Further Inspection: Leveraging Housing Inspectors and City Data to Improve Public Health in Chelsea, MA

FURTHER INSPECTION: LEVERAGING HOUSING INSPECTORS AND CITY DATA TO IMPROVE PUBLIC HEALTH IN CHELSEA, MA

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Abstract

Substandard housing represents an important and growing public health problem. It is associated with higher rates of mental illness, chronic and infectious disease, and other negative outcomes. Housing inspectors, by nature of their work inside homes and close contact with residents, are some of the only public officials to witness these risks. Early intervention can reduce public health risks and reduce costs to governments and society. However, current housing inspection focuses on technical enforcement of housing codes rather than broader socioeconomic or health impacts that the codes were originally designed to address. Further, the potential for early intervention is limited because 1) cities are not aware of problems soon enough, as inspection is often reactive or relies on tacit knowledge, and 2) housing inspectors lack systems to respond to the range of public health risks they encounter. In response to these problems, the objective of my DrPH dissertation was to:

1) Develop and implement a social-service referral innovation within a city's inspectional services department that leverages the unique role of housing inspectors to link at-risk residents with social services, and
2) Develop an approach to using city data to identify and prioritize the response to prevalent housing-related health threats.

I carried out this work in Chelsea, Massachusetts, in collaboration with Chelsea City Hall and other City agencies. The goal is that the complex public health risks related to substandard housing are reduced because the City is aware of problems sooner and housing inspectors respond with both enforcement and service provision interventions.

I drew from action research methods, a process of systematic inquiry that is collaborative, reflective, and participatory. The result was a sub-contract between City Hall and a local social-service agency to respond to referrals from housing inspectors and intervene early on problems that cannot be resolved through code enforcement alone. Further, through aggregating and analyzing City data, I identified housing-related public health problems and ways to improve efficiency, effectiveness, and equity of code enforcement. In this dissertation, I capture the lessons learned, describe the impact achieved, and lay a conceptual foundation for future inquiry and public health change.

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Chapter 1 - The Need for Further Inspection: Housing, Health, and the Role of the Housing Inspector

Housing and Health in the 21st Century

Safe, habitable housing is central to the health of individuals and communities. Housing is more than physical shelter; it is a fundamental and powerful social determinant of health, affecting security, privacy, social relationships, and access to jobs and community resources (Foley, 1980). Substandard housing can mean deprivation across a range of social, economic, and opportunity dimensions, which in turn determines health and health trajectories (CSH, 2014). Poor housing is associated with health outcomes as far reaching as respiratory and cardiovascular diseases, lead poisoning, mental illness, domestic abuse, fire risk, infectious disease, and impaired child development (Adamkiewicz et al., 2014; Dunn, 2000; Jacobs, 2011; Krieger and Higgins, 2002; Viveiros et al., 2015). These risks stem from physical aspects of the home environment, such as insect infestations causing asthma exacerbations (Beck et al., 2014), financial aspects that result in poor property maintenance (Acquaye, 2011), and social aspects, such as overcrowded conditions straining interpersonal relationships (Gove et al., 1979). The important connection between health and housing is further evidenced by the growing number of clinical programs that include screening patients for housing insecurity (TBF, 2014; Uwemedimo and May, 2018) and home-visiting interventions to mitigate asthma, lead exposure, and other housing-related problems (Brown et al., 2006; Dong et al., 2018; Rosofsky et al., 2016).

Tens of millions of Americans are housing insecure (Steffen, Barry L. et al., 2015), defined as facing "high housing costs in proportion to income, poor housing quality, unstable neighborhoods, overcrowding, or homelessness" (Johnson and Meckstroth, 1998). Rising rents, stagnant incomes, and the inadequacy of policy responses have increased the share of severely rent-burdened households (households paying more than 50% in rent) (Desmond, 2012). In 2016, half of all renting households in the US paid more than 30% of their income on rent, and a quarter paid more than 50% (JCHS, 2017). Between the 1960s and 2016, the proportion of cost-burdened renters doubled from 23.8 to 47.5%, with

the largest increases occurring in the 2000s (JCHS, 2018). Over this period, median rent payments rose 61%, while the median renter income grew only 5%, adjusting for inflation (JCHS, 2018).

At the same time policies to support very low-income households with housing assistance have fallen short. A main source of assistance – housing vouchers –grew only 5.8% between 2011 and 2016 (JCHS, 2017). Meanwhile, the proportion of severely rent-burdened households increased by 27% (JCHS, 2017). Shelter is a fundamental need and rent is typically the first bill paid. This leaves little left for other necessities such as utilities, food, transportation, childcare, and healthcare. Faced with high rental costs, many low-income families withstand poor housing quality, unstable neighborhoods, and overcrowded conditions to make ends meet. Overcrowding is defined in the US Census as more than one person per room (Kevin S. Blake et al., 2007). Living in overcrowded conditions strains social relationships, impacts psychological health, and may also increase risks of injury and fire (Alison Gray, 2001; Bechtel and Churchman, 2003; Cardoso et al., 2004; Delgado et al., 2002; Evans and Saegert, 2000; Gove et al., 1979; Lepore et al., 1991). Children in overcrowded homes are more likely to have difficulties in behavioral adjustment at school, poor academic performance, and impaired parent-child relationships (Evans et al., 1998; Goux and Maurin, 2005); they are also more likely to witness domestic violence (Makinde et al., 2016).

The impact of housing insecurity and it's physical and social ramifications is not evenly distributed. Non-Hispanic Black Americans are more than twice as likely as Non-Hispanic White Americans to live in substandard housing (Jacobs, 2011). Immigrants, particularly those without legal status, are more likely to be housing insecure compared to native born residents (McConnell, 2013). A long history of discriminatory housing policies, combined with institutional and environmental racism and disinvestment in minority communities, exacerbate and maintain these disparities (Adamkiewicz et al., 2011; Jacobs, 2011; Krieger and Higgins, 2002; Singh et al., 2017). Further, gentrification, eviction records, documentation status, and other factors limit access to affordable, safe housing (Desmond, 2012; Krieger and Higgins, 2002). Given the powerful role housing plays in shaping health, and the rising

proportion of Americans who are housing insecure, improving housing conditions is an important mechanism for reducing social inequality and improving public health.

Sanitary Reform and the Emergence of the Housing Inspector

The idea that housing and health are connected is not new. High rates of infectious disease and fire in overcrowded urban slums of the early 19th century drew the attention of city governments, social theorists, and health officials (Spivey, 2005). In his 1845 writings on the condition of the working class in England, philosopher Friedrich Engels noted that, "There is ample proof that the dwellings of the workers who live in the slums, combined with other adverse factors, give rise to many illnesses" (Engels, 1872). Writing in the late 1800s, Florence Nightingale, statistician and founder of modern nursing said, "The connection between health and the dwelling of the population is one of the most important that exists" (Lowry, 1991).

There was an early mandate for cities to improve housing and health. In the mid-19th through the early 20th century, rapid population growth among the urban poor and lack of affordable, adequate housing gave rise to overcrowded and severely substandard housing conditions. These tenements, in which large families lived in single rooms, often lacked ventilation, sanitation, and means of escape from fire (Citizens' Association of New York, 1865; Riis and Sante, 1997). The burgeoning slums increased fear among the wealthier classes of the "threat from the bottom" (*i.e.* foul smells, diseases, and fires in the poorer classes spreading to the middle and upper classes) as well as concerns about the corrupting influence of poor living conditions on the "moral standards" of the poor (Björkman, 2012; Riis and Sante, 1997).

These concerns spurred sanitary reform movements across the United States (US) and Europe (Chadwick, 1843; Griscom, 1845; Krieger and Higgins, 2002). In the US, sanitary reform was organized and executed by boards of health and voluntary health associations, which, in 1866, established the country's first housing laws in New York City (Krieger and Higgins, 2002). The housing codes, which were born out of health concerns, required improve ventilation, sanitation facilities, adequate lighting, and regular waste removal (Riis and Sante, 1997). During this time publicly financed improvements in

drinking water supplies and sanitation also dramatically reduced the spread of infectious disease, as did advances in science, medicine, and technology (Cutler et al., 2006; Cutler and Miller, 2004).

A major contribution of the sanitary reform movement was the establishment of legislation regarding housing conditions. From these statues, the role of housing inspectors emerged (Krumbiegel, 1951). The role was held largely by medical officers and their, often female, deputies, who not only worked to ensure compliance but also provided general hygiene education (Björkman, 2012). It was thought that female inspectors were a more "social" solution for housing-related public health problems, and would be better received by residents as "friendly visitors" (Björkman, 2012; Dale, 2018; Haynes, 2006). From its inception, housing inspection held in its preview not only issues pertaining to health and safety of residents and the prevention of urban decay, but also an element of the "preservation of domestic tranquility" (Gribetz, 1971). In the early 1900s, improving housing conditions was seen not only as a means to control disease and fire but also as a means to impact the morals and upbringing of the population, *e.g.* "men would stay home in the evening instead of going to pubs, women would do a better job rearing children, and public health would improve" (Björkman, 2012). The role of the housing inspector was both normative and punitive – involving education on housekeeping and basic hygiene behaviors, as well as enforcing housing codes (Björkman, 2012; Riis and Sante, 1997).

The 1939 American Public Housing Associations (APHA) Principals of Healthful Housing included four fundamental categories by which housing standards should be measured: physiological needs, psychological needs, protection against contagion, and protection against accidents (Stewart, 1999). Psychological needs such as provision for "normal family and community life" were considering alongside physiological needs, such as adequate heating. By the early 1900s, the largescale fires and epidemics of Engels' and Nightingale's day had receded, due in large part to improvements in housing conditions (Krieger and Higgins, 2002).

As the 20th century progressed, overall housing conditions improved and consequently budgets for public health departments shrank (Spivey, 2005). More enfranchised classes were less concerned about the "threat from the bottom" due to advances in modern medicine (such as antibiotics dimensioning

the threat of infectious disease) and urban planning practices that isolated the wealthy from the poor (Jacobs, 1992). With less political will for comprehensive housing and health programs and the major threats to mortality reduced, health departments turned their focus to single-issue programs, such as lead removal or tuberculosis control (Spivey, 2005).

The approach to housing and health also became siloed, shedding its previous more "sociological viewpoint" (Krumbiegel, 1951). In many cities, housing inspection, which previously fell within the domain of health departments, became its own specialized department focused solely on inspection and enforcement (Stacy et al., 2018). Accordingly, the role of the housing inspector became increasingly compliance-focused and detached from public health, making it difficult to coordinate service across sectors to resolve housing and health problems (Stacy et al., 2018). In 1971, a former regional administrator for the US Department of Housing and Urban Development lamented that, "code enforcement, like the computer, is an inert tool until it is energized by human skill and energy. In code enforcement there is not a cadre of professionals to supply this skill and energy" (Gribetz, 1971).

Housing Inspection in the 21st Century

There are many kinds of housing codes and inspections: building codes, focused on physical risks and integrity of the structure; health/sanitary codes focused on habitability and resident safety; fire codes, focused on fire risks; zoning codes, focused on legal and appropriate use of buildings, and other types of codes. In some cities these are combined; in others they are separate. Each type of inspection is governed by a different code, law, or city ordinance, has a different focus, and requires different training and expertise of inspectors. In this paper, the term "housing code" refers to the minimum standard of housing fitness/habitability for rental properties.

Housing codes ascribe specific duties to landlords and tenants and focus on mainly on visible, physical hazards, the easiest to objectively identify and enforce (Benjamin and Vernon, 2014; Stewart, 1999). The minimum standards stipulate that housing should be structurally stable, free from serious disrepair and dampness, have adequate provision of lighting and ventilation, a kitchen and bathroom with running water, and means of escape from fire (Stewart, 1999). The housing codes of the 21st century bare

strong resemblance to those laid out during the sanitary reform movement of the previous century (Jacobs, 2011), but are adapted and updated by states and municipalities across the country (Benjamin and Vernon, 2014). Modern housing inspection is primarily compliance focused and complaint-driven (Stewart, 1999). Tenants or landlords report unsatisfactory conditions to local governments and housing inspectors visit the property to determine if there is a code violation. If a violation is found, fines are issued until the problem is resolved.

Housing code enforcement is an effective tool to improve basic housing conditions, promote public health, and reduce the spread of blight (Beck et al., 2014; Stacy et al., 2018; TRF, 2014). In areas with high housing demand and low supply, and where landlords are paid regardless of the conditions, there is often little incentive for landlords to invest in their properties. Code enforcement programs induce landlords to improve conditions. Nevertheless, the majority of housing code enforcement programs are structured to alleviate immediate safety threats and easily observable problems around a narrow set of minimum standards, rather than address and improve health and social conditions (Stacy et al., 2018). Lack of systems to address a wider range of health and social issues identified during housing inspections not only impedes the ability of housing inspectors to enforce codes but also erodes public health and wellbeing, with costly and devastating consequences. While epidemics and residential fires no longer ravage US cities, persistent public health and housing challenges remain. There is a need for a more dynamic and forward-looking approach to housing inspection and a renewed focus on public health.

Collaboration and Innovation in Housing Inspection

Increasingly, there are calls for greater collaboration between local government, public health, and social service institutions (ChangeLab Solutions, 2015a). While cities contain high densities of residents facing housing-related health threats, cities are also home to high densities of diverse social service and public health agencies. While the work of these institutions is often fragmented and uncoordinated, there are promising opportunities in strategically harnessing these resources to address pressing health and social concerns (Stine et al., 2013).

ChangeLab Solutions, a policy innovation organization, issued a report recommending that code enforcement take a holistic approach through collaboration with other government and community agencies (2015b). Through collaboration, code enforcement can be more effective, efficient, and equitable. For example, housing inspectors can liaise with community organizations to provide support when inspectors encounter language barriers or mental illness. Similarly, when community organizations identify issues such as mold or pests in homes, they can connect with housing inspectors to coordinate services systematically (ChangeLab Solutions, 2015b).

This approach has been successfully implemented in several cities. In Greensboro, North Carolina, housing inspectors work with counselors from a local non-profit to solve housing problems and minimize dislocation of residents. The non-profit counselors notify inspectors of potential code violations and the inspectors consult the counselors on complicated cases (GHC, 2018). In Newark, New Jersey, a task force of city agencies was established in 2014 to coordinate efforts in response to code violations when the health of residents was at risk (ChangeLab Solutions, 2015b). They also implemented standardized data collection and mapping to learn more about the most prevalent issues and where they were occurring. In Boston, Massachusetts, the Breath Easy at Home program allows health professionals to refer patients with asthma for housing inspections if they suspect that housing conditions may be contributing the child's asthma (Rosofsky et al., 2016). Actions like these can make code enforcement an effective tool for early intervention and promoting public health.

In addition to pioneering collaborations, cities have also employed innovative models for housing code enforcement to overcome the shortfalls of complaint-driven, siloed models. These models range from combining enforcement with compliance assistance (*e.g.* linking low-income landlords with subsidized lead remediation services (Allegheny County, 2018), to using behavioral insights to modify the language on form letters to increase landlord compliance (Hillenbrand, 2016), to using data to predict which properties are vacant and intervene before blight spreads) (Goldsmith, 2014). Increasingly, cities are also adopting proactive inspection models whereby rental units are inspected at set intervals or upon

tenant turnover, improving the equity of code enforcement and distribution of city resources (ChangeLab Solutions, 2014).

Nevertheless, even the most progressive and collaborative code enforcement programs have been criticized as a form of gentrification, by which cities induce landlords to make improvements to properties, which in turn cause landlords to raise rents, forcing lower income families out (Desmond, 2012; PolicyLink, 2007). Further, tenants are often disincentivized to report housing issues to inspectors for fear of retaliation by landlords (*e.g.* eviction, raised rent) or fear of disclosing their documentation status (Desmond, 2012). At the same time, housing inspectors may be one of the few points of contact between residents and city officials, representing an opportunity for breaking the link between poor health and poor housing. Early intervention on health and housing can reduce public health risks and costs to governments and society, but it must be done in a way that does not displace residents. Greater value can be delivered to the public when enforcement is problem-oriented to identify and resolve risks through critical engagement on the problem, rather than simply applying a rule-driven approach (Sparrow, 2001). This is because critical engagement allows for the development of operational capacity to respond holistically, and reflects a learning mindset that can adapt to solve problems.

Housing Inspectors as Agents of Change: Breaking the link between poor housing and poor health

Given the powerful role housing plays in shaping health and the growing proportion of Americans who are housing insecure, re-imagining the role of the housing inspector as an agent of public health change is critical. The role can continue to evolve and address the health and housing needs of the 21st century. Other frontline professions have expanded their duties and overcome siloed work to respond to modern public health threats. For example, police and firefighters have become medical first responders in the opioid epidemic, equipped with tools and training to identify and reverse overdoses and coordinate with medical personnel (Hatt, 2018; Kim et al., 2009). In housing, while physical hazards remain a problem, social determinants of health are also a major source of morbidity and mortality (Krieger and Higgins, 2002). In some low-income, disenfranchised communities across the US, families

still face many of the health and social challenges faced in the tenements of New York City in the late 1800s (*e.g.* poor ventilation, overcrowding, inadequate access to sanitation) (Adamkiewicz et al., 2014, 2011; Evans et al., 1998; Evans and Saegert, 2000; Lepore et al., 1991) and are also burdened with modern risks to public health (*e.g.* the opioid epidemic) (Bousquet, 2018). As was done over a century ago, housing inspectors can play a larger role in addressing public health concerns and the public health community can re-engage on this challenge.

The role and forms of collaboration between local government, public health, and social service agencies may look different in different cities. Depending on the population and housing needs, housing inspectors, in combination with partner agencies, could provide not only enforcement but service provision. This could range from education on reducing asthma triggers in the home, to risk reduction strategies in overcrowded conditions, to connecting vulnerable residents with needed social services, such as eldercare or fuel assistance.

The success of any of these collaborations hinges on the re-animation of the housing inspector as an agent of public health change. The image of many city housing inspectors is one of an intransigent frontline-worker who is resistant to change or to assuming tasks outside of the job description. Nevertheless, understanding the priorities and challenges housing inspectors face, and engaging them in the process of change is critical to breaking the link between poor housing and poor health.

Action Research to Improve Housing and Health at the City-Level

In the following chapters, I will describe the action research I undertook, as part of my DrPH dissertation, to expand the capacity of housing inspectors, leverage existing city data, and improve health and housing in Chelsea, Massachusetts (MA). Action research is a form of systematic inquiry that is collaborative, self-reflective, critical, and undertaken by the participants of the inquiry (Herr and Anderson, 2015). It builds and applies theories within the practice context (in this case, the City of Chelsea, MA), and tests them through experiments in the form of interventions. The experiments serve both to test hypotheses and to effect change (Herr and Anderson, 2015).

My goal was to contribute to organizational transformation by empowering those inside the organization (namely housing inspectors and City leadership) to make housing inspection more effective, efficient, and equitable. I did this through embedding myself, as an outsider in close collaboration with insiders, in Chelsea City Hall. My work was motivated by a belief that my dissertation research should benefit practice, both in the present through improving conditions, and in the future through laying the groundwork for further transformative action. In my dissertation, I was interested both in effecting public health change, and in studying the process of change management through real-world engagement. In the subsequent chapters, I capture the lessons learned while doing and the impact achieved.

Chapter 2 - The Development and Implementation of a Novel Social-Service Referral Process within Housing Inspectional Services in Chelsea, MA

Overview:

Substandard housing is associated with complex public health problems, including risks to physical and psychological wellbeing (Dunn, 2000; Krieger and Higgins, 2002). Housing inspectors, by nature of their access to people's homes, are some of the only public officials to witness these public health risks. Inspectors routinely encounter threats to physical and psychological wellbeing, but lack systems to respond to the range of risks to public health identified in home environments. Early intervention can reduce these risks and reduce costs to governments and society; however, housing inspection focuses primarily on enforcement (not service provision), and on physical hazards (not other threats to physical and psychological health).

This chapter describes the development and implementation of an innovative program to establish a more comprehensive and coordinated approach to housing inspection that results in greater public health impact. The program leverages the unique role of housing inspectors to identify public health problems that cannot be resolved through code enforcement alone and link at-risk residents with referrals to services. The work was carried out in Chelsea, MA, a small, densely populated city near Boston where the majority of residents are people of color, immigrants, and low-income.

Implementation of a social service referral process within the housing inspection department required challenging existing processes, inspiring a shared vision, managing conflict, and building relationships. There was not a predefined solution that could be faithfully applied, but rather a process of learning and fitting the innovation to the context. It required developing new capacity and re-imagining the public health role of inspectors and the systems in which they operate.

A team of students and I conceptualized and designed the innovation in the Harvard Kennedy School's Innovation Field Lab course in the Spring of 2018. I then worked to implement the innovation though an Innovation Fellowship at Chelsea City Hall in the Summer of 2018, a position also supported

by the Innovation Field Lab. In this chapter, I describe health, housing, and housing inspection in Chelsea; the collaborative and iterative process of designing the innovation; and the approach and impact of enabling change.

Health and Housing in Chelsea, MA

Substandard and overcrowded housing is a critical problem facing the city of Chelsea, MA. Located across the river from Boston, Chelsea is just 2.2 square miles, and home to an estimated 40,227 residents,[1] making it the second most densely populated city in Massachusetts. The majority of residents are people of color, immigrants, and low-income (Table 1) (US Census, 2017). Two-thirds are Hispanic/Latino/a and almost half of residents are foreign born (US Census, 2017). One fifth of the population live below the poverty line (US Census, 2017). Per capita income averages $23,240 per year (US Census, 2017).

Table 1: Chelsea's Demographic Characteristics

Demographic Characteristic	2017 Estimate based on 2010 US Census
Population	40,227
Population Growth 2010-2017	14.4%
Hispanic/Latino	65.9%
White, Non-Hispanic/Latino	21.9%
Black, Non-Hispanic/Latino	7.1%
Asian	3.6%
Foreign Born Persons	45.6%
Persons in Poverty	19.5%
Per Capita Income	$23,240/year

Chelsea's housing stock is old, comprised primarily of wooden multifamily units, only 26% of which are owner-occupied (US Census, 2017). Many homes are in significant need of repair, posing

[1] Informal estimates of the population are much larger. Community organizations estimate the true population to be between 60,000-80,000 due to the large proportion of undocumented immigrants who are less likely to counted in the official census.

health hazards such as exposure to the elements, lead, fire hazards, and rodent and insect infestations (Mt. Auburn Associates, 2018). Chelsea is emblematic of the affordable housing crisis facing many cities, where skyrocketing rents and stagnant wages have increased the proportion of residents who are housing insecure (Desmond, 2012). In 2018, home values rose 7.6% and are projected to rise another 10% in 2019. Compared to the surrounding area, rental prices in Chelsea remain low (median rent is $1,900, compared to a median rent in Boston of $2,895) (Zillow, 2019); however, the city faces strong gentrification pressure and many low-income residents have already been displaced. The court ordered eviction rate is 2.3%, higher than Boston's rate of 1.3% (Eviction Lab, 2019).

Residents cope with high housing costs in a variety of ways. Approximately 19% of Chelsea's housing stock is subsidized (Ambrosino, 2017). Those who are unable to access subsidized housing, employ strategies such as doubling or tripling up with other families or living in cheaper substandard or illegal conversion apartments (*e.g.* basements, closets, porches). Families also cope with high housing costs through frequent moves, evidenced by an 18.6% turnover from one year to the next in the Chelsea Public Schools (MA Department of Education, 2011). Chelsea is a sanctuary city, meaning that the city limits their cooperation with the national government's effort to enforce immigration law. For the last century, Chelsea has been home to many first generation immigrant families and today is home to many residents (with and without legal immigration status) fleeing violence and lack of economic opportunity in Central America (Mt. Auburn Associates, 2018).

City officials and community organizations in Chelsea describe poor quality, overcrowded housing as a major problem (Robb et al., 2018). Available data corroborate this: 38% of residents report difficulty paying rent on time, increasing the risk of eviction (CAPIC, 2016); and families living in unlawful conversions are found at least once each month by housing inspectors (Robb et al., 2018). The impact of housing insecurity extends beyond the human suffering inflicted upon the housing insecure, and extends to the wellbeing of all residents in a community, in the form declining property values, lost tax revenue, crime, increased fire risk, and other impacts (Beck et al., 2014; Goldsmith, 2014; Holtzen et al., 2016). Figure 1

summarizes the public health problem motivating this work and the opportunity for innovation to improve quality of life for residents and processes for City staff.

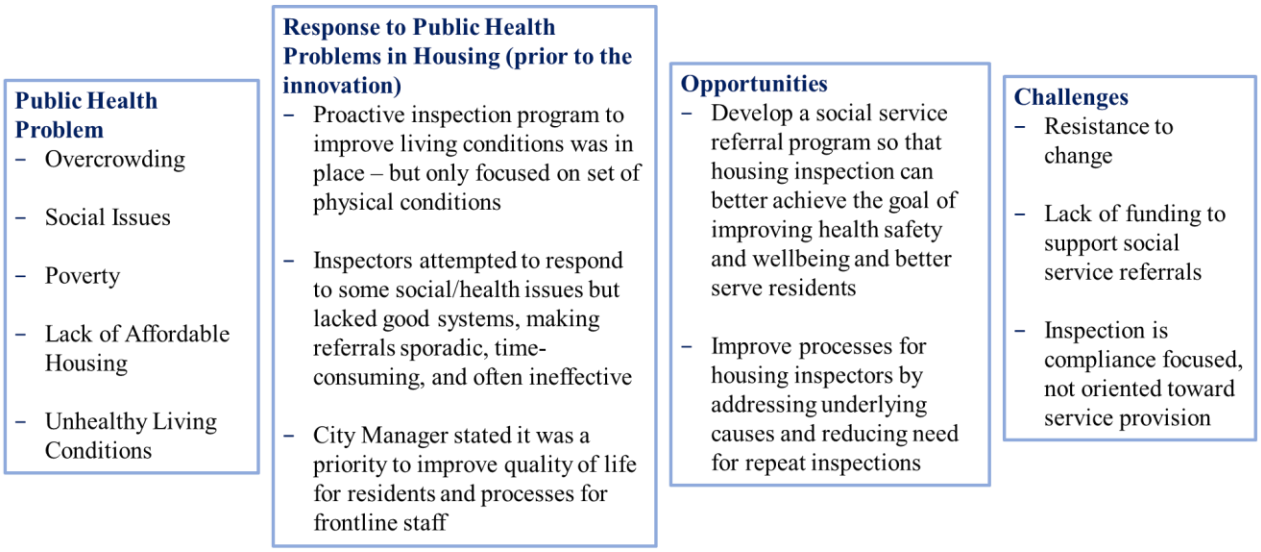


Figure 1: The Public Health Problem and The Opportunity for Innovation

Housing Inspection in Chelsea MA

In Massachusetts, the state sanitary code sets the minimum standards of fitness and conditions for human habitation of rental properties. The goal of the sanitary code is to "protect the health, safety, and well-being of the occupants of housing and of the general public" (MA Department of Public Health, 2007). As in other US states, housing inspectors enforce the code through issuing fines. In most municipalities, housing code enforcement is triggered by housing complaints made by tenants. The code includes ensuring smoke detectors are functional, fire exits are clear, kitchens and bathrooms have running water, and the property is free of infestations from insects or rodents, among other factors (MA Department of Public Health, 2007). Through their work, housing inspectors have the potential to impact important determinants of health.

In 2014, the City of Chelsea launched a proactive rental property inspection program with the goal of inspecting each rental unit every five years and upon tenant turn-over (City of Chelsea, 2018). Under the program, three housing inspectors proactively visit rental properties every day, in addition to responding to housing complaints. Prior to this, the City had been relying on a complaint-driven model only. However,

the complaint-driven approach missed some of the most severe housing issues and often the most vulnerable tenants feared reporting problems to the City due to fear of landlord retaliation or disclosure of immigration status.

In Chelsea, housing inspectors and other staff report that they routinely encounter families and individuals in crisis. As one inspector put it, "*When you see a mother walk into the office with her children on the brink of crisis, I have no idea what to do. If someone could just set up some procedure to support them...*" Another stated "*You see some things you just can't walk away from, they keep you up at night. But what can you do?*" These crises stemmed from eviction, homelessness, substance use disorders, mental health issues, domestic abuse, poverty, and other problems. Inspectors described finding families with young children living on enclosed porches or basements without access to water, sanitation, or heat. They described the unhygienic conditions of houses where residents hoarded food or animals. They described unclothed children sitting in corners during inspections of apartments strewn with alcohol bottles or drug paraphernalia. They described bare cupboards, no heat in the winter, and severely disabled indidivials or seniors for whom independent living was severely unsafe.

Social issues frequently impede the work of housing code enforcement, causing delays and repeat visits. These issues also take a toll on the wellbeing of inspectors who see human suffering every day without a way to easily connect residents with the support they need. Inspectors have a mandate to make homes safe but lack the tools to fully realize this mission, since many problems cannot be solved through enforcement alone. Further, inspectors lack the training, systems, and mandate to respond to the range of social and health issues they encounter. At the same time, Chelsea is a small, close-knit community with a robust network of social service providers with the skills and systems to respond to many of the threats to health and wellbeing inspectors encounter. These community organizations are known and trusted by community members and City Hall. Out of these challenges and opportunities, the idea for a social service referral system within housing inspectional services was born.

Innovation Field Lab

The Innovation Field Lab (IFL) is a partnership between the Ash Center for Democratic Governance and Innovation at the Harvard Kennedy School and five Massachusetts cities, including Chelsea (de Jong, 2017). The goal of the partnership is to improve social conditions through collaborative, multi-sector efforts. Since 2015, a Spring IFL course, led by Dr. Jorrit de Jong, has provided students with an experiential opportunity to develop holistic, data-driven strategies to prioritize and resolve problem properties. 'Problem properties' are used as the unit of analysis to explore issues such as foreclosure, vacancy, and other housing-related problems. Graduate students work in teams of four to six in close partnership with local government in the city to which their team is assigned. The IFL course has three phases: Discovery, Design, and Delivery. In the Discovery Phase, students familiarize themselves with the social and administrative conditions faced in the city. This problem diagnosis work is done through meetings with city officials and community organizations, attending community events, and accompanying housing inspectors on inspections. In the Design Phase, students design an innovation to address an issue(s) of problem properties that adds value to the city, is feasible for the city to implement, and is authorizable by city leadership. Using design thinking and prototyping, students iterate and improve on their innovations through dialogue with city staff. Finally, in the Delivery Phase, students present their innovation recommendations to city leadership. After the Spring semester, the IFL offers a Summer Fellowship opportunity for graduate students, this time working independently embedded in city halls, to take the recommendations developed in the Spring semester and lead the implementation of the innovation package.

Teamwork

I was a student in the IFL course in the Spring of 2018 and my team was paired with the City of Chelsea. We were a diverse team, representing the Harvard schools of government, business, public health, and education. Although we approached the problem differently, each of us brought curiosity, passion and empathy to the work, factors foundational to effective teaming (Edmondson, 2013). The diversity of experience, expertise, and work style helped us to think creatively about the problem and

solutions and transcend organizational domains. Our teamwork was supported by the IFL course, which drew from well-established teaming theory in providing a compelling direction (*e.g.* to deliver value to the city), structure (*e.g.* moving through the Discovery, Design, and Delivery phases), and support (*e.g.* a team coach) (Hackman, 2002).

When working on diverse teams, teaming theory suggests that teams should focus on tasks at the early stages, rather than on interpersonal relationships (Gratton et al., 2007). In our first workshop as part of the IFL course, prior to getting to know each other, we were asked to dive into a simulated challenge, similar to the one we would be tackling with problem properties. Only later were we asked to set team norms. This intentionality formed the foundation for strong teamwork. Rather than form subgroups based on similarities or establish norms in the absence of understanding work styles, we got to know each other's skills first. We then built relationships. Setting norms once we had some experience working together resulted in less generic norms, which helped form a stronger team. We also made time for team social events which facilitated trust and psychological safety, core components of teamwork (Edmondson, 2013). Through relationship building, we were able to minimize defensiveness and negative behaviors. Toward the end of the course, as we moved from Design into Delivery, we divided the work into concrete tasks based on skillsets with rapid cycles of feedback and iteration. This energy moved us out of our phase of contemplation and deliberation during the Discovery and Design phases, and into a phase of high performance and productivity in the Delivery phase.

Discovery. Design, Delivery Phases of Innovation

Changing the City's response to housing-related health problems necessitated not only an in-depth understanding of the problem, but also an understanding of what types of solutions were authorizable, valuable, and feasible. This required listening to the aspirations and constraints of different stakeholders and authorizers, iterative adaptation of designs, and re-thinking norms about the role of housing inspectors. There was no clear solution to this problem and therefore it required iteration and creativity, while closely managing the authorizing environment and stakeholders. Throughout the three-month course, at least one member of our student team was in Chelsea each week, and often more

frequently. With each significant iteration of our problem definition and innovation, we checked in with the City staff and with community organizations to test our hypotheses and get feedback.

During our first meeting with the City Manager, he asked that we work on a solution that would improve the quality of life for Chelsea residents, particularly those in substandard and overcrowded living conditions, and improve processes for housing inspectors. Students working in other cities were tasked with different challenges such as addressing foreclosures or nuisance Airbnb properties. In past years, students teams in Chelsea had worked on using City data to develop risk scores to intervene early on problem properties or improve business processes in meetings; however, these innovations were ultimately not adopted by the City. Given this history, our team was intent on ensuring our innovation was relevant and valuable to those who would use and benefit from it.

We explored several innovation ideas such as pairing inspectors and community organization representatives to facilitate access to hard-to-reach properties and aid in resolving social issues identified during the inspections. We also thought about ways to enhance prevention and recognition of problem properties such as through mailers to residents about how to keep their homes safe and block parties where residents could learn more about risk mitigation in their homes and their rights as tenants. We considered a system where inspectors themselves made a link between residents and relevant social service agencies, or shared cards with contact information for social service agencies. In the end, these ideas and others were jettisoned due to concerns about feasibility, authorizability, and the value they would add.

Ultimately, we designed an innovation to leverage the unique role of housing inspectors to identify vulnerable residents and systematize a referral processes to connect residents to services, by means of a case manager. The proposed innovation worked as follows (Figure 2): During a routine inspection, an inspector identifies a situation that may need a referral. This could range from a crisis with an immediate safety threat (such as eviction from an illegal conversion apartment) or for less urgent but still vital services (such as for food assistance or mental health services). Inspectors would receive training to identify these situations and engage with the resident. If a referral was indicated, the inspector

would then connect the resident with the case manager. The case manager would follow up with the resident after reviewing information about the referral and the property, to determine if, what type, and where a referral should be made. The case manager would then work closely with the resident and the relevant social service agency(s) to ensure a connection. Inspectors would receive feedback on the outcome of the referral and the City would receive quarterly reports on the outcomes of the program.

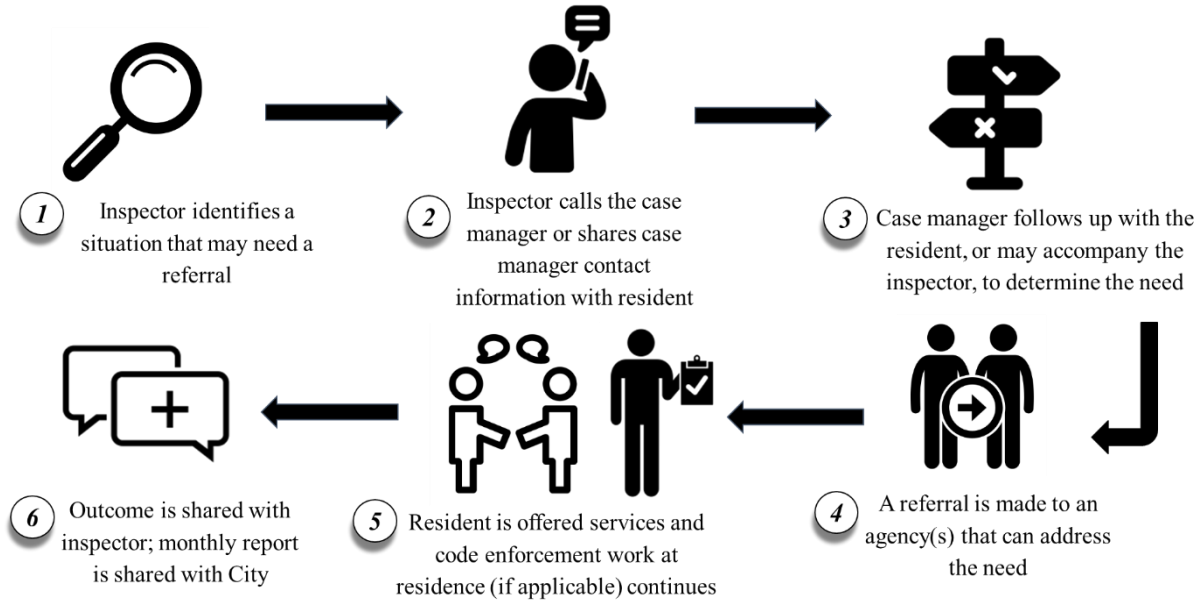


Figure 2: Social Service Referral Model

The innovation was predicated on the hiring of a case manager to be the liaison between housing inspectors and social service agencies. The case manager could be employed by City Hall or sub-contracted from a local social service agency. Through our time spent exploring the problem, it was clear that asking inspectors to diagnose problems and make referrals to a range of social service agencies would not be feasible given current capacity and workflow and would also not be authorizable given job descriptions, backlash from the union, and urging too much change too quickly.

The course concluded with my team and I presenting the innovation to the City leadership and housing inspectors. The City Manager, along with other leaders from the Police and Fire departments endorsed the idea, agreeing that it would add value and be authorizable. With funding, which they thought the City Council could approve, it would also be feasible.

The Innovation Fellowship

It was through this experience in the IFL course that I saw an opportunity to achieve public health impact by making the implementation of this innovation the foundation of my DrPH dissertation. The IFL Summer Fellowship afforded me the opportunity to carry forward and adapt the work my team and I had developed, while applying change management and adaptive leadership skills. Appendix A provides a timeline for the development and implementation of this innovation.

In my first meeting with the City Manager, a month after my team's final presentation, he informed me that it would not be possible for the City to fund the case manager position critical for the innovation. He had just come from a bruising budget meeting with the City Counselors where he was told they would not support any more funding for "soft" projects that they saw as disconnected from economic development. The City Manager encouraged me to explore external funding sources or see what I could accomplish without funding.

Three month later, in September of 2018, an early version of the innovation was in place. Without additional funding, housing inspectors were making referrals and residents were being connected with services in ways they had not before the innovation. In October of 2018, the City Manager notified me that City Hall would fund this initiative, allowing it to be improved and sustained. The following sections of this chapter document the journey to enabling this rapid change.

Implementation of the Innovation

In June of 2018, I began the Summer Fellowship at Chelsea City Hall to implement the social service referral process innovation within housing inspectional services. My approach drew from strategies for social innovation, adaptive leadership, and change management. I used these strategies because the task required challenging existing processes, inspiring a shared vision, managing conflict, and building relationships. The innovation I sought to implement was not a predefined solution that could be implemented by faithfully executing a plan, but rather a process that would require learning and fitting the innovation to the context. It required developing new capacity within local government, particularly among inspectors, and working with stakeholders across the city to re-imagine the role of housing

inspectors in public health. I drew primarily on Moore's Strategic Triangle (2004), Kotter's 8 step process to leading change (2012), and *The Practice of Adaptive Leadership* by Heifetz *et al.* (2009). There are many change management frameworks; however, I selected these approaches because they are well-established and fit the adaptive challenge I confronted.

Moore's Strategic Triangle is a three-part framework for strategic management in the public sector. In order to expand public value, change agents must effectively manage the authorizing environment and build capacity. As re-framed by de Jong and colleagues in *Agents of Change*, within Moore's framework there are three types of work that must be accomplished (Cels et al., 2012):

1. Political work - obtaining and maintaining legitimacy/support from the authorizing environment
2. Managerial work - expanding capacity to implement the innovation
3. Imaginative work – envisioning new public value

Figure 3 describes how I applied this framework to ensure the innovation was authorizable, feasible, and valuable.

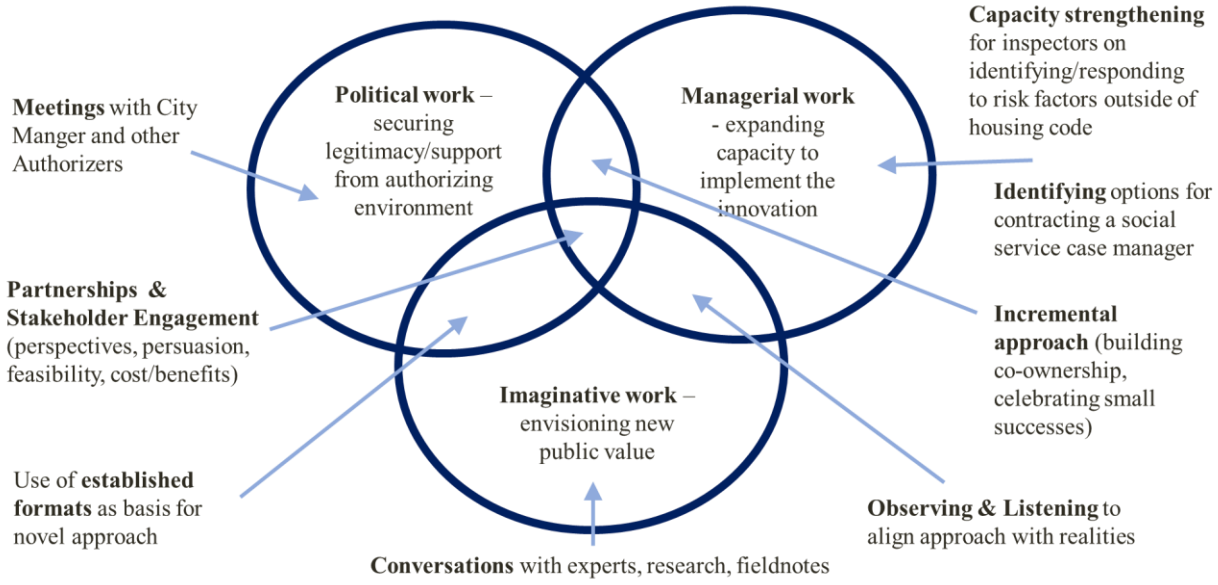


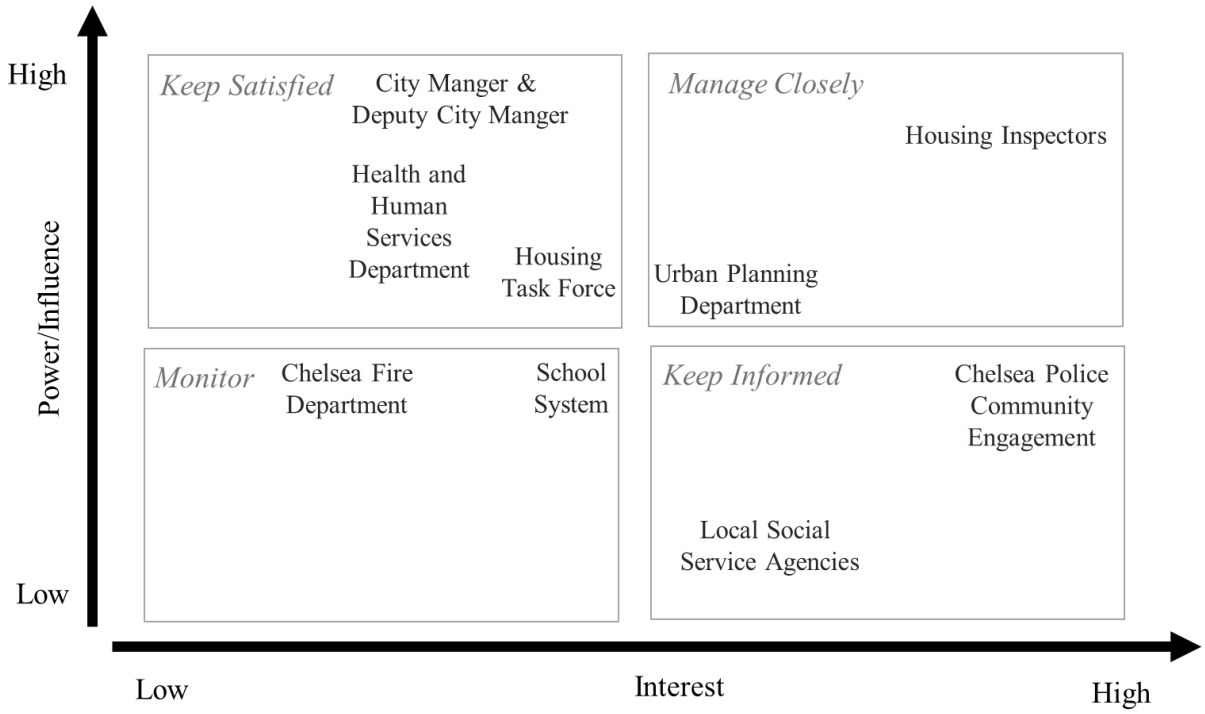
Figure 3: Approach to Creating New Public Value

Kotter's 8 Step Process to leading change describes a sequenced theory, starting with establishing a sense of urgency for the change, and moving through: building a guiding coalition, generating short

term wins, and instituting the change, among other steps (Kotter, 2012). This roadmap, used extensively in the private and public sectors, was useful in anticipating the challenges in the process of leading change and helpful in planning my implementation strategy.

Lastly, I drew from Heifetz's adaptive leadership framework. Adaptive challenges are those for which there is no clear solution, and which necessitate changes in values, beliefs, and roles. Adaptive solutions require experimentation in which the people with the problem are part of solving it (Heifetz et al., 2009). Heifetz describes moving back and forth between the "balcony" and "dance floor" to continually assess what is happening in an organization in order to take corrective action. He describes how people observe and experience the problem and solutions differently when immersed in them on the dance floor versus watching from the balcony. Adaptive leadership requires both perspectives. Heifetz also uses the metaphor of pressure cooker for the process of adaptive change. He describes how change agents must carefully play with heat and pressure in order to generate the transformation they envision. For example, if trust and informal authority are high, the system may tolerate more "heat" without exploding. Where trust is low, high heat cannot be applied at first. Similarly, too little heat and pressure will not generate adaptive results.

I built momentum for the innovation through experimentation, adopting and rejecting various parts of the innovation, and moving between the "dance floor" and "balcony." In this way, I was able to ensure quality, relevance, feasibility. There were many stakeholders involved in the process, with varying levels of influence and interest (Figure 4). Using the approaches described above, I focused my efforts on those with high interest and influence (*e.g.* the housing inspectors), worked to engage those with high influence but more limited interest (*e.g.* the City leadership), and consulted and informed those with high interest but little influence on the innovation's adoption (*e.g.* local social-service agencies).



This map shows the interest and power/influence of the key players at the beginning of the implementation process, with descriptions of the most salient below.

Housing Inspectors: Housing insepctors had the most power/influence over whether the innovation could be successfully implemented. If they didn't buy in, City Leadersihp could not force them to change their practices. Inspectors also had high interest in the innovation, not as supporters at first, but an interest in thwarting the innovation in order to maintain the status quo. Over time, their interest turned to one of collaboration.

City Manager & Deputy City Manager: The City Manager and Deputy City Manager had high power and influene but this could not be leveraged until sufficient evidence that the innovation could be successful was achcieved. As the feasibility and value of the innovation grew, so did their interest.

Chelsea Police Department Community Engagement Specialist: The Community Engagement Specialist was very interested in the innovation because the Police Department had recently adopted a new model to community police work that involved coordinated case management services for residents. He saw the innovation with houisng inspectors as comperable and was eager to help bring more support to Chelsea residents. However, he had little power within City Hall to influence the uptake of the innovation.

Figure 4: Stakeholder Map

Targets into Agents of Change

Engaging housing inspectors in the process of change was essential. They were the targets of the change, and while they also stood to gain, they were the group with the most to lose. Without inspectors seeing the value and expanding their capacity to identify social and health issues and make referrals to a case manager, successful and sustainable implementation of a social service referral process would not be possible. To innovate, I needed to turn inspectors from targets of change into agents of change. I approached this through building 1) relationships with the inspectors to establish trust and learn about their loyalties and perspectives on the problem, 2) an understanding of their work processes and their challenges through observation, and 3) informal authority to lead change. As described in by Heifetz *et al.,* informal authority can be built through strengthening relationships, particularly with those that have a large stake in the challenge, regardless of their perspective on the challenge (2009).

I therefore focused much of my time over the three-month fellowship observing and building relationships with the three housing inspectors and the head of the Inspectional Services Department in Chelsea. I made a point to drop by their offices almost every day for social conversations (about their families, weekends, or if they wanted to get lunch) and business-related conversations. I also accompanied them on over 15 inspection trips to rental properties. I saw firsthand the crowded conditions in which many residents lived, the poverty residents faced, and the vulnerability of inspectors entering apartments without knowing what was behind each door. I saw the impact a good landlord could have on keeping residents safely housed, and the challenges landlords faced when tenants destroyed property. I saw the impact unscrupulous landlords had in renting units to tenants with walls covered in mold or kitchens crawling with cockroaches. Inspectors described homelessness, substance use disorders, hunger, hoarding, heating assistance, maintaining hygienic conditions, and preservation of tenancies as some of the most pressing issues impacting residents and the ability of inspectors to effectively carry out their jobs. Table 2 describes the public health risk factors identified by housing inspectors and their frequency, as reported by the head of Inspectional Services.

Table 2: Public Health Risk Factors Identified by Housing Inspectors and Their Reported Frequency

Risk Factor	Frequency
Substance Use Disorder (alcohol, other drugs)	3-4/Year
Youth Issues (missing school, gangs)	1-2/Year
Infant/Young Children Issues (neglect, parenting issues)	1/Year
Hoarding	2-3/Year
Suicidality	1/Year
Emotional disturbance	Monthly
Poverty (fuel or food assistance, weatherization)	3-4/Year
Unemployment	1/Year
Crime Victimization/ Public Safety Issue	3-4/Year
Sexual or Domestic Violence against Adults	2/Year
Physical Health Problem in Need of Intervention	1-2/Year
Severe Overcrowding	1-2/Year
Rooming House Conditions	Weekly
Eviction	2-3/Month
Homelessness	4/Year
Unhygienic Conditions/Very Poor Housekeeping	Weekly
Unsafe Housing Conditions (needing immediate relocation)	4/Year
Elderly Abuse and Child Abuse	Hard to see but suspected

Through observation of inspections and while driving from house to house or on coffee breaks, I was able to learn about the challenges inspectors faced, what their priorities and loyalties were, and how they viewed the problem of social and health issues related to housing. At first, the three inspectors were reluctant to take me on inspections and resistant to the idea of social service referrals. They saw me at best as a well-intentioned, naive outsider. At worst, they saw me as someone who threatened to disrupt processes they relied on and uncover problems for which they may be implicated. Regardless of their

stance, their strategy was that if they could ignore or hold off meetings for long enough, soon the fellowship would be over.

However, over time and through my frequent visits to their office, our relationship grew, and they began to see my ideas as less threatening. Their primary concern was that the innovation would add additional work for which they did not have time. I learned that they already felt too many demands were placed on them from different departments and from the public. They felt under-resourced and underappreciated within City Hall. Inspectors were frequently caught up in disputes between landlords and tenants and under pressure to stick to a rapid proactive inspection schedule. They agreed in principle that people could benefit from linkages to social services, but they also felt that social service referrals were too far outside of their responsibilities and that making referrals would open a Pandora's box of problems that they would be expected to solve. They also thought that if people wanted services, they had other routes to obtain them, and that a referral coming from an inspector could damage relationships with tenants and landlords or cross professional boundaries in uncomfortable ways.

I didn't dismiss their concerns or try to convince them that there would not be pain involved in this change. Instead, following Kotter's advice from *Leading Change*, I tried to share a vision for the value of the innovation that was simple, sensible, and appealing to the heart (2012). I described how for some residents, contact with the housing inspector was the only point of contact with an outside authority and a critical point for intervention. I described issues inspectors knew all too well, such as suspected child abuse in overcrowded living conditions, eviction leading to homelessness, or substance use disorders leading to overdose death as real examples of outcomes that could be prevented with early intervention and linkages to social services. I also made it clear that the innovation would not require them to make the referrals to individual social service agencies themselves, only to identify the situations that might benefit from a referral and inform a case manager. I spent the most time with the lead housing inspector. He had decades more experience as an inspector than the other two and was initially the most open to me accompanying him on inspections. He was a dominant personality in the department and the

most vocal opponent. The other inspectors would not adopt the innovation unless he did. Gaining his trust and convincing him of the value of the innovation was critical.

Through my observations and conversations, I saw and heard how the social issues inspectors encountered impeded the work of housing code enforcement, causing delays and repeat visits. I observed the toll on the wellbeing of inspectors who observed human suffering every day and had adopted various coping methods—from disengagement, to blaming residents for their plight, to attempting to help residents at great personal and time-related cost. Inspectors shared with me their frustration over not having a system in place and described the challenges of navigating referrals without adequate training, time, or support. When inspectors worked to link residents to services on their own, they reported that it took days of time away from their core responsibilities.

At the same time, unresolved social issues interfered with residents' and landlords' abilities to remedy housing code violations. For example, mental illness may cause a tenant to engage in activities, such as hoarding, that result in code violations. But issuing fines alone does little to bring the property into compliance when the underlying mental health problem is not addressed. Inspectors also described occasionally having to ignore high-risk situations because there simply weren't ways for them to intervene. Inspectors had different thresholds and different points of contact for dealing with social issues as well. One would privately make referrals but on a case-by-case basis and did not want the process to be systematized. He liked using his own discretion and own networks. One felt that referrals were completely outside the realm of her responsibility. The other said she would be willing to make referrals but that she never saw reasons for making referrals. However, in accompanying her on inspections, it was clear that she did visit homes where referrals would be indicated, but that part of what enabled her to get through her work was that she looked past these situations. The need for a liaison to link vulnerable residents with services was clear throughout my conversations and observations. The end result of the situation without a system for referrals was a missed opportunity for early intervention to prevent crises, even when the warning signs were clear, and the consequences costly.

I spent the first two months of the Innovation Fellowship building relationships in order to gather inspectors' input and understand their reality. It allowed me to effectively sequence the implementation of the innovation at a rate I knew they could absorb and once I had sufficient informal authority to do so. It wasn't until the end of the summer that I began asking inspectors tough questions to uncover the reasons they were resistant to the innovation and challenging their expectations for their roles. I began "turning up the heat and pressure" in my conversations with the inspectors, and analogy used by Heifetz *et al.* to describe the necessary conditions for adaptive work. By the end of the fellowship, each inspector was, if not convinced of the value of the innovation, willing to give it a try. They saw the potential value the innovation could bring as being worth the risk of changing the status quo. The early wins achieved in the implementation of this program were largely due to the adaptive challenge housing inspectors accepted – to take a risk and try something different.

Crafting the Case for Innovation

Housing inspectors and public health change exist within a wider system and therefore stakeholder engagement across City departments and community organizations was essential. I met with over 20 City staff from all levels of City Hall, Police, and Fire Departments. I also met with staff from five community organizations and attended community meetings and events. Through this, I sought to incorporate new perspectives into the innovation, while also convincing stakeholders of the value and increasing the feasibility of the innovation. As described in *Agents of Change*, innovators must leverage and sustain their innovation by proactively managing meaning (Cels et al., 2012). The value proposition and the stakes involved for each person I met with were different, as was the perspective they added to the innovation. For example, for some city staff, particularly those in the Urban Planning Department and School Department, the value proposition was about fulfilling wider civic goals of making the city safer and better-connected through supporting the most vulnerable residents. For other departments, such as the Fire and Police, the value proposition was about prevention to reduce the need for emergency services. For community organizations, the value proposition was about expanding transparency and collaboration with city government and the reach and quality of social service programs. Engaging stakeholders across

the City in one-on-one meetings allowed me to develop relationships, gain valuable information about how the cost and benefits of the innovation were distributed, and make more personalized cases for the change I sought to enable. I also attended community events and meetings to build relationships through more informal conversations and as part of diverse groups.

Crafting the case for change is an essential part of social innovation (Cels et al., 2012). *Agents of Change* provides several strategies successful innovators have used in crafting their case. One such strategy is leveraging the evidence of success. This is broken down into three categories: capitalizing on small successes, gathering indirect evidence, and the social construction of credibility. It was important to understand how different groups and sub-groups within the City departments and community organizations were responding to the idea so that I could plan my strategy accordingly. Through an incremental approach, of first building relationships through one-on-one meetings and gathering information, I was able to identify allies for the vision of change, agnostics, and those opposed to the change and learn from each one. As with the housing inspectors, building relationships helped me to build credibility and informal authority.

Through the process, I also learned more about the community resources and opportunities for social service referrals. Chelsea has a robust network of social service agencies; however, they are in competition with each other over scarce funding resources. Those providing direct services said they would not be able to serve as a key referral point for inspectors unless they received funding. However, the community agencies endorsed the need for the innovation. In asking questions and learning more about their work, I also saw that in the future, the referral innovation could open new opportunities for collaboration across the agencies.

In the course of my conversations with community leaders, I found an enthusiastic ally for the innovation within the Chelsea Police Department: the Community Engagement Specialist (CES). The Chelsea Police department runs an initiative program known as “The Hub,” which is led jointly by the CES and other community partners. It is a group of social service and City agencies that meet weekly at

the Chelsea Police Department to mitigate risk for families and individuals facing crises and needing support from more than one agency (CPD, 2019).

The CES saw the value of engaging housing inspectors to link residents with social services and was well connected with the social service agencies in Chelsea. The innovation appealed to him out of a deeply held belief that a community should show concern for and help all residents, regardless of their circumstances, and that each resident has the potential to thrive when given the chance. He saw how the role of police officers in Chelsea had changed over the last several years from that of only law enforcement, to one of connecting residents with services through the establishment of the Chelsea Hub. He agreed to serve as an interim case manager for the inspectors to establish a proof-of-concept that the innovation could work. He was excited about the prospect of eventually having a counterpart at City Hall that could support community engagement work. To implement this new referral process, the CES gave a presentation to the Inspectional Services Department (ISD) on how the new referral process would work, similar to the model in Figure 2, with the CES serving as the case manager. The design of the process incorporated feedback from ISD, the CES, and other stakeholders. However, it did not include formal mechanisms for reporting and documentation, as neither inspectors nor the CES were willing to do so.

Experimentation and Short-Term Wins

With the proof-of-concept referral process in place, when inspectors encountered a threat to the health, safety, or wellbeing of residents that could not be resolved through enforcement alone, they had the option to contact the CES. The CES then worked to link the resident(s) to the services they needed, either through a referral to the Chelsea Hub or directly to a social service agency associated with the Hub. After the initial presentation, inspectors began making occasional referrals to the CES. These referrals resulted in early interventions. For example, an inspector alerted the CES of a complaint a resident shared of illegal drug activity occurring at her property. As a result, the police intervened, substance abuse treatment was offered, and the drug activity at the property ceased. On another occasion, a resident's home was out of code due to hoarding. Inspectors had spent several months working with the resident to

try to bring the home into code. The CES took the lead on linking the resident to mental health services that specialize in hoarding.

The referral process also proved to be bi-directional. At a Chelsea Hub meeting, a woman with young children was facing eviction for non-payment of rent. The reason she gave was for unsafe housing conditions. The Hub contacted ISD who were able to provide a timely inspection of the property and work with the landlord to ensure the violations were resolved. With help from other social service agencies and collaboration with ISD, the family was able to stay in their home. This rate of referrals and timeliness of their resolution was not present prior to the implementation of this proof-of-concept innovation.

In August of 2018, I presented these finding and my recommendations for sustaining a social service referral process at a meeting at City Hall. Over 30 people from across City departments attended, including the housing inspectors. The diversity in department representation and leadership-level at the meeting was a rare occurrence. With each person present, I had had at least one one-on-one meeting. I made a point during my presentation of elevating the role of the housing inspectors, expressing the pressures inspectors face and the hard and valuable work they do. I needed to strike a balance in presenting the innovation in a light that made the inspectors feel that I had their backs while also pushing the City leadership for adaptive change within the ISD department. Using data and testimonials I'd collected, I urged the City to hire an equivalent of the Police Department's CES, but at City Hall and proposed several grant funding sources that might be explored. At the suggestion of the CES, such a position had been written into a grant earlier that summer, but ultimately the grant was not funded.

In the presentation, I described how this proof-of-concept model was done without allocation of new resources, but rather, through expanding the imagination and capacity of city government to solve real problems. The uptake of the innovation package was not a given. Throughout the summer I worked to iterate and overcome concerns about change. This was only possible through working closely with stakeholders; positioning housing inspectors as agents (rather than recipients) of change, and through strategic leveraging of social relationships. In the end, the steps that staff in Chelsea took to implement

the proof-of-concept innovation were of their own accord. Through a process of envisioning new value, securing support, and expanding capacity, change was made.

Expanding Adaptive Work

My final presentation activated city leadership. Surfacing the threats to health and wellbeing that inspectors encountered and the toll these took on residents and inspectors "raised the temperature." Presenting the City Manager and Deputy City Manager with both a compelling description of the problem and a viable solution in front of a range of City stakeholders, reduced complacency with the current system and created an opening for real change. The momentum after the presentation turned many who were neutral into supporters and those who were supports into more active helpers, a characteristic phenomenon after early wins, as described by Kotter (2012). He writes that as a general rule, "the more cynics and resisters, the more important are short-term wins." The presentation demonstrated that the innovation was viable and could reduce human suffering in the City and improve processes for inspectors. Some at City Hall were strongly opposed to the innovation, but that brought them into the conversation. While an important first step, the proof-of-concept model also had many drawbacks and parts that needed to be clarified and elaborated, such as considerations for accountability, inspector training, and resident confidentiality. After the fellowship ended, I continued on at City Hall through weekly visits.

I realized after the presentation that while I had put great effort into engaging housing inspectors and other City staff, I hadn't involved City leadership much in the process. While the City Manager and Deputy City Manager had attested to the value of the innovation early on and given me authorization to try to implement it, my sense was that they were not convinced it would be feasible. They also had other priorities and it was riskier for them to come out in strong support of the innovation before there was evidence of its feasibility and value, especially with the potential of denunciation from dissenters. My approach to overcome this was to try to show compelling evidence that the innovation could produce results before bringing them into a guiding coalition to make it possible. However, it is possible that if I had engaged them sooner, I could have benefited from their authority and achieved more traction faster.

Nevertheless, after the presentation, the Deputy City Manager began taking the innovation seriously and thinking through how it could be improved and sustained. He wanted to know more about the frequency and type of issues that were encountered by housing inspectors. In response, I interviewed housing inspectors, compiling a list of the most common types of social issues they encounter and their frequency (Table 2). I began to face more pressure from my authorizing environment at City Hall to work with City stakeholders to address the concerns of dissenters and cultivate more champions of the work. They now had skin in the game and wanted the innovation to succeed.

After a month of the proof-of-concept model in place, flaws became evident. This served as an important step in the iterative process. As described in the Heifetz model, it is through experimental trial and error that we can make change – moving from dance floor to balcony to understand what is happening and to take corrective action (2009). The emergence of the flaws also required quick action to turn the challenges into momentum to make improvements rather than a reason to throw out the idea all together. A major limitation of the proof-of-concept model was that there was no accountability built into the process. Housing inspectors cited examples of making referrals and nothing happening or making a referral but then just being told to handle it by themselves. The larger system needed attention and change, not just the housing inspectors.

City leadership, including a City Counselor and the Director of the Health and Human Services also had strong reservations about the innovation. These included concerns about privacy of residents, accountability, and reliance on the CES and the Chelsea Hub, which they didn't feel was the appropriate partner for most social service referrals (believing the Hub to be focused on substance use disorders and prostitution). They thought a different social service agency in the City would be a more appropriate partner. Their preferred agency had a longstanding relationship with prominent City Counselors and the City Manager. I agreed that the social service agency would be a more natural partner in this work given their focus on poverty alleviation and their strong connection with other social service agencies in the City; however, in my conversations with this organization early on, it was clear they would not be willing to serve in the role of case manager unless there was funding attached. They reported to operate on very

slim margins and that supporting additional residents identified by housing inspectors and providing case management would not be possible. Through this process, I saw the different mandates and loyalties at play, and the "turf" boundaries within and outside of City Hall. The ecosystem in which the innovation was operating began to come into view.

I began to strategize with the Deputy City Manager about how to bring the more reluctant leadership on board and how to address their concerns. Heifetz states that "If you are singing a song you have sung before without great success, get someone unexpected to sing it for you" (2009). The Deputy City Manager and I did this by engaging the head of ISD to be an advocate of the innovation, what de Jong and colleagues call the social construction of credibility. We guessed that the head of ISD's testimony of the need for social service referrals during a meeting of the heads of each of the City departments would be powerful and unexpected. The head of ISD was a reluctant supporter of the innovation. He was skeptical that it could work and worried it would increase work and that his subordinates would push back. However, he was also convinced of the value. The relationship and trust I'd built with him allowed me to know when I could press him with questions to uncover his resistance to change and when it was best to concede or try a new approach. Through a series of conversations, eliciting his feedback and allowing space for him to vent concerns, I coached him on making a pitch to City leadership. Heifetz goes on to say that "connections with unlikely allies could make a strong impression on those who oppose your change initiative or have not yet decided how they feel about it" (2009). Kotter writes that key players in enabling change are often middle or lower-level managers of the department where the desired change is to take place. Gaining the support of these managers is crucial to reduce compliancy and increase urgency (Kotter, 2012). Their support is needed to sell the vision to others.

The approach proved successful. After the testimonial from the head of ISD on the toll that social issues placed on Chelsea residents and on inspectors, and the need for a referral system, the Deputy City Manager moved the issue forward. He engaged the more reluctant members by proposing to partner with the City leadership's preferred local social service agency. This change in partner addressed some of the

chief concerns of the dissenters, allowing for better accountability and building on an existing relationship they knew and trusted. However, funding and confidentiality concerns remained. The Deputy City Manager's leadership in moving the innovation forward was critical. He carried far more authority with the heads of departments and advancing the innovation in a meeting at which I was not present showed his commitment, independent from the relationship with me or the IFL. His championing of this innovation amongst City leadership turned the innovation from an outsider's project to a City Hall-lead initiative.

Learning from the Dissenters

Over the Fall of 2018, I met with those who were opposed to or had a specific concern about the innovation. Heifetz *et al.* recommend protecting and engaging the voices of dissent because even though they can be unproductive much of the time, they have the "uncanny capacity for asking the really tough key questions that you have been unwilling to face up to yourself or that others have been unwilling to raise" (2009). I found this to be particularly true in my conversations with the strongest voices of dissent. Once I engaged them in conversation and assured them that their opinions mattered, I was also forced to confront short-comings of the innovation. I then sought to bring the dissenters on board to help guide the innovation process and solve the problems they identified. The most vocal dissenters reported that they often felt marginalized by the organization for raising concerns on issues. Bringing them into the coalition working toward a solution helped to not only soften their opposition and gain important insight into gaps, but also make them feel included in the process.

With time, more people at City Hall began to talk about how to improve upon the social service referral model and express a demand for it. At the Housing Task Force Meetings, staff from ISD and other departments, such as Urban Planning, started listing examples of how the referral innovation could be useful for the problems they were experiencing. Momentum was growing.

In October, a mechanism to fund the innovation arose. The City Manager decided that it no longer made sense for the City to fund a local agency doing anti-prostitution work because he saw the

work as duplicative with other organizations. This opened a source of funding that would not need to go before the City Council since the use of the funds for social service had already been approved.

In March 2019, the City began a three-month pilot program with the designated local social service agency to receive referrals from ISD and link vulnerable residents with needed services. The learnings from the pilot will be used to inform a 5-year sub-contract, subject to renewal after two years. In February 2018, a new team of Innovation Field Lab students began working in Chelsea. In collaboration with the social service agency, the team will help to define the scope of work, develop mechanisms for documentation, accountability, confidentiality, and performance and impact metrics based on early learnings from the pilot. A new Innovation Fellow will carry the work forward in the summer of 2019.

Conclusion:

In conclusion, fulfilling the mandate of the Massachusetts State Sanitary Code to "protect the health, safety, and well-being of the occupants of housing" requires re-imagining the role of housing inspectors as agents of change. Through this innovation, when inspectors encounter threats to health and safety that cannot be addressed through code enforcement alone, they now have a system to link residents to the services they need. This not only allows for early intervention but also improves workflow for frontline staff. Given the central role that housing plays in the health of individuals and communities, the innovation represents a catalyst to reduce social inequality and improve public health. The implementation of this innovation also shows how public health knowledge translation can take place through strategic approaches to change management and social innovation.

These approaches do not require an Innovation Fellow or partnership with an Innovation Field Lab, but they do require cross-disciplinary collaboration and relationship building, experimentation, and imagination. Further, models like the one described here could be developed and adapted to fit other city contexts, as the housing-related social and health problems facing residents in Chelsea exist in cities throughout the country. Through adaptive leadership and innovation, progress can be made toward breaking the link between poor housing and poor health.

The next chapter builds on the social service referral innovation by describing an approach to using existing city data to identify public health and housing threats and intervene early with both enforcement and service provision interventions.

Chapter 3: Leveraging Existing City Data to Identify Housing-related Public Health Problems and Intervene Early on High-risk Properties

Introduction

Housing is a powerful social determinant of health, impacting social relationships, economic opportunity, environmental exposures, security, and a range of other factors (CSH, 2014). The conditions of homes and neighborhoods influence everything from respiratory health to behavioral health (Scally et al., 2017). One of the primary strategies for breaking the link between poor housing and poor health is the enforcement of housing codes (Benjamin and Vernon, 2014). Modern housing codes, enforced by housing inspectors, stipulate minimum health and safety standards in rental housing and assign specific duties for landlords and tenants (Benjamin and Vernon, 2014). The codes vary slightly by community, but their function and scope are similar (MA Department of Public Health, 2007).

Implementation of modern housing codes focuses on the technical enforcement of the code rather than broader socioeconomic or health impacts that the codes were originally designed to address when first developed in the late 1800s (Krieger and Higgins, 2002; Stacy et al., 2018). The codes are oriented toward the remediation of a set of immediate and readily observable problems. As such, code enforcement responds to problems after the damage is done and sometimes only achieves temporary solutions, rather than addressing underlying or more complex drivers (Elliott and Quinn, 1983). Further, inspections concentrate on building features, when often the concerns lay with the tenants living in the buildings. This represents an important missed opportunity to improve public health.

Most inspection departments operate separately from other city departments and have little resources, authority, and capacity to take on more proactive, coordinated strategies (Scally et al., 2017). In addition to being siloed, inspection departments rarely make use of housing code violation data or data from other city departments to take a wider, intentional approach to improving health and housing (Stacy et al., 2018). They also lack the tools and partnerships, outside of issuing fines, to respond to the range of threats to public health that inspectors encounter.

While housing codes are intended to apply citywide, inspections are frequently carried out in response to residents' complaints or in limited areas, generally excluding both the poorest and the most affluent neighborhoods (Elliott and Quinn, 1983; Stacy et al., 2018). The working norms of inspectors often emphasize professional discretion and selectivity in code enforcement, rather than equity-focused or data-driven approaches (Elliott and Quinn, 1983). Inspection efforts are therefore concentrated of the servicing of complaints or in middle- and lower-middle-income areas. Some cities seek to overcome the pitfalls of complaint-driven models through proactive enforcement programs where properties are inspected according to a schedule or upon tenant turn-over. However, it is often not possible, or an efficient use of city resources, for inspectors to inspect every rental property according to this schedule because of the staff and resources needed (ChangeLab Solutions, 2014).

Table 3. Factors Limiting the Effectiveness, Efficiency, and Equity of Housing Code Enforcement to Address Public Health Problems

1	It is reactive, often responding to damage once it is already done
2	It is complaint driven, meaning problems in less enfranchised areas go undetected
3	It is focused on a narrow set of immediate threats to safety, missing often less visible threats to physical and psychological health
4	It is focused on buildings when many problems concern the occupants
5	It is resources constrained, in that there is never enough capacity to inspect all buildings comprehensively and in a timely manner
6	It does not have the remedial tools or partnerships, outside of fines, to respond to the range of public health threats encountered

Despite these challenges (summarized in Table 3), local governments are uniquely positioned to improve the conditions in which residents live. Resource-constrained code enforcement practices can be made more effective, efficient, and equitable by leveraging data to inform a focused allocation of attention and effort. Increasingly, cities have access to a range of administrative property-level data in formats that can be integrated across departments. These data may come from police and fire departments, tax assessor's information, utilities, the census, and other sources. Taken together, these data can be used to identify high-risk properties and efficiently target them for inspection and intervention. For

example, certain code violations are 1) indicative of health risks in vulnerable populations (*e.g.* the association between mold or insect infestations and asthma) and/or 2) of high priority to cities (*e.g.* to identify properties that are overcrowded to mitigate risks and plan for future housing stock needs). Using city data, combined with the accumulated knowledge of housing inspectors, cities can ensure code enforcement and service provision are targeted to the areas in the most need.

Progressively, cities across the US are using data to improve effectiveness, efficiency, and equity in provision of services and in response to public health threats. City data can be used to inform, target, and evaluate initiatives to improve housing-related health. Table 4 describes distinct ways cities may use data. Each use of data has a different purpose, serves different interests, and varies by the people or departments doing the work. Combinations of approaches are also used.

Table 4: Approaches and Purposes for which Cities May Use Data to Address Housing and Health Problems

Regression Analysis	Using data to understand correlational and causal relations in order to better characterize problems and their root causes
Predictive analytics	Using the knowledge gained from regression analysis combined with real time data to intervene early based on detection of predictors
Operational cross-functional data-sharing	Using data to better coordinate efforts between different departments: bringing data from police, fire, health, inspectional services, *etc*. together to inform a more coordinated and effective operational approach
Risk-based inspection schedule	Using data to generate inspection schedules and target interventions based on risk
Strategic data-analysis	Using data to detect patterns and trends and inform strategic action and policy
Performance management	Using data to evaluate performance of operational government action
Program evaluation	Using data to evaluate overall government policy

For example, in 2017 Washington DC was facing a growing rodent infestation problem. Rather than relying only on the density of rodent-related 311 calls (non-emergency calls) to target abatement services, the city developed a predictive model to inform the response, as 311 calls are more likely to be made by more informed citizens (Weaver, 2018). Using data on population density, zoning, building age, and the presence of impervious surfaces, they were able to deliver abatement services to areas in the most

need (Weaver, 2018). In cities such as Cleveland, Chicago, Los Angeles, New York, and Philadelphia, information systems with aggregated property-level data are being used to predict which properties are at greatest risk for vacancy (Appel et al., 2014; Hillier et al., 2003; Martin et al., 2017). Vacancy, and living near vacant homes, has been linked to negative social and health outcomes such as violence, substance abuse, and chronic disease (Leon and Schilling, 2017). These examples highlight the use of predictive analytics to inform targeted action and improve public health.

In Rochester, NY, researchers used housing-inspection data, alongside data on the age of homes, assessed value, and other factors, to identify the highest-risk housing stock (Korfmacher and Holt, 2018). The study recommended that cities use data from proactive housing inspections to inform public health interventions. For example, cities can identify areas with high rates of safety-related housing code violations (*e.g.* broken handrails, stairs) and older adults in order to prevent the risk of falls or use data on violations such as plumbing leaks and mold to predict asthma emergency department visits at the census block level (Korfmacher and Holt, 2018). This is an example of using data to detect patterns and trends and inform strategic action and policy.

However, the potential of city data to inform public health and housing initiatives is underexplored. This is perhaps because data-driven approaches require prioritization by city leadership, and often expanded capacity of city staff and cross-departmental/cross-agency collaboration.

Chelsea, MA

The city of Chelsea, MA is uniquely positioned to leverage existing city data to identify housing-related public health problems and intervene early. Not only does the City have a proactive housing code enforcement program and access to aggregated cross-departmental property-level data, but the City also recently adopted a social-service referral program, described in Chapter 2. Through this program, when housing inspectors identify residents with social, safety, or health needs beyond what can be addressed through housing code enforcement, they can link at-risk residents with needed services.

Located just outside of Boston, Chelsea is a small, densely-populated city where the majority of residents are people of color, new immigrants, and low-income families (US Census, 2017). Half of

Chelsea's housing stock are buildings with 2-4 family homes and many homes are in poor condition (Ambrosino, 2017). The average home was built in 1913, but some homes were built as early as 1825 (City of Chelsea administrative records). Almost 70% of residents are renters and 60% of housing units are two bedrooms or fewer (Ambrosino, 2017). Diverging from national trends, Chelsea's household size is growing as its population grows, driven by a large proportion of multigenerational families (Ambrosino, 2017). Many residents face overcrowded, unsafe living conditions, and the threat of eviction (Ambrosino, 2017).

In 2014, Chelsea City Hall decided to take a new approach towards housing inspections to address the poor quality of the housing stock and improve health and wellbeing. The goal of the initiative, known as the Certificate of Habitability Program, was to inspect all rental properties every five years or upon tenant turnover within a target area of the city (City of Chelsea, 2014). The target area include approximately 60% of properties in the city and encompassed the poorest areas. Grant funding that restricted the program to the target area ended in July 2018, but the City is continuing to fund proactive inspection of rental properties and has extended its purview to the entire city. Currently, housing inspectors rely on tacit knowledge to identify sections of the City for proactive inspection. This method means that high risk properties may go unidentified.

Data on the housing code violations resulting from the proactive inspection program between 2015 and 2018 are available and linked to each property. In 2018, the City began working with a web-based platform called Building Blocks, which integrates city data across departments into a single application, linked at the property-level (Tolemi, 2019). In addition to housing code violation data, the city has other property-level data such as police and fire calls, age of the home, delinquent taxes, vacancy, and other data in digital, up-to-date databases. Within the Building Blocks application, current and historical information about properties can be accessed, analyzed, and visualized. These integrated data can be used to augment (or displace) tacit knowledge in order to identify, and prioritize for inspection, homes where residents are at high risk for housing code violations or complex social or health concerns.

The data can also be used to describe some of the most prevalent housing-related issues to help the city and community organizations prioritize their response efforts.

Objective and Goal

The objective of this work was to describe the prevalence of health-related housing code violations in Chelsea, MA and their association with property-level and census-block group attributes. The goal of this early-stage analysis was to 1) identify proof-of-concept predictors of housing-related public health problems in order to 2) demonstrate their value in helping inspectors to prioritize inspections and give other departments or service providers opportunities for early intervention.

Methods

Identification and Preparation of City Datasets

Property-level data from across City departments (Billing, Legal, Police, Fire, Planning, Public Works, Inspectional Services, and more) were identified based on their relation to housing or the social conditions within housing. Through meetings with heads of departments to explain how the data could be used to help the City and the department's own business processes and through working closely with the City's Information Technology department and staff at Building Blocks, the datasets were obtained and cleaned. Using Application Programming Interface (API) when possible, and digital reports when not, data were linked to Building Blocks. Some datasets were more difficult to obtain than others given restrictions in the way information was formatted, who (the city versus the vendor) had access to the datafiles in forms that were interpretable, and whether departments were willing to make changes in the way they stored data (*i.e.* moving from word documents to Google Sheets that could be linked to Building Blocks in real time). Different departments had different levels of data automation and different levels of understanding of how the data they used was structured. However, as more datasets were assembled in Building Blocks, the value of integrated data became more apparent, and departments were increasingly willing to contribute data in workable formats. Census data were also included. A list of datasets, their characteristics, and the rationale for their inclusion is summarized in Appendix B, along with recommendations for additional datasets.

Description of Datasets Used in Analysis

The analysis was restricted to rental properties within the Certificate of Habitability Program target area that received an inspection between August 1st, 2015 and July 1st, 2018. The 35-month period was chosen because this was the time period for which housing code violations resulting from the proactive Certificate of Habitability Program were available. While inspections were completed outside of the target area, these were excluded as they were in response to landlord or tenant requests and therefore not representative of housing conditions in the area or comparable with properties that were inspected proactively. Incident data (such as police calls or municipal fines) were restricted to the period between August 1st, 2015 and July 1st, 2018. The target area contained part or all of 19 different census block groups. Although housing code violations were linked to specific housing units on properties, the majority of the covariates of interest (police calls, municipal fines, *etc.*) were aggregated to the property-level. As such, analyses presented in this chapter aggregate housing code violations to the property level (for example, for a 3-family home, code violations or police calls would accrue to the whole property, whether or not they came from the same unit or different units on the property).

Outcomes of Interest

Of 36 possible hosing code violations, four code violations were selected as main outcomes interest: "Smoke Detectors and Carbon Monoxide Alarms," "Locks," "Extermination of Insects, Rodents and Skunks," and "Maintenance of Areas Free from Garbage and Rubbish." These violations were selected due to their close association with social or health problems about which the City is concerned (Table 5). Hereafter, the main outcomes of interest are shorted to "Smoke Detectors," "Locks," "Extermination," and Garbage in Living Areas." Each outcome was transformed from a count variable to a binary variable for whether or not the code violation was present on the property during the program period. An aggregate binary variable was also generated for the presence of any of the four main outcomes of interest at a property. This was done to inform an early-stage model to describe property- and census block group- level predictors of health-related housing code violations.

Table 5: Housing Code Violations and Rationale for Their Selection as Main Outcomes of Interest

Outcome Variable State Sanitary Code Violation	Rationale for Selection
"Smoke Detectors and Carbon Monoxide Alarms" Violation # 410.482	The death rate in homes without functional smoke detectors is twice as high as homes with functional smoke detectors (Ahrens, 2019). Chelsea has the highest rate of fires in Suffolk County at 12.4 fires per 1,000 people (Coan, 2013).
"Locks" Violation # 410.480	While the "Locks" violation may refer to inadequate provision of locks to prevent unlawful entry into homes, in Chelsea, inspectors state that close to 100% of lock violations issued are due to illegal locks on internal room doors. Tenants place locks on internal doors when there are unfamiliar/unelated individuals or families living together. Housing inspectors describe the "Locks" violation as a very strong indicator of overcrowded conditions. The City is particularly concerned about the negative social and health consequences of overcrowding, such as poor school performance and domestic and sexual abuse (Goux and Maurin, 2005; Gove et al., 1979; Makinde et al., 2016).
"Extermination of Insects, Rodents and Skunks" Violation # 410.550	Insects and animal infestations are not only created by deteriorating and unhygienic conditions, but also exacerbate these conditions. Insect or animal infestations also spread infectious disease and trigger asthma attacks (NCHH, 2019; Wang et al., 2008).
"Maintenance of Areas Free from Garbage and Rubbish" Violation # 410.602	Uncontained garbage in the home creates unhygienic conditions and may attract infestations of insects or animals. Garbage in living areas may also be an indicator of a resident's inability to maintain a property, representing a possible behavioral health concern or physical disability (PAH, 2007).

Covariates:

Additional property attributes were selected for inclusion based on previous literature and consultation with housing inspectors in Chelsea. Count variables were recoded as binary presence/absence variables to ease interpretation. Each census variable had 19 unique values depending on the census block group in which the property was located. These values were also recoded as binary variables indicating whether the property was in a census block group at or above the mean value for that variable.

Data Analysis:

The goal of the analysis was to describe the prevalence and spatial distribution of the main outcomes of interest and their relationship with other attributes of the property or census block group. Univariate and bivariate analyses were conducted, as well as linear regression. Linear regression was used, despite a binary outcome, to maximize interpretability for a lay audience.

Validation of Results with Housing Inspectors

Housing inspectors hold immense experiential knowledge about the City's housing conditions and the way code violations manifest. Therefore, an important part of this work was discussing the results with housing inspectors and other City staff. This served to both inform the interpretation of the results and to augment the tacit knowledge of inspectors and City staff.

Results:

Descriptive Analysis

1,238 rental properties were inspected within the target area between August 1st, 2015 and July 1st, 2018. Of these, 680 (55%) had at least one housing code violation (range 0-77, with >0 violations median=2). The most common violation type was "Owners Responsibility to Maintain Structural Elements" (impacting 37% of inspected properties).[2] The second most common violation was related to smoke detectors (32%), followed by locks violations (29%). Extermination was required in 18% of properties and 10% of properties failed to maintain the living area free from garbage. Approximately half (54%) of properties had at least one of the main outcomes of interest. This information, along with additional property attributes is summarized in Table 6.

Table 6: Percentage of Properties Inspected as Part of Certificate of Habitability Program with Main Outcomes and Covariates of Interest

Property Characteristic	Percentage of Properties
Main Outcomes of Interest	
Any Smoke Detector Violation	32
Any Locks Violation	29
Any Extermination Violation	18
Any Garbage in Living Areas Violation	10
Any of the Violations Above	54
Other Property Attributes	
Owner Occupied	39
Any municipal fine for a trash violation	36
Any call to the fire department	51
Any call to the fire department for a medical reason	46
Any call to the police department	68
Any call to the police department related to assault	20
Any call to the police department related to damage of property	33
Note: Properties had many types of police and fire calls. The proportion of properties with each sub-type of reasons for police/fire calls sum to greater than the proportion of properties with police/fire calls.	

[2] These violations typically concern plumbing, gas fitting, and electrical wiring standards. The violation category is broad, making it difficult to draw specific connections to health.

Violations were more prevalent in the southern section of the target area, compared to the northern section (Figure 5).

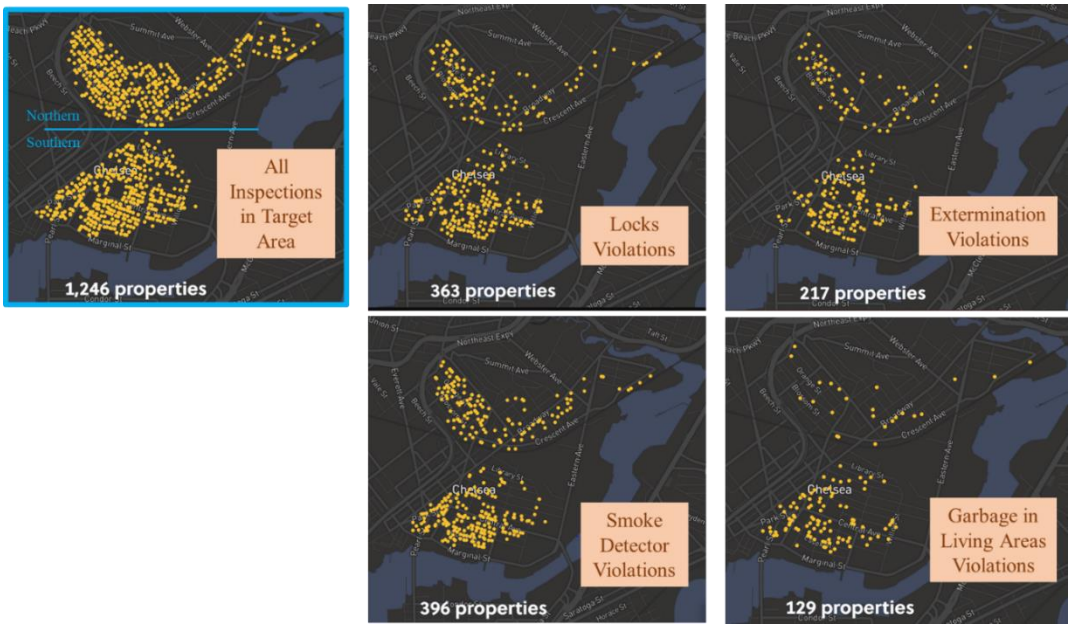


Figure 5: Spatial Distribution of Inspections in Target Area and Sanitary Code Violations

Tests of Associations – Property-Level Attributes

There was no association between the age or size of the home and any of the four main outcomes of interest. There was also no association between the number of police and fire calls and any of the main outcomes of interest.

Table 7: Associations between Outcomes of Interest and Other Property Attributes

Outcome of Interest/Covariate Odds Ratio *p*-value	Owner-Occupied Property	Any Police Call	Any Fire Call	Police Incident - Destruction of Property	Police Incident - Assault	Fire Incident-Medical	Municipal Fine for Trash Violation
Any Smoke Detector Violation	1.1 *0.443*	1.0 *0.937*	1.0 *0.788*	1.0 *0.845*	0.9 *0.547*	1.0 *0.810*	1.6 *<0.001*
Any Locks Violation	0.8 *0.134*	0.9 *0.666*	0.8 *0.209*	1.0 *0.861*	1.1 *0.482*	0.8 *0.081*	1.8 *<0.001*
Any Extermination Violation	0.8 *0.109*	1.5 *0.024*	1.6 *0.012*	1.2 *0.354*	1.6 *0.007*	1.5 *0.004*	2.5 *<0.001*
Any Garbage in Living Areas Violation	0.4 *<0.001*	0.9 *0.715*	1.3 *0.263*	1.2 *0.449*	1.2 *0.464*	1.1 *0.592*	2.2 *<0.001*

Note: All variables were binary (presence/absence) and *chi*-squared tests were used to calculated odds ratios and *p*-values. Associations at the 0.5 significance-level are in bold.

Properties with municipal trash violations were more likely to have each of the main outcomes of interest compared to properties without municipal trash violations (Table 7). Properties where the owner lived on premises were 0.4 times less likely to have a violation for garbage in living areas (p<0.001). Properties with at least one police call were 1.5 times more likely to have required extermination compared to properties with no police calls (p=0.024). Similarly, properties with at least one fire call were 1.5 times more likely to have required extermination compared to properties with no fire calls (p=0.012). There was no association between police incidents for destruction of property and any of the main outcomes of interest. However, properties with police calls for assault were 1.6 times more likely to require extermination, and properties with fire calls for medical purposes were 1.5 times more likely to require extermination compared to properties without these call types (p=0.007 and p=0.004, respectively).

Tests of Association- Census Block Group Data

Table 8: The Percent Change in the Probability of a Code Violation for Properties in Census Block Groups Above the Mean Value for the Census Variable

Results of Bivariate Analyses	Coefficient	*p*-value
Any Smoke Detector Violation		
Owner Occupancy Rate	-0.115	0.000
Proportion Households with Children Under 6	0.068	0.011
Proportion of Households that are Low Income	-0.064	0.016
Any Locks Violation		
Owner Occupancy Rate	-0.118	0.000
Proportion Households with Children Under 6	0.052	0.047
Proportion of Households that are Low Income	-0.092	0.000
Any Extermination Violation		
Owner Occupancy Rate	-0.900	0.000
Proportion Households with Children Under 6	0.072	0.001
Proportion of Households that are Low Income	-0.660	0.002
Any Garbage in Living Areas Violation		
Owner Occupancy Rate	-0.095	0.000
Proportion of Households that are Low Income	-0.092	0.000
Each census variable was tested independently with each outcome of interest using linear regression. Census variables were recoded as binary (0/1). 1 indicates a census block group variable value above the mean value in the target area.		

Among the 19 census block groups in the target area, the mean owner occupancy rate was 23.6%, the mean proportion of households with children under 6 was 14.7%, and the mean proportion of low-

income households was 54.4%. Table 8 shows the increased or decreased likelihood of a specific code violation for properties in census block groups above or below the mean value for the census variable within the target area. For example, smoke detector violations were 11.5% less likely, lock violations were 11.8% less likely, extermination was 9.0% less likely, and trash in living areas violations were 9.5% less likely in properties in census block groups with owner occupancy rates above the mean value for the target area. Properties in census block groups with proportions of households with children under 6 above the mean value for the target area had increased likelihood of each of the main outcomes of interest. Properties in census block groups with proportions of low-income households above the mean value for the target area had decreased likelihoods of each of the main outcomes of interest, apart from garbage in living areas.

Multivariate Modeling – Combining Property-Level and Census Block Group Data to Predict the Main Outcomes of Interest

Table 9: Predicted Probability of the Presence of Any of the Main Outcomes of Interest when Controlling for Select Property-Level and Census-Block Group Attributes

Property Attribute	Beta Coefficient	*p*-value
Any municipal trash violation	.129	<0.000
Owner occupancy rate of census block group	-.0064	<0.000
Proportion of low-income households in census block group	-.0064	<0.000
Proportion of children under 6 in census block group	-.00024	0.866
Any medical call to fire department	.0009	0.975
Any assault call to police department	-.015	0.667
Note: Outcome is a binary variable for the presence of any of the main outcomes of interest at the property. The model only explains 5% of the variation in the outcome (adjusted r^2=.05).		

When controlling for covariates, any municipal trash fine was associated with a 12.9% increase in the probability of the presence of any of the main outcomes of interest compared to properties without such fines (Table 9). A 10-percentage point increase in the proportion of owner-occupied units within a census block group was associated with a 6.4% reduction in the probability of any of the main outcomes of interest, when controlling for the other covariates. A 10-percentage point increase in the proportion of

low-income households living within a census block group was associated with a 6.4% decrease in the probability of any of the main outcomes of interest, when controlling for other covariates.

Discussion:

The results of these analyses lay a conceptual groundwork for the value of linking proactive housing inspection data with other city data to improve public health and housing responses. Using data inspectional services and other departments are already generating, cities can shift from addressing only surface-level problems as they arise to more holistic, people-centered approaches.

More than half of rental units proactively inspected had at least one housing code violation. Because these codes vary by municipality and not all municipalities use proactive programs, it is difficult to make comparisons between cities. Nevertheless, as the housing code includes only minimum standards for habitability and a narrow set of violations, the fact that more than half of Chelsea's renters live in homes with at least one code violation is significant. A study in Cincinnati found that the density of housing code violations was associated with population-level morbidity independent of poverty, and that the density of code violations explained 22% of the variation in rates of asthma-related emergency department visits and hospitalizations (Beck et al., 2014).

Almost one-third of the renting population did not have functioning smoke detectors or carbon monoxide alarms. These two devices are low-cost interventions that can substantially improve survival in the case of fire and elevated carbon monoxide levels. The lack of them may signify landlord negligence. Tenants may also be tampering with or removing detectors and alarms. Chelsea has the highest rate of fire in the county (Coan, 2013). Housing inspectors and the Fire Chief described a particular challenge in homes of recent immigrants from rural areas who are not aware of urban fire safety precautions and the risks associated with lighting fires indoors. Data on the prevalence of the problem, combined with anecdotal evidence of the root causes, may be useful in prioritizing fire safety programs in schools or community centers. Alternatively, given that inspectors report many homes have detectors but lack the batteries, inspectors could carry batteries with them to resolve smoke detector violations immediately. An

intervention like this might reduce overall costs because it would avoid the inspector needing to return for a re-inspection to insure a battery was replaced.

Lock violations were present in 29% of rental homes. Inspectors report that this type of violation is almost exclusively issued for internal locks on doors, a strong indicator of overcrowded living conditions in Chelsea. Nationally, it was estimated in 2017 that 14% of urban children live in homes that are overcrowded (more than one person/room, not just bedrooms) (Kids Count, 2017). The Chelsea School Superintendent and Police Chief cite overcrowded conditions as one of the most important problems impacting their work and a driver of mental health incidents among school-children and sexual violence among the general population. Internal locks on doors is only one indicator of overcrowding and inspectors describe finding illegal rooms or apartments several times each month in Chelsea (*e.g.* rooms in closets, unfinished basements, and porches). Other data could be combined with locks violations to better estimate overcrowding, such as data on water consumption (which may be higher than expected in overcrowded conditions) and electrical wiring violations (which may be used to power refrigerators or hotpots in illegal apartments).

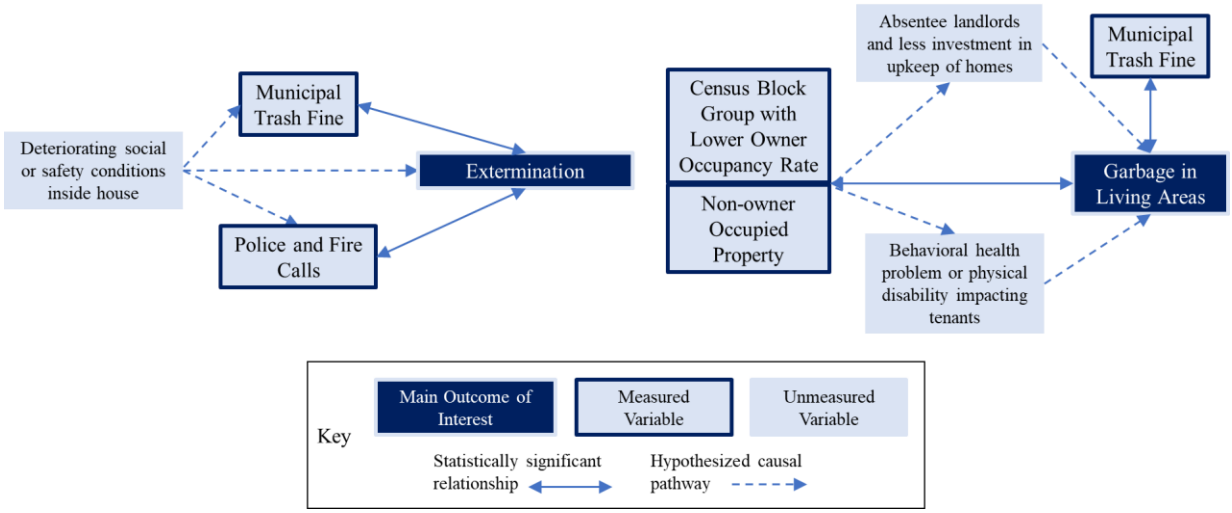


Figure 6: Hypothesized Relationships between Main Outcomes of Interest and Other Variables (Measured and Unmeasured) Using Extermination and Garbage in Living Areas as Examples

Extermination and garbage in living areas violations were less prevalent (18 and 10%, respectively) but strong indicators of deteriorating living conditions. Unlike smoke detector or locks violations, these violation types were associated with other property-level attributes, possibly indicating greater sensitivity for other problems within the home outside of the code violation itself.

Extermination was the only main outcome of interest associated with the presence of any police or fire call and with specific calls for assault or medical reasons. It is unlikely that police or fire calls cause infestations or vice versa; however, both police/fire calls and infestations may be caused by a shared unmeasured variable, deteriorating health and social conditions within the home (Figure 6). As calls to the fire department for medical purposes are costly to cities, intervening early in homes with infestations, and responding to not only to the infestation but also to social or health problems if present, could help to ameliorate problems before they require emergency services.

Apart from extermination violations, there was no association between police calls (total count and presence/absence) and the other main outcomes of interest. This finding is similar to other studies which show little relationship, or a negative relationship, between crime and housing code violations (Stacy et al., 2018). These studies hypothesize that code enforcement is not reaching high-crime areas (which is unlikely in Chelsea given that the target area included the highest crime areas), that code enforcement reduces crime (which could be possible in Chelsea although temporal associations were not examined), or that the crime and code violations are unrelated (Stacy et al., 2018). It may also be that given the diversity of reasons for police calls and the inability of this analysis to link police calls with specific units on a property, the data are too noisy to detect associations.

Rental properties in census block groups with higher proportions of home-owners were less likely to have any of the main outcomes of interest. Further, properties where the owner lived on premises were less likely to have violations for garbage in living areas (Figure 6). Inspectors in Chelsea describe a prevalent problem of absentee landlords who let conditions deteriorate within homes and are slow to make repairs. The City is currently undertaking an initiative to increase home ownership rates among current residents, which could positively impact both housing conditions and neighborhood conditions.

Municipal fines for trash were strongly associated with each of the main outcomes of interest. Trash fines are issued when garbage is not properly contained outside of the home, which may be a leading or lagging indicator of residents' or landlords' inability to maintain healthy conditions within the home (Figure 6 shows one such pathway). Data on the location of municipal trash fines could be used to prioritize properties for inspection.

Census block groups with lower poverty levels were associated with lower probabilities of the main outcomes of interest. With a proactive inspection program, it might be expected that properties in lower-income areas may have higher rates of violations, as low-income families are often forced to compromise on the quality of housing in order to make ends meet (Dunn, 2000). However, low-income households may also be more likely to live in subsidized housing, which is subject to more stringent regulations regarding housing conditions (HUD, 2004).

In unadjusted analysis, census block groups with more children under 6 were more likely to have each of the main outcomes of interest, apart from garbage in living areas. Results such as this may be useful in facilitating cross-departmental and city-community partnerships. For example, community organizations, such as those offering head start programs, or the public-school system in Chelsea may be interested in learning about the prevalence of housing code violations in areas with high proportions of young children. Community organizations and the school system could support healthy home environments through educating parents on healthy homes and landlord responsibilities.

Using data to improve efficiency, effectiveness, and equity of code enforcement and city service provision

Bringing a home into compliance for smoke detectors, locks, extermination, or garbage violations may only temporarily relieve a problem. After inspectors leave, smoke detectors may be removed, locks reappear, infestations return, and trash piles up. City data can be used to take a wider and more intentional approach to improving health and housing through facilitating cross-departmental/city-community partnerships, prioritizing higher-risk homes and violations, and using a combination of enforcement and service provision (*e.g.* through programs such as linkages to social services).

While the analyses do not provide comprehensive, high validity results, they can still be very helpful in moving toward a more effective, efficient, equitable approach to housing code enforcement. Because proactive housing code enforcement cannot reach every property, using data can allow for higher risk properties to be prioritized. Data can also inform what kind of response may be needed in terms of a greater focus on enforcement or service provision. For example, city data can identify landlords with multiple properties in poor condition and target these with enforcement. For properties with code violations stemming from tenant poverty or behavioral health problems, service provision through linkages to social services could improve housing conditions and health. Further, census indicators could be examined to identify census block groups that contain multiple risk factors for code violations (*e.g.* areas with the proportion of households with children under 6 or owner-occupancy above/below the mean value for the area). However, there are important caveats in the use of city data for targeted code enforcement in the absence of service provision and risks to violation of privacy and increasing stigmatization must be considered.

Analysis of city data can also help cities quantify problems that are important to their missions and constituents and generate data for grant writing within city government and community organizations. Several community organizations in Chelsea are working to ensure that current residents can benefit from increasing gentrification and have indicated their interest in using data on housing conditions, especially related to overcrowding, to bolster their grant applications and inform their response activities. For example, one such community organization recently held a workshop on how to live more safely in overcrowded conditions, a form of harm-reduction.

Analysis of city data can also inform the development of long-term strategies to address health and housing problems and identify areas for future research. For example, data on the size of the problem of overcrowding can be used to estimate future housing stock needs. Data on housing conditions could be linked to health or educational outcome data through partnerships with schools, health systems, and academic partners to gain further insight into the impact of housing on health and social conditions. Future studies should examine the use of predictive models for housing code violations of interest. To

facilitate use of such models by city staff, they should be built in consultation with housing inspectors, incorporating inspectors' on-the-ground knowledge. Models should be actionable and interpretable in order to be integrated into city business practices.

Limitations

Missing data – The proactive Certificate of Habitability Program officially began in December of 2014; however, data from December 2014 through July 2015 are not available. Prior to August 2015, the city was using a different software package to record inspections. Therefore, the housing code violation data used in this analysis is missing an unknown number of properties inspected over a 7-month period.

Temporality – This analysis did not examine the temporality of the associations between violations and other property attributes, such as police calls or municipal fines. Therefore, it is not known whether the property attributes are leading or lagging indicators or if their association may differ if temporality was considered. It is also not known if the same tenants were living on the property when the housing code violations and other incidents (police calls, fines, etc.) occurred.

Unit of analysis – Most properties in Chelsea contain more than one housing unit; however, the incident data are only available at the property level. It is possible that predictors of interest, such as municipal fines, could have accrued to a unit on a property that is not the same as the one that received a housing code violation. Further, properties with more units may have a higher probability of having a code violation or other incident variable, which could lead to spurious results and should be considered in future analyses.

Rigor of Model Building – The model presented in this chapter is an early-stage proof-of-concept. It shows that modeling can be done, but future work should apply more rigorous approaches to model building. Logistic regression or machine learning approaches should be considered, along with additional covariates.

Data availability - The work to integrate more datasets into Building Blocks is ongoing. Over the coming months, more complete data on Certificate of Habitability inspections will be integrated, along

with data on water consumption, water shut-offs, and fire inspections. Future analyses should incorporate these data sources and consider additional data from community organizations and academic institutions.

Conclusion:

Despite the limitations, these analyses serve as an important proof of concept for the value of integrating and analyzing city data. The analyses used only data generated by the city for its business processes or by the census. Thus, this work could be readily applied to other cities. Through this novel approach to using existing city data, housing-related threats to public health can be identified and addressed more efficiently, effectively, and equitably. Housing conditions have far-reaching impact on the health and well-being– and city investment in a holistic, data-driven code enforcement and service provision is an investment in the health of individuals and communities.

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Appendix A: Timeline

	Jan - May 2018	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 2019	Feb	Mar-Onward
Problem diagnosis & design of innovation with IFL team											
Innovation Fellowship											
Observation of housing inspections and relationship building with housing inspectors											
One-on-one interviews with city officials and community organizations to build case for innovation and incorporate feedback											
Workshop to initiate proof-of-concept referral process											
Prototype referral process innovation in place											
Presentation of findings and recommendations to City											
Strategic meetings with City leadership to improve and sustain innovation											
Funding source for referral process innovation became available											
Sub-contract with local social service agency developed											
Provision of case management services for social/health issues identified during inspections established											

Appendix B: City Datasets

Data Set	Data Source	Description	Rationale for Inclusion
Vacancy Registry	Municipal fire department/Inspectional services	List of all vacant properties	Vacant properties have a higher chance of poor maintenance, as well as a higher probability for trespassers to use for illegal activities.
Foreclosed Property Registry	Registry of deeds (City/County)	List of all foreclosed or bank-owned properties	Foreclosed properties may be more likely to have code violations, police calls, and fire incidents because of the potential for a lack of active property maintenance.
Fire Incidents	Municipal fire department	Incident ID, date, location, type, and status	Can identify where fires overlap with other risk factors, like code violations.
Police Incidents	Municipal police department	Incident ID, date, location, type, status, and disposition	Police incidents show where problem properties have led to (or are a symptom of) other issues, like property crime, violent crime, and drug use.
Parcel Attributes	Municipal assessor / clerk	Parcel number, owner, owner address, assessed value, property use type, type of unit, square footage, year built, bedrooms, bathrooms	These data points provide a basic understanding of the characteristics of the property and can be used to examine associations with other property incidents.
Sales History - properties	Municipal assessor / clerk	Parcel number, sale ID, sale date, amount, type, old owner, and new owner	Can identify properties that are investor-owned (potential absentee landlords).
Permits	Inspectional services /Building department	Permit ID, date, location, type, status, description, fee, and valuation	Building permits can show when action is being taken to remediate or improve properties.
Certificates of Fitness/Occupancy/ Habitability	Inspectional services /Health department	ID, issued date, location, type, status, and description	An indicator of property being up to health code; violation types may indicate larger issues (e.g. infestations and asthma triggers).

Appendix B: City Datasets (Continued)

Code Enforcement	Building department or Inspectional services	ID, issued date, address, type, status, description	Identifies the types of violations that a property has and the extent to which properties are continual problems or one-time violators. Violation types may indicate larger issues (e.g. overgrown grass = abandonment).
Receivership status	City Attorney/Solicitor	Date of petition, days in court, status	Properties in receivership may be more likely to have code violations, police calls, and fire incidents because of the potential for a lack of active property maintenance.
Delinquent Taxes	Municipal or county tax collection, treasure or finance department	Tax bill ID, due date, parcel number, address, current amount delinquent, contact name, and contact address	May be an indicator of property abandonment and would make a property more difficult to sell and/or repair due to added expenses.
Calls for Services (311)	Mayors' office	Property address, date of call, details of complaint	Can help identify which properties are nuisances to nearby residents and may have visible problems or violations.
Census	US Census	Basic demographic and economic indicators	Compare census block groups on issues such as poverty and education level, the proportion of senior citizens, etc.
Recommendations for Additional Datasets			
Overdoses	Police/Fire	Location of drug overdoses, date	Shows where drug activity is occurring and if it correlates with property attributes.
Water Billings	Municipal water company	Billing ID, date, parcel number, address, amounts, usage, contact number, contact address, type, and meter status	High water bills or usage may be a sign of overcrowding, and low or non-existent water bills may be a sign of abandonment.

Appendix B: City Datasets (Continued)

Water Shutoffs	Municipal water company	Account ID, shutoff date, parcel number, address, and shutoff type	An indicator of property abandonment and habitability.
Rental Registry	Inspectional services	List of all rental properties, owner occupancy rate	Rental registry can help identify where potential tenant-landlord issues may arise and identify absentee landlords.
Fire Inspections	Municipal fire department	Inspection ID, date, location, type, status, fee, and notes	Can help identify which properties have higher fire risks due to the absence of an inspection, which may mean properties are not up to fire code.
Neighborhood deprivation index	HRSA	Available at census block level and includes indicators of income, education, employment, and housing quality	Allows for ranking of neighborhoods by socioeconomic status and disadvantage.
Lead inspection	Commonwealth of MA	Registry of homes that have passed a lead inspection	Shows whether a home has been determined to be "lead safe."
MA Env. Health Tracking System	Mass.gov	Exposure (water, air, radon, etc.) (lead, asthma, diabetes, etc.) and outcome data but only at city level	Compare city level exposure and outcome data
Child Opportunity Index	Diversity Data Kids	Categorizes neighborhoods based on opportunity indices	Compare opportunity across neighborhoods.