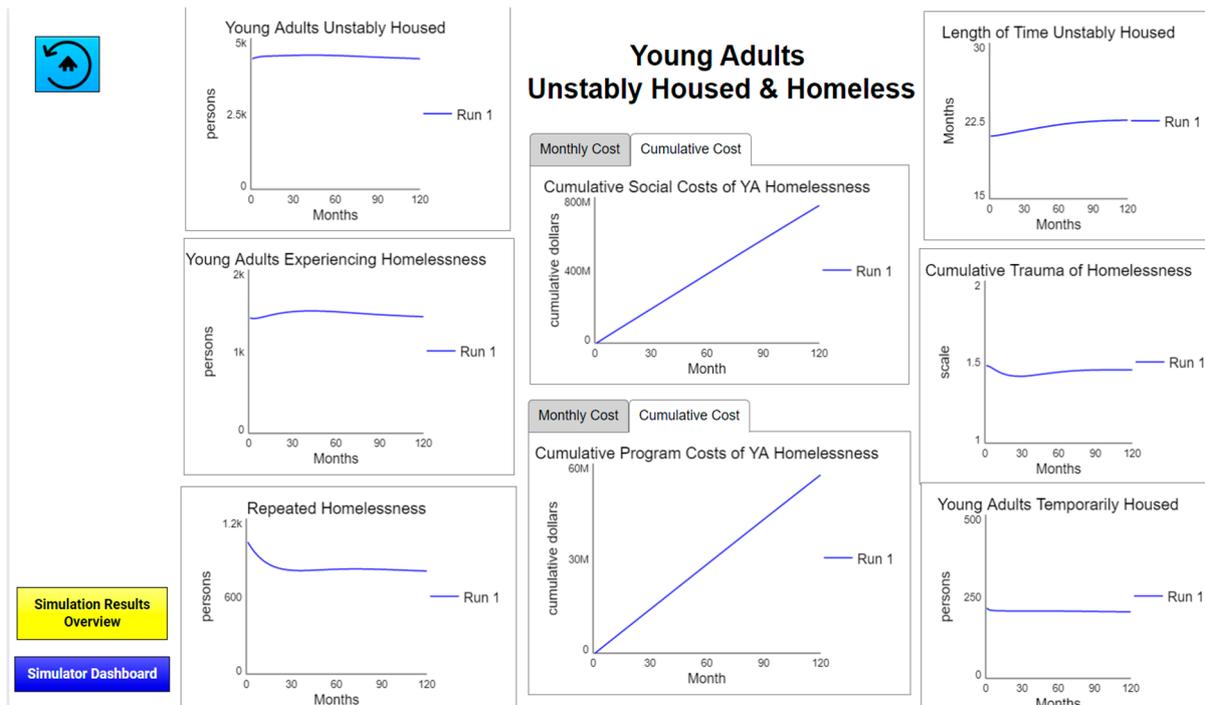


Figure 5. Detailed Results Screen for Young Adults' Housing Instability.

#### 4. Discussion

Some of the benefits of dealing with Connecticut's youth homelessness challenge came from the model's development itself. The CMDT was a diverse group of stakeholders representing multiple state agencies and non-profit organizations concerned with various aspects of youth homelessness, as well as young adults who had experience with housing instability and homelessness. Though CMDT members were coming from different agencies that each had their own agenda, team members agreed they were seeking a holistic approach to the problem rather than representing their agencies' narrower perspectives. Seeing the problem as a coherent whole rather than in fragments and sharing insights had an immediate effect in producing a collective understanding of the need for comprehensive strategies rather than policies that focused separately on one aspect of homelessness or another.

Once developed, the model with its interface was employed in a series of Learning Labs. Approximately 20 people attended the first Learning Lab and a core group of 15 stakeholders continue to use the model to develop a strategy for addressing youth homelessness across the state of Connecticut. During the Learning Labs, participants spoke of a number of benefits and insights gained through using the simulation model:

- As with the CMDT's experience in developing the model, stakeholders spoke of the process of using the model as valuable, extremely important, and different from anything that they have experienced before. They attributed this to the process of bringing people together who have different experiences and perspectives and who come from diverse sectors of the system. For example, attendees of the Learning Lab included policy-makers, front-line staff, and people with lived experience from different parts of the system, including schools/education, criminal/juvenile justice, mental health, employment, child welfare, homelessness crisis response, and housing. Some of these system stakeholders had worked together, but many had not. Additionally, young people with lived experience of homelessness and housing instability both contributed to the development of the model and also co-led some of the Learning Labs. Their engagement and unique perspectives were greatly valued by other stakeholders, resulting in a rich dialogue and new understanding of why programs may or may not be working.
- A big "ah-ha" moment for stakeholders was a shift in thinking about the time it takes to see their desired changes in outcomes after implementing an intervention. They realized that they may not see the positive effect of interventions until several years down the line. This realization brought about some reflection regarding how they may be shifting strategies too early because they had believed the strategies to be ineffective when reviewing short-term performance metrics that indicated no change. In fact, those strategies may actually be working, and anticipating a longer-term view of change was important. One of the stakeholders commented: "I'm telling other people about the model. It is really groundbreaking if we can think this way. It made me think differently about time—how it might take more time for an intervention to have its effect." This insight also resulted in a dialogue about how to communicate with policymakers and funders that some programs will take time before seeing the desired effect so that funding is maintained over the necessary period.
- Stakeholders were able to test a widely-held theory that youth homelessness could be significantly reduced by targeting funding and resources to increase the capacity of the current crisis response system (e.g., outreach, diversion, and housing programs). They were surprised to see that this strategy was both expensive and had only a limited impact. When they added prevention efforts to this strategy, they observed a significant cost reduction and much higher impact on reducing youth homelessness. The insight that 'housing helped less than prevention' was not what they had expected. They learned that a balance of preventive programs with crisis response interventions was most effective in reducing youth homelessness. They also learned that some interventions may be redundant, and adding interventions may achieve diminishing

returns. This led to the insight that it is important to be very selective in crafting combined strategies when resources are limited and coordinating programs from different agencies is a challenge. The model provides a framework for experimenting with different combinations of interventions to find the most efficient one for reaching a particular goal.

- They learned there are unintended consequences to some strategies that can result in greater, rather than fewer, young people experiencing homelessness. For example, when screening and referrals of minors and young adults to Systems of Care (SOCs) were increased, more youth/young adults experienced homelessness than in the baseline simulation. They discovered that this was the result of having more young people leaving those Systems of Care without adequate discharge planning and falling into unstable housing and homelessness. Increased referrals to SOCs had to be combined with expanded discharge planning in order to avoid that negative effect.
- Finally, the stakeholders using the model learned that youth homelessness could not be driven to zero regardless of how many resources are applied. Experience across a large number of simulations suggested that the maximum reduction in homelessness was around 67%. When the number of youths experiencing homelessness is significantly reduced, the ones remaining will be those with more significant problems that will make them more difficult to house.

There are naturally some limitations to the work. One is that the model is a learning environment, not a program planning or predictive tool. The state-level model lacks the precision and explicit variables to plan the implementation of programs. Insights gained from using the model can guide planning, but other tools are required to plan the implementation of indicated interventions. Taking the model down to the regional level will still face the same limitation. Using data specific to each region will adjust the model parameters so that the simulation results will be on a scale familiar to regional users. However, the use of the model will still be for learning rather than planning the specific details of interventions.

Another limitation is the baseline assumption that the rates of youth experiencing unstable housing and homelessness will remain constant in the absence of new or stronger interventions. This is an assumption that may have to be revisited periodically to see if those rates are remaining stable or if they are trending upward or downward. Those trends could be the result of changes in the state's environment (e.g., economic stresses) or as a result of programmatic interventions that have an impact on youth homelessness. The model's parameters would have to be adjusted to reflect the causes of those trends.

## 5. Conclusions

The System Dynamics simulation model has achieved its initial goal of engaging Connecticut stakeholders in the search for leverage points for reducing youth homelessness. A large number of people participated, including representatives of agencies and organizations dealing with various causes and consequences of youth homelessness and young people with lived experience with the problem. Their participation has produced shared insights that enable them to pursue solutions in a more coherent manner. There is now an extensively tested decision-support tool in place that enables additional stakeholders to explore combinations of interventions for reducing youth homelessness.

The Learning Labs using the statewide model have continued. The Learning Labs have focused on: (a) the CMDT building their capacity and confidence in using the simulation model and sharing the model with others; (b) learning and identifying key system insights from using the model; and (c) developing a plan for engaging key system stakeholders in using the model as a learning- and decision-support tool. For example, some initial model insights highlight a need for engaging stakeholders in changing policies and practices concerning discharge planning from Systems of Care, as well as advocating for potential reallocation or leveraging of resources. Future Learning Labs would engage important decision makers on these issues. In addition, the CMDT plans to facilitate regional use of the

model at the level of Connecticut’s eight regions. Each region will be given a spreadsheet to enter its own data and have the model simulate the results of various strategies for its region.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/systems11030163/s1>, Table S1: Initial Values of Statuses (Stocks) in the Model; Table S2: Flow Rates and Intervention Assumptions, (A): Minors at Risk (Including in SOC’s), (B): Young Adults at Risk (Including in SOC’s), (C): Minors Unstably Housed or Homeless, (D): Young Adults Unstably Housed or Homeless, (E): Formerly Homeless Stably Housed Minors, (F): Formerly Homeless Stably Housed Young Adults; Table S3: Flow Variables Developed by Model Calibration or from Data Dashboards; Table S4: Cost Data Used on the Youth Homelessness Model.

**Author Contributions:** The phase 1 model building process was facilitated by H.I.M.; Model conceptualization in phase 2 was done by both G.B.H. and H.I.M.; literature review and data acquisition were done by H.I.M.; H.I.M. managed interactions with the CMDT advisory panel and other key stakeholders; G.B.H. developed the quantitative model; the interface was designed by both G.B.H. and H.I.M.; both G.B.H. and H.I.M. wrote sections of the article. All authors have read and agreed to the published version of the manuscript.

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**Institutional Review Board Statement:** The study was approved by the Institute for Community Research Institutional Review Board (No. 2017-01).

**Data Availability Statement:** All relevant data and their sources are cited in the Supplementary Materials.

**Acknowledgments:** The Core Modeling and Data Team (CMDT) played an essential role in developing and using the model. Membership organizations are listed in Appendix A. Rebecca Niles led a number of the Learning Labs based on the simulation model.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

### Connecticut Organizations Represented on the Core Modeling and Data Team

1. Career Resources/Capital Workforce Partners
2. Center for Children’s Advocacy
3. CT Court Support Services Division
4. CT Department of Children & Families
5. CT Department of Housing
6. CT DMHAS—Young Adult Services
7. Journey Home
8. Partnership for Strong Communities
9. The Connection, Inc.
10. Tow Youth Justice Institute
11. University of New Haven
12. Youth Action Hub/Institute for Community Research

## Appendix B

### Intervention Descriptions

Prevention	Legislation, Policy and Investment Strategies That Build Assets and Address System Gaps That Increase the Risk of Homelessness.
School Counseling and Academic Support for Minors	Improves graduation rates and academic performance, reduces fraction of minors at risk by 20%, and increases later employability of young adults, also by 20%.

<b>Prevention</b>	<b>Legislation, Policy and Investment Strategies That Build Assets and Address System Gaps That Increase the Risk of Homelessness.</b>
Diagnostic and Behavioral Services for Minors	Reduces the fraction of minors at risk by 20% by identifying and providing services for various conditions.
Family Mediation and Counseling for Minors	Reduces fraction of minors at risk by 20% and increases ability of young adults to remain with family.
Screening and Referral of Minors to Systems of Care	Increases the fraction of minors at risk entering Systems of Care by 20%.
Young Adult Screening and Referral to Systems of Care	Increases fraction of at-risk young adults entering Systems of Care and receiving services by 50%.
Juvenile Justice Diversion for Minors	Reduces likelihood of juvenile justice involvement of minors and later criminal justice involvement as young adults by 50%.
Criminal Justice Diversion of Young Adults	Halves likelihood of young adults' involvement with criminal justice system and affects employability and ability to remain with family and, in turn, reduces the fraction at risk by 17%.
Pregnancy Prevention	Reduces fraction of both minors and young adults at risk due to pregnancy and parenting by 20%.
Remedial Education and Job Training	Doubles employability of young adults and reduces fraction at risk by 17% (Impact will depend on job creation intervention).
Job Creation	Will increase availability of jobs and is necessary for job training to have its full impact on fraction of young adults at risk.
Transition/Permanency Planning from Systems of Care for Minors	Doubles the fraction of minors aging out of Systems of Care going into appropriate programs as young adults.
Young Adult Discharge Planning in Systems of Care	Reduces fraction of young adults leaving Systems of Care becoming unstably housed or homeless by half.
<b>Crisis Response</b>	<b>Policies and Practice to Identify Young People Experiencing Housing Instability or Homelessness and to Intervene Early by Connecting Them to Housing and Supportive Services.</b>
Systems of Care Outreach to Unstably Housed Minors	Increases flow of unstably housed minors into Systems of Care that can provide services by 50%.
Outreach to Homeless Minors	Connects 50% more minors experiencing homelessness to housing.
Outreach to Homeless Young Adults	Connects 50% more young adults experiencing homelessness to housing, preventing persistent homelessness.
Outreach to Repeatedly Homeless Young Adults	Outreach with special emphasis on young adults who have experienced repeated homelessness to connect them to housing.
Diversion Programs	Increases the number of young adults who can receive diversion funds that keep unstably housed young adults from experiencing homelessness, reduces fraction of unstably housed who might experience homelessness by 20%. Examples: financial, utility, and/or rental assistance, short-term case management, conflict mediation, connection to jobs and mainstream services, and housing search.
Expand Access to Emergency Housing and Services	Increases the number of emergency beds/apartments to serve a larger number of young adults experiencing first time and repeated homelessness.
Mental Health and Substance Abuse Services for Homeless Young Adults	Services that reduce cumulative trauma of being homeless by half and thereby reduce the fraction of young adults who experience repeated homelessness. Examples: Mental health services and substance use programs delivered by agencies or community providers.

Housing Stability	Initiatives and Support for People Who Have Experienced Homelessness That Allows Them to Exit Homelessness Quickly and Never Experience It Again.
Expand Temporary Housing Capacity	Increase the capacity of temporary housing programs to serve a larger number of young adults experiencing first time and persistent homelessness. Examples: Transitional housing, host homes, DMHAS Young Adult Services' supervised apartments, and rapid re-housing programs that are time-limited and aim to stably rehouse young people by providing them with housing/rental assistance and supports for health and well-being, education, and employment.
Expand Long-Term Supportive Housing	Make additional housing units available for young adults experiencing persistent homelessness who require extensive additional services to keep them stably housed. Examples: Permanent supportive housing that combines affordable housing assistance with voluntary support services.
Preventing Returns to Homelessness	Reduce the flow of young adults by half who had achieved stable housing and fell back to unstable housing with short-term rental assistance and other supports. Examples: Temporary housing programs that offer short-term assistance to young adults who experience a housing crisis (loss of job/roommate, increased rent, etc.) within a year of exiting their programs.

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