The Build Change Guide to Resilient Housing

An Essential Handbook for Governments and Practitioners

BUILD CHANGE

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BUILD CHANGE

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Cover photo: A street in the San Isidro neighborhood, in Usme, Bogotá, Colombia

"The entire retrofitting experience has been wonderful. I didn't realize that you would put so much love into what you do … it's so much more than just adding columns… It's clear that you do what you do with love, and that you really know what you're doing."

Nohelia Rosa, a homeowner from Medellín, Colombia

"It's a great experience for me to see that I can make good blocks … It's not just the big manufacturers that can, but the small ones, too."

Fred Elicart, a concrete block-making business owner in Port-au-Prince, Haiti

"This has been a good experience for my family … We lost something—our house—but we got back not only a house, but a chance to work and learn as well."

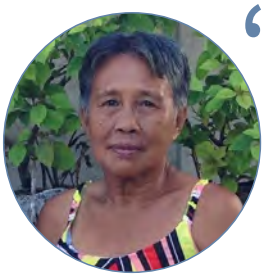
Eusi Raloso, a homeowner from Sulangan, Eastern Samar, Philippines

"Build Change has provided us with training to improve our bricks' quality, and show us how to test them. I understand now that good building materials have an impact on the strength of the building … The shops are now willing to pay more for our bricks, which has been very beneficial to us."

Sudirman, a brickmaker and quality controller of Bata Jaya Cooperative, Indonesia

"I no longer have to worry about providing a safe shelter to my grandchildren. They are very happy to live in our retrofitted house, which makes me very happy too. I can't thank Build Change enough for their technical assistance and support in improving our lives."

Brinda Timilsina, a homeowner from Kavre, Nepal



"I got to work with Build Change on the design of my new house ... This house is stronger and much more resilient than my old house."

Lilia Cabrero, a homeowner from Sulangan, Eastern Samar, Philippines

"I am very confident that the house is now safe to live in, with my family. Moreover, it looks beautiful and strong."

Urmila Dahal, a homeowner from Kavre, Nepal

"My house needed structural reinforcement. I received structural training, which is just what I needed. Now I feel safer."

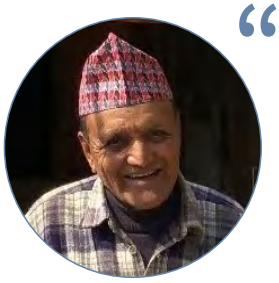
Jorge Prada, a builder in Bogotá, Colombia, who retrofitted his own home with the support of Build Change

"I will be able to survive and run this business by myself. I believe women can do what men can do."

Rusi Saryuni, a brick-making business owner who trained with Build Change in Indonesia

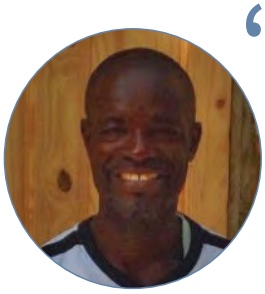
"I wanted to retrofit my house because I wanted my family [to be] safe. Before, my house was not strong, but after Build Change retrofitted my house, I have peace of mind because my family is safe."

Cynthia Vargas, a homeowner from the Philippines



"[My son] asked how I came to know about earthquake-resistant construction. I told him that there are engineers from Build Change in our village now, so it is no longer difficult to build earthquake-resistant houses."

Dilli Prasad Poudel, a homeowner from Nuwakot, Nepal



"I'm extremely proud of what I do and I'm not prepared to build anything that I think won't be safe."

Nazaire François Dit Vileresse, a carpenter who worked alongside Build Change trainers in Carrefour, Haiti

"More homeowners are aware of earthquake-resistant construction now … I feel tremendous satisfaction when I am able to build safe homes for people to live in."

Erwin Guaciano, a builder who trained with Build Change in Indonesia

"I am very happy to live in an earthquake-resistant house. My family is safe and protected now, and I can breathe a sigh of relief."

Min Prasad, a homeowner from Kavre, Nepal

"If it wasn't for Build Change, I think that I would have used poor construction techniques to rebuild the house … Thanks to Build Change I have a solid and safe house now."

Benisette Pierre Louis, a homeowner from Villa Rosa, Haiti

"We still cannot believe that they are going to fix our house ... This house is one of the few treasures I have."

Carolina Bohórquez, a homeowner from Bogotá, Colombia

Awards and Recognition

Build Change is the proud recipient of the following awards:

- Inaugural Global Engineering Professional Award, Mortenson Center for Global Engineering, University of Colorado at Boulder (2019) —awarded to Build Change's Founder and CEO, Dr. Elizabeth Hausler
- University of California, Berkeley Campanile Excellence in Achievement Award (2018) —awarded to Dr. Elizabeth Hausler
- PD3R Team named Global Runner-Up in the IBM Call for Code (2018)
- Social Design Circle honoree, Curry Stone Design Prize (2017)
- Skoll Award for Social Entrepreneurship (2017)
- Earthquake Engineering Research Institute Shah Family Innovation Prize (2016) —awarded to Build Change's Vice President of Engineering, Lizzie Blaisdell Collins
- OpenIDEO Urban Resilience Challenge Winner (2016)
- Autodesk Tech Impact Award (2014)
- Kappa Kappa Gamma Alumnae Achievement Award (2013) —awarded to Dr. Elizabeth Hausler
- Structural Engineers Association of California (SEAOC) Award of Excellence (2013) in partnership with Degenkolb Engineers and the Ministry of Public Works, Transport, and Communications, Haiti
- Structural Engineers Association of Northern California (SEAONC) Award of Excellence: Study/Research/Guidelines (2013) in partnership with Degenkolb Engineers and the Ministry of Public Works, Transport, and Communications, Haiti
- Schwab Foundation US Social Entrepreneur of the Year (2011)
- Lemelson-MIT award for Sustainability (2011) —awarded to Dr. Elizabeth Hausler
- Ashoka-Lemelson Fellowship (2009)
- The Tech Awards Laureate and Winner of the Katherine M. Swanson Foundation Equality Category for making culturally appropriate, earthquake-resistant housing solutions available to all homeowners, regardless of income level (2008)
- Graduate of the Global Social Benefit Incubator Program at Santa Clara University (2007)
- Excellence in Structural Engineering Award, Structural Engineers Association of Northern California (SEAONC), in partnership with volunteer structural engineering firms for house design for Aceh (2006)
- Draper Richards Kaplan Fellowship (2006)
- Echoing Green Fellowship (2004)

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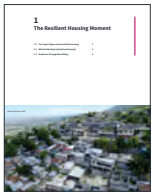

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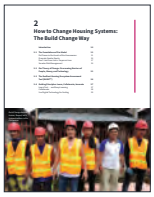

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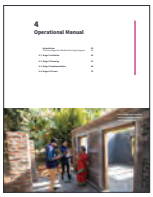

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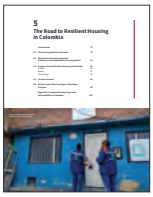

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The work would not have been possible without inputs and programming examples from national and local governments implementing or planning to implement home improvement programs for existing housing. We are grateful to the local and national governments of countries mentioned throughout this guide and in particular those whose experiences have been highlighted in examples and case studies.

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Cook Islands: Asian Development Bank; Government of the Cook Islands; Guy Carpenter; Risk Management Solutions

Dominica: Government of the Commonwealth of Dominica; Dominica Housing Recovery Project; International Finance Corporation; Ministry of Housing and Urban Development; World Bank

Haiti: American Red Cross; CARE; Center of Competence in Reconstruction (CCR); Cordaid; Degenkolb Engineers; Entrepreneurs du Monde; Forell/Elsesser Engineers; French Red Cross; Global Communities; Guy Nordenson & Associates; Hilti Foundation; Housing and Public Buildings Construction Unit (UCLBP); J/P Haitian Relief Organization (J/P HRO); Ministry of Public Works, Transport and Communications (MTPTC); Medicor Foundation; National Institute of Vocational Training (INFP); Save the Children; Sogebank; Sogesol; Solidarités International

Guatemala: Guatemalan Association of Structural and Seismic Engineering (AGIES); Municipality of Mixco; Project Concern International; Habitat for Humanity; World Bank

A homeowner in Nepal, where Build Change's technical innovation has enabled traditional rural homes to be retrofitted at national scale

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Nepal: American Red Cross; BBC Media Action; Call for Code; Foreign, Commonwealth, and Development Office; Government of India; Government of Nepal National Reconstruction Authority; Mercy Corps; Tribhuvan University; UNOPS; World Vision

Philippines: Alalay sa Kaunlaran Inc. (ASKI); Ahon sa Hirap Inc. (ASHI); Arise; ASA Philippines; Bohemian Foundation; Catholic Relief Services; City Government of Makati; Cordaid; Country Builders Bank (CBB); Czech Republic Humanitarian Aid; DRRNetPhils network; Fairbuilding network; German Red Cross; IDEO.org; JTI Foundation; Kasagana-Ka Development Center, Inc.; Kabuhayan sa Ganap na Kasarinlan Credit and Savings Cooperative (K-Coop); Lloyds Charities Trust; Ministry of Housing; National Housing Authority; Philippines Red Cross; PINGON; Plan International; Rural Bank of Gattaran, Inc.; Shelter Cluster network; Swiss Red Cross; Thornton Tomasetti Foundation

Saint Lucia: Saint Lucia Institute of Architects; Theobalds Consulting; World Bank

Samoa: Asian Development Bank; Government of Samoa; Guy Carpenter; Risk Management Solutions

Sint Maarten: National Recovery Program Bureau (NRPB); World Bank

Solomon Islands: Asian Development Bank; Guy Carpenter; Risk Management Solutions; Solomon Islands Government

Tonga: Asian Development Bank; Government of Tonga; Guy Carpenter; Risk Management Solutions

Vanuatu: Asian Development Bank; Government of the Republic of Vanuatu; Guy Carpenter; Risk Management Solutions

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Acronyms and Abbreviations

AI	Artificial intelligence
AIS	Association of Seismic Engineering (Colombia)
ATC	Applied Technology Council (USA)
BIM	Building Information Modeling
CBS	Central Bureau of Statistics (Nepal)
CDVD	*Casa Digna, Vida Digna* (Colombia)
COP	Colombian Peso
COVID-19	The global pandemic of coronavirus disease that began in 2019
CRED	Centre for Research on the Epidemiology of Disasters
DANE	National Administrative Department of Statistics (Colombia)
FEMA	Federal Emergency Management Agency (USA)
GDP	Gross domestic product
GFDRR	Global Facility for Disaster Reduction and Recovery
GPRH	Global Program for Resilient Housing
HRP	Housing Recovery Project (Dominica)
IDIGER	Bogotá Institute of Risk Management and Climate Change (Colombia)
ISVIMED	Social Housing Institute of Medellín (Colombia)
MFI	Microfinance institution
MIS	Management information system
MMW	Minimum monthly wages
MVCT	Ministry of Housing, City, and Territory (Colombia)
M_w	Moment magnitude
NGO	Nongovernmental organization
NPR	Nepalese Rupee
NRA	National Reconstruction Authority (Nepal)
PD3R	Post-Disaster Rapid Response Retrofit
PHP	Philippine Peso
RC	Reinforced concrete
RHEAT™	Resilient Housing Ecosystem Assessment Tool
RMS	Risk Management Solutions
SENA	National Vocational Training Service (Colombia)
TA	Technical assistance
UN	United Nations
UNDRR	United Nations Office for Disaster Risk Reduction
UNOPS	United Nations Office for Project Services
USAID	United States Agency for International Development
USD	United States Dollar
VR	Virtual reality

Key Terminology

Build back better: The use of the recovery, rehabilitation, and reconstruction phases after a **disaster** to increase the resilience of nations and communities through integrating **disaster risk reduction** measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies, and the environment.[1]

Building codes: These are typically **building standards** that have been enacted into law by local, regional, or national authorities, to secure the health, safety, and welfare of the building occupants.

Building standards: A set of definitions, processes, methods, or other minimum requirements intended to regulate aspects of the design, construction, materials, alteration, and occupancy of structures which are necessary to ensure human safety and welfare, including resistance to collapse and damage.

Confined masonry: A structural system that consists of **load-bearing masonry** walls with horizontal and vertical reinforced concrete confining elements built around the wall panel. These reinforced concrete elements are built *after* the masonry wall has been completed. The horizontal elements are interchangeably called "tie-beams," "**ring beams**," or "horizontal ties," and the vertical elements are called "tie-columns" or "vertical ties."

Construction value chain: Used in this guide to refer to the distinct stages of home improvement, specifically: information and data collection, information and data sharing, design, financing, building, and reporting.

Disaster: A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability, and capacity, leading to one or more of the following: human, material, economic, and environmental losses and impacts.[2]

Disaster risk reduction: Strategies aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience.[3]

Gender equality: Equal enjoyment of socially-valued goods, opportunities, resources, and rewards, by all people regardless of gender.

Gender equity: The process of putting measures in place to compensate for the historical and social disadvantages that have prevented people of different genders from operating on a level playing field. It is a pathway toward **gender equality**.

Habitability: The characteristic of being suitable for occupancy. The term "habitability improvements" is used in this guide to refer to improvements to a home that target the comfort, health, and safety of the occupant, such as improving sanitation or ventilation.

Homeowner: Used in this guide to refer in general terms to the person who lives in the home, and can make the decision to partake in a home improvement program. It cannot be assumed that this person has ownership of the land or property, nor are we suggesting that the right to **resilient housing** is contingent on property ownership.

Housing: Any place where people live, including single-family housing, multi-unit housing, dormitories, and institutions.

Housing deficit: Calculated as the difference between the population's need for housing and what is available, the housing deficit comprises (1) the "quantitative housing deficit," which refers to the amount of **housing** that does not exist or is unusable, compared to the number of families that require housing; and (2) the "qualitative housing deficit," which refers to the amount of existing housing that is structurally deficient, lacks basic **habitability** requirements such as access to services (water, sanitation, and electricity), or is otherwise of inadequate quality.

Informal housing: Housing that has been built outside of the processes recognized by formal construction, for example, it may have been built without the input of a licensed engineer or designer and without a construction permit. Informal housing is used in this guide to refer to the informal process through which the house was constructed, and does not make specific reference or judgment regarding the type of land on which the housing is present, or the ownership of the land or property.

Load-bearing masonry construction: A structural system in which the masonry walls (walls made of individual units such as bricks, concrete blocks, stone, adobe, etc.) support vertical loads other than their own self-weight, accounting for all or most of the building's vertical loads.

1 United Nations (UN) General Assembly, *Report of the Open-Ended Intergovernmental Expert Working Group on Indicators and Terminology Relating to Disaster Risk Reduction (A/71/644)*, 11.

2 UN General Assembly, 13.

3 UN General Assembly, 16.

Reinforced masonry: Construction using individual units (such as bricks, concrete blocks, stone, adobe, etc.) in which steel bars or mesh are embedded in mortar, grout, or concrete so that all the materials act together in resisting applied loads.

Resilient housing: Used in this guide to describe **housing** that fulfills and exceeds aspects of **safer housing** in several ways. We define it as **housing** that provides a safe, locally appropriate, healthy, and secure space. Moreover, it is affordable and a secure financial investment for its occupants. Resilient housing initiatives are sustainable, adaptable, and scalable.

Retrofitting: The reinforcement or upgrading of existing structures to make them more resistant and resilient to the damaging effects of hazards.[4]

Ring beam: A horizontal structural element at the top of walls, tying walls together to transfer and distribute hurricane and earthquake loads into bracing walls and increasing the lateral load they can resist. A ring beam is one of the primary confining elements used in **confined masonry** construction.

Safer housing: Houses that have been built to a certain standard to ensure that they will be less vulnerable than **informal housing** to the negative effects of different events, such as earthquakes, windstorms, flooding, etc. Targeted thresholds for safety are established locally, often through **building codes** and guidelines for the planning, design, and construction of **housing**—there is no global standard for safer housing.

Soft story: A level of a building in which the lateral system is markedly more flexible than the lateral system of the stories above it or adjacent to it. This is typically associated with large openings in the walls or an exceptionally tall story height in comparison to the adjacent stories. Soft stories can present a very serious risk to human safety and financial liability in the event of an earthquake.

Subsidy: Economic assistance provided to members of the public by the government for a particular purpose, according to certain eligibility criteria that may be applicable. In the context of this guide, subsidies are discussed in relation to supporting individuals to improve the structural and/or **habitability** conditions of their home.

Systems change: Systems change aims to create lasting change by addressing the root structures and mechanisms that make a system operate in a particular way. In this guide, we talk about systems change in relation to **housing**, and we group the root structures and mechanisms of housing systems into three categories: "People," "Money," and "Technology." Build Change is a systems change catalyst for **resilient housing**, i.e. an agent that provokes or speeds systems change in its goal to make every home resilient.

Technical assistance: Used in this guide to refer to non-financial support provided by a specialist, that may take the form of advice, assistance, training, and transmission of technical data, knowledge, and expertise. Build Change provides technical assistance to governments and implementers of **resilient housing** programs to enable them to support stakeholders through all stages of the **construction value chain** and to maximize the overall quality and impact of programs.

Unreinforced masonry: Construction using individual units (such as bricks, concrete blocks, stone, adobe, etc.) that does not contain sufficient steel reinforcement to be considered **reinforced masonry**, nor does it meet the requirements for **confined masonry**. Unreinforced masonry is brittle and has a low capacity to resist tensile forces developed from lateral loads, which makes it vulnerable to collapse in earthquakes and windstorms.

4 UN General Assembly, 23.

Executive Summary

"It's time we look at unsafe housing as the global epidemic it is, threatening one third of the global population."—Dr. Elizabeth Hausler, September 2018

The issue of vulnerable housing requires urgent action and massive investment.

By 2030, three billion people—about 40% of the world's population—will be living without adequate housing.[5] Inadequate housing is disproportionately inhabited by the poor, putting those who are already vulnerable most at risk when earthquakes, windstorms, floods, and pandemics strike. Against a rising qualitative housing deficit, climate change is increasing the frequency and intensity of many natural hazards, with severe consequences for those without a safe, resilient home.

It is time for the issue of vulnerable housing to be treated as a public health emergency.

Investment in better, safer, and more equitable housing must be prioritized if we are to protect people's health and well-being and better withstand future crises, whatever form they may take.

Upgrading existing housing is an effective way to save lives and resources.

At Build Change, we advocate for improving the homes that people already live in, rather than building new ones, wherever possible. The majority of homes can be made safer using relatively simple, tried-and-tested solutions that already exist. Along with a range of wider benefits, this approach is the most cost-effective: our studies show that the average cost to upgrade housing is 23% of the average cost of building new housing.

By strengthening existing housing, our efforts can be directed toward a preventative—rather than a reactive—response, and governments and funders can start saving and improving lives without delay. We can avert the devastation and financial losses caused by disasters that could have been prevented.

Resilient housing programs can improve lives and transform housing systems.

Beyond saving lives and resources, resilient housing programs can offer a range of wider benefits. Through a holistic approach that seeks to transform housing systems, they can improve people's quality of life and health, create jobs, reduce inequality, and change unsafe construction practices permanently. They can provide both a cost-effective and a long-term solution to the qualitative housing deficit that countries throughout the world are experiencing today.

Build Change staff member Alexandria training builders in Haiti in 2016

5 UN-Habitat, "Housing," accessed July 15, 2021, https://unhabitat.org/topic/housing

The Build Change model focuses on change in three key areas: People, Money, and Technology.

The most successful resilient housing programs put homeowners first and involve a wide range of stakeholders. They work to ensure homeowners have the awareness, and the financial and technical resources they need to make their homes safer, by driving change in three key areas:

- **People:** People have to want to strengthen and improve their homes. Demand for resilient housing increases when governments choose to prioritize it. Governments must lead change by raising awareness, providing technical support to homeowners and the workforce, and ensuring policy is designed to meet the challenges that lie ahead.

- **Money:** People must have the financial means to strengthen and improve their homes. This requires wider access to affordable financing options for homeowners, in particular for low-income families, and government support in the form of subsidies and incentives. Resilient housing at scale necessitates innovative financial solutions, and funders must commit to long-term change.

- **Technology:** The right engineering and construction technology must be locally available, widely known, and cost-competitive. Digital technology can be leveraged to create huge efficiencies, to support with scaling.

Since 2004, Build Change has supported resilient housing initiatives in 24 countries, impacting over 600,000 lives, safeguarding more than $1.5 billion in housing infrastructure assets, and helping to establish lasting mechanisms for resilient housing around the world.

- In **Colombia**, we have successfully advocated for key regulatory reforms and proved the feasibility of retrofitting at scale, enabling hundreds of thousands of low-income families to improve their homes through the *Casa Digna, Vida Digna* program. **» Go To: Part 3, Case Study 1**

- In **Nepal**, our innovation in engineering and technical resource development has made it possible to conduct structural retrofits of rural homes at a national scale, for approximately 15% of the cost of replacing them. **» Go To: Part 3, Case Study 2**

- In the **Philippines**, our proof of concept and market studies have shown that homeowners will borrow money to strengthen their homes to withstand disasters, when this is combined with making other improvements. Affordable home-improvement loans with targeted technical assistance are now available for the first time. **» Go To: Part 3, Case Study 3**

- In **Dominica,** our post-disaster expertise combined with technological innovation have supported the national Housing Recovery Project with a Management Information System (MIS), resulting in easy access to information and greater accountability. **» Go To: Part 3, Case Study 4**

- In **Haiti**, we carried out the first structural retrofits at scale for low-rise masonry houses, as an alternative to building temporary shelters post disaster. The program has created hundreds of jobs and enabled thousands of families to retrofit their homes.

- In **Guatemala**, we have demonstrated the huge opportunity to support vertical expansion (i.e. adding a second story) while strengthening the ground floor, thus achieving both growth and safety.

- In **Indonesia**, where we have been working since 2005, thousands of single-story schools are vulnerable to earthquakes. We began retrofitting schools by applying similar techniques to those used for housing, to address damages and increase their resilience.

SOURCE: FREE VECTOR MAPS

With the publication of *The Build Change Guide to Resilient Housing*, Build Change now wishes to provide governments, funders, and practitioners around the world with the tools they need to carry out successful resilient housing programs at scale.

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About The Build Change Guide

What is *The Build Change Guide to Resilient Housing*?

The Build Change Guide to Resilient Housing brings together our wealth of expertise, drawing on almost 20 years of experience in 24 countries. It makes the case for an urgent need to invest in improving the safety of existing housing, demonstrates that this work delivers results, and enables others to join us in our vision to make every home disaster resilient.

The guide has been designed as an essential handbook for governments, practitioners, and funders of home improvement programs to successfully execute a resilient housing program or to enhance their existing one. It is both a summary of the Build Change philosophy and model, and a practical manual focused on the design of national strategies, operational and investment plans. The guide includes detailed examples and case studies from housing programs around the world, to demonstrate how our model is being applied across a wide range of contexts.

The guide is intended for use in all places where there is a qualitative housing deficit, and in particular in areas at risk of earthquakes and windstorms. The guidance relates to improving residential structures of three stories or fewer. Such homes represent the majority of the housing stock, which, in most cases, can be made safer quickly and affordably, using relatively simple solutions that already exist.

Being able to scale resilient housing initiatives is essential for programs to have the greatest possible impact, and ways to support program scaling are emphasized throughout this guide. Through scaling, resilient housing programs can not only address the huge deficit and reach more people, but can achieve wider benefits, such as helping to establish standards to streamline safety and efficiency, and incentivizing long-term thinking around construction practices and policy development.

Limitations

This handbook does not discuss new homes, but focuses instead on strengthening or retrofitting existing buildings.[6] And, though post-disaster reconstruction is not discussed in detail, we encourage users to apply the information in this guide to begin strengthening damaged buildings immediately after a disaster where possible, as a viable alternative to temporary shelter.

Issues which are more comprehensively addressed through land-use planning and regulation are not covered (for example, houses that need to be relocated due to poor soil conditions, location in flood, landslide, or storm surge areas, or when the risk cannot be reduced by structural improvements alone).

Finally, though this guide can apply to any housing type, load-bearing masonry buildings receive primary attention—firstly, because of their prevalence over any other building typology for housing in emerging markets, and secondly, because of their significant vulnerability to earthquakes if built poorly. Timber frame and timber roofs receive secondary attention. Summarized information on these common building types, their typical deficiencies, and simple solutions for their mitigation can be found in Annex B.

How to Use This Guide

The handbook is divided into five parts:

Part 1: The Resilient Housing Moment

Part 1 makes the case for investment in resilient housing as a critical step in preparing for future natural events and pandemics. It then covers how Build Change defines resilient housing within the context of our work and this guide, given that the word "resilient" is used widely and may be subject to different interpretations. Finally, it explains the advantages and opportunities created by improving existing housing through retrofitting wherever possible, compared with new construction.

Part 2: How to Change Housing Systems: The Build Change Way

Part 2 is a comprehensive overview of the Build Change model. This outlines our emphasis on homeowner-driven implementation, gender equity, taking a holistic approach toward home improvement that goes beyond saving lives, and smarter risk management. It then discusses our Theory of Change which is based around overcoming what we consistently find to be the three major barriers to successful housing programs: People, Money, and Technology. This section also introduces our Resilient Housing Ecosystem Assessment Tool (RHEAT™). Finally, detailed, practical advice is provided in the form of three guiding principles that can be applied universally: Learn, Collaborate, and Innovate.

6 For new construction following a disaster, see Build Change for USAID, *Building Back Housing in Post-Disaster Solutions—Basic Engineering Principles for Development Professionals: A Primer*, (2014), https://buildchange.org/USAIDprimers.

Informal housing in Medellín, Colombia

Part 3: Case Studies

Part 3 contains an overview of six resilient housing programs in Latin America, the Caribbean, and Asia. This is followed by four detailed case studies presenting a cross section of our work in Colombia, Nepal, the Philippines, and Dominica. The case studies summarize the planning, implementation, and outcomes of our work, highlight individual homeowner experiences, and provide examples of how to address barriers of People, Money, and Technology throughout program design and implementation.

Part 4: Operational Manual

Part 4 is a practical, step-by-step operational manual for resilient housing programs, that guides the reader through each stage of a program: Initiation, Planning, Implementation, and Closure, following the overarching approach that was outlined in Part 2. Each stage is broken down into its more detailed parts, with stakeholders identified and their roles defined.

Part 5: The Road to Resilient Housing in Colombia

Part 5 provides an in-depth account of progress toward resilient housing in Colombia, where home strengthening at scale is being enabled by national-level investment, institutional commitment, and strong technical expertise. The Colombia case is an effective example of how resilient housing measures might be scaled worldwide.

Annexes

The annexes contain an extensive range of reference material and sample program documentation, to support practitioners across various stages of a resilient housing program. They can be downloaded from https://buildchange.org/guide-to-resilient-housing.

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The Resilient Housing Moment

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Port-au-Prince, Haiti

1.1 The Urgent Opportunity for Better Housing

Everyone should have access to a resilient home that can address basic needs, protect families from hazards and climate extremes, and be a place of growth and opportunity.

The reality is that many people lack this fundamental necessity. By 2030, UN-Habitat estimates that three billion people—about 40% of the world's population—will be living without adequate housing.[1]

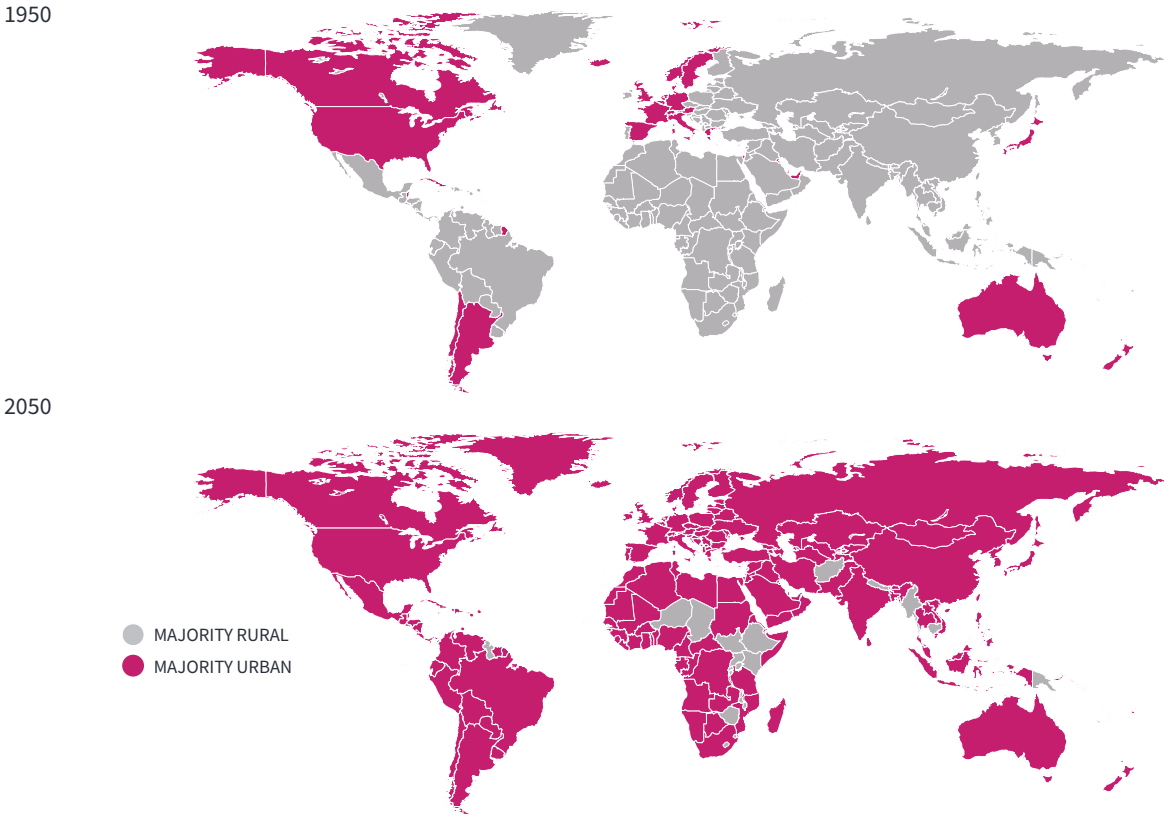
There is an urgent opportunity to invest in better, safer, and more equitable housing, before the next earthquake, windstorm, or pandemic.

The Rise of Vulnerable Housing

Urbanization has increased exponentially over the past century and continues to rise (Figure 1). In many cases, governments have struggled to meet housing demand, or the formal housing market has been inaccessible or unsuitable to newcomers, leading to an increase in informal construction.

Informally constructed buildings typically do not conform with formal building standards, and are built without a licensed engineer or designer. They may be structurally deficient, lacking in basic habitability requirements such as access to water, sanitation, and electricity, or otherwise of

FIGURE 1 Share of the population living in urban versus rural areas, 1950 and 2050



Here, 'majority urban' indicates more than 50% of the population live in urban centers; 'majority rural' indicates less than 50%. Urban populations are defined based on the definition of urban areas by national statistical offices.

SOURCE: OUR WORLD IN DATA BASED ON UN WORLD URBANIZATION PROSPECTS (2018) COMBINED WITH UN PROJECTIONS TO 2050. PUBLISHED ONLINE AT OURWORLDINDATA.ORG. RETRIEVED FROM: HTTPS://OURWORLDINDATA.ORG/URBANIZATION

1 UN-Habitat, "Housing," accessed July 15, 2021, https://unhabitat.org/topic/housing.

inadequate quality. Such homes are particularly vulnerable to extreme weather events, earthquakes, and other shocks, and disproportionately inhabited by the poor.

As populations expand and increase in density, and competition for land intensifies, the exposure to risk of these buildings becomes even greater. Informal construction is emerging in established urban areas, while also extending to hazardous regions and green zones. Furthermore, as families grow and as means allow, homes may be expanded by adding a second or third story on top of an already precarious and poorly conceived and constructed building.

The result is a global qualitative housing deficit, with serious implications. Today, one in four people in cities are living in conditions that are harmful to their health, safety, and prosperity.[2]

Disasters are Preventable

An increasing qualitative housing deficit is taking place against a backdrop of the continued and rising threat of natural hazards. Global warming is increasing the frequency and intensity of windstorms, flooding, and wildfires, with severe consequences for those without a safe, resilient home.

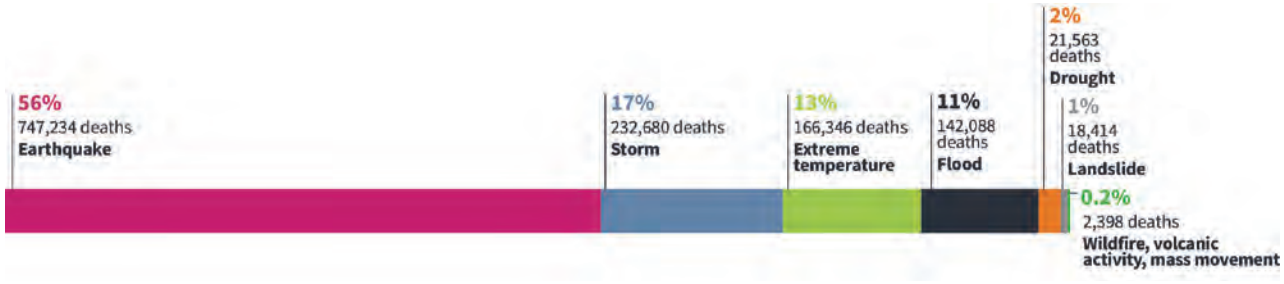
In recent years, the deadliest and most damaging disasters due to natural hazards have been earthquakes and windstorms. From 1998–2017, earthquakes were responsible for 56% of deaths caused by natural hazards, followed by storms (including tropical cyclones and hurricanes), which caused 17% of fatalities over the 20-year period (Figure 2).[3]

These disasters have an unequal impact on those who are already vulnerable. For example, studies have shown that women and children are fourteen times more likely than men to die during a disaster.[4] Others who are most at risk include the poor, ethnic and racial minorities, the elderly, and people with disabilities.

But earthquakes and extreme weather events do not have to be destructive or deadly. Lives can be saved and disasters can be prevented by changing the way that we build. In the case of earthquakes and windstorms, most deaths can be attributed to the collapse of poorly designed and built housing units.[5] In earthquakes, the loss of life is higher when families occupy informally constructed buildings of multiple stories, which may lack reinforcement or have heavy roofs. In fact, over three quarters of fatalities (77%) from the deadliest earthquakes of the last 100 years are associated primarily with the collapse of masonry structures.[6]

77% of fatalities from the deadliest earthquakes of the last 100 years are associated primarily with the collapse of masonry structures.

FIGURE 2 Number of deaths per disaster type, 1998–2017



SOURCE: BASED ON DATA FROM THE CENTRE FOR RESEARCH ON THE EPIDEMIOLOGY OF DISASTERS (CRED) AND UN OFFICE FOR DISASTER RISK REDUCTION (UNDRR), *ECONOMIC LOSSES, POVERTY & DISASTERS 1998–2017* (2018), 9.

2 UN-Habitat, *World Cities Report 2020: The Value of Sustainable Urbanization,* (Nairobi: United Nations Human Settlements Programme, 2020), https://unhabitat.org/World%20Cities%20Report%202020.

3 Centre for Research on the Epidemiology of Disasters (CRED) and UN Office for Disaster Risk Reduction (UNDRR), *Economic Losses, Poverty & Disasters 1998–2017* (2018), 7–9, https://www.cred.be/unisdr-and-cred-report-economic-losses-poverty-disasters-1998-2017.

4 Soroptimist International of the Americas, "Reaching Out to Women When Disaster Strikes," White Paper (2006): 2, https://bit.ly/3ymg4kA.

5 Much of the broader understanding around how poorly constructed buildings kill people in earthquakes can be attributed to the work of the earthquake engineer and risk management expert Peter Yanev.

6 The World Bank, *Roadmap for Resilient Housing: The Path to Livable, Disaster and Pandemic Resilient Housing*, (Washington, D.C.: Global Program for Resilient Housing, 2020).

Resilient Housing For An Uncertain Future

Improving housing quality aligns with Sustainable Development Goal 11: Make cities and human settlements inclusive, safe, resilient, and sustainable.

However, the factors that make a home unsafe or unsuitable are not limited to its capacity to withstand the impacts of earthquakes and strong winds. Substandard housing often results from a mix of deficiencies, ranging from the ability to withstand hazards, to a lack of sufficient ventilation and adequate water and sanitation. The COVID-19 pandemic has reasserted the importance of the home for preventing the spread of disease and sustaining livelihoods. It has intensified the living conditions of those who are most vulnerable, who may lack access to running water to wash hands and cook, a well-ventilated space in which to isolate and recover from illness, or suitable conditions in which to study and work.

Investments in resilient housing can support families to better withstand future crises, whatever form they may take.

Against an increasingly uncertain future, a home is the ultimate protection for families (Figure 3). By directing our efforts and resources toward upgrading homes to make them safe and resilient, we can start saving lives and improving living conditions without delay. Investments in resilient housing can support families to better withstand future crises, whatever form they may take, and avert the devastation and financial losses caused by disasters that could have been prevented.

FIGURE 3 A home is the ultimate protection for families

SOURCE: BUILD CHANGE

1.2 What Do We Mean by Resilient Housing?[7]

"Housing" is any place where people live, including single family housing, multi-unit housing, dormitories, and institutions. "The right to adequate housing" refers to the right to live somewhere with security, peace, and dignity. Living in adequate housing is to have security of tenure, availability of services/infrastructure, affordability, habitability (physical safety, space, and protection), accessibility, location, and cultural adequacy.[8]

"Safer housing" refers to houses that have been built or retrofitted to a certain standard to ensure that they will be less vulnerable than informally constructed housing to the negative effects of different events, including earthquakes, windstorms, flooding, etc. Targeted thresholds for safety are established locally, often through building codes and guidelines for the planning, design, and construction of housing; there is no global standard for "safer housing."

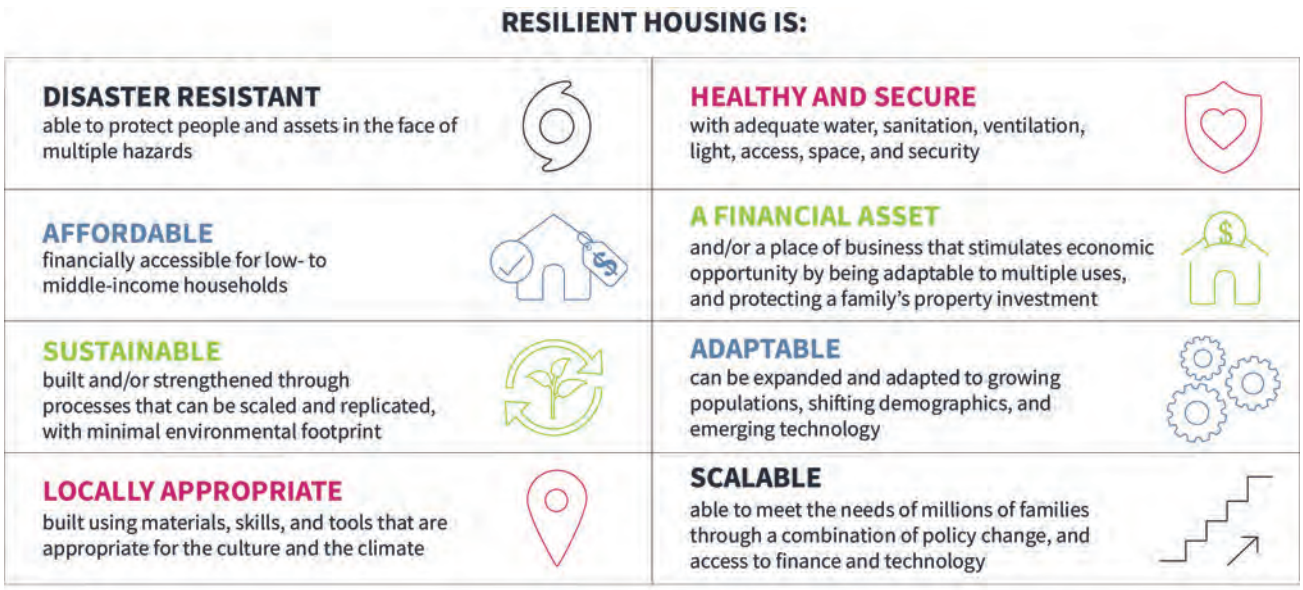
Safer housing can be achieved in the following three ways:

1. by promoting formal housing that complies with applicable building codes;
2. by reducing exposure to hazards through relocation;
3. by investing in mitigation: physical improvements that enhance a building's performance subject to hazards.

"Resilient housing" fulfills and exceeds aspects of safer housing in several ways. It can be defined as housing that provides a safe, locally appropriate, healthy, and secure space. Moreover, it is affordable and a secure financial investment for its occupants. Resilient housing initiatives are sustainable, adaptable, and scalable (Figure 4).

The Build Change Guide to Resilient Housing focuses on proposed mitigation investments that improve the quality of existing housing *beyond* making it safer. It recognizes that a home is the ultimate protection for families (Figure 3) and promotes resilient housing as a means to minimize risks from future events of any kind—physical, natural, health, social, and financial.

FIGURE 4 What do we mean by "resilient housing"?[9]



SOURCE: BUILD CHANGE

7 Based on material from The World Bank's Global Program for Resilient Housing, *Roadmap for Resilient Housing: The Path to Livable, Disaster and Pandemic Resilient Housing*, (2020).

8 Office of the United Nations High Commissioner for Human Rights and UN-Habitat, "The Right to Adequate Housing," Fact Sheet No. 21, Rev. 1 (New York: Office of the United Nations, 2014).

9 Elizabeth Hausler, "Long-Term Change in Construction Practice Through Post-Earthquake Reconstructions," (paper presented at the 1st International Conference on Urban Disaster Reduction, Kobe, Japan, January 17–20, 2005), https://bit.ly/1ICUDR-Hausler-2005.

1.3 Resilience Through Retrofitting

Throughout the world, many residential buildings have been constructed without consideration of building codes. For many older buildings in various countries, construction predates the adoption of modern codes and therefore may not include adequate seismic or wind provisions, for example. For more recent informally constructed buildings, factors such as lack of awareness, lack of code enforcement, lack of incentives, or financial limitations have contributed to substandard construction.

In almost every country today, the greatest housing deficit is qualitative, not quantitative. In spite of this, most housing policies focus on building new homes, rather than strengthening and improving existing homes ("retrofitting"). Although such projects are valuable and need to continue, Build Change advocates for improving existing housing through retrofitting or structural strengthening *before* the next earthquake, windstorm, or pandemic.

By committing to improve the quality of existing housing, governments can work to resolve multiple issues simultaneously. They can avert a disaster when natural events strike, and avoid fatalities and the high costs of reconstruction and debt financing after houses collapse. Furthermore, they can support efforts to contain the urban footprint by reducing the need to develop new land for construction.

Our experience shows that most informal houses can be made safer both quickly and affordably, using solutions that already exist. The images below show some examples of straightforward improvements made to houses through resilient housing programs supported by Build Change in Haiti, Nepal, and Guatemala. More information about other programs and in-depth case studies can be found in Part 3 of this guide.
» Go To: Part 3, Case Studies

Most informal houses can be made safer both quickly and affordably, using solutions that already exist.

The Advantages of Improving Existing Housing

Compared with new construction, improving existing homes can provide a more cost-effective path to reducing the quantitative and qualitative housing deficit, while offering families affordable and appropriate alternatives to living in dangerous homes or moving to unfamiliar neighborhoods. Retrofitting should be prioritized over new construction, where appropriate, given the range of societal, environmental, financial, and political advantages it brings.[10]

It is more cost efficient. There are many additional costs associated with rebuilding houses that have collapsed, or entirely new construction, compared with taking preventative measures to improve existing housing. After hundreds of detailed retrofit designs and cost estimations, and dozens of actual retrofits performed, Build Change has found that the average cost to upgrade housing is 23% of the average cost of building new housing.[11]

It is effective. Unlike larger infrastructure efforts, retrofitting is relatively simple. In many cases, small, inexpensive solutions can make a big difference, reducing vulnerability quickly and improving living conditions. For example, in a typical informal house in Colombia, strengthening and improving the condition of walls and adding a ring beam cost approximately 20% of a full retrofit, but succeeded in reducing the risk of housing collapse by 75%. This work can be done by local builders under the supervision of engineers trained in these simple solutions.

10 It should be noted that there are exceptions to the effectiveness and applicability of retrofitting for reducing risk when certain critical site hazards are present. For example, if a home is located in a storm surge area or on a riverbed, then relocation may still be warranted. This is discussed in more depth in Part 2 of this guide.

11 See Build Change, *The Cost of Improving Vulnerable Housing: Recommendations for Investments in Housing Resilience from an Analysis of Global Project Data*, (2022). Available at https://buildchange.org/cost-of-improving-housing.

Home improvement in Haiti

New ring beam, repaired damaged wall, added plaster, and new roof

Home improvement in Nepal

New ring beam, through ties, strongbacks, slab strips, plaster, stone gable infill replaced with lightweight timber panels, and improved roof [12]

Home improvement in Guatemala

Added and strengthened interior walls; new reinforced concrete slab roof

12 "Through ties" (or "wall ties") are wire or metal ties placed evenly through a wall to join both sides of it together (typically used for thick walls). "Strongbacks" are vertical braces used to provide a secondary support to a wall, like a spine. "Slab strips" are reinforced concrete strips placed at the floor which are used to help transfer loads through the building.

The average cost to upgrade housing is 23% of the average cost of building new housing.

It avoids delay. This is critical given the urgency and scale of the qualitative housing deficit. Through improving existing housing, lengthy bureaucratic processes typically associated with new construction are kept to a minimum. In many countries, home improvements that do not change the use or the structure of a house may not require new permitting or planning applications. Furthermore, the processes associated with acquiring new land for construction are avoided.

Additionally, the complexities associated with retrofitting taller, more complex structures can be avoided by turning our immediate focus to improving modest residential structures in hazard-prone areas, to reduce risk without delay.

It puts the homeowner first. Retrofitted houses are improved, safer versions of the houses that families lived in already, and which they chose to build or buy originally. The argument for improving existing housing is one which acknowledges the significance that families attach to their homes and the area they live in, and leverages the investments that they have already made. It can mean that homeowners take pride in their retrofitted houses and are inspired to commit their own funds toward improvement and maintenance.

It avoids relocation. Improving existing housing avoids relocating people to new neighborhoods, where this relocation—and the characteristics of the new home or neighborhood—may be incompatible with what families want and need. It avoids the broader social and economic consequences associated with relocation, such as disruption to livelihoods, education, and social and support networks. Through retrofitting, houses and neighborhoods can be modified in a way that respects their existing characteristics and allows people to stay.

It has a reduced environmental impact. The building and construction sector is responsible for almost 40% of energy- and process-related CO_2 emissions.[13] The carbon impact of the housing sector can therefore be significantly reduced through investing early in resilient housing, to strengthen houses before the next disaster and prevent future collapses, and recycle existing construction.

It supports urban densification efforts, and saves additional investment in new utilities, roads, and infrastructure. Improving existing housing on land that has already been developed reduces expansion of the urban footprint into protected or agricultural land, and reduces the need to assign new land for urban development, which may be scarce or already at capacity. It also avoids a need to build new, accompanying infrastructure that may be necessary in the case of new construction.

It can change embedded construction practices. Resilient housing programs can build local capacity in the use of disaster-resistant, code-compliant techniques to reduce bad practice across future construction. Local engineers and builders can be trained to design and construct retrofit solutions, which promotes an understanding of the key weak points in the construction practice that led to the existing vulnerability. These skills will be used in the future to design and build safer structures, spreading this knowledge beyond the houses involved specifically in the program.

It addresses multiple concerns. By making improvements to existing housing, governments can address multiple concerns simultaneously, to maximize impact. Disaster-mitigation measures can be coupled with improvements to living conditions (lighting, ventilation, sanitation, etc.), while construction activity can stimulate local economies and support small and medium-sized businesses. In the long term, improving homes can increase real estate options, for example, through adding a second or third story, or through mixed-use housing (combined residential/commercial use).

The remainder of this guide will be dedicated to laying out the approach that Build Change recommends for delivering resilient housing programs, with an emphasis on improving the existing housing stock, to enable governments and practitioners to apply this to the design and implementation of programs in their country.

13 Global Alliance for Buildings and Construction, International Energy Agency, and the United Nations Environment Programme, *2019 Global Status Report for Buildings and Construction: Towards a zero-emission, efficient and resilient buildings and construction sector*, (2019). Available at https://www.iea.org/reports/global-status-report-for-buildings-and-construction-2019.

2

How to Change Housing Systems: The Build Change Way

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Build Change builder trainer, Raquel, with trainee builders in the Philippines

Introduction

Resilient housing programs are ongoing around the world: at the time of writing, Build Change has applied its model for resilient housing successfully in 24 countries. Our experience shows that home improvement programs focused on improving existing housing can be carried out successfully across a range of country and disaster contexts, regardless of a country's technical and financial constraints.

Underlying our work is the desire to have a positive and lasting impact, by **changing housing systems**. To do this, we promote a program model that is both economically and socially sustainable. Our model looks beyond construction and engineering, to creating an environment in which people want to improve the safety of their homes, and in which it is possible and affordable for them to do so. It emphasizes stimulating local demand for better housing, while driving investment and building local capacity to meet this demand. We believe programs that follow our model can provide an efficient and long-term solution to the qualitative housing deficit that countries throughout the world are experiencing today.

Part 2 of *The Build Change Guide to Resilient Housing* is designed to support governments, implementing partners, and funders to take a holistic approach toward the design and implementation of housing programs: one that anticipates the complexities and challenges that lie ahead, while embracing the many tried-and-tested opportunities to overcome them.

2.1 The Foundations of Our Model
To begin, we set out the core ideas behind the Build Change model, with its emphasis on four key aspects:

- homeowner-driven implementation
- promoting gender equity
- a holistic approach toward home improvement, which goes beyond saving lives
- a smarter approach toward risk management, to start saving and improving lives without delay

2.2 Our Theory of Change: Overcoming Barriers of People, Money, and Technology
Systems change cannot be achieved without overcoming the major barriers to success for resilient housing programs. Consistently throughout our programs these barriers have related to **People**, **Money**, and **Technology**.[1] Successful programs must plan to overcome them from the very beginning.

2.3 The Resilient Housing Ecosystem Assessment Tool (RHEAT™)
Developed by Build Change, RHEAT™ provides a series of indicators to track progress in the three areas of People, Money, and Technology, to help to maximize the chances of a program's success.

2.4 Guiding Principles: Learn, Collaborate, Innovate
The three guiding principles shared in this section relate to an iterative process that emphasizes **learning**, **collaboration**, and **innovation**, and can be applied universally. We believe they are key to building successful programs that can be scaled nationally.

More detailed operational guidelines for governments and practitioners, with considerations and recommendations for each stage of a resilient housing program, can be found in the Operational Manual in **Part 4** of this guide.

Learning from the successes and challenges of past and ongoing programs is essential if we are to build upon progress that has been made. To this end, **Part 3** of this guide contains case studies from our work in Colombia, Nepal, the Philippines, and Dominica, presenting a range of contexts in which the Build Change model is being applied successfully. A more detailed account of progress toward resilient housing in Colombia is the focus of **Part 5**, where the government and private sector have been collaborating—with the support of Build Change—to optimize conditions around People, Money, and Technology, and make structural home improvement accessible to those who are most vulnerable.

1 See Elizabeth Hausler, "Long-Term Change in Construction Practice Through Post-Earthquake Reconstructions," (paper presented at the 1st International Conference on Urban Disaster Reduction, Kobe, Japan, January 17–20, 2005), https://bit.ly/1ICUDR-Hausler-2005, and Elizabeth Hausler, "Build Change: Keynote and Master Class for Lemelson-MIT Award for Sustainability," (presentation at Lemelson-MIT EurekaFest, MIT, June 16, 2011).

» 2.1 The Foundations of Our Model

Put Power in the Hands of the Homeowner

Whether pre- or post-disaster, our work has consistently demonstrated that the most successful and sustainable programs are those which are driven by homeowners themselves.[2]

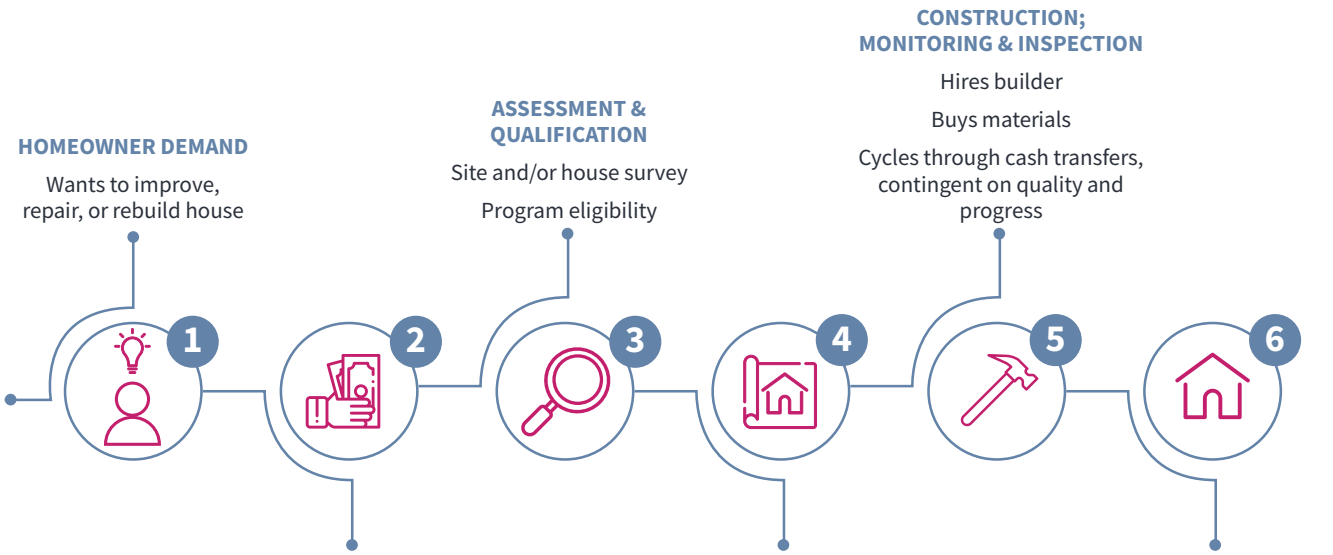
The choice of implementation model for a resilient housing program is crucial, as it determines who the funding is allocated to (and how), and who makes the key decisions about how this money is spent. In a homeowner-driven implementation model, the homeowner is provided with financing, through public subsidies or private loans, and financing is disbursed in conditional installments that are contingent on progress and quality of construction.

Throughout the process, the homeowner retains control over the procurement of labor and materials, while the program implementing agency provides technical assistance and ensures compliance with the agreed program standards, building codes, and land-use regulations.

Figure 5 shows the different stages of a home improvement or reconstruction program from the perspective of a homeowner progressing through them—the "homeowner journey." While each program will be different, and the homeowner journey adapted accordingly, the general principles are the same.

Increasingly, a homeowner-driven model is replacing donor-, contractor-, or community-led implementation models, in which homeowners were minimally involved in design or construction, if at all. A comparison of these models is summarized in Table 1.

FIGURE 5 The homeowner journey to resilient housing



SOURCE: BUILD CHANGE

2 The term "homeowner" is used throughout this guide to refer in general terms to the person who lives in the home, and can make the decision to partake in a home improvement program. It cannot be assumed that this person has ownership of the land or property, nor are we suggesting that the right to a resilient house is contingent on property ownership.

Since we began, Build Change has always advocated for a homeowner-driven approach. It is consistently the most successful implementation model, the most conducive to permanently changing unsafe construction practices, and it multiplies the positive change of building better.[3]

The Advantages of a Homeowner-Driven Model

It empowers women. Across the world, we've found women to be incredible stewards of their family's safety and wealth, when they gain power through access to the necessary knowledge and financing to lead the design and construction of their homes.

It leads to higher homeowner satisfaction. Homeowners are more satisfied when they determine the design of their own home, what materials are used, and who builds it.

It leverages existing resources. Homeowners can contribute their own financial resources or labor, or reuse materials. This is a more sustainable model and contributes to ownership of the process.

It stimulates the local economy. Homeowners typically purchase materials from local suppliers and procure local labor.

It develops and sustains a local workforce. Training builders develops local technical capacity, and produces a larger, more specialized, more employable workforce who can then train others.[4]

It is more cost efficient. Giving money directly to homeowners minimizes overheads and bureaucracy, and reduces opportunities for graft or theft.

It reduces waste. When homeowners manage design and construction, they typically build only what they need. Not only do they consume and waste less, they also reuse and recycle more.

Homeowner engagement is central to the success of this model, along with overcoming challenges associated with People, Money, and Technology (see Part 2.2). It is necessary to create demand for safe housing among homeowners, enable them to pay for construction and engineering services they could otherwise not afford, support them with technical assistance and construction oversight, and build the capacity and awareness within the wider community that are needed for a safe living environment (Box 2.1).

Leveraging digital technology can be an excellent way to engage homeowners at scale. A simple, transparent mechanism such as a Management Information System (MIS) or a homeowner awareness mobile app can greatly improve communication with homeowners and help to support them through all stages of the process. **» Go To: Part 2, Use Digital Technology for Scaling**

Box 2.1 Engaging and supporting homeowners with decision making

Following the 2015 Gorkha earthquake in Nepal, retrofitting of homes was a new concept for most stakeholders, including homeowners, local masons, engineers, and local municipalities. Build Change worked closely with the National Reconstruction Authority to sensitize people and develop a common understanding regarding the need, benefits, and methods for retrofitting houses. Information, Education, and Communication were delivered through a range of media, including videos, posters, and radio programs. Virtual Reality (VR) technology was a powerful tool in supporting homeowners with decision-making and creating demand for safer housing, by helping them to more easily visualize their retrofitted home. **» Go To: Part 3, Nepal: Using Technological Innovation to Enable Post-Disaster Retrofitting at Scale**

A homeowner viewing her future home through VR
CREDIT: JOHN RAE/UNOPS

3 For more information on the homeowner-driven model refer to Elizabeth Hausler, "Building Earthquake-Resistant Houses in Haiti: The Homeowner-Driven Model." *Innovations: Technology, Governance, Globalization* 5, no. 4 (2010): 91-115, https://doi.org/10.1162/INOV_a_00047.

4 See also Jha et al., *Safer Homes, Stronger Communities: A Handbook for Reconstructing after Natural Disasters*, (World Bank, 2010), https://openknowledge.worldbank.org/handle/10986/2409.

TABLE 1 Comparison of homeowner-driven, community-driven, and donor-driven housing reconstruction implementation models[5]

	Homeowner-Driven	Community-Driven	Donor-Driven
Architecture and Design			
Who Chooses Structural System	Homeowner	Donor or government	Donor or government
Who Chooses Floor Plan	Homeowner can choose any layout provided it conforms with disaster-resistant design standards	Donor, community groups, or homeowners choose from a limited number of floor plans	Donor or homeowners choose from a limited number of floor plans
Homeowner Satisfaction with Type and Floor Plan	High	Can be low if floor plan is too small or not appropriate for lifestyle or climate	Can be low if floor plan is too small or not appropriate for lifestyle or climate
Construction			
Who Builds	Small scale, local builders hired by homeowner or small groups of homeowners; in limited cases, homeowners themselves	Local builders or contractors hired by groups of homeowners; in limited cases, homeowners themselves	Large scale contractors hired by relief agencies or governments (may be non-local)
Resource Consumption	Lowest	High	Highest
Use of Recycled Materials	Highest	Low	Rare
Quality and Time			
Who Supervises	Homeowner, technical consultant, and/or government	Homeowner, community group, technical consultant, and/or government	Contractor, technical consultant, and/or government
Quality	Varies; can be high and can be very poor; depends on homeowner's budget and desire for a safe house; helps if government enforces building standards	Varies; can be high and can be very poor; depends on competence of implementing agencies and willingness to enforce quality standards	Varies; can be high and can be very poor; depends on competence of implementing agencies or government staff, avoidance of corruption, and willingness to enforce quality standards
Homeowner Confidence in Construction Quality	Can be highest (if funding sufficient)	Varies	Can be low (homeowner not involved)
Potential for Corruption	Low; project "owner" is the homeowner	Medium; project "owner" is the implementing agency or donor; more peer pressure mechanisms in place	Highest; project "owner" is donor or contractor
Speed	Unpredictable; can be accelerated through fast, sufficient disbursement of cash grants	Can be fast or slow	Fast if managed well, slow if not
Photo Op Potential	Genuine, but not always finished or pretty	Varies	Good
Financial			
Who Pays	Homeowner, with grant from government or donor, or own savings and/or loan (if available)	Donors or government pay community groups or contractors directly	Implementing agencies or government act as contractors or hire and pay contractors; contractors purchase materials and hire labor

5 Elizabeth Hausler, "Homeowner-Driven Housing Reconstruction in Haiti," (presentation at Build Change Monthly Mixer, Port-au-Prince, Haiti, June 9, 2011).

	Homeowner-Driven	Community-Driven	Donor-Driven
Who Hires Builder	Homeowner	Community group or implementing agency	Donor or implementing agency
Who Buys Materials	Homeowner or builder	Community group, implementing agency, or contractor	Donor, implementing agency, or contractor
Level of Homeowner Contribution	Highest	Medium	Lowest
Who Profits in Addition to Homeowner	Local builders and materials producers	Community members, local builders, and materials producers	Contractors, consultants, larger-scale materials producers (may be non-local)
Cost Per House			
Design	High	Low	Low
Construction Management	Low	Varies	High
Materials and Labor	Lowest	High	Highest
On-the-Job Training	Highest	Varies	Low
Overall Cost to Donor	Lowest	Varies	Highest
Development Potential			
Type of Model	Bottom-up	Top-down with some bottom-up elements	Top-down
Role of Implementing Agencies	Limited to technical assistance only; may provide materials vouchers or cash grants to supplement government grants	Limited to technical assistance, grant disbursement	More extensive; design-build, hire contractors, manage construction
Donor Contribution	Technical assistance, capacity building, cash to build a house	Varies; technical assistance, capacity building, cash, house	House
Potential to Cause Long-Term Change in Practice	Highest	Varies	Low
Potential to Increase Dependency and Cause Social Conflict	Lowest; empowers homeowners to drive process, allows for more equitable treatment	Varies	Highest; houses are given away, homeowners are not empowered, unlikely all will be treated equitably due to high cost
Where Model Has Been Used For Permanent Housing	2001 Gujarat, India; 2007 and 2009 West Sumatra, Indonesia; 2008 Wenchuan, China; 2010 Haiti; and others	2004 Aceh, Indonesia; 2004 Sri Lanka; 2005 Balakut, Pakistan; 2006 Central Java, Indonesia; and others	1993 Maharashtra, India;[6] 2001 Gujarat, India; 2004 Aceh, Indonesia; and others
Host Country Government Preference	Preferred model in India, Indonesia, China; Indonesia now strongly discourages donor-driven housing	Varies	High initially due to apparent scale, efficiency, and possibility for kickbacks in some countries; lower as costs rise and social conflicts occur
Homeowner Satisfaction	Highest, except for homeowners with the most limited funds	Varies; model can result in conflicts between homeowners and communities if quality or size of house varies by agency	Varies; model can result in conflicts between homeowners and communities if quality or size of house varies by agency

SOURCE: BUILD CHANGE

6 Though the donor-driven approach was employed in the reconstruction of houses in approximately 50 villages that were most severely damaged by the Maharashtra earthquake, many other damaged houses—approximately 200,000—were repaired or reconstructed using the homeowner-driven approach, with technical assistance provided by the government.

Promote Gender Equity

In Part 1, we highlighted the gender disparities among fatalities in disasters, and the fact that women are fourteen times more likely than men to die when a disaster occurs. But disasters are a man-made problem, to which there must be a man-made—or a woman-made—solution. Build Change strives to prevent this disproportionate loss of life and go further still, by placing gender equity at the center of our work.

Disasters are a man-made problem, to which there must be a man-made—or a woman-made—solution.

Gender equity refers to putting measures in place to compensate for the historical and social disadvantages that have prevented people of different genders from operating on a level playing field. It is a pathway toward gender equality, which requires equal enjoyment of socially-valued goods, opportunities, resources, and rewards by all people, irrespective of gender.

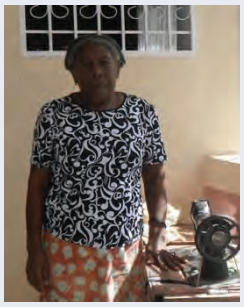
Where gender inequalities exist, it is typically women who are excluded or disadvantaged in relation to access to information and economic and social resources. Women often have more tenuous forms of employment, carry most of the care-giver burden, face increased risk of gender-based violence, and confront heightened reproductive health risks. For many women, the loss of a home can also mean the loss of their only source of income (Box 2.2).

Build Change promotes gender equity by leveraging women's existing capacities to position them as active agents of strategies that increase long-term resilience. In our experience, giving women greater autonomy to manage their own lives, ensuring their full and effective participation, and providing them with opportunities for leadership and decision making about their home supports them to lead change and to create a better future for their families.

Build Change promotes gender equity in resilient housing programs in some of the following ways:

- ***Supporting women to lead the design and construction of their home:*** Across the world, we've found women to be incredible stewards of their family's safety and wealth. In Haiti, an estimated 47% of homeowners who Build Change supported with construction supervision were women. These 750 women oversaw reconstruction to ensure that their home was safe for their families, and were some of the most involved in the process (Box 2.3).

Box 2.2 The loss of a home can mean the loss of a business



Oramene Lamarre, Haiti

For many women, the loss of a home means the loss of a home business, and with it the source of income needed to rebuild and start over. This was the case for Oramene, who lost her home and her sewing business in the 2010 Haiti earthquake. Retrofitting her existing home offered Oramene a faster and more affordable solution, when compared to the longer, more expensive alternative of building a new home. Build Change supported Oramene to oversee the retrofitting work, enabling her to return home more quickly and start generating much-needed income for her family following the disaster.

Box 2.3 Supporting women to lead design and construction

Guerda Chery, Carrefour Feuilles, Haiti

Following severe damage to their home in the 2010 Haiti earthquake, Guerda and her family were living in a camp. When Guerda's son became sick due to the unsanitary conditions, they decided to return to live in their damaged house. After hearing about Build Change from a neighbor, Guerda applied to join the retrofitting program. Guerda went on to lead the reconstruction, from participating in the design of the retrofit, to purchasing materials, hiring the builder, managing the subsidy budget, and overseeing work on the building site. In this way, Guerda retained full control over the work, while knowing it could be completed in line with her family's needs and expectations.

Women clients from our partner financial institutions in the Philippines learning about affordable loans for home strengthening

- ***Providing women with cash grants:*** A vital component of Build Change's programming involves promoting conditional cash grants, through our homeowner-driven model. Providing grants to women gives them more power to actively participate in decisions around their home's design and construction, while supporting them to be viewed and respected as leaders.
- ***Supporting women to access affordable loans:*** Women are proven responsible borrowers. In the Philippines, Build Change works with microfinance institutions whose client bases are 80–100% women, to support them with information and access to affordable and incremental loans to strengthen their homes.
- ***Training women construction workers and materials producers:*** As an organization that is founded by a woman engineer, Build Change has always advocated for and supported women's involvement in the housing and construction sectors. We actively support women as engineers, architects, builder trainers, materials producers, and construction workers, through all stages of the construction value chain (Figure 9). As part of the Better Building Materials program in Indonesia, Build Change supported small and medium enterprises of brickmakers with technical assistance and business skills, with women representing approximately 65% of the brickmakers we worked with. Women kiln owners were also supported with additional training on business management.

To read more about how Build Change supports women to lead change, visit https://buildchange.org/women.

Training women construction workers in Nepal

65% of brickmakers that Build Change worked with in Indonesia were women

CREDIT: LOLA GOMEZ

Don't Just Save Lives—Improve Lives

At Build Change, we believe that resilient housing programs should take a holistic approach toward home improvement: one that recognizes the home as the ultimate protection for families and works to ensure it is a safe, locally appropriate, healthy, and secure space, which can provide opportunities for growth.

The factors that make a home unsafe or unsuitable are not limited to its capacity to withstand the impacts of earthquakes and strong winds. Substandard housing often results from a mix of deficiencies and vulnerabilities, ranging from ability to withstand hazards, to lack of sufficient ventilation and adequate water and sanitation. Making health and safety improvements to housing can provide a unique opportunity for governments to simultaneously improve the safety and well-being of their citizens.

Recommended areas for health and safety improvements in houses include the following:

- water and sanitation
- electricity
- lighting and ventilation (indoor air quality)
- temperature
- space and distribution
- kitchen
- accessibility and egress
- fire safety
- water intrusion prevention (site drainage, roofing, and walls)
- floors
- security

For more detailed guidance on health and safety hazards and assessments, practitioners can refer to relevant national guidelines, such as the Healthy Home Rating System from the U.S. Department of Housing and Urban Development.[7]

Homeowners can further benefit by making changes to their home that will improve their day-to-day lives, or that will provide opportunities for growth. Structural changes may enable a homeowner to improve their use of the space—for example, adding a dividing wall to create an additional bedroom, increasing the size of the kitchen, or making their home more secure. Strengthening the ground floor can allow for a second story to be added in future, which can create an additional source of income through rental or commercial opportunities (Box 2.4).

Bundling structural strengthening with habitability improvements in this way further supports the argument for a homeowner-driven model, through which owners have a central, active role in the design and reconstruction of their home. It also supports the creation of demand among homeowners through an increased desire to invest in reinforcing their home. This is particularly important where the focus is on preemptive home improvements—it is typically easier to convince someone of the need to strengthen their home in the aftermath of a major disaster, rather than against the more abstract threat of a future hazard.

Beyond strengthening and improving homes, resilient housing programs present a major opportunity to improve lives by investing in people—in particular, women. Through building local capacity, Build Change has been improving the livelihoods of construction professionals, site supervisors, block makers, and many others. Furthermore, training provides new, marketable skills to young adults which will scale up the spread of safe, resilient construction practices in the future.

Box 2.4 What factors might encourage a homeowner to strengthen their home?

» **The presence of hazards or damage**
An increased awareness and understanding of the presence and recurrence of disasters in their region; damage, cracks, or other structural deficiencies in the building can be observed; the original construction of the building was only partially completed.

» **Security, access, and space**
Security: Missing walls, sharing walls with neighbors, or lack of secure doors and windows.
Access: Improving the stairs and doors.
Space: Adding interior walls may not only strengthen the building, but could improve the use of space—for example, by allowing different generations to have separate bedrooms.

» **Improvement to daily lives**
The opportunity to bundle structural strengthening with changes that can improve day-to-day living—for example, fixing a leaking roof, improving floors, adjusting ventilation and light, improving kitchens, toilets, water and sanitation, and installing or modifying electrics.

» **Growth and livelihoods**
Strengthening the ground floor to enable addition of a second story in future can create a new source of income generation, for example, a space for a home business. This point also relates to the perceived investment potential of improving the home, which may be especially attractive to families who lack banking facilities.

7 Information and resources for the Healthy Home Rating System including an overview of the system, a hazards summary chart, and an assessment tool can be found at https://www.hud.gov/program_offices/healthy_homes/hhrs.

Smarter Risk Management

Strengthening existing homes through retrofitting can save lives and protect property. It is critical to start improving homes quickly and at scale to avoid loss of life when major hazards occur, and respond promptly and effectively to the qualitative housing deficit being experienced globally.

Smarter risk management is about prioritizing the easiest solutions with the highest impact that can start taking place immediately. While we can conduct studies and work to refine our ability to assess risk and predict hazards, there are actions that can be taken now to reduce risk and save lives. Too many studies and not enough action will not save lives.

Smarter risk management is about prioritizing the easiest solutions with the highest impact that can start taking place immediately.

Through smarter risk management, houses that can be made safer quickly and affordably should be identified, and addressed first. Easy-to-implement, pre-approved solutions can then be developed for these homes, to prevent their collapse in the event of a major hazard at low cost and without delay.

Here we lay out four strategies for smarter risk management:[8]

1. Reduce risk in earthquakes and windstorms

Globally, earthquakes and windstorms have been some of the deadliest natural hazards, responsible for approximately 73% of all disaster-related loss of life in the past two decades.[9] However, these hazards do not have to be destructive or deadly. The features and structural systems of houses with weak earthquake and/or wind resistance are often similar (Box 2.5), and can be fixed using proven, existing technologies developed in disaster-prone areas to save lives and dramatically reduce property losses. Our recommendation is to implement practical measures for strengthening these structures to mitigate risk without delay. In locations with exposure to both risks, the interventions on houses required to reduce risk for either are usually complementary, creating efficiencies.

Beyond earthquakes and windstorms, there are other natural hazards which may affect housing risk, such as flooding, snowstorms, volcanoes, wildfires, and tornadoes. While not covered in detail in this guide, these hazards should be assessed for applicability and considered where relevant in planning resilient housing programs, so that appropriate planning and mitigation measures can be put in place to reduce the largest risks.

Box 2.5 Typical vulnerabilities in residential buildings

Many residential buildings that are vulnerable to **earthquakes** fall into at least one of two categories:

1. Brittle structural systems, such as unreinforced masonry, non-ductile concrete frames, and improperly designed confined masonry, that break instead of deforming and dissipating energy under seismic loads.
2. Structural irregularities, causing concentrations of earthquake forces: Examples include buildings with irregular plan shapes, uneven distribution of walls in plan, and soft or weak stories.

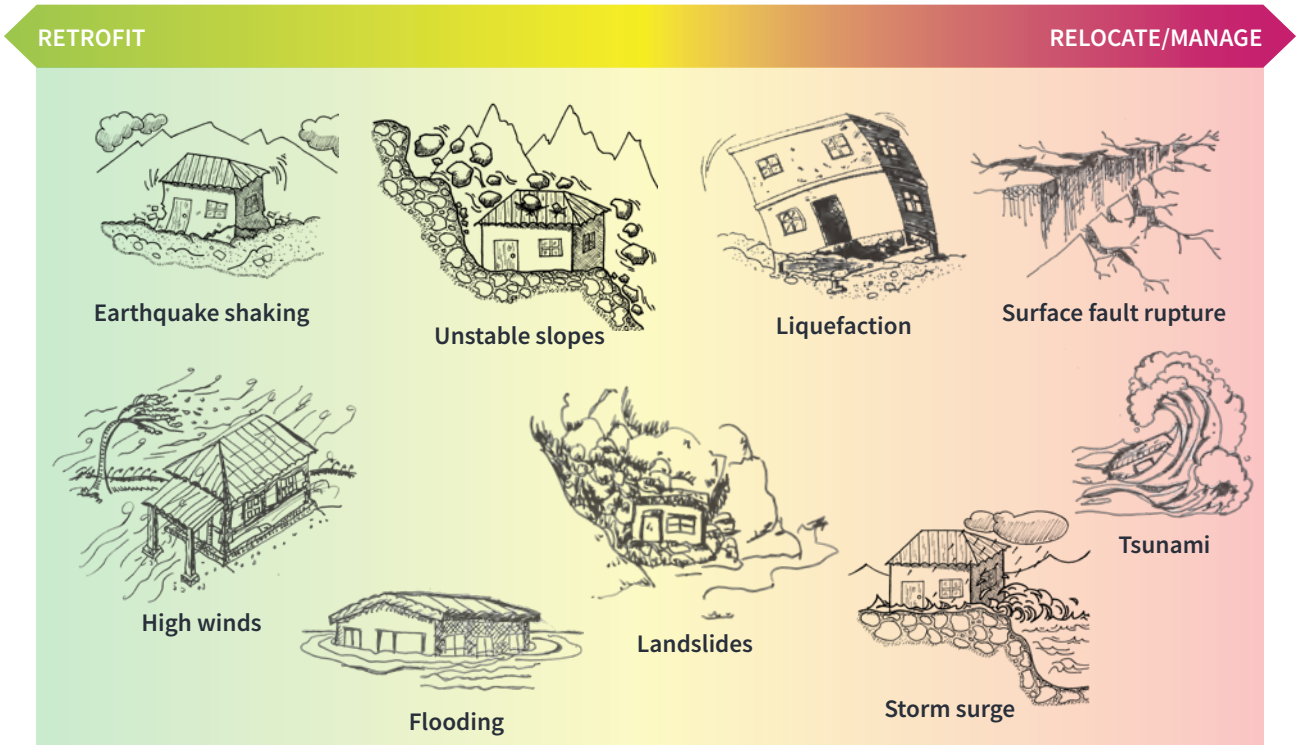
Many residential buildings that are vulnerable to **windstorms** share the following features:

1. Lack of connectivity and strength in the structural system, from the roofing material to the roof structure, to the walls, and down to the foundation. For example, lightweight roofs that do not have strong enough members or adequate tie-downs and can break or blow off in a storm, or even wood-framed houses themselves that are not adequately secured to a solid foundation and can slide or lift off the foundation.
2. Poor configuration and attachment of roofs and appendages—such as large overhangs, carports, or porch roofs that can catch wind and negatively impact other parts of the house.

8 Strategies 1–3 are as discussed in The World Bank's Global Program for Resilient Housing, *Roadmap for Resilient Housing: The Path to Livable, Disaster and Pandemic Resilient Housing*, (2020).

9 CRED and UNDRR, *Economic Losses, Poverty & Disasters 1998–2017*, 7–9.

FIGURE 6 Concepts of hazard mitigation[10]



SOURCE: BUILD CHANGE
Illustrations for "liquefaction" and "landslides" reproduced from *Guide de bonnes pratiques pour la construction de petits bâtiments en maçonnerie chaînée en Haïti*, (Ministry of Public Works, Transport and Communications (MTPTC) and Ministry of the Interior and Territorial Communities (MICT), Government of the Republic of Haiti: Port-au-Prince, 2010).

2. Prioritize improving building performance

Disaster risk is commonly considered as the combination of hazards, exposure to the hazards, and vulnerability to damage.[11]

When it comes to existing housing, examining each component of risk shows that reducing vulnerability to damage is usually the most efficient way to reduce risk.

The hazards present for an existing building depend on the existing site's location and cannot typically be changed. For example, proximity to an active seismic fault cannot be changed without moving to a different location.

The number of people and existing houses exposed to a hazard can be managed through developing and enforcing planning and zoning laws that aim to prevent densification of existing housing in high hazard areas and limit any new construction in areas most exposed to hazards, such as areas susceptible to landslides. Resettlement programs can also aim to reduce exposure to hazards—for example, by relocating existing households away from storm surge areas. For houses exposed to site hazards such as tsunamis, storm surge, flash floods, landslides, liquefaction, and surface fault rupture, the most effective way to reduce risk may be to relocate the house, or in some cases manage the risk, such as through evacuation structures and drills for tsunamis. In these cases, making improvements to the physical properties of the houses can be important, but is not likely to be the most effective way to reduce risk overall.

The most effective way to reduce risk to housing due to earthquake shaking or high winds is to reduce the building's vulnerability to damage through physical improvements. It is also feasible to make physical improvements to a building or site in order to reduce vulnerability to other hazards, such as localized slope failures or some types of flooding; however, these typically require an additional investment (Figure 6).

10 Elizabeth Hausler, "Housing Policies in Countries At High Risk to Natural Disasters," (presentation in Roundtable 5 at the Conference on Urban Resilience in Small States at High Risk to Natural Disasters, World Bank, Castries, St. Lucia, November 14-15, 2017).

11 UNDRR, "Understanding Disaster Risk," accessed September 16, 2021, https://www.preventionweb.net/understanding-disaster-risk/component-risk/disaster-risk.

Most homes can be improved using solutions that already exist, and at reasonable cost.

3. Focus on structures for which solutions already exist

As a starting point for home improvement efforts, Build Change recommends focusing on houses of up to three stories high. Such homes represent the majority of housing units, and most are similar in terms of the construction systems used to build them and their deficiencies. Crucially, these homes can be improved by applying straightforward, tried-and-tested engineering and construction solutions that already exist, and at reasonable cost. By contrast, taller buildings are more complex, and require a more advanced level of analysis when it comes to designing and building them and ensuring their safety under different hazard scenarios.

4. Encourage voluntary incremental risk reduction improvements.

Incremental improvements can reduce housing vulnerability and have been shown to be cost effective even for some of the most seismically vulnerable houses.[12] In the absence of code-prescribed triggers (such as a change of use or significant building addition), some locations allow voluntary partial or incremental improvements.

In many locations, however, policies still require full building upgrade to current code when any structural interventions are made, and do not allow voluntary incremental or partial improvements. In these instances, homeowners who may want to invest in reducing some of their risk are forced to choose between two extremes in order to comply with local regulations: take no action, or bring their entire house up to current building code. In many cases, given limited resources and other priorities, homeowners are driven to inaction. On the other hand, by allowing and facilitating voluntary partial or incremental improvements, homeowners are empowered to gradually reduce risk in their own home.

A home in Lombok, Indonesia, constructed in unreinforced masonry, with a low capacity to absorb seismic energy

12 Nicola Giordano et al., "Financial Assessment of Incremental Seismic Retrofitting of Nepali Stone-Masonry Buildings," *International Journal of Disaster Risk Reduction* 60 (2021): 102297, https://doi.org/10.1016/j.ijdrr.2021.102297.

2.2 Our Theory of Change: Overcoming Barriers of People, Money, and Technology

Retrofitting existing housing at scale is often considered complex due to the specialized technical and engineering expertise involved. However, we have consistently found that the greatest obstacles to successful programs do not relate to technical capacity, but to broader components that are common to many development challenges. Put simply, homeowners will not build disaster-resistant houses unless they can afford to, and have access to needed technology, materials, and skilled construction workers. They also need government ministries able to provide incentives and enforce building standards.

At Build Change we place the major barriers to adoption into three categories: People, Money, and Technology.[13] The high level of interdependence between them makes it necessary to take a holistic approach that considers all three, to successfully design policies, programs, or products to overcome gaps and challenges in any one area (Figure 7).

Build Change supports governments to identify where policy change can enable home improvement with risk reduction at scale, and to develop incentives for homeowners and the private sector to invest in resilient housing. By working to simultaneously overcome barriers of People, Money, and Technology, we are working to transform housing systems in the long term.

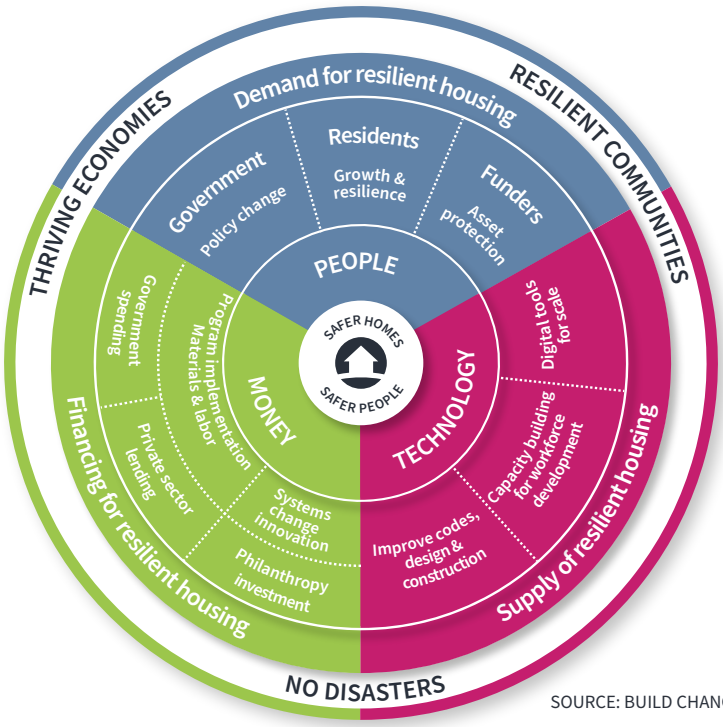
What follows is a description of the different considerations and challenges contained within each category, with recommendations for how to overcome them. While the specifics will vary between countries or cities, and from one disaster to the next, the principles are universal.

People (P)

Homeowner-Driven » Policy that Works » Demanded by All

People have to want to make their homes safer, and governments have to define and enforce construction standards. However, the high prevalence of substandard

FIGURE 7 The Build Change Theory of Change



SOURCE: BUILD CHANGE

13 Elizabeth Hausler, "Long-Term Change in Construction Practice Through Post-Earthquake Reconstructions," and Elizabeth Hausler, "Build Change: Keynote and Master Class for Lemelson-MIT Award for Sustainability," (presentation at Lemelson-MIT EurekaFest, MIT, June 16, 2011).

housing shows that demand alone is not enough, and enforcement is not always possible. "People" here refers to the different roles of stakeholders in creating demand for resilient housing, while ensuring the policy conditions that enable it to happen are met.

Transforming housing systems requires behavior change on the part of all stakeholders, but in particular the key drivers of demand: homeowners, the government, and funders and lenders.

- *Homeowners* must demand better housing—recognizing it to be critical to their resilience and growth—and be supported to achieve it through a balance of incentives and enforcement.
- *Governments* must raise public awareness, commit to long-term change, define and enforce construction standards, and ensure that policy works to optimize a program's chance of success.
- *Funders and lenders* (donors, multilateral financial institutions, private sector lenders) must be in support of funding complete, long-term housing solutions over temporary or partial ones.

Stakeholder groups and roles are discussed in more detail in Part 2.4. **» Go To: Part 2, Collaborate**

The following are some key principles for overcoming challenges related to "People":

1. **Drive wider demand for resilient housing.** Create a situation in which everyone demands better housing. To drive demand, investment, and innovation, governments should take the lead by prioritizing resilient housing on the public agenda, and acknowledging that there are feasible solutions.

2. **Incentivize homeowners (1): Use conditional cash + technical assistance.** Homeowners are incentivized to improve their home when this is within their reach, both financially and technically. The most successful programs adopt a homeowner-driven implementation model and provide owners with conditional financing and technical assistance.

3. **Incentivize homeowners (2): Combine strengthening with other improvements.** While homeowners may not need convincing of the need to build back better after a disaster, this can be more challenging when strengthening is advised as a preventative measure, when the threat of disaster may feel abstract or ambiguous. Combining strengthening with non-structural improvements that can enhance day-to-day life—by improving security, for example—can provide an effective incentive (Box 2.4).

4. **Align policies to meet the challenge.** National policy and legal frameworks that consider building habitability, structural vulnerabilities, and the threats posed by hazards need to exist and be managed by government agencies. Wherever possible, national and local regulatory frameworks should align. New regulations can help to reduce risk—for example, zoning regulations can be enforced to halt the construction of additional stories above three, because building taller than this can vastly increase the likelihood of structural failure and thus the lethality of extreme events.

5. **Simplify procedures.** Regulatory reform may be required to facilitate and streamline homeowner qualification processes, design and construction permits, and quality assurance during construction. This can eradicate unnecessary barriers and reduce bottlenecks, which may discourage common-sense structural retrofits and deter people from taking action.

6. **Commit to long-term, transformative change.** Funders and lenders must commit, resolutely, to funding holistic, long-term housing solutions, over those that are temporary or only resolve a part of the problem. Such behavior change requires building consensus that systems change is necessary, possible, and worthwhile, with the acceptance that it will require sustained investment over a longer period. Governments must recognize that real change will require long-term planning and collaboration that extends beyond the limits of a typical four-year electoral cycle, and must commit to this. Figure 8 is an example of the steps that can be taken by governments to plan for initiating and scaling a national housing program, while ensuring that this is developed throughout their term and into the next. The process is a continual journey, with opportunities for incremental improvements to continue refining the program.

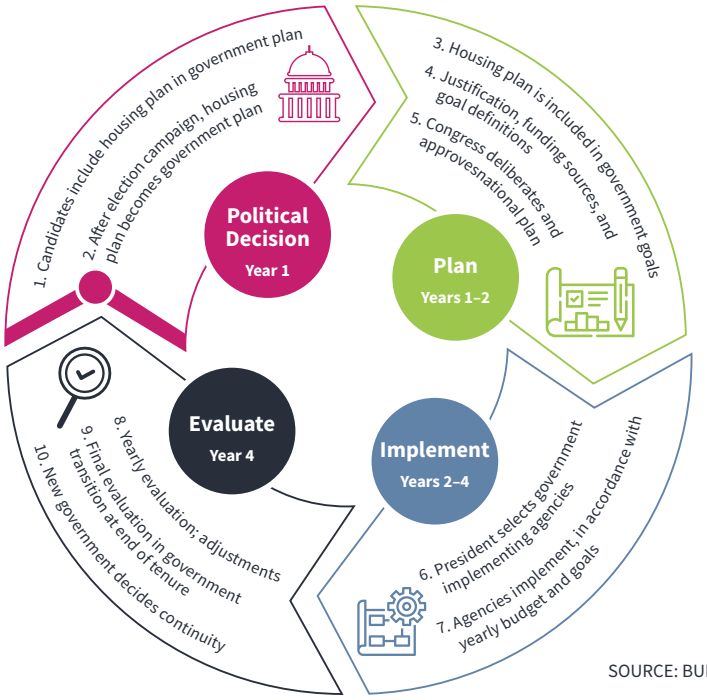
Money (M)

Invest in Systems Change » Fund Program Operations » Cash for Construction

The road to resilient housing begins long before construction and extends far beyond it. Successful programs must direct sufficient funding toward three key areas:

- **Systems change:** With our goal to make every home resilient, Build Change advocates, campaigns, innovates, and raises awareness of the need for better housing, to create demand, drive investment, and change housing systems.

FIGURE 8 The government journey to resilient housing (four-year electoral cycle)



SOURCE: BUILD CHANGE

- **Program operations:** The implementation of home improvement programs involves a broad range of operations that all need funding. This includes technical assistance, market research, engineering, design, and construction expertise, technology development, training, and construction supervision.

- **Construction:** Homeowners require money for materials and labor to enable them to build safely and completely.

"Money" here relates to both driving sufficient investment for resilient housing, and to the ways that financing can be brought together and administered to improve outcomes. This can be supported in the following ways:

1. **Drive investment from public and private sectors.** Closing the gap between the supply and demand for funding for home improvement can be achieved through building awareness of the advantages of investing in resilient housing for all involved. This may include improved living conditions, job creation, and the economic impacts of increased construction activity. Incentives for the private sector may include insurance premium reductions, interest rate subsidies, ease of doing business index improvements, and so on.

   Rapid, high-level cost-benefit analyses can emphasize the opportunity to save lives and reduce economic losses by protecting homes against hazards. Catastrophe models can provide a compelling justification for investment, when the cost of taking action is compared with the much higher cost of doing nothing. For example, modeling by Risk Management Solutions (RMS) showed that over 120,000 deaths and $2.8 billion in losses could be avoided by retrofitting existing informal housing in four neighborhoods in Bogotá, Colombia.[14]

2. **Make affordable finance widely available to homeowners.** How money is made available to homeowners is critical to the long-term success of resilient housing programs. Homeowners will not choose to make structural improvements to their home if they cannot afford to. While Build Change studies have shown that many homeowners are willing to take out a loan to protect their home, access to finance that is within their borrowing capacity is often lacking. An essential part of our work is dedicated toward widening access to affordable financing for low- and middle-income families, to provide realistic

14 This preliminary analysis modeled a 200-year return period earthquake event and studied retrofitting in four neighborhoods of Bogotá over a ten-year period. The study was based on Build Change retrofit methodologies and existing government subsidy systems. The direct effects of retrofitting conducted by Build Change was modeled by RMS in terms of costs, cost savings, reduction of losses, and reduction of injury and deaths.

opportunities and effective incentives for them to strengthen their homes. Collaboration with governments, banks, the private sector, and non-profit organizations can create or augment home improvement finance markets, and establish successful pathways for financing (Box 2.6).

Box 2.6 Market demand for residential retrofitting and home improvement in the Philippines

In January 2019, Build Change published *Disaster Resiliency in Housing in the Philippines: A Market Study of Residential Retrofit Financing.* Through this study we demonstrated that market demand for home improvement loans exists in the Philippines and is achievable within the borrowing capacity of low-income families. We have since partnered with six private microfinance institutions to enable them to offer families affordable loans combined with technical assistance for strengthening their homes—a first for the Philippines. **»Go To: Part 3, Philippines: Developing Home Improvement Microfinance Products to Increase Homeowner Participation**

3. **Use mixed financing strategies.** Funding is best achieved through strategies which supplement homeowners' own resources (savings or materials) with government subsidies and private sector lending.[15] While building in this way may take longer when compared to a donor-driven model, as families accumulate savings and the financial market adapts, our experience has shown it to be a much more sustainable long-term financing strategy.

4. **Use subsidies and price controls as incentives.** These could include combining subsidies for structural improvements with those for habitability improvements, or placing price controls on certain building materials to incentivize their use. Incentives should not force homeowners to choose between a structural improvement that will help keep them safe in an earthquake or windstorm, and a water and sanitation fix that directly impacts their daily lives and health—they should allow them to do both.

5. **Make finance provision contingent on applying minimum construction standards.** In a homeowner-driven construction model, financing can be administered in a way that incentivizes safer construction practices and helps to enforce code-compliant construction, to ensure funds are directed toward their intended use. This is best done in stages, through which compliance with specific construction requirements must be met in order for the homeowner to receive the next stage of funding.

Box 2.7 Financial market-sector and cost studies

Build Change conducts financial market-sector and cost studies to support governments with exploring opportunities and needs in the financial sector for home improvement, and to incentivize and enable families to prioritize home improvement. We then work with governments, banks, the private sector, and non-profit organizations to create or augment the home improvement finance market and establish successful pathways for financing that are informed by best practices.

Financial studies can help to identify gaps in the supply of financing and demand for financing, and find opportunities to resolve these, for example, by developing new financial products with the private sector and identifying how governments can subsidize private-sector offerings.

Studies can help to:

- define the costs of different levels of home improvement interventions;[16]
- explore the mechanisms currently available for financing home improvements in full and in their entirety, and ensure the accessibility of these financial options to all population groups;
- understand local demand and capacity for borrowing money for home improvements;
- identify who the relevant financial agents are—in the public and private sectors—and what they can offer;
- overcome a lack of innovation in financial products that promote resilient building construction; and
- manage the attitudes to risk of lenders (low risk tolerance from private lenders can result in restrictive terms for loan approval, that make it difficult for people from lower income groups to borrow).

15 Build Change, *Disaster Resiliency in Housing in the Philippines: A Market Study of Residential Retrofit Financing*, (Build Change, 2019), https://buildchange.org/app/uploads/2019/01/Disaster_Resiliency_in_Housing_in_the_Philippines-Web.pdf.

16 Understanding the full costs of different interventions supports our aim for families to have access to affordable housing all the way from the initial phase through to completion. This "financial closure" is best achieved through a combination of financing mechanisms, and it is first necessary to determine what resources are available. Typically, these resources will come from homeowners themselves, government subsidies, and private-sector lending (including microfinance institutions).

Technology Ⓣ

Engineering, Design, Construction » Workforce Development » Digital Technology

"Technology" here relates to the supply of resilient housing, throughout the different stages of the construction value chain (Figure 9). From assessment and evaluation, through design and construction phases and reporting, delivering resilient housing at scale relies on professional engineering, design, and construction expertise combined with continuous workforce development to ensure long-term technical capacity is sustained.

The following are some key principles for overcoming challenges related to "Technology".

1. **Ensure recommended building technology is locally available, widely known, and cost competitive.** This will help to drive demand and encourage adoption of the principles of resilient housing. Build Change emphasizes making small, low-cost changes to existing, culturally preferred technologies wherever possible. It is easier and more sustainable to make minor, low-cost improvements to existing ways of building than it is to introduce a completely new technology or reintroduce a traditional building method that is no longer common.

2. **Recognize and leverage the technical capacity already present in most countries,** such as vocational institutions, universities, engineering code bodies, local masons, and many others. Programs are also more successful when implementers engage with local enterprises and the private sector from the start, and seek opportunities to collaborate.

3. **Provide guidelines, regulations, and enforcement.** Governments must make comprehensive technical information widely available. This includes applicable, up-to-date building codes and standards, guidance documents, and existing data around hazards and land use. These documents should include provisions for all relevant hazards and clear, complete guidelines for each common structural system, with evaluation, analysis, and design procedures and solution detail drawings. Governments must enforce building standards compliance.

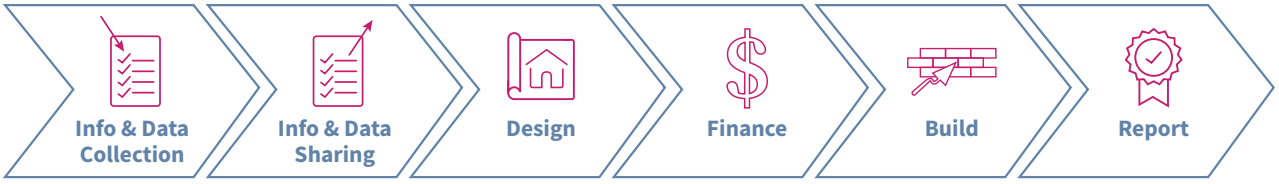
4. **Develop and retain institutional capacity.** Municipal officials or operators must develop and retain capacity within the workforce in order to manage and implement home improvement programs in the long term and at scale. Inspectors must be trained to enforce compliance with construction standards. Homeowners must be provided with adequate technical assistance throughout all stages of the process, from establishing their eligibility and enrollment in the program, and understanding financing requirements and milestones, to contracting workers, choosing materials, and overseeing construction.

5. **Develop the local workforce.** Local builders, engineers, architects, and materials suppliers must be trained to deliver code-compliant construction according to the requirements of the program. Opportunities for construction worker capacity building should be pursued to enable a larger portion of the workforce to meet qualifications. This can be promoted through partnerships with public and private programs and schools to provide training, licensing, and certification.

6. **Use digital technology for scaling.** Digital technology is continuing to transform the scope of what is possible for resilient housing programs and add efficiencies to each stage of the construction value chain (Figure 9). Examples include using geospatial data for rapid assessments, Building Information Modeling (BIM) technology and Artificial Intelligence (AI) for automating design processes, digital tools to more accurately capture and share assessment data, homeowner awareness mobile apps, and an end-to-end MIS.

Build Change recommends making use of digital technology where appropriate to greatly save time and costs, and transform data management. The ways in which digital technology can be leveraged to support scaling are discussed in Part 2.4. **» Go To: Part 2, Use Digital Technology for Scaling**

FIGURE 9 The construction value chain[17]



SOURCE: BUILD CHANGE

17 Elizabeth Hausler, "Building for Good: Redefining Resilient Infrastructure," (presentation at Design Night Boston Presented by Autodesk, Boston, MA, May 9, 2018), and Build Change, "Six-Step Model" and "Construction Value Chain," (unpublished internal documents, 2009, 2016).

2.3 The Resilient Housing Ecosystem Assessment Tool (RHEAT™)

The Resilient Housing Ecosystem Assessment Tool (RHEAT™) has been developed by Build Change to help countries, states, territories, and cities to identify key gaps and challenges as they work toward achieving resilient housing at scale.

RHEAT™ can be used by governments and implementers as they prepare to launch a housing program, or during the implementation of an existing program. The tool supports users to obtain a snapshot of the current housing environment, by assessing conditions at a given point in time. It can be a useful monitoring tool to guide understanding on priorities and resource allocation, and in doing so can help to maximize the chance of a program's success.

RHEAT™ specifically tracks progress against the three areas of People, Money, and Technology. Users are guided by a series of benchmark indicators, and a score is assigned to each based on the current level of progress in that area. The tool should be revisited at regular intervals to review and reassess progress against each indicator. Over time, progress is observed as the colors on the assessment tool change from red—indicating that certain criteria are inexistent or not working—to blue—indicating that resilient housing goals have been achieved.

A summarized version of RHEAT™ is shown in Figure 10. A full version is available in Annex A, with more details on how to use the tool and guidance on each of the indicators and sub-indicators.

Part 5 of this guide shows how RHEAT™ is being applied in Colombia, where Build Change has been working since 2012 to support progress toward resilient housing. **» Go To: Part 5, The Road to Resilient Housing in Colombia**

FIGURE 10 Resilient Housing Ecosystem Assessment Tool (summarized version)[18]

	Baseline	Period 1 (Years 1–5)	Period 2 (Years 6–10)	Resilient Housing at Scale
PEOPLE/POLICY				
Policy and Legal Framework for Risk and Resilience				
Understanding and Framing of Risk				
Enabling Environment for Effective Building Codes and Standards				
Program Implementation Framework				
Implementation Framework: Building Permitting				
Implementation Framework: Construction Monitoring				
Enabling Environment for Construction Workforce				
Homeowner Perception and Participation				
MONEY				
Budget Allocations for Resilient Housing Policy and Technology				
Supply of Resilient Housing				
Government Finance for Resilient Housing				
Private Sector Finance for Resilient Housing				
Homeowner Participation and Demand for Resilient Housing				
TECHNOLOGY				
Technical Content and Quality of Building Codes and Standards				
Risk Data and Mapping				
Technical Capacity of Construction Workforce				
Digital Technology				
Homeowner Perception and Participation				

KEY

- Initial stages (Inexistent or not working)
- Getting ready (Existent, needs fixing)
- On the road (Working, needs fine-tuning)
- At desired level (All good)

SOURCE: BUILD CHANGE

18 Build Change, *Increasing Resilience by Retrofitting Homes Through Public-Private Partnerships in Colombia*, (final report submitted to Swiss Re Foundation, August 12, 2017).

» 2.4 Guiding Principles: Learn, Collaborate, Innovate

What follows are three guiding principles that capture some of the most important lessons Build Change has learnt through our work across the world. They can be applied universally, and adapted according to country contexts, and technical or financial constraints.

1. Learn First … and Keep Learning

Learning should be the first step of any home improvement program and is critical to each part of the construction value chain (Figure 9) and across all stages of a program (Initiation, Planning, Implementation, and Closure—see Part 4). Through our emphasis on improving existing housing, Build Change meets people where they are, in the home they already live in. Here, learning first is about understanding the context within which home improvement can take place and developing appropriate solutions, rather than trying to enforce an imported ideal.

From the outset, practitioners must adopt a position of curiosity and set aside assumptions. This starts with observation and investigation, through housing subsector studies (Box 2.8). Robust and up-to-date information should be collected, shared, and evaluated, and home improvement programs should

Box 2.8 Learning through housing subsector studies

Housing subsector studies provide an opportunity to:

» **Understand the causes of collapse or failure.**
Where a disaster has already occurred, the post-disaster environment presents an ideal laboratory in which to learn why some buildings collapsed or failed and others did not. Identifying causes of failure can help shape and inform reconstruction guidelines, especially in situations in which building codes or guidelines are not available.[19]

» **Understand and assess hazards.**
Studies may be necessary to quantify the likelihood and magnitude of future hazards, including tsunamis, earthquakes, hurricanes, cyclones or high winds, floods, landslides, climate extremes, and pandemics.

» **Understand current preferences and cultural norms.**
The desire of homeowners to invest in strengthening their homes will be short-lived if the proposed housing interventions do not meet the needs and reflect the preferences of the families who will live in them. Acceptance is more likely when structural requirements align with homeowners' ideas about layout of interior and exterior spaces, orientation to light/wind/view, privacy, security, and future growth. Housing studies should therefore address questions such as: *What size, shape, number of stories, and layout are common? Where do people cook, bathe, and use the toilet?*

» **Understand local materials and technology.**
It is easier and more effective to make minor, low-cost improvements to existing ways of building rather than introduce completely new technology or reintroduce a traditional building method that is no longer common. Retrofitting programs should be based upon design solutions that can be understood, learned, and implemented by the local workforce using local materials. Housing studies should therefore address questions such as: *How are houses commonly built? What systems, techniques, and materials are used? What is the skill level of local builders? What tools and technologies are locally available?* Examples of housing surveys are included in Annex D.

» **Determine which building standards apply.**
It is necessary to determine if adequate building codes and standards exist, and if they are relevant to the most common structural system used for housing. For example, in some countries, building codes for multi-story buildings exist, but applying these codes to one- or two-story single-family homes may result in overly conservative design and construction guidelines which lack important details on essential techniques to build a disaster-resistant structure.

19 For a summary of causes of collapse for confined masonry buildings in Indonesia, see Appendix 1 of Build Change for USAID, *Building Back Housing in Post-Disaster Situations—Basic Engineering Principles for Development Professionals: A Primer*, https://buildchange.org/USAIDprimers.

respond closely to the findings. The results of our investigations can and should have wide-reaching impacts: from the choice of implementation model, to the design of individual houses.

Opportunities to learn are not limited to the initial stage of a home improvement program—the most successful programs recognize that learning is a continuous process, with the flexibility and dynamism that allow for necessary adjustments during planning, implementation, and thereafter. There are lessons to be learned at every stage, on every program. Preferences and technologies may change, needs will differ, and disasters are distinct. These lessons provide a valuable opportunity to refine our work and keep our assumptions in check. Monitoring, capacity building, and accurate record keeping can ensure information is captured during the program's execution, while reporting mechanisms during the closure stage can ensure that lessons learned and best practices can be carried forward into future programs.

2. Collaborate

Progress toward resilient housing is facilitated when the skills and resources of all stakeholders are combined. It is therefore important to clearly define the role of each stakeholder group in a home improvement program, understand what motivates them, and leverage the core competencies of each.

The major stakeholder groups and their roles are identified here. Refer to Part 4 of this guide for more details on stakeholder mapping and inter-institutional coordination.
» Go To: Part 4, Operational Manual

Stakeholder Groups

Demand Creators

Demand creators are those that create demand for better housing: homeowners, governments, and funders and lenders.

Homeowners: Homeowners may be motivated to demand better housing for a variety of reasons, which must be understood and leveraged to encourage them to invest in strengthening their home (Box 2.4).

Governments: For resilient housing to become the norm for all income levels, governments must lead: for policy and regulation change, provision of subsidies, and enforcement of building standards.

Funders and lenders: Funding is needed for three main purposes: first, for the market development, advocacy, and supply chain innovation that leads to permanent systems change; second, for program implementation/ technical assistance; and third, for the cost of materials and labor for construction.

Supply Providers

Supply providers are those that supply better housing: engineers, builders, building materials suppliers, and nongovernmental organizations (NGOs) delivering home improvement programs. Such entities are essential to resilient housing, though their capacity may vary across countries and sectors.

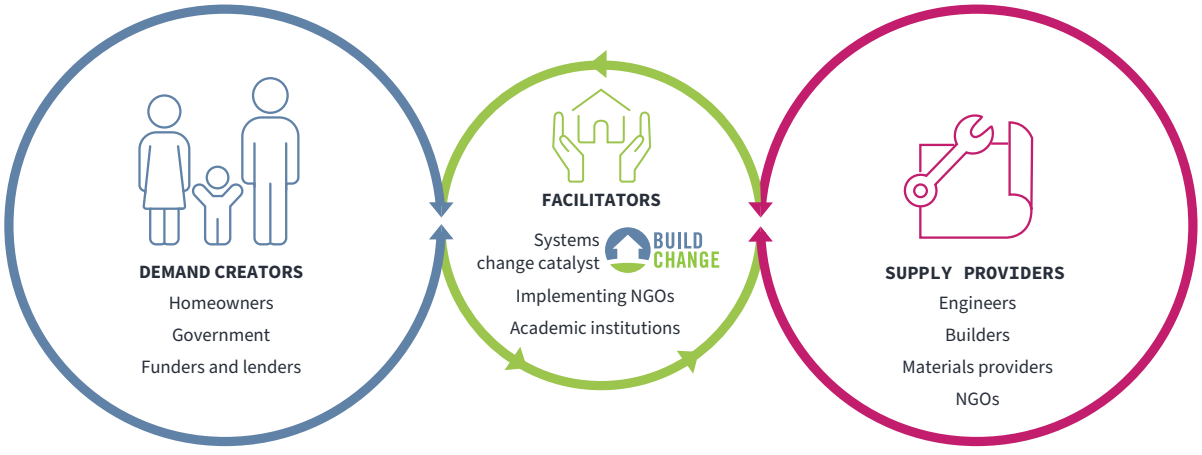
Facilitators

This includes systems change actors like Build Change, team leaders from multilateral organizations, consultants, implementing NGOs such as the American Red Cross, Catholic Relief Services, Habitat for Humanity, housing finance providers such as Water.org and Microbuild, and academic institutions.

Roles of Stakeholders

The role of each stakeholder may vary by location and program. Some common roles are listed here:

FIGURE 11 Stakeholder groups



SOURCE: BUILD CHANGE

Government (relevant ministries, municipal engineers, and building inspectors)

- produce or adopt consensus-based, clear, easy-to-implement building standards and guidelines, including required loading and design hazard levels
- provide certification programs or licensure regulations for builders, engineers, and government officials
- provide plan review and permitting services to homeowners or contractors, and carry out building inspections to ensure compliance with approved construction documents
- establish qualification criteria and approve final list of homeowners who qualify for the program (where applicable)
- resolve land tenure issues
- manage disbursement of financial subsidy to homeowner or contractor
- provide subsidies or enforce price controls
- implement infrastructure projects relating to essential local services
- conduct civil works such as building retaining walls that protect more than one house

Funders and Lenders

- provide funding for systems change, program implementation/technical assistance, and construction costs
- elevate the urgent opportunity for resilient housing across philanthropy

Homeowners

- participate in the design process and approve final designs
- procure the building materials
- hire the contractor
- oversee construction
- pay for building materials and pay the contractor

Technical Assistance Providers

"Technical assistance providers" refers to the engineers and architects who provide support in developing the building standards and direct technical assistance to homeowners during reconstruction.

- develop evaluation, analysis, design, construction, and materials guidelines, and related resources and tools
- develop information collection and dissemination tools
- support the government in building code and guideline development, adoption, and enforcement
- provide training and capacity building to homeowners, builders, engineers, building materials producers, and government officials
- guide the homeowner through the design, builder selection, and construction process
- supervise construction and provide on-the-job training to builders as needed

Private Sector Enterprises and Institutions

- provide construction contracting and labor
- provide building materials, material transportation, and equipment rentals
- provide financial products such as loans, microloans, and insurance

3. Use Digital Technology for Scaling[20]

Appropriate use of digital technology throughout different stages of a program can vastly improve compliance, efficiency, and accountability, and broaden the scope of what is possible across the construction value chain (Figure 9).

Build Change advocates for the widespread adoption of digital technology where relevant and feasible, and supports governments and implementers to incorporate it into their existing workflows.

Examples of how digital tools are being leveraged to enhance home improvement programs and support scaling are given below, and others are highlighted throughout the guide.

1. **Leverage and connect existing resources.** City and national governments, more than ever, have access to Big Data, and regularly commission large-scale collection of data. This includes satellite imagery, street-level imagery, permitting, and land registry databases, feeds from surveillance cameras, and socioeconomic databases. Technology can be used to access these large, dynamic depositories of information and to analyze them for the purposes of:

    - **assessing** technical vulnerability, hazard exposure, property values, and local infrastructure rapidly and at scale;
    - **analyzing** other relevant data that can be used in program design—for example, the specific socioeconomic criteria of the residents of the most vulnerable homes, or the most common structural deficits in a given area;
    - **integrating** administrative requirements such as permitting and land registry changes into the digital workflow, saving time and increasing reliability; and
    - **streamlining** the design and construction processes through step-by-step planning, sequencing, and coordination to optimize results, costs, and project time.

20 With the exception of Figure 12, the material in this section has been adapted from The World Bank's Global Program for Resilient Housing, *Roadmap for Resilient Housing: The Path to Livable, Disaster and Pandemic Resilient Housing*, (2020).

2. **Assess, inventory, design, permit, and build in a much faster manner.** Assessing, tracking, design, and permitting can be a very time-intensive process, requiring multiple visits to a home, use of disparate and disconnected technology and tools, and labor- and paper-intensive permitting processes. Automation using BIM tools, such as Revit and Dynamo, and the use of low-cost, widely available digital tools can integrate workflows and reduce time and effort by up to two orders of magnitude.

   Specifically, the use of a data collection platform such as Fulcrum (Box 2.9) has enabled processes associated with structural evaluation, design, and reinforcement procedures, and eligibility checks for subsidies, credit, and financing to be brought together for the first time, reducing months of work to just a few minutes. Combining these technologies with AI has allowed us to semi-automate the entire retrofitting design process as part of the "technology journey" to resilient housing (Figure 12).

Box 2.9 Using a data collection platform to optimize evaluations

Build Change has created the Global Housing Survey application within Fulcrum to optimize the evaluation stage via a range of specific key functions. By digitizing, optimizing, and automating data collection, the use of Fulcrum in this way enables real-time data analysis in the field by a non-technical expert, and without the need for an internet connection. Such technology has made it possible to assess whether a home is eligible for structural and/or habitability improvements, within the constraints of a given program, and to provide advice to homeowners in the field, during a single, initial site visit.

The platform is first pre-loaded with relevant criteria from existing databases, such as basic household data, seismic and wind parameters, and land and permitting data for a given area. Once on site, a mobile device can be used to enter additional data, such as observed structural and non-structural deficiencies or homeowner preferences, supported by visual references like photos, videos, or signatures.

This data can then be processed immediately, to provide "smart," reliable outputs while in the field, where bespoke human data analysis and multiple site visits would have previously been necessary. Calculating a home's exposure to risks, screening houses for applicability of certain design methodologies, performing hazard-specific engineering calculations, and providing a preliminary cost estimate can all be done quickly while with the homeowner, thus greatly improving both communication and efficiency. Data then syncs to the cloud, from where it can be instantly viewed and exported for use throughout the different stages of design, financing, construction, and monitoring that follow (Figure 12).

3. **Interact (not merely communicate) with homeowners at scale.** True scale, meaning—at a minimum—country-wide reach, is achievable thanks to the ubiquitous nature of technology such as cell phones, smartphones, and internet browsers. Entire populations can volunteer information and be serviced through combinations of these technologies, while messaging and advice can be tailored to the technical specifications of a house and the socioeconomic contingencies of its owners.

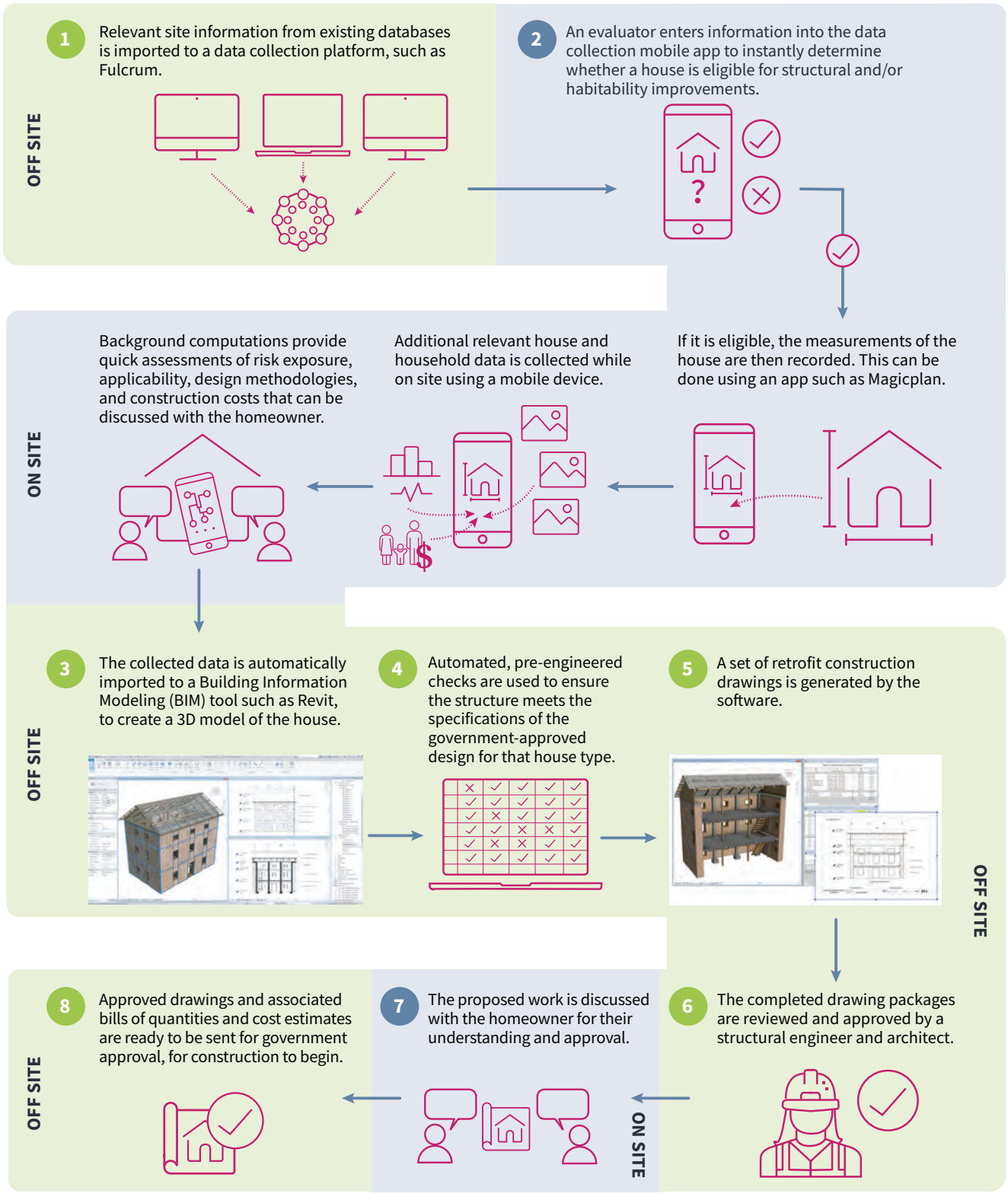
   Homeowner awareness mobile apps developed by Build Change have been a highly successful way of communicating with homeowners at scale in Nepal, Indonesia, the Philippines, and Dominica. Interaction with homeowners (and other stakeholders) has been enhanced through the use of an end-to-end MIS for improved information management and accountability across program stages. An MIS enables a project to securely collect and store large quantities of data, process the data against desired criteria, and output it in an informative manner that allows for easy decision making, tracking, and reporting. **» Go To: Part 3, Dominica: Building a Management Information System for a National Housing Recovery Program**

4. **Improve traceability and accountability.** Current technology greatly enhances the transparency of workflows, by creating traceable, auditable, geolocated, user-by-user information trail records. These can be augmented by geotagged photos, scans, signatures, PDFs, and videos, which all act as auditable supportive documentation to validate decisions. Particular issues can be traced back to a given house, a given person or contractor, and a given moment. This improves accountability and leads to improvements in reliability and productivity.

   Data can be sorted, analyzed, and reported to a variety of constituencies across all levels.

   Further accountability is also possible through stakeholders' ability to monitor construction progress. Construction quality concerns (for example, whether the bricks are adequately spaced or enough mortar is being used) can be addressed immediately by taking a photo on a mobile device through a "Go"/"No-go" app that makes use of AI. This can provide instant reassurance or

FIGURE 12 The technology journey to resilient housing



KEY Off site: Away from the home (in the cloud or office) On site: At the home

SOURCE: BUILD CHANGE

A homeowner in Central Sulawesi, Indonesia, using the Rumah Aman *(Safe House) homeowner-awareness mobile app*

allow stakeholders to flag construction quality issues, communicating them immediately and directly through apps that connect to project-monitoring dashboards.

5. **Overcome expertise shortages.** Technology allows for engineering design criteria to be applied widely for similar buildings, removing the need to conduct detailed engineering analysis on every unique building. Smartphones or cameras enabled with AI (or calculation software) can generate tailored technical advice. These can be used by anyone, regardless of their level of technical knowledge, and avoids the need to have a technical specialist present at each house. This overcomes workforce shortages and enables a small team of technical experts to oversee a system affecting tens, thousands, or hundreds of thousands of houses. It can also open up interesting economies of scale and profit incentives for builders and contractors, who can access data prior to visiting the site. **» Go To: Part 3, Nepal: Using Technological Innovation to Enable Post-Disaster Retrofitting at Scale**

6. **Help protect workers, builders, and homeowners in the COVID-19 era.** Better integrating technology into operators' workflows in the COVID-19 era will be essential to enabling a safe return to activity, or for keeping human interaction to a minimum at times or in places where this may be necessary. Examples of areas that can be supported in this way include:

   - **Evaluations:** Homeowner-operated mobile applications are key to conducting house evaluations and to collecting socioeconomic data without requiring physical contact between families and program staff.
   - **Site visits:** Digital technology can help reduce the number of visits to sites—and even eliminate the need for site visits altogether when paired with homeowner-operated house evaluation tools.
   - **Procurement of labor and materials:** Mobile/online service-matching functionalities can enable homeowners to select a builder, contract a loan, and purchase construction materials for delivery.
   - **Site supervision and inspection:** This can be performed as remotely as practically feasible, by combining homeowners' and builders' ability to crowdsource key site information, and by incorporating AI and other background computational tools to automate as many quality assurance workflows as possible.

3
Case Studies

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Construction quality assurance in the Philippines

Introduction

Our work provides clear evidence that affordable, straightforward structural improvements can prevent houses from collapsing and save lives when hazards strike. But they must go further: through a holistic approach, housing programs can move from making housing safer, to making it resilient, acknowledging that better housing means better health, better economic opportunities, and a better future.

In **Part 2** of *The Build Change Guide to Resilient Housing* we shared the core ideas that inform the Build Change model, from our extensive experience of resilient housing programs in a wide range of countries and contexts. In sharing these principles, we hope to support governments, implementing partners, and funders to commit to resilient housing programs with confidence, through building awareness of the challenges that lie ahead, and providing recommendations to overcome them.

Part 3 provides the evidence, drawing on past and ongoing programs from around the world, where Build Change has been supporting governments to overcome barriers of People, Money, and Technology to drive systems change. Building upon the success of these programs and learning from their challenges is essential if we are to move forward with the urgency that the global qualitative housing deficit demands.

3.1 Examples of Resilient Housing Initiatives: This table summarizes different implementation models and housing types for six resilient housing programs in Latin America, the Caribbean, and Asia.

3.2 Case Study 1, Colombia: In Colombia, preventative structural home improvement has been put firmly on the national housing agenda as part of the *Casa Digna, Vida Digna* program, which is now enabling hundreds of thousands of families to upgrade their homes. The Colombia model shows that national-level investments and institutional commitment coupled with strong technical expertise in resilient housing make an effective model for scaling resilient housing measures worldwide. A more detailed account of Colombia's progress is the focus of **Part 5** of this guide.

3.3 Case Study 2, Nepal: In Nepal, Build Change has worked with the National Reconstruction Authority to broaden the scope of post-disaster reconstruction subsidies to include structural retrofit of damaged buildings, following feasibility and cost studies. Our innovation in engineering has established guidelines for stone and mud-mortar homes to be retrofitted, while our technical resource development has enabled the program to be scaled nationally.

3.4 Case Study 3, Philippines: In the Philippines, our proof of concept and market studies have shown that homeowners will borrow money to strengthen their home to withstand disasters, when this is combined with making other improvements. Affordable home-improvement loans with targeted technical assistance are now available for the first time, and this case study explains how we have been working with microfinance institutions to support them with developing resilient housing loans that are accessible to low-income families.

3.5 Case Study 4, Dominica: In Dominica, we applied our post-disaster expertise and innovation in technological resource development to support the Ministry of Housing and Urban Development following Hurricane Maria. Build Change developed a Management Information System (MIS) for the National Housing Recovery Project that will support 420 families to rebuild their homes.

3.1 Examples of Resilient Housing Initiatives

TABLE 2 Examples of resilient housing initiatives

Location	Bogotá, Colombia[1]	Guatemala[2]	Greater Port-au-Prince, Haiti[3]	Greater Manila, Philippines[4]	Nepal[5]	Gujarat, India[6]
Housing Deficit	9.33% quantitative (National) 25.26% qualitative (National) 70% qualitative deficit if structural criteria are considered (Build Change estimate)	29% quantitative 61% qualitative (National)	250,000 houses destroyed by the 2010 earthquake	Quantitative: 12.3 million by 2030 (6.7 million 2015 deficit + 5.6 million projected demand) Qualitative: Market for home strengthening is 15.6 million units housing 69 million people (Build Change estimate)	750,000 stone and mud masonry houses damaged or destroyed in 2015 earthquakes	215,000 stone and mud masonry or earth homes destroyed, 1 million damaged, 7.7 (M_w) on January 26, 2001
Hazards	Earthquake	Earthquake	Earthquake and wind	Earthquake and wind	Earthquake	Earthquake
Common Housing Types	Load-bearing masonry	Load-bearing masonry	Load-bearing masonry	Load-bearing masonry and infilled reinforced concrete (RC) frame	Load-bearing masonry	Load-bearing masonry
Example Photo						
Type Description	1–2 story Hollow clay tile masonry walls, partially confined RC slab floors RC slab or light-framed roof	1–2 story Concrete block masonry walls, partially confined RC slab floors RC slab or light-framed roof	1–3 story Concrete block masonry walls, partially confined RC ribbed slab floors RC slab or light-framed roof	1 story unreinforced masonry, or 1–2 story RC frame with infill Concrete block masonry walls RC slab floors RC slab or light-framed roof	2–3 stories Stone masonry with mud-mortar walls Timber-framed floors and pitched roof covered with corrugated galvanized iron (CGI)	1 story Stone masonry with mud-mortar walls Timber-framed floors and pitched roof covered with CGI, tiles, or thatch
Retrofit Solutions	Add/complete walls Add wall plaster or reinforced overlays Add ring beam (light roofs) Add/complete confining elements Fix leaking roofs	Add/complete walls Add wall plaster or reinforced overlays Add ring beam (light roofs) Add/complete confining elements Fix leaking roofs	Add/complete walls Add wall plaster or reinforced overlays Add ring beam (light roofs) Add/complete confining elements Wind strengthening of light roofs	Add/complete walls Add wall plaster or reinforced overlays Add ring beam (light roofs) Add/complete confining elements Wind strengthening of light roofs	Add wall through-stones Add strongbacks Add RC slab strips and wall anchors Add ring beam Replace masonry gable with light one Add wall plaster Fix leaking roof	Add/complete walls Add RC slab strips and wall anchors Add vertical reinforcement, including at corners Replace or tie down roofs
Total cost per building (USD)	$8,000 (Full retrofit)	$3,200 (basic) $7,800 (improved)	$3,540	$5,000	$3,000	$120–$560
Cost per m^2 (USD)	$107	$40	$85	$100	$40	$10

Location	Bogotá, Colombia[1]	Guatemala[2]	Greater Port-au-Prince, Haiti[3]	Greater Manila, Philippines[4]	Nepal[5]	Gujarat, India[6]
Regulatory Highlights	Retrofit subsidy can be stacked with habitability subsidy. One time subsidy from city, for families making up to 2 minimum monthly wages (poor) City subsidy does not exclude National subsidy. City will retrofit only fully-permitted interventions. Social criteria determine subsidy eligibility, not housing vulnerability.	National funding exists for both new housing and home improvement. Neighborhood Improvement Policy in congress has addressed structural retrofitting as well as qualitative upgrading. Cities do not implement direct subsidies—currently done at National Government level.	The Government of Haiti established UCLBP (l'Unité de Construction des Logement et des Bâtiments Publics). UCLBP provided normative guidelines on housing reconstruction, including recommendations for reconstruction actors implementing using an owner-driven methodology to provide specific levels of subsidy depending on whether a house had to be fully reconstructed or could be retrofit. The normative framework created by UCLBP was filled and interpreted to different degrees as numerous operators implemented targeted projects in different neighborhoods of Greater Port-au-Prince. Unification of subsidy amounts and methodology was always a challenge.	In February 2019, the Philippines Government wrote the new executive Department of Human Settlements and Urban Development (DSHUD) into law, responsible for management of housing and related development. The microfinance industry in the Philippines is well regulated and robust.	The Government of Nepal created the National Reconstruction Authority to oversee reconstruction. Owner-driven reconstruction methodology Housing reconstruction subsidies disbursed at scale	Gujarat State Disaster Management Authority (GSDMA) issued retrofit and repair guidelines. Owners with houses in three damage categories were given a single grant of between USD 120–560. Use of the grant for structural retrofit was not required or enforced, hence uptake and enforcement were limited.
Implementer	Caja de la Vivienda Popular; Secretary of Housing Technical assistance by Build Change	Project Concern International (USAID) and Build Change National Implementer: FOPAVI (Housing Fund) Technical assistance by Build Change	Several International NGOs, UN Agencies, Red Cross Movement members Implementation across multiple neighborhoods of Greater Port-au-Prince Technical assistance by Build Change	Partner microfinance institutions (MFIs) including: ▪ Alalay sa Kaunlaran Microfinance Social Development Inc. ▪ Kabuhayan sa Ganap na Kasarinlan Credit & Savings Coop & KASAGANA-KA Development Center, Inc. ▪ Ahon Sa Hirap Inc. ▪ Country Builders Bank Inc. Technical assistance by Build Change	The National Reconstruction Authority was the chief implementer of beneficiary enrollment, owner-driven subsidy disbursements and construction inspections. Homeowners received subsidies directly and spent the money on labor and materials, with technical assistance from numerous partner organizations engaged in the Nepal reconstruction and recovery effort. Technical assistance by Build Change	GSDMA; NGOs; technical assistance providers

Location	Bogotá, Colombia[1]	Guatemala[2]	Greater Port-au-Prince, Haiti[3]	Greater Manila, Philippines[4]	Nepal[5]	Gujarat, India[6]
Funding Model	Public funds, city government driven, implemented with contractors hired by city. Homeowner vetting and approval required, but homeowners do not receive subsidies directly.	Public funding model, government driven Private models exist also, through NGO and microfinance. Public funds mainly used for new housing. Finance model for home improvement needs facilitating.	Institutional donor funding, through International NGOs, UN Agencies and government. Also funded through private donations and private foundations. In a great many neighborhoods, direct subsidies were disbursed to homeowners (owner-driven). Small attempts at funding through microcredit, including by leading Haitian MFI SOGESOL	MFIs provide client-centric house strengthening loan products with technical assistance and capacity-building activities. Incremental house strengthening intervention stages linked to low-income household tailored loan levels of on average USD 1,500; repayment conditions of $20/week, with repeat cycles	Two categories of housing subsidies: a lower subsidy for repair and retrofitting (USD 900), and a higher subsidy for full construction of a new house (USD 2,700). Subsidies disbursed incrementally, contingent on the level of house completion progress and compliance with National Reconstruction Authority guidelines.	Public reconstruction funds, philanthropic technical assistance funds
Key Lessons	Retrofit is possible with current model, but can be improved. Funding is enough for basic retrofit and sanitary improvements. Technology can reduce time and cost of evaluation and design to a tenth. Permitting needs fast tracking, both in process, and in technical tools. Technical assistance has a "supervision" approach; needs to shift to a "capacity development" approach.	FOPAVI subsidy thresholds enough to strengthen houses and improve sanitation. Prescriptive interventions possible, as density is low; cost to retrofit comparatively low. As city ramps up densification, opportunity to add second and third stories with structural and habitability upgrades to existing home. High demand for expansion opportunities, and general home improvement.	Retrofits could be implemented following an owner-driven methodology. "Red"-tagged (too damaged for occupancy) houses could be retrofitted. Applying retrofit subsidy levels per family vs per house permitted the retrofitting of 2 to 3 story houses in locations such as Delmas 32. Slope mitigation measures such as retaining walls could be retrofitted or added as retrofit components.	Homeowners are willing to take out loans to strengthen their houses. MFIs are willing to trial client-centric house strengthening loan products. Incremental house strengthening can be linked to suitable loan cycles, level, and repayment conditions.	Traditional stone masonry and mud-mortar houses can be retrofitted using a standard methodology based on pre-engineered designs, thus reducing the unit cost of design.	One of the earliest attempts to retrofit damaged low-rise unreinforced masonry buildings after earthquakes, but reached only limited scale; subsidies were provided in only one tranche without enforcement or technical assistance at a large scale.

SOURCE: BUILD CHANGE

1 Build Change, *Increasing Resilience by Retrofitting Homes Through Public-Private Partnerships in Colombia*, (final report submitted to Swiss Re Foundation, August 12, 2017). Refer to Part 3.2 and Part 5 of this guide for more information, and Annex G for examples of design and construction documents.

2 Build Change, "*Barrio Mío* Housing Retrofits in Mixco, Guatemala," (unpublished internal documents, December, 2014).

3 Build Change, *Successes in Haiti: From Post-Earthquake Recovery to Sustainably Improving Community Resilience to Natural Disasters—Achievements from 2010 to 2018 (and beyond),* (Build Change, 2018), https://bit.ly/Haiti-8-Years. Refer to Annex G of this guide for more context, and for examples of design and construction documents.

4 Build Change, *Disaster Resiliency in Housing in the Philippines: A Market Study of Residential Retrofit Financing*, (Build Change, 2019), https://buildchange.org/app/uploads/2019/01/Disaster_Resiliency_in_Housing_in_the_Philippines-Web.pdf. Refer to Annex G of this guide for more context, and for examples of design and construction documents.

5 Government of Nepal, National Reconstruction Authority (NRA), *NRA Experience Paper on Retrofitting of Private Housing Post 2015 Gorkha Earthquake*, (NRA, 2021), https://bit.ly/NRA-Experience-Paper and *Ready-to-Use Manuals for Repair and Retrofitting of Masonry Structures*, (NRA, 2021), https://bit.ly/NRA-Ready-to-Use. Refer to Part 3.3 of this guide for more context, and to Annex G for examples of design and construction documents.

6 Elizabeth Hausler, "Housing Reconstruction and Retrofitting After the 2001 Kachchh, Gujarat Earthquake," (13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, August 1-6, 2004), http://www.iitk.ac.in/nicee/wcee/article/13_1723.pdf.

Case Study 1: Colombia

3.2 Colombia: Prioritizing Structural Improvements for Existing Homes Through a National Housing Program[7]

The *Casa Digna, Vida Digna* (Dignified House, Dignified Life) program shows that national-level investments and institutional commitment, coupled with strong technical expertise, make an effective model for scaling resilient housing measures worldwide.

Context

Colombia's population is one of the most urbanized in Latin America, with over 77% of people now living in cities.[8] Estimates suggest that more than 28 million Colombians live in informal housing that is structurally inadequate and vulnerable to even moderate earthquakes.[9] Colombia's mountainous, volcanic landscape exposes its people to a range of hazards, but it is earthquakes that pose the greatest threat to housing—and the potential loss of lives and financial resources as a result.

Colombia has been implementing subsidized housing programs for decades, with the right to dignified housing for every Colombian declared in the Constitution. However, public funding for home improvement has typically been directed toward improving living conditions in rural homes, or new construction initiatives. This has started to change in recent years, with the Government of Colombia now directing funding toward the structural upgrading of existing informal housing in urban areas as part of a flagship national home improvement program, *Casa Digna, Vida Digna*.

Build Change's Work in Colombia

Build Change has been working in Colombia since 2012 to demonstrate the opportunity for strengthening existing housing and to create the necessary policy, economic, and technical conditions to support the government to achieve this at scale. Through our work with the Ministry of Housing (*Ministerio de Vivienda, Ciudad y Territorio*, MVCT), the Cities of Bogotá and Medellín, and others, we have demonstrated the clear opportunity to save lives and reduce economic losses, and succeeded in driving national investment in resilient housing.

Informal housing in Medellín
CREDIT: BRIAN KYED/UNSPLASH

7 Build Change, *Increasing Resilience by Retrofitting Homes Through Public-Private Partnerships in Colombia*, (final report submitted to Swiss Re Foundation, August 12, 2017), and Build Change, "Reducing Seismic Risk Through Home Improvement in Colombia," (unpublished internal document, August, 2019).

8 National Administrative Department of Statistics (DANE), 2018 census data

9 Build Change arrived at this figure by taking a national population of 48.3 million people, and applying the fact that 83% (40 million people) reside in areas of high and medium seismic risk. By applying estimates for the number of homes constructed using unreinforced masonry, we are able to assert that 70% of that figure (28 million people) live in structurally substandard housing.

Proof of Concept

The initial proof of concept was obtained through initiatives in Bogotá and Medellín, where Build Change evaluated, designed, and carried out structural upgrades to fifteen homes in collaboration with our partners. These were the first funded, permitted, code-compliant structural upgrades of informal housing in Colombia in over 15 years. A preliminary modeling estimate performed by Risk Management Solutions indicated that similar structural upgrades in four neighborhoods in Bogotá could save an estimated 120,000 lives and US$2.8 billion in losses in the event of an earthquake.[10]

The proof of concept provided clear evidence that it was possible to reduce structural deficiencies in existing vulnerable housing with prescriptive pre-engineered interventions, and within the current government subsidy amounts. Following its success, a Retrofit Manual for Build Change's evaluation and retrofit design method was developed and approved by the Permanent Advisory Committee for Seismic Resistant Construction in 2015. Build Change was also appointed as the technical consultant to the MVCT to design a framework for *Casa Digna, Vida Digna* that would support the scaling of structural home improvements nationally.

Regulatory Reform Success

Build Change has also been working to remove many of the financial and legal obstacles that can prevent homeowners from accessing resilient housing. Our financial studies have demonstrated market demand for affordable home improvement loans among low- and middle-income families, and proposed mixed strategies for public subsidies and private sector lending. Our push for key regulatory reforms relating to building permits and subsidies have further supported these efforts:

- **Permitting:** The *Curaduría Cero* (Zero Curatorship) initiative has reclaimed the assessment, design, and permitting process of informal housing from private agencies, and placed it back into the hands of local government. This will ensure that technical assistance and permits for existing informal housing in cities are provided free of charge to those who are most vulnerable.
- **Subsidies:** The City of Bogotá reformed its subsidy policy in 2017 to increase the amount of the retrofit subsidy given to homeowners by 45% and to combine the retrofit subsidy with the habitability subsidy, resulting in simplified procedures and a wider reach.[11]

Enabling Structural Home Improvements at Scale

Casa Digna, Vida Digna is a groundbreaking initiative in Latin America as it has been designed to incorporate the structural assessment and improvement of existing housing at a national scale—something that has not been attempted before. Build Change's work in Colombia has been a catalyst for directing national funding and attention toward upgrading existing housing, and has led to thousands of structural home improvements to date.

MVCT

Central to this success has been process innovation. Build Change has been leveraging digital technology to enhance the quality, speed, and efficiency of processes across all stages of the construction value chain. Through institutional capacity building, we are enabling the MVCT to successfully conduct structural evaluations and classifications across the country, training operators in cities where the program is underway, and integrating the new processes and digital tools with existing government systems.

In May 2021, the World Bank announced it would be providing $136.7 million in financing to improve housing and vulnerable neighborhoods in urban and rural areas of Colombia. This will help to reach 246,000 homes as part of *Casa Digna, Vida Digna*, while supporting other housing initiatives. The government of Colombia has successfully rolled out the program with their own funds, and is now scaling up efforts with this funding from the World Bank. Build Change's work providing lessons learned and recommendations to the World Bank, along with technical expertise and guidance to the Government of Colombia and Findeter (the program implementer) has been instrumental to the program's success.

***Part 5** of this guide provides a more detailed account of progress toward resilient housing in Colombia, and how Build Change has been working across areas of People, Money, and Technology to drive systems change.*

Examples of home improvement design and construction documents for Colombia can be found in Annex G.

10 This preliminary analysis modeled a 200-year return period earthquake event and studied retrofitting in four neighborhoods of Bogotá over a ten-year period. The study was based on Build Change retrofit methodologies and existing government subsidy systems. The direct effects of retrofitting conducted by Build Change was modeled by RMS in terms of costs, cost savings, reduction of losses, and reduction of injury and deaths.

11 From 18 to 26 times the national minimum monthly wage. A minimum monthly wage is equivalent to COP 877,803 or approximately USD 234 (2021) (considering USD 1 = COP 3750)

Case Study 1: Colombia

Mrs. Luz Marleny Gallo, Medellín, Colombia

Mrs. Gallo, who is retired, lives with her daughter and her grandson in Comuna 2, Santa Cruz, Medellín.

ISVIMED and Build Change staff delivering the completed home to Mrs. Gallo and her grandson

Their one-story home was built using multiple construction systems. The walls of the front section were built of solid brick and plaster, and showed no major structural deficiencies. However, the back section revealed horizontally perforated clay tile walls, and beams with shear cracks supporting a poorly connected prefabricated slab.

With the support of the Social Housing Institute of Medellín (ISVIMED) and Build Change, Mrs. Gallo's home underwent primarily a habitability intervention, which focused on improving vulnerable areas of the structure. The construction system was converted to confined masonry at the back of the house—by adding structural walls, confining columns, and a ring beam to support the slab—and some walls were plastered to achieve the necessary shear strength. A kitchen counter was also added, and the remainder of the house was plastered and painted.

The work was completed at a cost of COP 10 million (USD 2,666) over a period of five weeks.

Virquez family, Bogotá, Colombia

Gabriel Virquez lives in El Curubo, Usme, Bogotá, with his wife Marina and their two sons. Both Gabriel and Marina work, and their boys go to school.

Marina and Gabriel in front of their retrofitted home

The Virquez family's one-story home was partially built from non-confined masonry. The lightweight roof made of mixed materials of poor quality was not adequately anchored to the walls. Structural deficiencies observed included an absence of any ring beam or structural shear walls.

As the implementing agencies, Build Change and *Caja de la Vivienda Popular* obtained a permit to carry out a full remodel and structural retrofit, which included extension, modification, and structural reinforcement of the home.

The construction system was converted into confined masonry, adding structural walls, columns, and a ring beam. Some of the walls were plastered to achieve the necessary shear strength. The roof was completely replaced, improving lighting and interior air circulation as well as the structure. Electrical and plumbing improvements were also made. The home also received three new rooms, for improved privacy for the couple and their children.

The work was completed at a cost of COP 19 million (USD 5,066) over a period of eight weeks.

3.3 Nepal: Using Technological Innovation to Enable Post-Disaster Retrofitting at Scale[12]

Through an innovative mix of engineering and technology, Build Change has developed a comprehensive system that brings technical assistance at scale to rural earthquake-affected homeowners engaged in new construction and retrofitting.

Context

In April and May 2015, Nepal was hit by two consecutive earthquakes, killing 8,800 people and resulting in a tremendous scale of destruction. More than one million houses collapsed or incurred damages, mostly in rural and hard-to-reach areas of the Himalayan region. The most common type of construction among the affected buildings was traditional rural stone and mud-mortar masonry structures, of two or two-and-a-half stories.

The Government of Nepal created the National Reconstruction Authority (NRA) with a mandate to oversee and coordinate the reconstruction effort. Some key points relating to policy actions and decisions for the reconstruction process follow.

- A comprehensive survey of affected housing was conducted by the Central Bureau of Statistics (CBS).
- For housing reconstruction, it was determined that a homeowner-driven reconstruction methodology would be used throughout the earthquake-affected areas
- Housing reconstruction subsidies were announced in two categories: NPR 100,000 (USD 900) for repair and retrofitting, and NPR 300,000 (USD 2,700) for full construction of a new house.
- Homeowners could enroll for either level of subsidy dependent on the CBS survey damage assessment of their house. Subsidies would be disbursed incrementally, contingent on construction progress and compliance with NRA guidelines.
- The government published two approved design catalogues, containing standard design and input quantity estimations for several approved resilient new construction housing designs.
- Government engineers would conduct the site inspections and authorize tranche disbursement.

Damage to traditional stone and mud-mortar masonry construction in Nepal following the earthquake
CREDIT: NRA

12 Build Change, *Build Change Post-Disaster Reconnaissance Report: April 25, 2015, Gorkha Earthquake, Nepal*, (May 31, 2015), https://bit.ly/PDR-Nepal-2015; Build Change, "Nepal Program Update," (unpublished internal report, May 29, 2017); Government of Nepal, National Reconstruction Authority (NRA), *NRA Experience Paper on Retrofitting of Private Housing Post 2015 Gorkha Earthquake*, (NRA, 2021), https://bit.ly/NRA-Experience-Paper.

Case Study 2: Nepal

A homeowner speaking with a Build Change engineer in Nepal

From the outset, the NRA's strategy for the Nepal reconstruction was skewed by high-profile attention toward badly-damaged districts where total collapse of houses was predominant. As a result, nearly all training and technical assistance systems promoted by the government during the first three years following the earthquake were aimed at new construction only.

This approach contrasted with data from the CBS detailed assessment, which showed that only 29% of affected homes needed to be reconstructed, while 71% needed retrofitting.

Build Change's Work in Nepal

Build Change set to work developing a technical solution for retrofitting stone and mud-mortar homes, in order to mitigate the key vulnerabilities of these structures during a retrofit intervention. Guidelines for this solution were approved by the Government of Nepal in 2017. Example design and construction documents for retrofitting these homes can be found in Annex G.

Additionally, the Build Change team proposed policy and implementation solutions for overcoming some of the major challenges to the overall reconstruction process. These included:

- Providing technical assistance at scale to homeowners whose houses were damaged but still standing.
- Improving the cost efficiency and effectiveness of post-disaster reconstruction technical assistance at scale—for new construction as well as retrofitting.
- Using *Surakshit Ghar* (Safe House), a government-branded, Build Change-supported, free "Build Back Safer" mobile application, to provide services to homeowners at scale and low cost. The app would also be integrated with a network of government-sanctioned Technical Support Centers located across earthquake-affected districts.
- Scaling the retrofit type design for stone and mud-mortar houses, along with a minimum inspection criteria checklist approved by the NRA. This methodology is aimed at greatly reducing the time and cost associated with designing retrofits in remote rural areas.
- Training homeowners and builders in retrofitting (in addition to existing training in new construction) to support long-term, sustainable adoption of retrofitting practices in Nepal.
- Raising awareness and training government, NGO, and private sector decision makers and engineers to apply retrofitting to the Nepal reconstruction context.

Case Study 2: Nepal

- Incentivizing the most vulnerable families to engage in reconstruction through community-based social systems for pooling construction labor, such as "*Parma*" or "*Alo Palo*".

System, Tools, and Methodology

To support its recommendations, Build Change leveraged digital technology to overcome key challenges and drive the rollout of retrofitting at scale. This system would be adopted and scaled up by partners, ranging from local and international NGOs, to UN agencies, government field inspectors, and the Government of Nepal.

» Digital Tools

Digital platforms and app-based construction checklists were used to streamline all stages of the home improvement program for both new construction and retrofitting. This enabled work to take place across multiple hard-to-reach districts, and improved the cost efficiency and effectiveness of providing technical assistance at scale. By enabling local stakeholders to conduct remote house evaluations, the system helped to overcome expertise shortages while also enabling traceable and auditable construction monitoring and site inspection.

Mobile app Surakshit Ghar *(Safe House)*

» Remote Support and Awareness Mobile App

The mobile application *Surakshit Ghar* was developed by Build Change and endorsed by the Government of Nepal. The app is designed primarily for homeowners, and gives users free access to a variety of useful tools:

- government-approved regulations
- messaging on resilient construction practices
- an interactive library of over 1,100 downloadable resilient house designs
- site safety recommendations
- instructions on obtaining government subsidies
- contact information of trained masons, engineers, and district/municipal governments
- a hotline and a messenger functionality for requesting technical assistance

» Semi-Automated Retrofit Design Process

The system's second key element combined retrofit type designs with a semi-automated retrofit design tool based on Autodesk's Revit software. This process reduces the cost of retrofit design by two orders of magnitude when compared to conducting bespoke retrofit designs for each house, and increases data accuracy throughout the project stages.

» Training Artificial Intelligence (AI) to do a rapid "Go"/"No-go"

Build Change's team in Nepal also created Post-Disaster Rapid Response Retrofit (PD3R), a system that uses visual recognition and AI to quickly determine, from a single photograph, if a rural house is a strong candidate for structural retrofitting. PD3R was runner-up in the 2018 Call for Code Global Challenge.

More information on leveraging digital technology can be found in Part 2 of this guide. **» Go To: Part 2, Use Digital Technology for Scaling**

At the height of its post-disaster programming in Nepal, in 2018, Build Change had established technical resources and systems that enabled its Nepal team, along with local and international partners, to operate a network of more than 20 Technical Support Centers providing free advice, free designs, and free site supervision support to over 20,000 homeowners, across multiple earthquake-affected districts.

Furthermore, the system developed by Build Change provided the impetus for a large-scale retrofitting program, fully integrated with the NRA's apparatus, and aimed at capacitating more than 3,000 government site inspectors throughout all 32 earthquake-affected districts.

Case Study 2: Nepal

Badam Bhadur Pulami, Sindhuli district, Nepal

Badam Bhadur Pulami in front of his home

Badam Bhadur Pulami is a farmer living with his four young grandsons in the rural municipality of Tinpatan, Sindhuli district.

When the April 2015 earthquake struck, Badam's home was partially damaged, leaving minor cracks and wooden members displaced.

With their home classified as eligible for retrofitting following the government's damage assessment, but unaware of what retrofitting was or what the process involved, Badam and his grandsons continued to live in their partially damaged and unstable family home. Badam was only prompted to take action after a social mobilizer visited him and encouraged him to visit an information clinic and watch a retrofitting awareness video. "The encouragement of the social mobilizers helped me to retrofit my home," he recalls.

Before it was strengthened, Badam's house would rattle in the wind, and rain would frequently wash away the mud-plastered walls. Now, because of the improved connections and cement plaster, Badam knows his house is structurally stable and seismic resilient, and he understands the structural principles of a stone masonry and mud-mortar house.

He is also grateful he started the retrofitting process, as it revealed the previously hidden rotten wooden members, which have now been replaced. According to Badam, "retrofitting has increased the life span of the building."

Kanchi Maya Tamang, Nuwakot district, Nepal

Kanchi Maya Tamang (right)

Kanchi Maya Tamang is a resident of Kaule, Nuwakot district in Nepal. She raised her three children as a single mother, after her husband passed away 20 years ago. She now lives with her son, daughter-in-law, and grandchild, and earns a living from tending to crops on her land.

Kanchi was working in the field on April 25, 2015, when she watched her house collapse in the earthquake. Fortunately, no one from her family was at home. Kanchi had fond memories of her home, where she had raised her children and spent her entire life. As a single parent on a low income, her options for rebuilding her home were extremely limited.

Through community members Kanchi learned of a program being run by the American Red Cross, Nepal Red Cross, and Build Change. The program would provide up to NPR 300,000 (USD 2,700) to rebuild her house.

A technical team visited Kanchi to provide detailed information about her options for rebuilding, as well as guidance on the process of obtaining the government housing grant. The family decided to build a two-room stone and mud house, which took eight months to complete at a cost of NPR 360,000 (USD 3,200).

Kanchi recalls how the *"Parma"* system was critical in making it possible to afford to rebuild. While most community members could not afford to hire workers, they could spare the time to do the work themselves. The *"Parma"* system works by sharing construction labor among all households in the *"Parma"* group, bringing significant cost savings to its members.

Kanchi and her family now live in their new home. She says, "I am very happy that our house is complete ... after what seemed like an endless period of sorrow and despair, we are once again able to stand up and run."

3.4 Philippines: Developing Home Improvement Microfinance Products to Increase Homeowner Participation[13]

In the Philippines, Build Change has been working with microfinance institutions to pioneer the provision of home improvement loans combined with technical assistance, and to make this affordable for low-income households.

Context

In the Philippines, rapid urbanization and limited land space have resulted in increased population density, while driving substandard construction in high-risk locations. In January 2019, Build Change published *Disaster Resiliency in Housing in the Philippines: A Market Study of Residential Retrofit Financing* which estimates that 70 million Filipinos live in substandard housing. This number is projected to grow to 113 million people by 2030.[14]

The Philippines ranks ninth globally for disaster risk.[15] The country endures approximately 20 typhoons annually, of which four to six make landfall, with devastating consequences. It is also crisscrossed by fault lines and overdue a major earthquake. Modeling by RMS has shown that a 7.2-magnitude earthquake in Manila today would cause $5.7 billion in property damage to housing alone, resulting in $1.4 billion in lost GDP and over 388,000 casualties.

Build Change's Work in the Philippines

Build Change has been supporting post-disaster reconstruction in the Philippines since Typhoon Haiyan (known locally as Yolanda) struck in 2013, and later launched its disaster-prevention program in 2016. Since then, we have demonstrated market demand for retrofit loans, proven that this is achievable within the borrowing capacity of low-income families, and identified private financial institutions willing to partner in launching resilient housing loan products.

A view over Pembo, Makati City, Greater Manila

13 Build Change, *Disaster Resiliency in Housing in the Philippines: A Market Study of Residential Retrofit Financing*, (Build Change, 2019), https://buildchange.org/app/uploads/2019/01/Disaster_Resiliency_in_Housing_in_the_Philippines-Web.pdf, and Build Change, "House Strengthening MFI Loan Project, in Partnership with Philippine Financial Service Providers," (unpublished internal presentation, February, 2020).

14 Build Change, *Disaster Resiliency in Housing in the Philippines: A Market Study of Residential Retrofit Financing*, 18.

15 *World Risk Report* 2020, produced by Bündnis Entwicklung Hilft and Ruhr University Bochum – Institute for International Law of Peace and Armed Conflict (IFHV), available at https://weltrisikobericht.de/wp-content/uploads/2020/12/WRR_2020_online_.pdf

Case Study 3: Philippines

Proof of Concept

The original proof of concept took place in Pembo, Makati (Greater Manila) in 2018, where Build Change supported 19 homeowners to access financing for home strengthening and improvement interventions. This successful pilot project resulted in approximately 171 safer people and $190,000 of assets protected. An example of home improvement design and construction documents for the Philippines can be found in Annex G.

In the Philippines, access to finance for home repairs and strengthening can be a key constraint for poorer families, who can rarely meet the minimum requirements set by major lenders such as housing developers, banks, and housing finance agencies. The proof of concept in Pembo demonstrated that home improvement programs could be executed successfully through combining a homeowner-driven approach to safe and resilient construction with client-centric financial services, and that this could be done inexpensively, sustainably, and at scale.

The publication of a market study[16] by Build Change in 2019 had helped to confirm the huge market for retrofitting in the Philippines, and the demand for retrofit financing among certain segments of the population. The learnings from the proof-of-concept phase subsequently led to strong partnerships and increased collaboration between Build Change and microfinance institutions (MFIs) to find ways to scale up home strengthening loans to reach a larger client base.

Scaling Up Through MFI Partners

There is a robust microfinance industry in the Philippines, with strong, established client bases. Many MFIs are working to alleviate poverty and help raise the living standards of their clients and communities through the provision of financial services tailored to local needs.

In recent years, Build Change has partnered with six MFIs to support them to develop loan products for resilient housing that are within the borrowing capacity of low-income families: Kabuhayan sa Ganap na Kasarinlan Credit and Savings Cooperative, Alalay sa Kaunlaran Inc., Country Builders Bank, ASA Philippines, RB Gattaran, and Ahon sa Hirap Inc.

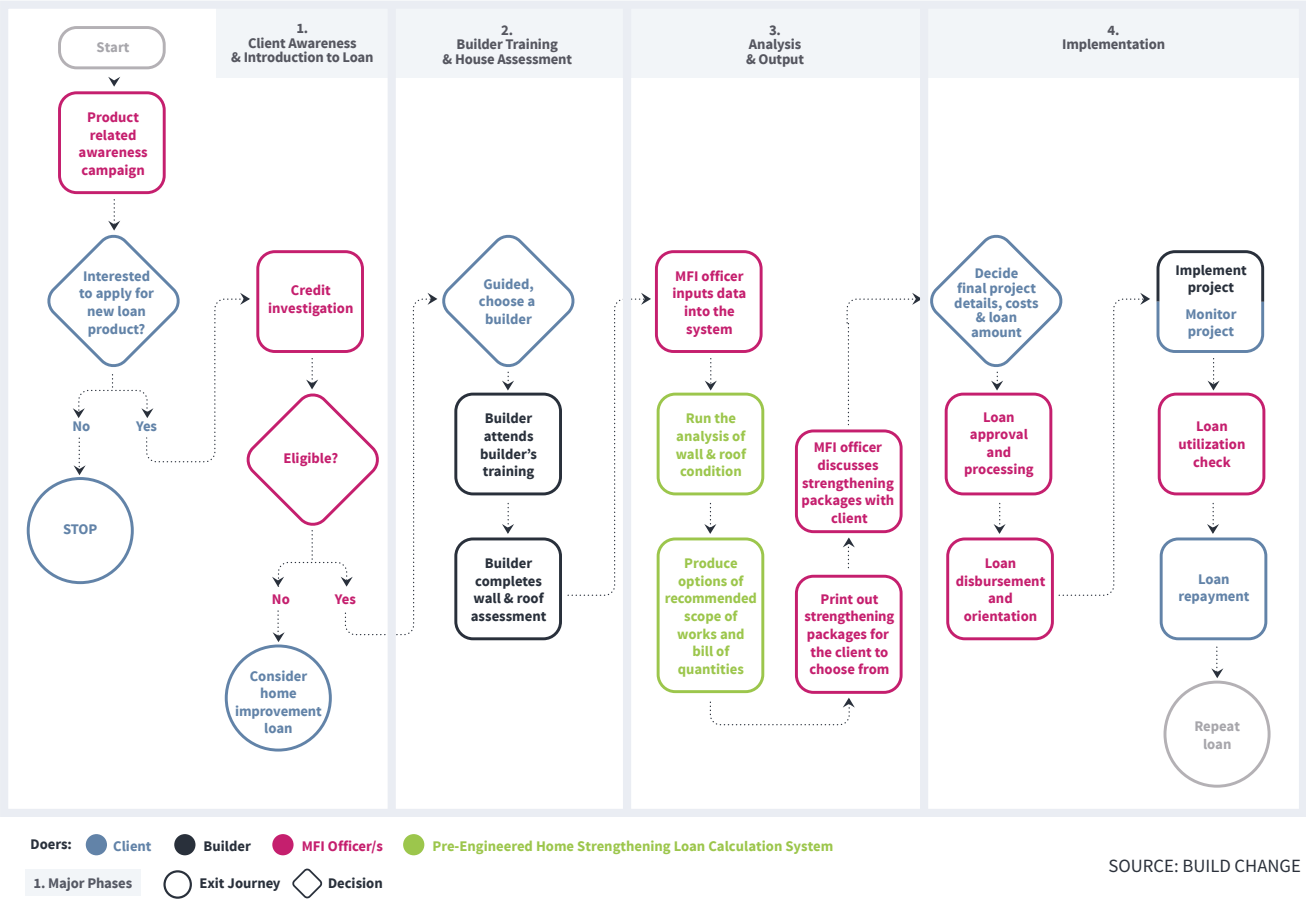
Through our work, we are finding ways to build the technical capacity of MFIs, increase their fund source for housing loans, and mitigate the risk associated with lending. By collaborating with bigger lenders with higher financial capacities and risk tolerance, we hope to catalyze the flow of financial investment from the mainstream financial market and make larger funds available to MFIs.

In 2020, four MFIs were offering home-strengthening loans packaged with technical assistance, specifically for clients to increase the resilience of their home against disasters—a first for the Philippines.

Staff training for MFI partner Alalay sa Kaunlaran Inc.

16 Build Change, *Disaster Resiliency in Housing in the Philippines: A Market Study of Residential Retrofit Financing*.

FIGURE 13 The microfinance journey to resilient housing[17]



SOURCE: BUILD CHANGE

In 2020, four MFIs were offering home-strengthening loans specifically for clients to increase the resilience of their home against disasters—a first for the Philippines.

The process through which MFIs are integrating with home improvement programs in the Philippines is illustrated in the "microfinance journey to resilient housing" shown in Figure 13.

Build Change continues to work collaboratively on refining microfinance products and loans to make them more efficient and scalable, and to ensure their continued ability to meet the needs of homeowners. For example, an incremental approach comprised of multiple loans and strengthening stages has helped to make home improvement more affordable for homeowners, and we are piloting a scheme to make financing available for building new homes.

Working with MFI partners has also enabled us to scale up our existing efforts on awareness raising and training for safe and resilient construction that have been underway for several years in the Philippines. This work builds upon technical innovations such as the *Tibay Balay* (Strong House) homeowner awareness app which was developed by Build Change for the Philippines in 2019. As we partner with MFIs, we continue this emphasis on awareness raising and capacity building, by ensuring that all finance products are accompanied by a comprehensive range of support materials tailored to the local construction environment. These include implementation tools, workshops, and training materials for local homeowners, MFI loan officers, and builders.

17 Build Change, "House Strengthening MFI Loan Project, in Partnership with Philippine Financial Service Providers," (unpublished internal presentation, February, 2020).

Case Study 3: Philippines

Edna and Eric Doctolero, Makati, Philippines

When Edna and Eric Doctolero decided to fix and strengthen their home to protect it from the impacts of typhoons and other hazards, they had two children and another baby on the way. They also wished to expand their home to create an additional room to rent out, to help send their children to school and prepare for the future.

The Doctolero family learned about Build Change from their neighbors, who had attended meetings and were able to explain the retrofitting program to them. Several of their neighbors were improving their homes in this way, which helped to reassure them.

Edna Doctolero, her daughter Euna, and son Mark in their retrofitted home

While Edna and Eric would not have been able to afford to fix their house all at once, the monthly loan payment that Build Change facilitated for them was affordable for their family.

According to Edna, the retrofitting program helped the family "to not worry about disasters anymore, and helped us prepare for our children's future." She added, "Build Change is a big blessing for us that helped our family in so many ways." Edna feels she has a safe living environment, loves the improvements to her home, and feels confident—and less worried—for her family's future.

Mary Grace Bunyi, Metro Manila, Philippines

In 2009, Mary Grace Bunyi's home was completely destroyed by Typhoon Ondoy and the flooding brought on from the intense rain.

As a long-time client of the MFI Ahon sa Hirap, Inc. (ASHI) Mary Grace was able to get a loan to purchase a unit in the APRROOT* housing village, which had been built by ASHI for its clients who had lost their homes in the typhoon. However, as time went on, Mary Grace and others grew worried about the quality of construction of their units, which seemed unlikely to be able to withstand another typhoon.

ASHI was also disappointed in the construction quality of the houses in the APRROOT village. Subsequently, it decided to make loans available to its clients to enable them to strengthen their homes, and approached Build Change to assist.

Mary Grace leaving an ASHI center with her daughter, after making a loan repayment

The APRROOT homeowners could not afford to retrofit their houses all at once, but could afford to pay for some of the strengthening measures. In view of this, Build Change designed an incremental strengthening approach, where the first loan could be used to build a ring beam at the top of the walls and strengthen the gable walls, and a subsequent loan could be used to strengthen the openings around the windows and doors and add a stronger plaster to the walls.

Mary Grace took a loan of about PHP 20,000 (approximately USD 400) to build a ring beam and strengthen her walls. To save costs, her husband was able to contribute the labor, supported by training from Build Change to ensure the quality of the work. The work took just one week to complete, and was finished before Christmas, giving Mary Grace peace of mind for her family of seven during the holiday season.

**APRROOT = ASHI Project Relief and Rebuilding to Overcome Ondoy's Tragedy*

3.5 Dominica: Building a Management Information System for a National Housing Recovery Program

Following Hurricane Maria, Build Change has been providing technical expertise to the Dominica Housing Recovery Project, and has developed an end-to-end Management Information System for the reconstruction process.

Context

In 2019, the Government of the Commonwealth of Dominica launched the Housing Recovery Project (HRP) in response to Hurricane Maria in 2017. The category-5 hurricane affected 90% of the housing stock, with more than 4,500 houses destroyed and over 20,000 partially damaged. The identified needs for reconstruction and resilience interventions to "Build Back Better" across all sectors in Dominica amounted to $1.37 billion.[18]

The HRP will prioritize and subsidize the rebuilding of 420 small homes that were completely destroyed by Hurricane Maria. While addressing the immediate need for housing reconstruction for low-income families following the disaster, the HRP aims to increase the adoption of resilient building practices in Dominica's housing sector, in accordance with internationally recognized best practices in engineering and construction, revised building codes, and vital safeguards to address environmental, social, health, and safety risks.

Build Change's Work in Dominica

Build Change applied its years of expertise in running post-disaster reconstruction programs to provide technical assistance to the Ministry of Housing and Urban Development in Dominica. The HRP has subsequently adopted a homeowner-driven model, through which conditional financing and technical assistance is provided to homeowners to enable them to rebuild.

Jennifer Julien-Laudat, Financial Specialist for the HRP Project Implementation Unit, speaking at a homeowner enrollment meeting in Roseau, Dominica, 2020.

CREDIT: DOMINICA HRP

18 Government of the Commonwealth of Dominica, *Post-Disaster Needs Assessment, Hurricane Maria, September 18, 2017*, available at https://www.gfdrr.org/en/publication/post-disaster-needs-assessment-dominica

Case Study 4: Dominica

As part of this work, Build Change designed and built an end-to-end Management Information System (MIS) to enable the timely screening, selection, and registration of 420 priority individuals to the HRP and facilitate information management and communication throughout the program. Using an MIS can help to ensure the consistent, accurate, and timely delivery of key information to all stakeholders to support this model.

The HRP Management Information System

The MIS comprises a suite of interconnected digital tools through which information is collected, shared, and managed.

- **Web platform:** This is the primary interface for user interactions and the main processor for much of the system functionality (screening, decision making, progress tracking, and reporting).
- **Mobile apps:** These included the Data Collection app, used by HRP project staff, and the Homeowner Awareness app, available to the public to receive information, updates, and report grievances.
- **Government website interface:** An interaction channel for the public to receive general project information and for those enrolled to log in and track their own progress.
- **Databases:** The use of databases enabled the secure storage of all files and data.

From the start of a homeowner's application to the program, subsequent project stages are defined by the experience of a homeowner progressing through them—or the "homeowner journey" (Figure 14).

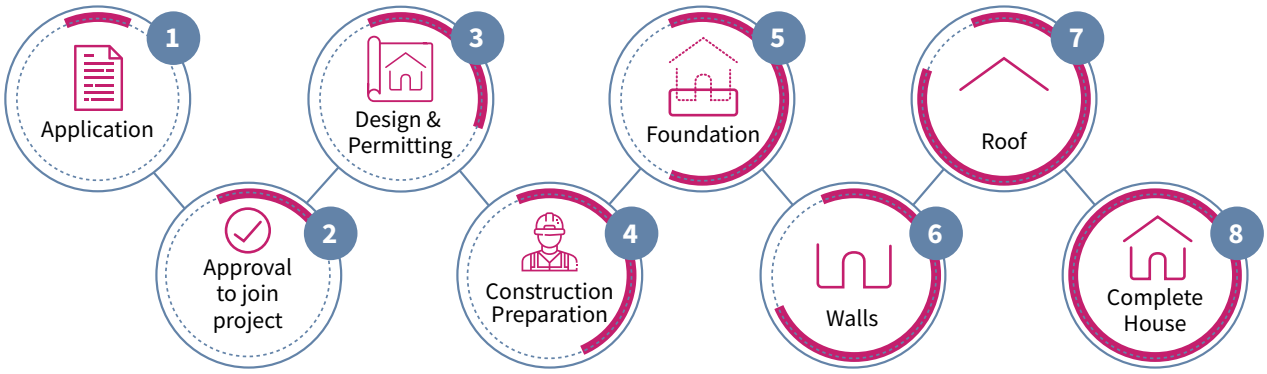
The MIS platform is designed to interact with additional systems and processes relating to different stages, namely design, construction quality monitoring and inspection, and tracking the disbursement of conditional funding installments. For example, it will enable construction site inspection forms and reports to be synchronized with all data pertaining to a particular house's progress, and can be used to record any new or existing social disbursement mechanisms, or additional construction loans and microloans.

As part of its work supporting the HRP in Dominica, Build Change developed a communications strategy to ensure that the necessary financial, technical, and administrative assistance will be delivered to homeowners, builders, and suppliers throughout the reconstruction journey. Additional technical and training materials for project implementation were developed and tailored to the specific needs of government agencies, local builders, donor partners, and project stakeholders at large.

Capacity building of staff is critical to the future implementation of the MIS by the Ministry of Housing and Urban Development in Dominica, and to support the management and maintenance of the MIS by the Information and Communication Technology Unit. This has been achieved through a comprehensive training program comprising support materials, seminars, and workshops delivered by Build Change technical teams.

While the MIS was originally created to serve the HRP, it has been designed in a way that can be easily adapted for use on other projects in the future. The possibility exists that the MIS could be scaled up to facilitate the permitting of all buildings in Dominica, beyond the homes covered by the HRP.

FIGURE 14 The homeowner journey to resilient housing: Dominica



SOURCE: BUILD CHANGE/DOMINICA HRP

4
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Build Change staff speaking with a homeowner in Nepal
CREDIT: JOHN RAE/UNOPS

Introduction

Part 4 of *The Build Change Guide to Resilient Housing* is the Operational Manual—a practical, step-by-step guide that takes the reader through each stage of a resilient housing program. It is supported by an extensive range of reference material and sample program documentation, which can be found in the Annexes.

The Operational Manual is driven by the Build Change Theory of Change, with an emphasis on overcoming barriers of People, Money, and Technology to set programs up to succeed in the long term, and change housing systems permanently. It also builds on the foundations of our model, which emphasizes:

- a homeowner-driven implementation model, with conditional financing and technical assistance provided to the homeowner;
- gender equity, by supporting women to be active agents of resilience building who lead change;
- a holistic approach toward home improvement—resilient housing programs must go beyond saving lives and seek to improve living conditions and support opportunities for growth;
- smarter risk management, to start saving and improving lives without delay. We recommend focusing on residential structures of three stories or fewer, as these homes can typically be made safer quickly and affordably, using relatively simple solutions that already exist.

We encourage readers to refer to **Part 2** of this guide for more information on the Build Change Theory of Change and the foundations of our model, along with key guiding principles to support with program scaling, sustainability, and long-term success.

Build Change is proud to collaborate with the World Bank's Global Program for Resilient Housing (GPRH). The material in **Part 4** uses content that was produced for the *Roadmap for Resilient Housing: The Path to Livable, Disaster and Pandemic Resilient Housing*, a 2020 publication by the World Bank's GPRH. Build Change is grateful to the World Bank and the GPRH for their permission to reproduce this material.

Limitations

In keeping with the rest of the guide, this Operational Manual focuses on strengthening or retrofitting existing buildings, whether before or after disasters.

Post-disaster reconstruction is not covered in detail, but we encourage users to apply the information to begin strengthening damaged buildings immediately after a disaster where possible, as a viable alternative to temporary shelter.

Issues which are more comprehensively addressed through land-use planning and regulation are also not covered (for example, houses that need to be relocated due to poor soil conditions, location in flood, landslide, or storm surge areas, or when the risk cannot be reduced by structural improvements alone).

Finally, although this manual can apply to any housing type, masonry load-bearing buildings receive primary attention—firstly, because of their prevalence over any other building typology for housing in emerging markets, and secondly, because of their significant vulnerability to earthquakes if built poorly; timber frame and timber roofs receive secondary attention. Summarized information on these common building types, their typical deficiencies, and simple solutions for their mitigation can be found in Annex B.

The Four Stages of a Resilient Housing Program

FIGURE 15 The four stages of a resilient housing program

	People (P)	Money (M)	Technology (T)
Stage 1: Initiation	Overall readiness/demand City or neighborhood-level context Lessons from past projects and demonstration projects		
	Stakeholder mapping Legal and institutional framework Awareness needs assessment	Financial framework Funding sources	Building codes and standards Characteristics of houses and the construction value chain
	Characteristics of households		
Stage 2: Planning	Program goals Permitting and approval processes Inter-institutional coordination Temporary housing needs assessment	Funding mechanisms Financial instruments Program operation costs Technical assistance costs	Technical assistance level Implementation and delivery models Use of technology for planning
		Preliminary home strengthening and improvement designs and costs	
	Quality assurance system		
Stage 3: Implementation	Hiring implementing parties Homeowner engagement	Construction costs Money transfers and authorization	Design and construction documents Construction and quality control Use of technology for implementation and reporting
Stage 4: Closure	Formalizing completion	Contract closures	Updating resources
	Sustainability		

SOURCE: BUILD CHANGE

Stage 1: Initiation

FIGURE 16 Stage 1: Initiation

	People (P)	Money (M)	Technology (T)
Stage 1: Initiation	Overall readiness/demand City or neighborhood-level context Lessons from past projects and demonstration projects		
	Stakeholder mapping Legal and institutional framework Awareness needs assessment	Financial framework Funding sources	Building codes and standards Characteristics of houses and the construction value chain
	Characteristics of households		

SOURCE: BUILD CHANGE

The first stage—or the prerequisite stage—of a resilient housing program is the Initiation stage.

During this stage, it is necessary to develop an understanding of the existing context and enabling environment, in order to identify key gaps, challenges, and opportunities.

To provide support with this initial assessment, Build Change has developed the Resilient Housing Ecosystem Assessment Tool (RHEAT™) for use by governments and implementers as they prepare to launch a resilient housing program (Figure 17). The RHEAT™ uses indicators (grouped by People, Money, and Technology) to generate a high-level, visual representation of the existing context and enabling environment for resilient housing at a given point in time. It can be used to assess and monitor progress over time and is a useful tool to help determine priorities and therefore maximize the chances of a program's success. **» Go To: Part 2, The Resilient Housing Ecosystem Assessment Tool (RHEAT™)**

Each of the steps discussed in this section addresses one or more of the main barriers to making housing resilient at scale, and should be explored during the Initiation stage of a program.

1.1 Overall Readiness/Demand (P) (M) (T)

For the program location (country, region, city), assess the high-level demand for a resilient housing program by asking these questions:

Does the country/region meet a minimum threshold for political stability? For example, is it a typical four-year governance cycle that is likely to be completed without major interruption?

Are other higher priority needs being addressed? (medical care, food security, water and sanitation, livelihoods, crime)

Is there a predominant qualitative component in the housing deficit? Are quantitative and qualitative data available for housing vulnerability and hazard exposure?

Is political leadership interested in and willing to engage in improving existing housing? Is there national-level acknowledgment of a need for resilient housing?

Is there an existing home improvement program in place?

1.2 Stakeholder Mapping (P)

The following stakeholders should be identified, and their roles defined. Examples of questions to ask various stakeholders can be found in Annex D.

When identifying stakeholders, it can be useful to group them according to their role in addressing barriers of People, Money, and Technology (Figure 18).

Stage 1: Initiation | Stage 2: Planning | Stage 3: Implementation | Stage 4: Closure

FIGURE 17 Resilient Housing Ecosystem Assessment Tool (summarized version)

	Baseline	Period 1 (Years 1–5)	Period 2 (Years 6–10)	Resilient Housing at Scale
PEOPLE/POLICY				
Policy and Legal Framework for Risk and Resilience				
Understanding and Framing of Risk				
Enabling Environment for Effective Building Codes and Standards				
Program Implementation Framework				
Implementation Framework: Building Permitting				
Implementation Framework: Construction Monitoring				
Enabling Environment for Construction Workforce				
Homeowner Perception and Participation				
MONEY				
Budget Allocations for Resilient Housing Policy and Technology				
Supply of Resilient Housing				
Government Finance for Resilient Housing				
Private Sector Finance for Resilient Housing				
Homeowner Participation and Demand for Resilient Housing				
TECHNOLOGY				
Technical Content and Quality of Building Codes and Standards				
Risk Data and Mapping				
Technical Capacity of Construction Workforce				
Digital Technology				
Homeowner Perception and Participation				

KEY

- Initial stages (Inexistent or not working)
- Getting ready (Existent, needs fixing)
- On the road (Working, needs fine-tuning)
- At desired level (All good)

SOURCE: BUILD CHANGE

FIGURE 18 Stakeholders grouped by People, Money, and Technology

People (P)	Money (M)	Technology (T)
Systems change catalysts (Build Change)	Systems change catalysts (Build Change)	Systems change catalysts (Build Change)
National government housing authority	Private, foundation, and corporate philanthropic donors	Construction code stewards and stakeholders (professional associations; government)
Local government housing policy implementer	Multilateral organizations	Academia, architecture, engineering, construction, finance, and policy stakeholders
Community and neighborhood associations	National government home improvement funders	Construction interest groups (Construction Chamber)
Homeowners	Local government home improvement funders	Technology providers
Contractors	Private and blended funders (pension fund administrators, microfinance institutions)	Vocational training providers
Builders	Community and neighborhood associations	
	Homeowner funding or in-kind contributors	

SOURCE: BUILD CHANGE

1.3 Legal and Institutional Framework (P)

Ask these questions to establish the status of the legal and institutional framework of the country/region/city:

Which institutions participate and which policies address the home improvement space? Where are there gaps, if any, and how do the policies, laws, and institutions influence the path to resilient housing?

Is decent, safe housing a constitutional right? Is it included in national development plans?

Is there a housing policy in place? Does it cover upgrading existing housing? Does it include both structural improvements to withstand disasters and habitability (non-structural) upgrades?

Are growing challenges to resilient housing addressed, such as urbanization and climate change?

How are land ownership, use, and management addressed in policies and how are they enforced?

Are there dedicated government offices or departments for housing resilience and disaster risk management?

Is there an implementation framework for delivering resilient housing? Is it effective? Are both design (permitting) and construction (observation and inspection) accounted for in the associated laws and regulations?

1.4 Awareness Needs Assessment (P)

There are two key questions to be asked with regard to awareness:

To what extent has the issue of substandard housing been identified by stakeholders?

How well do different stakeholders understand the issue?

Understanding the level of awareness among the general population, the government, and the architecture, engineering, and construction professional communities is of particular importance. After setting a baseline for awareness, a needs assessment can then be drafted to understand the level of effort that will be needed to generate demand for resilient housing.

1.5 Financial Framework (M)

The key questions in relation to the financial framework are as follows:

Does a financial framework for a resilient housing program exist and in what form? What framework can be created or improved if needed?

Is there a national or local home improvement program?

Is there ongoing funded engagement in the housing sector?

What mechanisms and financing exist for tear down and replace?

Has a cost-benefit analysis been completed?

1.6 Funding Sources (M)

Questions to ask at the outset in relation to funding sources include the following:

Are public or financial products, supported by national or local governments, available for structural and habitability home improvements?

Are microfinance lenders, social compensation funds, or other sources of capital available for structural and habitability home improvements?

How are existing programs' operations funded?

How can operational and technical assistance funding be sourced for all phases, from initiation, to planning, to implementation and closing?

The road to resilient housing begins long before construction and extends far beyond it. Successful programs must obtain funding for three key components:

1. **Systems change:** To advocate, campaign, innovate, and raise awareness of the need for better housing, in order to create demand, drive investment, and change systems permanently.

2. **Program operations:** The implementation of home improvement programs involves a broad range of operations that all need funding. This includes technical assistance, market research, community outreach, engineering, design, and construction expertise, technology development, training, construction supervision, and program closure.

3. **Construction:** Homeowners require money for materials and labor to enable them to rebuild safely and completely.

Understanding these components can assist with identifying and pursuing appropriate sources of funding for them. Putting adequate resources in place may require funding from multiple sources to be combined.

When existing sources of funding have been identified, consider whether there may be opportunities within this to benefit all stakeholders—for example, demonstrating opportunities to redirect finance planned for new construction toward upgrading existing houses instead—supported by cost studies (Box 4.1), or combining subsidies for habitability improvements with structural retrofit subsidies, to help incentivize essential structural work.

1.7 City or Neighborhood-Level Context (P) (M) (T)

City- or neighborhood-level assessments should be carried out at this stage to obtain more detailed contextual information for the region, city, or neighborhood that has been selected for a home improvement program.

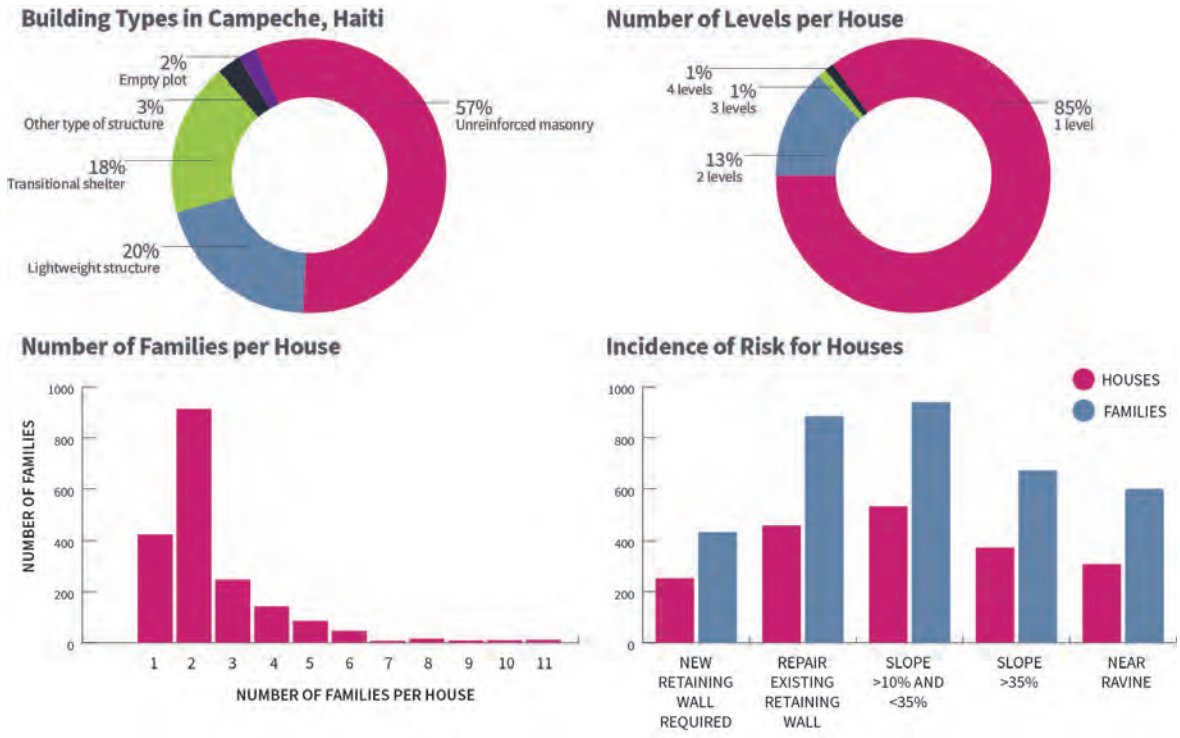
Where possible, assessments should leverage existing resources, such as land registry or socioeconomic databases, satellite imagery etc. Other relevant data for use in program design can also be analyzed—for example, the specific

Box 4.1 Demonstrating the cost savings of retrofitting in Haiti

Build Change performed a study of its retrofitting programs in Haiti to compare the cost of retrofitting damaged homes with the cost of new construction and transitional shelters.[1]

The study showed that retrofitting red-tagged (severely damaged) houses costs less than half of both the cost of new construction and the cost of building T-Shelters. Retrofitting yellow-tagged (damaged) houses costs less than one third of the cost of new construction, and just over a quarter of what it costs to build T-Shelters. This calculation only considers initial cost and does not account for the useful life of the structure. On a life-cycle basis retrofitting is even more cost effective.

FIGURE 19 Neighborhood-level assessment, Haiti



SOURCE: BUILD CHANGE WITH GLOBAL COMMUNITIES, *HOUSING ASSESSMENT RESULTS AND PROPOSED IMPROVEMENT STRATEGY: LAMIKA PILLAR THREE: PHYSICAL RENEWAL*, JUNE 2014. PREPARED FOR THE AMERICAN RED CROSS.

1 The study covered nine programs comprising over 1,300 houses from Build Change's first four years in Haiti following the 2010 earthquake. Costs were calculated on a per square meter basis. For more information see Build Change, *Homeowner-Driven Housing Reconstruction and Retrofitting in Haiti — Lessons Learned, 4 Years After the Earthquake*, January 9, 2014. Available at https://bit.ly/Haiti-HODR-lessons-learned.

socioeconomic criteria of the residents of the most vulnerable homes, or the most common structural deficits in a given area. This can support practitioners to assess technical vulnerability, hazard exposure, property values, and local infrastructure rapidly and at scale.

Assessments should try to identify the following kinds of information:

- **Risk conditions:** What risks are people in the area exposed to?
- **Hazard-prone areas:** Where are hazard-prone areas located?
- **Protected areas:** Are any areas environmentally protected?
- **Public services:** What services are available, where, and to whom?
- **House, households, and site:** For example, what type of buildings are common? How many stories are typical? How many families live in a house? What risks is the house or site exposed to?
- **Local funding or subsidy instruments:** What funding is available for home repairs, and for whom? Are public subsidies available for the kind of work that is needed, and can families access them? Are other financing options available e.g. microfinance?

See Figure 19 for an example of summary information prepared from a neighborhood-level assessment in Haiti, including house, household, and site information.

1.8 Building Codes and Standards (T)

Questions to ask in relation to building codes include the following:

Are there up-to-date building codes, regulations, or other guidelines in place for upgrading existing common building types?

Are there up-to-date hazard maps for the relevant hazards? Are they readily accessible?

Do the building codes or regulations include structural strengthening as well as architectural or habitability improvements?

Are the building codes relevant and applicable to the local context? For example, do they address the building types that are most common in informal, self-driven housing construction?

1.9 Characteristics of Houses and the Construction Value Chain (T)

At this stage, it is necessary to identify the most common types of houses and their vulnerabilities, and to identify the gaps in the construction value chain (Figure 20), including within the workforce and for construction materials.

Is a housing subsector study, or understanding of the local housing market, already available?

Housing subsector studies may already be available. They address the following overarching questions:[2]

House Assessment:

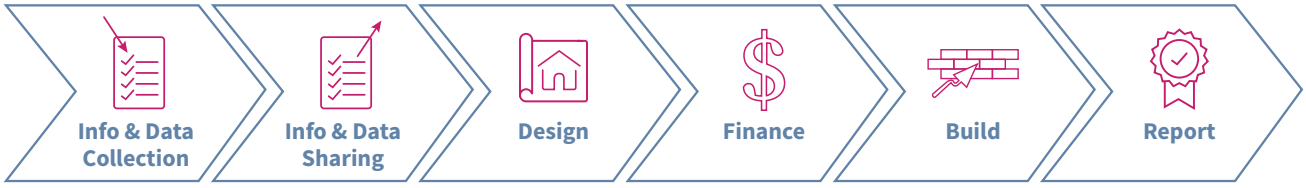
What types of houses do people live in now? What materials and structural systems are used?

What size, shape, number of stories, layout, are common?

Where do people cook? Bathe? Use the toilet?

What are common architectural, cultural, and climate preferences?

FIGURE 20 The construction value chain



SOURCE: BUILD CHANGE

2 Build Change for USAID, *Seismic Retrofit of Housing in Post-Disaster Situations—Basic Engineering Principles for Development Professionals: A Primer*, (2014), 17–18

Construction Material Needs Assessment:

What materials are used? Of what quality? Where are they produced and procured? How much do they cost?

Who buys the materials (homeowners, builders, contractors)? Where are they stored?

Workforce Needs Assessment:

What is the skill level of local builders? What tools and techniques do they use? How much do they earn and how are they paid?

How are houses commonly built? What systems and techniques are used? Do homeowners build themselves? Incrementally, or all at once? Or are housing units built by government or through the private sector?

Do homeowners consult engineering or architecture professionals?

What is the role of various professionals in the housing market? Is it formalized, or informal? Are there professional associations and if so, is membership common?

Have structural systems, vulnerabilities, and habitability deficiencies been identified and documented?

To obtain this information, there are several options:

1. **Do a field survey to capture structural and architectural deficiencies.** Several recent examples exist, including studies conducted by Build Change for the World Bank in Indonesia, Guatemala, Mexico, and Colombia.[3] Some examples of Technical Surveys for houses from these reports have been included in Annex D.

   Generally, a moderate sample size of detailed house investigations for each targeted structural typology (those with similar construction types and vulnerability parameters) can enable a basic range of deficiencies—both common and less frequently occurring—to be determined. Samples should be taken from a variety of locations that represent the houses and households that would most likely be targeted as part of the housing program (i.e. housing density and socioeconomic status).

   One advantage of using a sample of houses and households is that they correspond to the reality of the existing buildings and owners, versus a hypothetical or modeled situation, and can therefore provide a fairly objective view of the reality. This may include providing insight on the variety of housing conditions or homeowner opinions that may exist, what conditions or opinions are most common, and what conditions or opinions are more unique.

2. **In a post-disaster environment, use forensic engineering of collapsed buildings or reconnaissance studies to understand causes of collapse and building vulnerabilities.**
   Any country or location which has recently experienced a disaster is likely to already have a documented understanding of common housing types and their vulnerabilities. A post-disaster environment can function as a laboratory in which to learn why some buildings collapsed and others did not. Forensic engineering studies are regularly performed by professional engineers, technical assistance providers, and research institutions such as the Earthquake Engineering Research Institute to document the lessons learned and make recommendations for safe rebuilding or strengthening after disasters.

3. **Conduct rapid inventory and categorization.** This relates to the principle of "smarter risk management" from Part 2 of this guide, and is discussed in the next step. **» Go To: Part 2, Smarter Risk Management**

Rapid Inventory and Categorization

A building inventory can be completed using one of the methods listed below to rapidly categorize buildings and neighborhoods. Buildings can then be grouped according to the action required, working together with local authorities and experts. The goal is to identify shortcomings to be addressed and the type of intervention needed.

For example, buildings could be rapidly grouped into the following categories:

1. single-story buildings—candidates for retrofit and vertical expansion (i.e. adding a second story)
2. low-rise buildings with a soft story—candidates for ground floor strengthening
3. buildings requiring further analysis, as they may be too difficult or expensive to retrofit—potential candidates for replacement

3 Build Change for World Bank Group, *Expert Advice on Home Retrofitting Options to Mitigate Earthquake Risk, Indonesia Final Report*, (2017); *Expert Advice on Home Retrofitting Options to Mitigate Earthquake Risk, Guatemala Final Report*, (2017); *Expert Advice on Home Retrofitting Options to Mitigate Earthquake Risk for the Salina Cruz Region, Oaxaca, Mexico, Final Report*, (2019); and *Maximizing the Impact of Structural Retrofit Projects on Housing in Densely Populated Cities of Colombia*, (2018).

Rapid building inventories can be obtained by leveraging data and technology in some of the following ways:

Use Google Street View surveys
In support of the Government of Colombia's national housing program *Casa Digna, Vida Digna*, Build Change searched Google Street View to capture images of 274 neighborhoods in thirteen municipalities. Google Street View images existed for 70% of the required neighborhoods, enabling Build Change to quickly collect basic information about the buildings and neighborhoods (such as assessing the construction type, number of stories, and the presence or absence of steep slopes) and to rapidly determine whether a house would fit the criteria of the program. **» Go To: Part 5, The Road to Resilient Housing in Colombia**

Use Artificial Intelligence (AI)
Build Change's team in Nepal created Post-Disaster Rapid Response Retrofit (PD3R), a system that uses visual recognition software and AI to quickly determine, from a single photograph, if a rural house is a strong candidate for structural retrofitting.

Using PD3R, photos of houses can be taken and uploaded by anyone with a smartphone, using a mobile app. Identifiable patterns such as measurements and opening size and alignment are processed by the AI to determine whether the house is eligible for a structural retrofit intervention. This technology helps to overcome expertise shortages and reduces the number of site visits needed for evaluations, helping to save time and cost. Furthermore, it can help decision makers to prioritize retrofit intervention zones and only deploy resources in locations with a higher density of homes with retrofit potential.

Use a manual, building-by-building tagging approach
This may involve a similar methodology to the Federal Emergency Management Agency (FEMA) P-154 *Rapid Visual Screening of Buildings for Potential Seismic Hazards*, for vulnerability screening before an event. In areas at risk of earthquakes, FEMA P-154 provides a methodology to evaluate the seismic safety of a large inventory of buildings quickly and inexpensively, with minimum access to the buildings, with a view to determining if those buildings require a more detailed examination. It allows the user to quickly assess the seismic safety of existing buildings on a numerical scale, with building scores below 2 considered vulnerable and in need of retrofit.[4]

After an event, the Applied Technology Council's (ATC) ATC-20, *Procedures for Postearthquake Safety Evaluation of Buildings* can be used. ATC-20 is a rapid method for evaluating building safety for immediate reoccupation after earthquakes. Implementation results in tagging buildings as "Inspected" (apparently safe, green placard); "Limited Entry" (yellow placard); or "Unsafe" (red placard).[5]

1.10 Characteristics of Households (P) (M)

Households must also be assessed to determine socioeconomic information, vulnerability factors, and eligibility for subsidies or loans. This assessment can be embedded in a housing subsector study, and coupled with field surveys of buildings. The reports conducted by Build Change for the World Bank[6] include examples of summary information from these surveys, and some examples of homeowner and household surveys have been included in Annex D.

1.11 Lessons from Past Projects and Demonstration Projects (P) (M) (T)

As Part 3 of this guide demonstrates, home improvement programs with structural improvement have been implemented in multiple countries across a range of housing types. These programs offer valuable lessons which can be relied upon when scaling a program or beginning a new program.

Summarized and in-depth case studies from home improvement programs supported by Build Change can be found in Part 3 and Part 5 of this guide.

Demonstration and pilot projects can be undertaken to gain a more in-depth understanding of the opportunities, gaps, and challenges of a resilient housing program prior to the design and implementation of a scaled program. These projects can also be a critical way to demonstrate the feasibility of the work and to drive wider investment and demand for resilient housing.

» Go To: Part 3, Case Studies

» Go To: Part 5, The Road to Resilient Housing in Colombia

4 More information is available at https://www.fema.gov/media-library/assets/documents/15212

5 More information is available at https://www.atcouncil.org/atc-20

6 Build Change for World Bank Group, *Expert Advice…Indonesia Final Report,* (2017), *Expert Advice… Guatemala Final Report,* (2017), *Expert Advice…Mexico Final Report,* (2019), *Maximizing the Impact… Colombia,* (2018).

» Stage 2: Planning

FIGURE 21 Stage 2: Planning

	People (P)	Money (M)	Technology (T)
Stage 2: Planning	Program goals Permitting and approval processes Inter-institutional coordination Temporary housing needs assessment	Funding mechanisms Financial instruments Program operation costs Technical assistance costs	Technical assistance level Implementation and delivery models Use of technology for planning
		Preliminary home strengthening and improvement designs and costs	
	Quality assurance system		

SOURCE: BUILD CHANGE

The Planning stage provides an opportunity to determine the program scope, and how it will be achieved. This includes determining the type of interventions for home improvements (with preliminary designs and costs), identifying the most appropriate implementation model, determining the necessary steps for authorization and permits, and ensuring funding is in place for all costs—including technical assistance—throughout the duration of the program. During this stage, a quality assurance system should be put in place to ensure there will be quality control in the Implementation stage.

2.1 Program Goals (P)

For decision-making purposes in defining the project scope and breadth during the Planning stage, it is important to answer two essential questions:

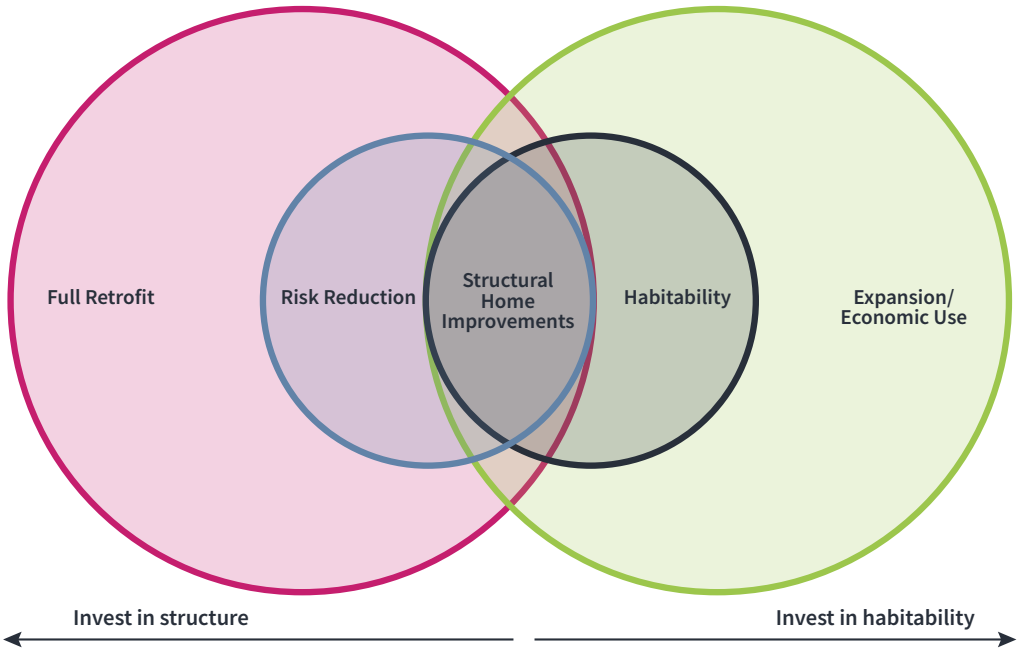
1. *To what level is the improved building expected to perform in the hazard(s) in question?* Existing buildings, especially houses, are not expected to be upgraded in compliance with building standards for new buildings.
2. *What additional improvements should be prioritized in a home improvement program?* Often, and especially in light of COVID-19, there is a need and opportunity to repair damage, fix leaking roofs, or improve utilities.

There are many different types or extents of interventions. The nature of each can be viewed in terms of its effect on the building structure and on the habitability of the home. In Figure 22, the scope of each type of intervention is represented by a different circle.

From the disaster-risk reduction point of view, there is a minimum set of risk-reduction measures that can be made on the home to significantly reduce its vulnerability to collapse in an extreme event ("Risk Reduction" circle). These are usually a subset of a larger intervention that is aimed at meeting a code-based performance objective, such as life-safety design in the event of an earthquake ("Full Retrofit" circle). In both cases, the interventions taken to reduce risk overlap with the interventions that can improve the habitability of the home ("Habitability" circle). This overlap area is designated as "Structural Home Improvements" and comprise what may be some of the more cost-effective items to implement because they have a dual benefit. Examples of such structural home improvements include:

- interior bracing walls, which improve structural performance but also the functionality of space inside the home;
- replacing or upgrading a damaged or poor-performing roof, to prevent leaks and secure it against hurricanes;
- using cement or cement-mesh plaster to finish walls, and adding a reinforced concrete tie element (ring beam) at the top of walls, both for increased strength and stability and also hygiene and aesthetics (Box 4.2).

FIGURE 22 Goals for home improvement interventions



SOURCE: THE WORLD BANK, *ROADMAP FOR RESILIENT HOUSING: THE PATH TO LIVABLE, DISASTER AND PANDEMIC RESILIENT HOUSING*, (WASHINGTON, D.C.: GLOBAL PROGRAM FOR RESILIENT HOUSING, 2020).

Box 4.2 Dual-benefit structural home improvements in Colombia

In a typical informal house in Colombia, Build Change determined that improving walls with reinforced or non-reinforced plaster and adding a ring beam represents on average 20% of the cost of a full retrofit, but reduces the risk of housing collapse by 75%. At the same time, it provides healthy, smooth wall surfaces that can be painted and kept clean.

Finally, once structural and habitability issues have been addressed, households can start considering expansion of the home to generate additional income—for example, by renting an independent apartment to another family ("Expansion/ Economic Use" circle).

Establishing goals for structural and habitability improvements

The goals for both structural and habitability improvements for houses in the program should be established, with consideration of the resources required to achieve them:

What is the goal for the building structure? Will it be upgraded to meet current code-level hazards? Will it be upgraded incrementally to a lower, but more frequent hazard level? Will only structural improvements that also improve habitability be done?

What is the goal for the habitability of the home? Will basic habitability needs be met? Will cosmetic improvements be included? Will provisions for future expansion be included, or will the expansion itself be included?

Consultation with engineers and architects experienced in disaster-resistant retrofitting and home improvement is typically required to develop information on the extent and nature of interventions needed to achieve certain goals. There are many references for retrofitting and habitability standards (Annex C). However, where references are not available, the design team may need to develop and perform local investigations. Experimental testing may be used to establish something simple—such as the typical, basic properties of materials in the existing housing stock—or something slightly more complex—for example, the quantitative benefit of certain improvement techniques. Annex E includes examples of experimental testing performed by Build Change and partners. Engaging with local stakeholders, in particular

academic institutions and professional engineering and design organizations, can help teams to understand what relevant investigations have already been performed.

Determining the types of interventions required for either structural or habitability improvements, or both
This is a subset of retrofitting or improvement techniques that corresponds to the typical range and type of deficiencies present in the targeted houses (see Table 3 for a list). Defining these deficiencies requires familiarity with the typical characteristics of the targeted houses, which can be gathered from demonstration projects, from field surveying and sampling studies, and from larger available databases, like census data. Census data often includes enough basic information that can help extrapolate detailed observations from a smaller sample to the larger context.

Once building deficiencies, local construction techniques and costs, and homeowner opinions and preferences have been taken into account, the most appropriate retrofit interventions can then be identified to meet the targeted goals. To aid in the definition of the project scope and criteria, interventions can be broken down into several different categories:

- interventions that repair the house condition or damage (particularly relevant in post-disaster contexts in which damage may be significant)
- interventions that improve habitability (may or may not affect disaster resiliency)
- interventions that help to finish or grow the home (such as wall and floor finishes, and provisions for future expansion)
- interventions that solely improve the disaster resilience of the house

Understanding the typical extent of interventions
In addition to understanding which interventions may be most appropriate for the houses and households in the program, it is also important to understand the extent to which houses may require those interventions. For example, do most houses need minor roof repairs or will most need a whole new roof? Using a representative sample of houses to develop full conceptual improvement designs is a useful way to estimate the typical extent of interventions required in the targeted households.

2.2 Permitting and Approval Processes (P)

During the Planning stage, it is important to define how the proposed improvements will be authorized and who will authorize them.

Simplification of the permit/approval process greatly facilitates access to home improvements for resilience at scale.

Permitting or other authorization is an important step in the quality and sustainability of the program, but it can also create a bottleneck or roadblock during the Implementation stage if not addressed early and adequately.

The following points are key considerations in defining the permit or approval procedures for a program.

1. Determine if the project work will require approval or permits from building officials. Different locations may have different requirements for when and how permitting or building official approval is obtained, and the corresponding authorities for the area where the work is taking place should be consulted.

2. Determine whether an alternative mechanism for authorization can be used for the program, or whether approvals will follow standard practices for permitting.

3. Identify how capacity can be increased for granting authorizations or permits, considering that the new program may generate an increased load of applications for the system.

4. Consider developing a simplified approach for authorizations. Where programs focus on a particular subset of building types (for example, single-story houses of not more than 6m x 12m), adopting a subset of certain pre-approved interventions can make it easier for officials to verify compliance with requirements, thus accelerating the approvals process.

5. If no current standard practices are in place, or an alternative approach will be used, identify what the minimum required checks or review points are for quality control and record keeping. Evaluate and plan how the authorization process can be made accessible to homeowners targeted by the program. This may be achieved through the choice of office location, communications and awareness campaigns, provision of technical assistance, etc.

6. Determine how construction quality supervision will be carried out and if it is linked to the authorization/permit.

TABLE 3 Components of strengthening and improvement design solutions

Cost Category	Category Description	Example Actions	
Structural Condition Repairs	Items that require repair or replacement due to damage from past events, insects, deterioration, etc.	Repair wall or foundation wall Replace damaged wall Replace damaged slab Replace damaged roofing Replace damaged framing or timber elements	
Habitability Upgrades	Items that are required to meet basic health and safety standards	Improve lighting & ventilation Improve security Improve kitchen Improve electricity Improve water & sanitation Improve accessibility & egress Improve drainage Fix leaking roof Improve fire safety Improve space distribution – add walls	
Finishings and Growth	Items desired by the homeowner, often forward-looking in their use of the house	Horizontal and vertical expansions (adding more rooms or another story) Conversions to more permanent construction materials New slab roof to replace light roof. Finish/plaster masonry walls Ceiling Painting	
Disaster Risk Reduction Measures	Items that are specifically added to mitigate risk of building collapse or other life-threatening hazards in the event of an earthquake or windstorm	Foundations	New foundation Wall to foundation connections
		Walls	New wall or sheathing/bracing New column or post New opening reinforcement Infill of openings Reinforced overlays Strongbacks New ring beam or top plate Gable wall replacement or bracing
		Floors	Diaphragm slab strips (to reinforce and to distribute seismic forces) Connection of walls to floor
		Roof	Wind bracing Strengthen or add roof framing or connections
		Building Envelope	Wind protection for openings

SOURCE: BUILD CHANGE

A Build Change engineer speaking with a homeowner in Mexico

2.3 Inter-Institutional Coordination (P)

Home improvement is an essential component of neighborhood improvement. Build Change's experience in Latin America shows that as informal urban areas become formal, tenure is regularized, urban services are improved, and densification and growth accelerate. Lightweight construction rapidly evolves into permanent, multi-level properties, often more vulnerable to earthquakes than before. It is essential to prepare the workforce, the market, the homeowners, and the existing construction for this growth to prevent large-scale urban disasters. To do this, it is necessary to coordinate closely across institutions, to enable home improvement programs to work in tandem in relation to intentions for land and urban upgrading projects.

2.4 Temporary Housing Needs Assessment (P)

Based on the program goals, the typical planned intervention, and the characteristics of the households, a needs assessment for temporary housing of building occupants during the work should be performed to facilitate the development of a strategy. In this way, the coordination, time, and costs for temporary housing needs can be accounted for in the Planning stage. Approaches to addressing temporary housing needs can range from providing a rental subsidy to the occupant, or directly providing temporary housing for them during the work, to providing assistance and supporting them to make their own arrangements for temporary housing.

2.5 Funding Mechanisms (M)

The most successful housing programs leverage homeowners' own resources, and combine government subsidy models and/or private sector lending models to cover the cost of materials and labor for construction.

However, while the contribution of a subsidy or loan can increase the value of the home and help to protect it, it should be recognized that the primary source of funding for home construction and home improvement in informal markets is still homeowners themselves, given that the majority of existing construction is self-funded. **» Go To: Part 2, Put Power in the Hands of the Homeowner**

Government subsidy models

Government subsidy models are being used across the world, including in Mexico, Nepal, Colombia, Indonesia, and Dominica. However, there is no single path, and there may be more than one way to achieve the same goal. For example, in Indonesia, the homeowner typically receives a cash subsidy and/or building materials and selects the builder for the work (or can even do parts of it themselves). In Colombia the homeowner is not awarded subsidies but receives the implemented work instead. The builder is selected by the government agency.

Private sector lending

Private sector lending as a funding mechanism must support resilient construction and be within the borrowing capacity of households. In the Philippines, Build Change has been supporting MFIs to develop affordable loans for low-income families, who often cannot meet the restrictive criteria of larger lenders. This was backed by research that demonstrated market demand among low- and middle-income families to take out loans to make structural and habitability improvements to their homes. **» Go To: Part 3, Philippines: Developing Home Improvement Microfinance Products to Increase Homeowner Participation**

2.6 Financial Instruments (M)

Multilateral banks can be a source of funding for program implementation, oversight, and technical assistance. Some banks, like the World Bank, offer options for financing instruments for project initiation, planning, and implementation. Governments may also be able to access bilateral and private funding sources for these types of investments.

2.7 Program Operation Costs (M)

The operational cost of the program should be estimated based on the resources required for implementation, including initial and ongoing technical assistance, quality control, grievance/feedback mechanisms, and other program needs, plus the length of the intended program.

The program will need operational governance and management at a level above the design- and construction-specific initiatives. These high-level program operational costs should be correctly estimated to ensure there is adequate capacity to operate efficiently at scale and to standardize the operation in order to save time and effort.

In some instances, it may be more cost effective to modify or improve an existing program's operation to include resilience improvements rather than to create a new program operation.

2.8 Technical Assistance Costs (M)

It is crucial that funding allocation includes the costs of providing technical assistance (TA) to relevant actors. Building the capacity of implementing agencies and other actors can help ensure that interventions achieve sustainability over time. Moreover, improvement in the capabilities of central and local governments can help scale up operations and adapt them to different contexts. Finally, providing TA to homeowners and builders can help raise awareness of the need to consider disaster risk in settlement and building activities.

2.9 Preliminary Home Strengthening and Improvement Designs and Costs (M) (T)

Example home improvement and strengthening options, including designs and drawings, prescriptive design criteria, bills of quantities (estimates of the quantity of materials and labor required to perform the work), costs, and construction documents should be developed. In some countries, these documents are already available from current and past projects. Home improvement design and cost options are available for low-rise masonry housing in the Philippines, Nepal, Haiti, Colombia, Guatemala, St. Lucia, Dominica, Indonesia, and elsewhere. See Annex F for examples.

2.10 Technical Assistance Level (T)

The level of TA required will depend on several elements. These have been discussed above, and include the following:

- **The existing state of building codes and standards and the regulatory environment.** If existing applicable and up-to-date codes do not exist or are not well understood, more TA will be required to establish and build awareness around standardized program technical guidelines.
- **The targeted goals of the program.** Generally, goals that are more performance-specific, such as code-level performance, use more resources to verify and ensure than goals that are more prescriptive in nature.
- **The characteristics of houses to be addressed and the types of interventions required.** Houses that are less vulnerable, simpler, and/or consistent in construction are likely to use less TA than houses that have high vulnerability and irregularity.

It is possible that within a program, several different levels of TA can be delivered. Some types of houses may require less TA, while others may require more. Programs can group homes by the type or level of TA required and work through them at different paces in order to stagger the implementation and get started with some, while working out the details of others.

2.11 Implementation and Delivery Models (T)

Homeowner-driven, community-driven, and donor-driven models have historically been used for rebuilding new housing after disasters, for new social housing programs, and for home improvement programs. These models are summarized and evaluated in Part 2 of this guide (Table 1).

Homeowner-driven implementation has many advantages over other implementation models, particularly in terms of sustainability and costs. Refer to Part 2 to learn why Build Change recommends putting the homeowner in the driving

seat, and for the different stages of how a homeowner experiences a typical home improvement program delivered through this model (the "homeowner journey").
» Go To: Part 2, Put Power in the Hands of the Homeowner

Implementation and delivery models may vary in how they deliver resources, and in the different ways in which the homeowner is involved, and this is determined during the Planning stage. For example:

- **Subsidy:** The subsidy may be paid directly to the homeowner to procure materials and labor, or the work may be delivered directly by government contractors.
- **Builder:** The homeowner may select the builder, or the builder may be selected by the government agency.
- **Design:** A facilitator helps the homeowner to develop a design/the builder makes an assessment and design proposal that families approve.

In all cases, homeowners should retain control over decisions regarding their home, and programs should be able to deliver similar results in terms of increased resilience.

2.12 Use of Digital Technology for Planning (T)

The use of digital technology can vastly improve compliance, efficiency, and accountability, can support program scaling, and can broaden the scope of what is possible across all stages of a home improvement program. The ways digital technology can be leveraged to support programs is discussed in detail in Part 2 of this guide.

During the Planning stage, the way in which data will be collected and processed during Implementation should be determined and technological systems put in place. This may include use of a digital platform, such as Fulcrum, or an end-to-end Management Information System (MIS). These technologies can support the Planning process itself, through improved communication, increased transparency, and timely dissemination of relevant information to all stakeholders.
» Go To: Part 2, Use Digital Technology for Scaling

2.13 Quality Assurance System (P) (M) (T)

Quality assurance requires establishing a framework and processes to ensure that there will be quality control in the Implementation stage. At this stage, the optimal system(s) that will be used for quality assurance should be identified.

Experience indicates that a holistic approach, such as the use of an MIS, can streamline quality assurance through all stages of a program, by providing stakeholders with complete and transparent access to the required parts of the quality assurance system. Refer to Part 3 for the Dominica case study, where an end-to-end MIS is being used to deliver the National Housing Recovery Program. **» Go To: Part 3, Dominica: Building a Management Information System for a National Housing Recovery Program**

Preliminary assessments taking place in Colombia, August 2020

Stage 3: Implementation

FIGURE 23 Stage 3: Implementation

	People (P)	Money (M)	Technology (T)
Stage 3: Implementation	Hiring implementing parties Homeowner engagement	Construction costs Money transfers and authorization	Design and construction documents Construction and quality control Use of technology for implementation and reporting

SOURCE: BUILD CHANGE

The Implementation stage builds upon the work done in the previous two stages and is the point at which subsidies are allocated and home improvement work takes place.

At this stage, implementing parties are hired and stakeholder roles are clearly defined. Homeowners should be engaged through all parts of the process, from awareness to temporary relocation during construction. This is the stage in which home improvement program standards, designs, costs, construction documents, and bills of quantities are fully developed, along with construction documents and capacity building to build technical capacity, manage quality control, and ensure construction worker safety. The use of technology can vastly improve compliance, efficiency, and support with scaling, while facilitating reporting throughout this stage.

3.1 Hiring Implementing Parties (P)

During the Initiation stage, different types of stakeholders were identified; at this stage specific stakeholder responsibilities and engagement mechanisms should be clarified, and relevant stakeholders hired where necessary. Refer to Figure 18 (1.2 *Stakeholder Mapping*) for a full list of potential stakeholders grouped by People, Money, and Technology.

3.2 Homeowner Engagement (P)

Homeowner engagement is essential for home improvement programs to succeed, and relates to engaging homeowners throughout all stages of the program, from awareness raising, to construction supervision.

More information regarding the different stages of a typical home improvement program from the perspective of the homeowner—the "homeowner journey", and the homeowner-driven implementation model can be found in Part 2 of this guide. **» Go To: Part 2, Put Power in the Hands of the Homeowner**

Figure 24 shows an example program plan for homeowner engagement, based on a model used successfully by Build Change in Haiti.

Awareness

Raise awareness about the program

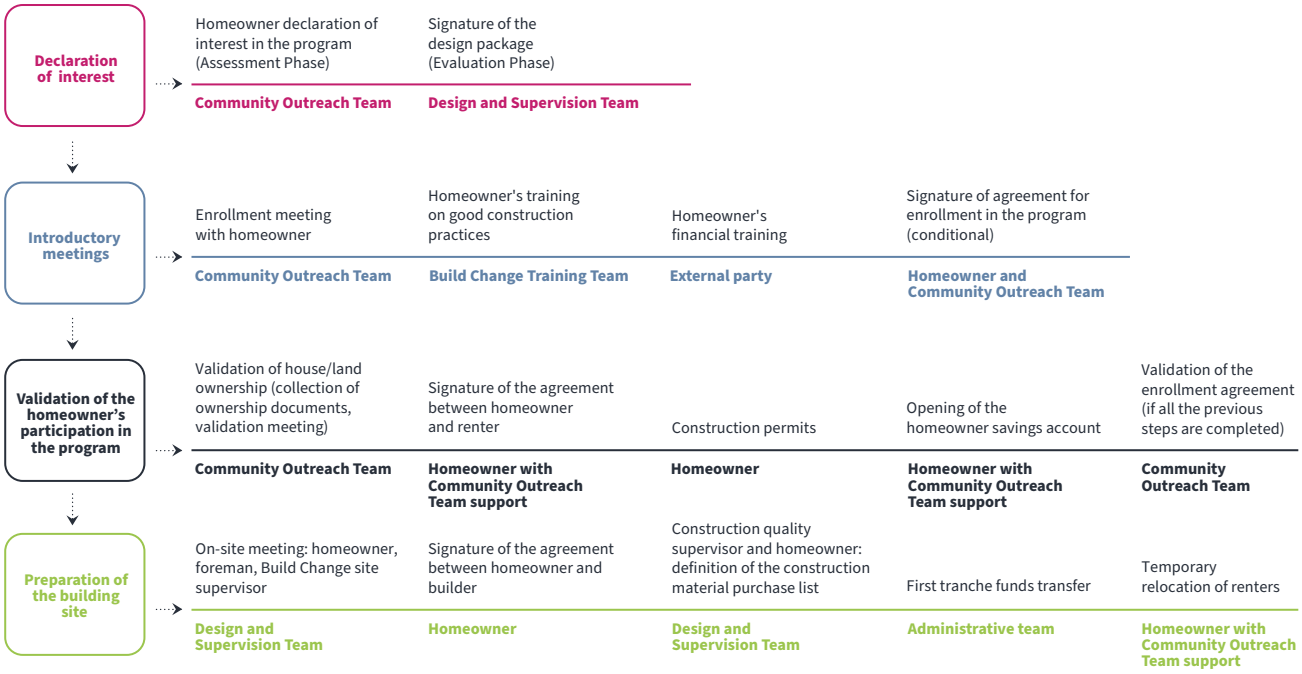
A clear communication strategy should be laid out to engage homeowners in the process and make sure the targeted communities are aware of the program.

Awareness materials should include the following information:

- why the program is important
- eligibility criteria to participate in the program
- how to enroll in the program
- what is being offered by the program
- relevant timeline constraints or scheduled milestones for the program

Stage 1: Initiation | Stage 2: Planning | **Stage 3: Implementation** | Stage 4: Closure

FIGURE 24 Example homeowner engagement journey: Haiti



SOURCE: BUILD CHANGE

Raise awareness among homeowners and builders about construction and material quality

A home improvement program also provides a unique opportunity to increase household and builder awareness of risk and safe construction practices. Communication materials can be an invaluable resource for households and builders both inside and outside the confines of the retrofit program, which is particularly relevant in cases where homeowners have future home improvement plans.

Communication mechanisms

There are a variety of communication options that can be leveraged for creating awareness:

- community organizations and meetings
- governmental notices
- community billboards and posters
- radio, TV, and online advertising
- direct communication through SMS or mobile apps
- local storytelling or theater productions

Examples of homeowner awareness materials developed by Build Change with MFI partners in the Philippines are shown in Figure 25.

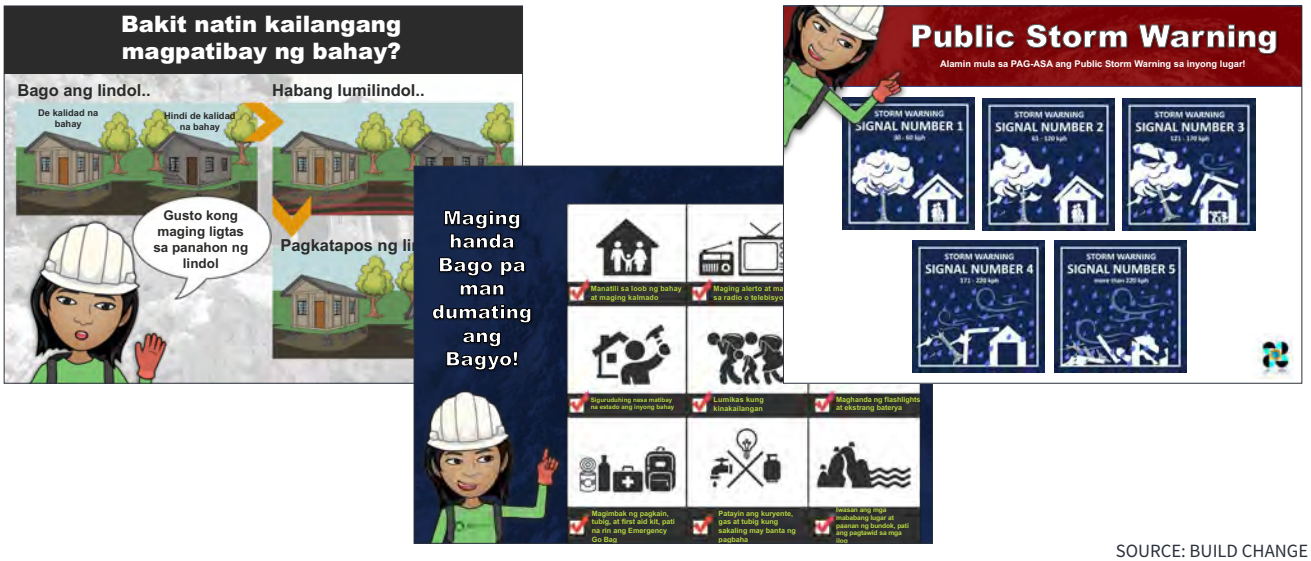
Enrollment

Once awareness around the program is created, households will start the enrollment process. It is likely that there will be both socioeconomic criteria as well as technical criteria to determine eligibility for enrollment. Transparency around these criteria during the enrollment process will help facilitate a smooth process, with fewer grievances from participants.

Approved and enrolled participants should be fully briefed on the program process, including what will be expected of them. A signed agreement or contract outlining the terms of participation in the program is recommended.

Socioeconomic criteria for household enrollment can include income level, type of tenure, accreditation of area residency, and/or access to housing subsidies, among others. Technical criteria can include level of compliance of construction with urban parameters, structural requirements, seismic or wind resistance, and/or location, etc. Governments need to assess the convenience of introducing some requirements while remaining aware of eligibility criteria that could exclude vulnerable households.

FIGURE 25 Examples of homeowner awareness materials, Philippines, 2020



SOURCE: BUILD CHANGE

Design Approval

People are more likely to accept structural requirements if their own requirements and preferences for what a home should be are respected—for example, the layout of interior and exterior spaces, orientation to light/wind/view, privacy, and security. Homeowner preferences and expectations should have been gathered during initial assessments and homeowners should be supported to incorporate these into the design of their improved home.

Before any work on the home begins, the homeowner needs to have a clear understanding of the proposed work to be performed, and an understanding of what is and is not included within the scope of the program. As many homeowners are not well versed in reading construction plans and details, a face-to-face walkthrough of the proposed work in the house is helpful. Where feasible, this can be supported by illustrative three-dimensional renderings or even a Virtual Reality walkthrough, to help the homeowner visualize how the works may affect their house.

After the work has been clearly explained to the homeowner, they should sign off on the specific plans to indicate their agreement on the scope of work (see 3.5 *Design and Construction Documents*) and the projected timeline.

If the homeowner has the option to include elective works supported by their own resources in the program works, this is the time to agree upon what the scope of those items is and how the homeowner will provide the resources for them.

Financing

As part of the enrollment contract, the financing scheme should be clearly outlined, whether it is a subsidy, partial subsidy, subsidy in kind, or loan that is being used to finance the works. The homeowner should be aware of and prepared with any additional financial infrastructure requirements they may need in order to access the financing, such as a bank account or money transfer mobile app.

Selecting Builders and Building Materials

If homeowners are hiring the builder directly, support should be provided to them in understanding how to select a qualified builder, and setting and signing contract terms with the builder.

Household Safety

For the safety of the occupants, arrangements may need to be made for their temporary relocation during the works. This can be facilitated by the program, or left to the responsibility of the homeowner. In either case, consideration for the homeowner's capacity to make the arrangements should be given and in no case is it recommended that significant construction should proceed on an occupied home, due to construction-related hazards but also for health and safety/security reasons.

Construction Oversight

In a homeowner-driven model, homeowners are at the frontline of construction oversight; they are personally invested in the successful outcome of the home improvements and can be empowered to help ensure success. Providing materials to homeowners (such as the expense register booklet shown in Figure 26) to facilitate their engagement with the construction phase is recommended.

3.3 Construction Costs (M)

This stage refers to determining the cost and required materials for each stage of the home improvement interventions. Both a bill of quantities and a cost estimate will be required for each house. Based on the quantities established in the bill of quantities, and the project unit prices for materials and labor, as well as other costs such as mobilization, transportation, and contingencies, a cost estimate should be developed.

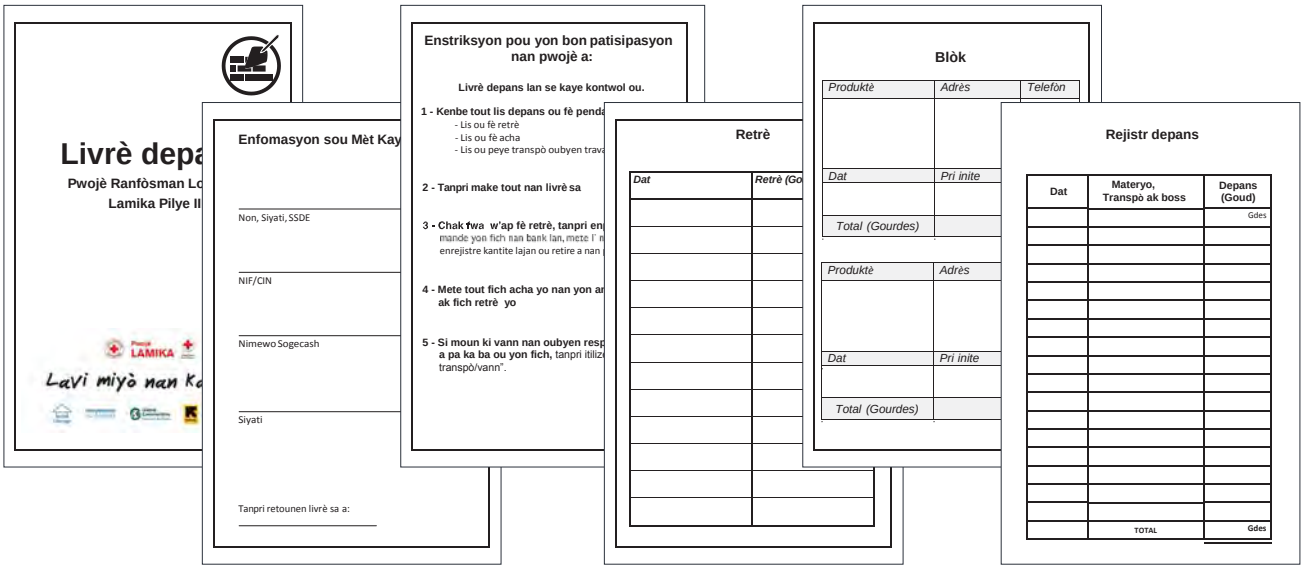
3.4 Money Transfers and Authorization (M)

As described in the Planning stage, subsidies or loan installments should be disbursed in a way that is conditional on compliance with the construction quality checklists. Different checklists may be required depending on the work agreed by the implementer and the homeowner during the enrollment stage. This not only helps maintain leverage, but also avoids wasting money in situations where the first tranche was not put to good use, and the investment will not result in a safer house. The same philosophy would apply for subsequent tranches. International experience on conditional tranches indicates that it could be useful to ensure the largest portion of payment for the builder in the last tranche. However, governments need to balance the advantage that this type of arrangement can generate with the possibility of excluding small developers without enough available working capital to wait until the works are completed to get paid.

3.5 Design and Construction Documents (T)

Sample packages of design and construction documents for Build Change programs in Colombia, Haiti, the Philippines, and Nepal have been included in Annex G. These packages demonstrate a range of different approaches toward design and construction, depending on the local context, requirements, and the available technology. While there is much emphasis within this guide on the use of Building Information Modeling (BIM) tools for producing building designs, drawings may

FIGURE 26 Example of an expense register booklet provided to homeowners participating in the *Lavi Miyò Nan Katye pa'm Nan* (LAMIKA) retrofit program, Haiti, 2014



SOURCE: BUILD CHANGE WITH GLOBAL COMMUNITIES, *HOUSING ASSESSMENT RESULTS AND PROPOSED IMPROVEMENT STRATEGY: LAMIKA PILLAR THREE: PHYSICAL RENEWAL*, JUNE, 2014. PREPARED FOR THE AMERICAN RED CROSS

be completed by hand (see Haiti sample package, Annex G) or drawings may not be required at all (see Philippines sample package, Annex G). Whatever the situation, the recommendations below aim to ensure that minimum requirements are met by the chosen methods of design and construction:

1. **Develop a standardized set of home strengthening and improvement design and construction documents.** One of the clear lessons learned in the implementation of resilient housing programs to date is that it is important to develop and use standardized resources for evaluating, prescribing, and implementing improvements. Regardless of the extent of intervention targeted by the program (home improvement, risk reduction, or full retrofit), the prescribed scope of work will need to be documented for each house as a basis for implementation, quality control, and financing. These documents often form part of the contract or formal agreement with the homeowner and/or the builder. Examples of these documents from a variety of projects and locations are included in Annex G.

2. **Have clear and objective tools for evaluating the house and prescribing the required risk mitigation and/or habitability interventions.** These would likely be adapted according to the building type(s) in the targeted areas. The required works should be outlined in a clear scope of work. This scope of work can be written in a tabulated format and/or identified in a set of construction documents and plans. Enough information should be provided so that:

    - The homeowner can understand what works are proposed in their house and can therefore make an informed decision about how to proceed.
    - The contractor/builder can perform the intended scope of works.
    - The construction quality supervisor knows what items require supervision and the quantity or extent of interventions.

3. **Prescribe standards for construction, such as typical details, material specifications, and specifications for work.** These construction details and specifications should be provided as guidance to set the minimum requirements for the quality and implementation of the works. These should include material quality requirements, implementation guidance, and the physical details of construction. They will also form the basis of the construction quality inspections made during the Implementation stage.

4. **Develop construction quality checklists.** These should be used during the construction process to objectively verify that the work has been performed as per the agreed scope, and meets the required quality standards outlined.

3.6 Construction and Quality Control (T)

Construction Materials and Practice

Different stakeholders may be responsible for procuring the construction materials for the works—the homeowner, the builder, or the program implementer—depending on the program implementation model. Procedures should be put in place to ensure that the responsible party is aware of and adhering to the required level of quality for the construction materials. This may require facilitation by the program, such as the following:

- training on how to identify quality construction materials
- (in some cases) training material producers on increasing the quality of their products
- providing lists of approved suppliers who meet the quality standards (making sure to have multiple options and avoid a monopoly)
- performing third-party testing and inspection of the procured materials on site

Construction practices must also conform to the quality outlined in the project documents and standards.

The program should be prepared to facilitate access to qualified builders that can perform to the required standards in ways such as the following:

- skills upgrading, training, or certification of builders to perform the work
- providing a list of pre-qualified builders, based on demonstrated competency to perform the correct construction practices
- performing construction quality assurance and control throughout the construction phase

Capacity Building

Adequately train and support implementers on technical requirements

Build Change's international experience shows the importance of dedicating sufficient time to ensuring implementers (those persons responsible for administering and overseeing the program on behalf of the government) fully understand the retrofit program mechanisms and have a keen familiarity with minimum disaster-resistant construction practices. Tailored presentation material should be aligned with the

simple program resources and, ideally, training should include an on-the-job component. This is because the theoretical expectations and designs discussed in the classroom rarely coincide fully with houses in real life. New implementers could be offered frequent opportunities to work under or receive support from experienced personnel and could be required to successfully supervise one project (resulting in compliant houses) before being given more responsibility and independence. A comprehensive implementer job description, including their obligation of ensuring construction quality, should be developed for the program.

Require vetted builders to be hired by homeowner; ensure sufficient supply of vetted builders through training and evaluation program

While it is important to ensure households can select the builder of their choice, it is also important the builder has the required technical capacity, especially regarding minimum hazard mitigation standards. Thus, comprehensive training and evaluation for builders before projects start should be considered a necessity. Most importantly, before being employed, and as part of the program conditions, the selected builder should pass a minimum knowledge evaluation, to make sure he or she is familiar with the project's minimum requirements. Should the builder not pass this evaluation, training can be provided.

Following training, the builder should be required to pass a further evaluation before being allowed to start work. While it would be ideal for the builder to demonstrate the entirety of practical skills needed to complete the work, this is not necessary. It is very common for builders to hire someone to perform parts of the work they cannot do, and sometimes the builder acts more as a contractor, outsourcing all of the work to someone else. Given that it is almost impossible to track who is to be responsible for what and who will be on site when, it is essential to establish a point person, someone to whom all concerns should be relayed and who has overall responsibility for the quality of construction. This will always be the person who signed the agreement with the household, and it is this person who should be subject to the aforementioned evaluation. That said, any training that can be offered to skilled or unskilled workers under these key people will always be beneficial.

In our experience, the training of builders is most successful in improving construction quality when it includes the following key elements:

Builder Training Center, Haiti, 2014

1. **Initial verification** of the builder's knowledge prior to the start of training, to understand if the builder has the minimum construction experience necessary to successfully complete the training.
2. **Self-assessment** by the builder in order to identify which skills require supplemental, formal training.
3. **Theoretical training** about earthquake/windstorm engineering, material quality, load path, etc.
4. **Practical training** in the required skills identified, mimicking the site conditions as closely as possible through use of training stations or a training center.
5. **Evaluation** through testing, to verify that the builder can demonstrate all of the skills required.
6. **Certification** of the builder for all portions of the required work, based on successful evaluation.
7. **On-the-job training** as the builder implements new skills in a house retrofit project.

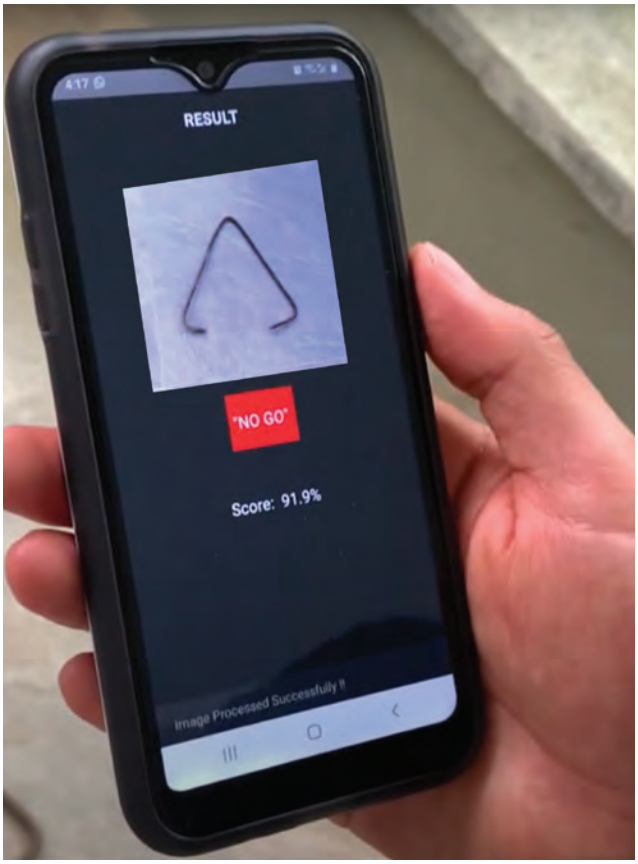
Construction Quality Assurance and Quality Control

Construction quality supervision must be provided while construction work is underway, for quality assurance and quality control. Prior to the start of any construction work, minimum requirements for observations and inspections should be outlined and coordinated with the builder(s). Supervision is typically provided by qualified third-party inspectors who review the works, visiting the site at key stages—such as prior to the pouring of concrete—and making use of the construction quality checklists developed for the project.

Requiring households to use materials and do work in a way that is compliant with program standards (and disaster-resistant construction standards) is of significant long-term benefit for the homeowner because, as well as saving lives, it helps protect both their and the government's investment. The opportunity to link finance installments to construction quality should therefore not be missed. Conditional payments based on construction quality checks and progress can be used to track the use of the subsidy, ensuring the efficient and satisfactory use of funds, and as a tool to monitor the progress of construction at each site.

The use of digital technology can help to streamline the visual observation and inspection process and reduce the amount of time a supervisor needs to spend at each site. Site supervision and inspections can be performed remotely where feasible or necessary (for example, to prevent the spread of COVID-19), by incorporating AI and other background computational tools to automate as many quality assurance workflows as possible.

Technology can also enhance a homeowner's ability to monitor construction in the absence of a technical expert.



Use of the "Go"/"No-go" app for quality assurance

Construction quality concerns (for example, whether the bricks are adequately spaced or enough mortar is being used) can be addressed immediately by taking a photo on a mobile device through a "Go"/"No-go" app that makes use of AI. This can provide instant reassurance or allow stakeholders to flag issues, communicating them immediately and directly through a mobile app that connects to project monitoring dashboards.
» Go To: Part 2, Use Digital Technology for Scaling

Unforeseen Conditions and Field Changes

Prior to the start of construction, a plan for dealing with unforeseen conditions should be laid out. Given the nature of working with existing houses, unforeseen conditions are expected and may require minor adaptation of the initial design or work plan. By having clear protocol on how this will be addressed, as well as some contingency funds set aside, the impact on the project timeline and outcomes is minimized. There is a trade-off between the level of investigation in a house structure during the design phase and the level of unforeseen conditions encountered in construction: to some extent, it is

Engineer and building inspector reviewing the construction works with the builder, LAMIKA Housing Retrofit Project, Haiti, 2014.

a more efficient investment to plan to accommodate some changes during construction than to perform extensive or destructive testing during the assessment and design phases.

Construction Worker Safety

Programs should develop a construction safety policy and an awareness and implementation plan for their execution. Some basic measures that can be used to help facilitate construction worker safety include the following:

- outlining safety policy requirements in the program
- contracts with implementers, or in the model contract
- drawing up contracts between homeowners and construction workers
- ensuring that the calculated construction costs and payments for construction workers include a sufficient amount of funding to put in place all required safety measures, such as personal protective equipment (PPE), barriers, temporary support and shoring, etc.
- including checks and confirmation of policy implementation as part of the regular construction quality site observation checks and reports

Particularly in the case of structural retrofitting of existing houses, construction worker safety also involves the appropriate use of shoring (i.e. installing temporary supports) and other temporary works to ensure the stability of the structure while the work is underway. Guidance on minimum requirements for temporary works and shoring should be provided to the contractor in the project documentation. Review of the shoring and temporary works should be part of the construction quality supervision process.

3.7 Use of Technology for Implementation and Reporting (T)

Digital tools and digital platforms can help to create efficiencies, improve transparency and accountability, and facilitate reporting during the Implementation stage.

Digital technology can help to keep records transparent and consistent throughout the program and will improve the efficiency and speed with which implementers collect and process data. Using a digital platform, this data can be made available instantly for reporting and other purposes, can help inform future programming, and can be used to make real-time adjustments to programs that are already underway.

In places where the use of smartphones and tablets is feasible, we therefore recommend that digital versions of inspection forms, guidelines, and handbooks should be used to support all stakeholders. While on site, implementers may benefit significantly from having the most up-to-date information available to share with project stakeholders via a phone or tablet.

Stage 4: Closure

FIGURE 27 Stage 4: Closure

	People (P)	Money (M)	Technology (T)
Stage 4: Closure	Formalizing completion	Contract closures	Updating resources
	Sustainability		

SOURCE: BUILD CHANGE

As the final stage of a resilient housing program, the Closure stage refers to formalizing completion of the program, in line with the necessary legal procedures for recording changes to property and allocation of subsidies, for example. Contracts for the completion of works must be closed and settled, and completion of obligations and payments verified. The Closure stage is also an opportunity to update resources, to ensure that updates and learning are carried across to future programs.

While the Closure stage might mark the end of one program, it is the beginning of a continual dialogue with homeowners who were part of the program to promote the sustainable use of home improvements and the resilience of future housing investments.

4.1 Formalizing Completion (P)

Once subsidies have been allocated and home improvements completed, all legal procedures must be finalized. This includes signing and obtaining legal documents to certify that subsidies have been allocated by the relevant authority, and to record home improvements in property registries and/or title deeds or certificates of occupancy.

4.2 Contract Closures (M)

When home improvements have been completed, implementers should verify that the work was done according to the technical specifications included in the contract, and the completion of contractual obligations must be certified. The process for this will differ across programs, depending on the choice of implementation model—there is no single route. In some cases (for example, in Colombia) the government hires construction firms to perform home improvements at scale. In other cases, it is the homeowner who hires individuals or small firms to complete the works. In all cases, contract closure should be duly documented according to national law, and any discrepancy (structural or other) should also be clearly recorded.

An essential element at this stage is for households to confirm that works have been completed according to the initial commitment and to the agreed quality standards.

4.3 Updating Resources (T)

The technical resources that were used as reference documents and tools for the project development and implementation should be reviewed and updated based on lessons learned during the course of the project execution. This will enable improvements to be made and facilitate the next cycle of resilient housing program implementation.

4.4 Sustainability (P) (M) (T)

Sustainability here refers to promoting sustainable use of home improvements and ensuring the resilience of future housing investments.

Once home improvements are complete, it is important to monitor the situation and maintain communication with the homeowner to ensure that resilience considerations are taken into account in the use of the home and any future structural changes or additions. The homeowner should be informed of the new limits of the house structure after the improvements—for example, where the future addition of stories, rooms, or wall openings could bring new or different risks, and what modifications may be acceptable. This continual dialogue and monitoring can also help the government to generate awareness among the wider population of the need to incorporate resilience considerations when building or improving a home.

5
The Road to Resilient Housing in Colombia

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Neighborhood assessments in Rafael Uribe Uribe, Bogotá

Introduction

Colombia is an example of a country with a large qualitative housing deficit, comprising high-density areas of informally-constructed housing in its cities, concentrated in areas exposed to earthquakes. **Part 5** of *The Build Change Guide to Resilient Housing* provides an in-depth account of progress toward resilient housing in Colombia, where the structural upgrading of existing informal housing as a preventative measure is today being enabled at scale through several groundbreaking subsidized home improvement initiatives.

Build Change and our partners have been working since 2012 to demonstrate the huge opportunity for the upgrading of existing housing as a viable solution to the qualitative housing deficit in Colombia, where an estimated 28 million Colombians need to improve the structural integrity of their homes. Through highlighting the case of Colombia, **Part 5** demonstrates how the fundamental ideas and principles contained within **Parts 1–4** of this guide are being applied, presenting a valuable and timely opportunity for governments and practitioners to learn from its successes and challenges.

Today, the Colombian government's flagship home improvement program, *Casa Digna, Vida Digna* (Dignified House, Dignified Life)—along with major local initiatives such as *Plan Terrazas* in Bogotá—are directly addressing the need to reduce structural deficiencies in informal housing, while also seizing the opportunity to improve living conditions in ways that can support growth and expansion (for example, by strengthening the ground floor to allow for the addition of a second story). Backed by institutional commitment and strong technical expertise, work is already underway in major cities, with thousands of homes improved to date.

In May 2021, the World Bank announced it would be providing $136.7 million in financing to improve housing and vulnerable neighborhoods in urban and rural areas of Colombia, as part of the Global Program for Resilient Housing. The government of Colombia has successfully rolled out the program with their own funds, and is now scaling up efforts with this funding from the World Bank. Build Change's work providing lessons learned and recommendations to the World Bank, along with technical expertise and guidance to the Government of Colombia and Findeter (the program implementer) has been instrumental to the program's success.

As part of our Memorandum of Understanding with the Ministry of Housing, City, and Territory in Colombia (*Ministerio de Vivienda, Ciudad y Territorio*, MVCT) Build Change is providing technical assistance to support the scaling of the CDVD program nationwide, while continuing to work with the Cities of Bogotá, Medellín, Cali and others on local initiatives. Together, we are working to reach more homes, develop the necessary mechanisms to improve homes of greater structural complexity, and to refine and improve processes through continuous innovation.

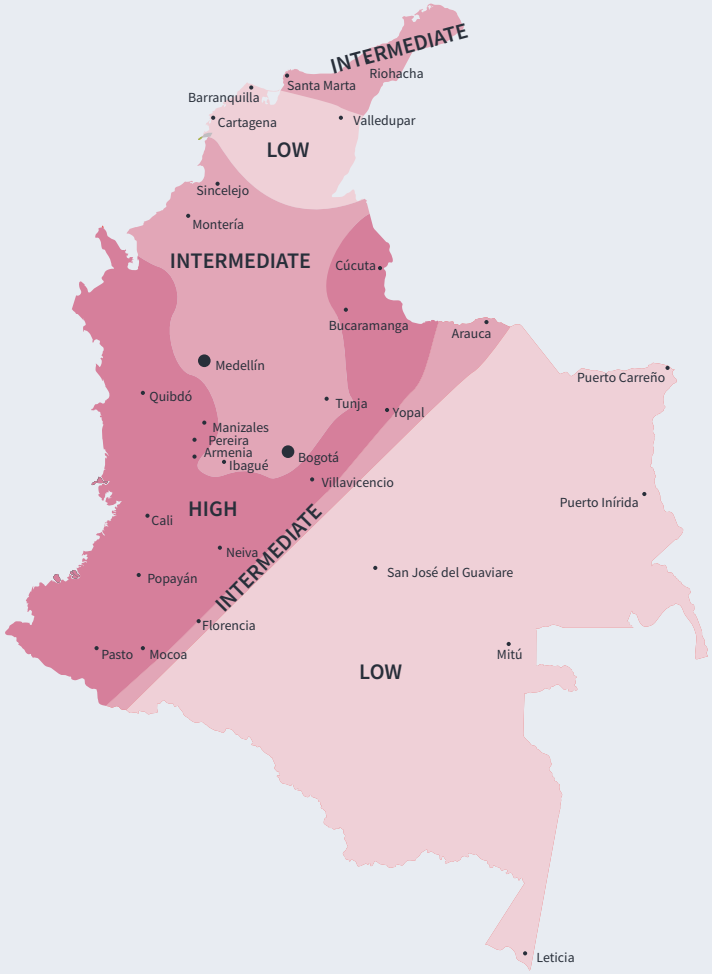
This section will look in more depth at how Build Change and other stakeholders have been working with the government to carve out a viable pathway for the resilient housing initiatives we observe today in Colombia. As we look at how areas relating to People, Money, and Technology are progressing, we will highlight some key milestones, look beyond to future opportunities, and reflect upon lessons learned.

Houses in the San Isidro neighborhood in Usme, Bogotá

» 5.1 The Housing Deficit in Colombia

Box 5.1 Colombia: Population, housing, and hazards statistics

FIGURE 28 Seismic risk zones in Colombia



SOURCE: ELABORATION OF MAP FROM COLOMBIAN ASSOCIATION OF SEISMIC ENGINEERING (AIS), *REGLAMENTO COLOMBIANO DE CONSTRUCCIÓN SISMO RESISTENTE NSR-10: TÍTULO A—REQUISITOS GENERALES DE DISEÑO Y CONSTRUCCIÓN SISMO RESISTENTE*, A-17.

Total population: 48.3 million people, 14.24 million households (3.4 people per household)*

Urban population: 37.2 million (77.1%)*

Quantitative housing deficit: 9.33% (1.32 million homes)*

Qualitative housing deficit:
Excluding structural vulnerability: 25.26% (3.6 million homes)

Including structural vulnerability: 70% (10 million homes) †

Hazards: Earthquakes, cyclones, flooding, landslides, volcanoes, tsunami, extreme heat, wildfires

Exposure to seismic risk: Approximately 83% of the population live in areas of intermediate or high seismic risk.‡

Common housing types: Load-bearing masonry, 1–3 stories, partially confined, reinforced concrete slab roofs, hollow clay tile, or concrete block masonry units

City-level loss estimates due to earthquakes:
Bogotá: $46–120 billion, Medellín: $17–41 billion §

* National Administrative Department of Statistics (DANE), 2018 census data

† The categorization of housing as qualitatively deficient by DANE includes an absence of roof, floor, or walls. This is the "excluding structural vulnerability" figure above. DANE's figures do not consider the structural vulnerabilities of those features when they are present. Therefore, the higher estimate stated under "including structural vulnerability" is based on Build Change housing studies.

‡ Based on information published by the Bogotá Institute of Risk Management and Climate Change (IDIGER), available at https://www.idiger.gov.co/rsismico.

§ The ranges represent losses in the case of a moderate-sized scenario (the lower number) and an extreme scenario (the higher number). Data retrieved from Lloyd's and Cambridge Centre for Risk Studies, "Lloyd's City Risk Index 2018," accessed July 15, 2021. Available at https://cityriskindex.lloyds.com.

Informal housing in Medellín, Colombia
CREDIT: MILO MILOEZGER/UNSPLASH

Colombia is an upper-middle-income country with a population of 48.2 million. It is highly urbanized, with over 77% of people now living in cities.

Rapid urbanization in Colombia has contributed to a significant number of people struggling to afford adequate and safe homes, and a high prevalence of informally constructed housing. According to the Center for Construction and Regional Urban Development Studies in Colombia (CENAC), three out of every five homes that are built are constructed informally, without the support of a licensed professional or a building permit.[1] Subsequently, it is very common to find multi-story homes with significant structural deficiencies, basic sanitation, and inadequate design and use of space.

In spite of significant investment by the Colombian government to build new social housing for low-income households in recent years, a huge and increasing number of families live in substandard housing. While official figures place this qualitative housing deficit at 25% of households (3.6 million households), this measure does not account for the structural vulnerability of houses. Studies by Build Change indicate that the deficit is closer to 70%, which would suggest that approximately 28 million Colombians live in structurally inadequate housing that is vulnerable to even moderate earthquakes.[2]

Earthquakes: A Major Threat to Lives and Financial Resources

Colombia's mountainous, volcanic landscape exposes people to a range of natural hazards, adding greater urgency to the issue of access to resilient housing. However, with most of Colombia's main cities located in areas of intermediate or high seismic risk (Figure 28), it is earthquakes that pose the greatest threat to housing—and the potential loss of lives and financial resources as a result.

Major earthquakes have generated high costs for Colombia, killing more people and causing greater damages and financial losses with each event. The 1983 Popayán earthquake (5.6 M_W),

1 IDIGER estimates that over 700,000 homes in Bogotá (70%) are built with substandard masonry (IDIGER, "Modelación del riesgo sísmico en edificaciones para la ciudad de Bogotá, 2018." Available at https://www.idiger.gov.co/rsismico). In Medellín, that percentage rises to up to 80% according to the Global Earthquake Model (https://sara.openquake.org/risk:detailed_exposure:risk_colombia).

2 Build Change arrived at this figure by taking a national population of 48.3 million people, and applying the fact that 83% (40 million people) reside in areas of high and intermediate seismic risk. By applying IDIGER estimates for the number of homes constructed using unreinforced masonry, we are able to assert that 70% of that figure (28 million people) live in structurally substandard housing.

caused an estimated 250 deaths and injured thousands. The 1999 Armenia earthquake (6.1 M_w), caused over 1,000 deaths, made an estimated 200,000 people homeless, and destroyed 60% of buildings in the region, with losses of US$1.9 billion.[3]

The 1917 Sumapaz earthquake (~M_w 6.9) was the last major earthquake to hit the country's capital, Bogotá, killing six people and causing approximately 300 buildings to collapse, at a time when the city had just 120,000 inhabitants. Today, over 10 million people live in the Bogotá savanna area. The Bogotá Institute of Risk Management and Climate Change (IDIGER) estimates that an earthquake of similar magnitude today in Bogotá would result in losses of US$19 billion, and damage to upwards of 38,800 city blocks.[4]

Common Housing Types and Vulnerabilities

Masonry construction represents 90% of residential buildings in Bogotá and Medellín—Colombia's two biggest cities, both located in areas of intermediate seismic risk. A large majority of informal houses are built of load-bearing masonry, which is typically unreinforced or insufficiently confined. This kind of construction is not permitted in areas of high or intermediate seismic risk under current Colombian law. In spite of this, IDIGER estimates that unreinforced masonry construction accounts for 75% of buildings in Bogotá.[5]

The majority of informal homes are one to three stories high, though examples of much taller structures have been regularly observed. Houses are frequently built incrementally, with additional stories added to the original building as resources allow. Deficiencies typically increase in relation to height, and the resulting increased demands on the building.

A more detailed overview of the typology and vulnerabilities for typical one-, two-, and three-story houses in Colombia can be found in Appendix 1.

Many informally constructed homes in Colombia are highly vulnerable to even moderate earthquakes

3 Cinna Lomnitz and Michio Hashizume, "The Popayán, Colombia, earthquake of 31 March 1983," *Bulletin of the Seismological Society of America* 75, no. 5 (1985): 1315–1326; José I. Restrepo and H. A. Cowan, "The 'Eje Cafetero' Earthquake, Colombia of January 25, 1999," *Bulletin of the New Zealand Society for Earthquake Engineering* 33, no. 1 (2000): 1–29; Colombian Geological Survey, "Sismicidad histórica de Colombia," available at https://www.sgc.gov.co/sismos.

4 Based on a model of 7.3M_w. IDIGER, "Modelación del riesgo sísmico en edificaciones para la ciudad de Bogotá, 2018."

5 IDIGER, "Modelación del riesgo sísmico en edificaciones para la ciudad de Bogotá, 2018."

5.2 Structural Home Improvements: A Response to the Qualitative Housing Deficit

As discussed in Part 1 of this guide, the strengthening of existing homes using simple, prescriptive interventions provides an opportunity for governments to make housing resilient against the impacts of hazards such as earthquakes in a way that is quick and affordable when compared to new construction, along with a range of additional advantages.
» Go To: Part 1, Resilience Through Retrofitting

Colombia has a strong history of government-funded home improvement programs. Support for increased resilience in housing has been most evident following major earthquakes in Popayán (1983) and Armenia (1999). Historically, however, investment has focused almost exclusively on new housing, or neighborhood improvements, such as sanitation, infrastructure, and public transportation upgrades. Making structural improvements to existing homes ("retrofitting") has yet to be achieved successfully at scale.

In recent years, the Ministry of Housing, City and Territory (*Ministerio de Vivienda, Ciudad y Territorio*, MVCT) has outlined a set of policies and programs to address critical gaps in their housing assistance interventions. One such initiative is the national home and neighborhood improvement program, *Casa Digna, Vida Digna* (CDVD), which will direct investment toward upgrading informal housing. This strategy is also being reflected at the local (municipal) level, through new city-wide initiatives such as *Plan Terrazas* in Bogotá.

With national attention and investment now being directed toward upgrading existing houses, there is a clear intention to address the structural inadequacies that make these houses vulnerable. This is a direct result of the on-the-ground efforts of Build Change and our partners, who have been working to demonstrate the advantages, feasibility, and affordability of addressing structural deficiencies for certain common housing typologies, and to support the government to start achieving this at scale through programs such as CDVD and *Plan Terrazas*.

Casa Digna, Vida Digna

In 2019, the national government launched a flagship home improvement program, *Casa Digna, Vida Digna* (CDVD), with the objective of reducing the qualitative housing deficit in 600,000 homes, increasing the resilience of housing, and reducing the indicators of monetary and multidimensional poverty in the country.

MVCT

A multi-story home in Guacamayas, San Cristóbal, Bogotá

CDVD provides home improvement subsidies to eligible low-income households to improve the quality of existing substandard housing and help it to reach minimum compliance with construction standards. CDVD also addresses issues of property titles and land tenure regularization, and supports upgrades to neighborhoods and public infrastructure (i.e. parks, public spaces, community centers, basic water supply, and sanitation).

CDVD is a groundbreaking initiative in Latin America as it has been designed to incorporate the structural improvement of existing housing at a national scale—something that has not been attempted before.

CDVD is a groundbreaking initiative in Latin America as it has been designed to incorporate the structural assessment and improvement of existing housing at a national scale—something that has not been attempted before. Structural strengthening works being carried out under the CDVD program include the following:

- construction of structural home elements and different types of retrofitting (i.e. foundations, roofs, beams, columns, and walls, among others)
- non-structural interventions that reduce the vulnerability of the home, such as adding lintels (structural horizontal blocks typically used above doors and windows), and adding or reinforcing dividing walls.

Following an initial assessment, eligible houses are placed into one of three categories, with incremental improvements defined for all three categories (Table 4).

The same categories are also used to determine the maximum available subsidy amounts, which are given in relation to the monthly minimum wage (MMW) in Colombia. The current maximum home improvement subsidy is equivalent to up to 18 times the MMW (18 x MMW, or approximately US$4,210) in urban areas and up to 22 times the MMW (22 x MMW, or US$5,150) in peri-urban and rural areas.[6]

Following categorization, home improvement needs will be identified and relevant solutions proposed.

As part of an agreement with the MVCT, and with the support of the Autodesk Foundation, Build Change is providing technical assistance to support the scaling of the CDVD program

TABLE 4 Home improvement intervention categories and subsidy amounts: *Casa Digna, Vida Digna*

	Description	Permitting	Maximum subsidy amount (in MMW)
Category 1 (Light): Habitability improvements	Homes that do not require complete structural strengthening but need other qualitative improvements Simple, effective interventions that contribute to vulnerability reduction, e.g. adding a ring beam and plastering walls	Permit not required	Up to 12 x MMW (US$2,800)
Category 2 (Intermediate): Structural improvements	Homes that require structural strengthening and habitability improvements Moderate intervention, with seven options for structural improvements	Permit and professional sign off required	12–18 x MMW (US$2,800–$4,210)
Category 3 (Heavy): Structural retrofitting	Homes that require structural strengthening and other qualitative improvements Extended intervention; full design and approval processes to be followed Structural interventions—which may include seismic vulnerability mitigation—must be carried out prior to other qualitative improvements	Permit and professional sign off required	Up to 18 x MMW in urban areas (US$4,210) Up to 22 x MMW in peri-urban and rural areas (US$5,150)

SOURCE: COMPILATION AND ELABORATION OF DATA ESTABLISHED BY DECREE 1077/2015 AND MODIFIED BY DECREE 867/2019 (GOVERNMENT OF COLOMBIA), AND INFORMATION FROM THE WORLD BANK'S *ROADMAP FOR RESILIENT HOUSING: THE PATH TO LIVABLE, DISASTER AND PANDEMIC RESILIENT HOUSING*, (GLOBAL PROGRAM FOR RESILIENT HOUSING, 2020).

6 For the year 2021, the MMW is COP 877,803 or approximately USD 235, applying a rate of USD 1 = COP 3,750.

nationwide and its expansion to include homes of greater structural complexity.

More details about CDVD, including how it is funded and structured, who the key stakeholders are, and implementation processes, have been included at the end of Part 5.

Plan Terrazas

Announced in February 2020, *Plan Terrazas* is a home improvement pilot program to help 1,250 families living in informal housing in Bogotá to structurally strengthen their homes in order to allow for the addition of a second story. In doing this, the goals are to increase the resilience of the home against earthquakes and other hazards, improve living conditions, and provide families with extra opportunities for income generation (for example, by generating commercial or rental income from the additional story).

CAJA DE LA VIVIENDA POPULAR

In many cases, the chance to make changes that will improve daily life, such as increasing the available space or improving sanitation, can be more appealing to homeowners than the need to make structural improvements (see Part 2, Box 2.4). *Plan Terrazas* is an example of how habitability improvements can act as an effective incentive for homeowners to undertake structural upgrades, leading to increased safety and resilience.

Plan Terrazas is an example of how habitability improvements can act as an effective incentive for homeowners to undertake structural upgrades.

In partnership with *Caja de la Vivienda Popular* (Bogotá's neighborhood and home improvement implementer), Build Change has been supporting the implementation of *Plan Terrazas* in several ways:

- by overcoming challenges within existing urban policy in order to pave the way for the retrofitting of informal housing, for example, by simplifying permitting procedures
- by advocating for subsidy increases and subsidy reform
- by providing technical assistance, technology, and training to the City of Bogotá

As the first city-wide program in Colombia that has incorporated retrofitting into its home improvement programs, *Plan Terrazas* is a significant initiative that will serve as a good basis for how to conduct more complex Category 3 retrofits, and in doing so contribute to progress at national level.

Plan Terrazas *will strengthen homes such as this one in Bogotá, to allow for the safe addition of a second story*

5.3 Progress Toward Resilient Housing in Colombia

As in other Latin American countries, Colombia's qualitative housing deficit is growing while its quantitative deficit is largely reduced. In recognizing this, the emphasis of national and local responses has been shifting from new construction toward home improvement. This section will look in more detail at the changes that have been taking place.

Build Change has directed our expertise toward innovating in the key areas of People, Money, and Technology, to progressively improve conditions for achieving resilient housing at scale. This has involved the alignment of new policies and regulations, designated funding for structural upgrading, and continuous technological innovation in order to enable both national and local governments in Colombia to confront the need for structural improvements to existing housing head-on.

Throughout our work, we have found that the principal barriers to resilient housing programs can be loosely grouped into these three categories. For example, some of the major reasons that structural retrofitting has not previously been successful in Colombia can be attributed to the following issues:

- complex bureaucratic processes with regard to permitting (People)
- a lack of adequate subsidies and financial incentives available for retrofitting (Money)
- a lack of easy-to-implement, pre-approved evaluation and design criteria (Technology)

By applying our Resilient Housing Ecosystem Assessment Tool (RHEAT™) (see Part 2.3), we have been able to assess and monitor progress against various indicators across each area.

What follows is a discussion around how progress toward resilient housing has developed across each area (People, Money, and Technology) in recent years, highlighting some key challenges and milestones, and reflecting upon future opportunities. **» Go To: Part 2, Our Theory of Change: Overcoming Barriers of People, Money, and Technology**

People (P)

"People" refers to the different roles of stakeholders in creating demand for resilient housing, while ensuring the policy conditions that enable it to happen are met.

National Policy and Legal Framework

The housing sector is led by the MVCT, with the National Planning Department responsible for national policies and program planning and reporting.

A comprehensive national policy and legal framework already exists for addressing the housing deficit in Colombia. This is reflected in the following ways:

- Decent housing is a constitutional right in Colombia.
- Housing is included in National Development Plans.
- The need to improve habitability and reduce the vulnerability of buildings has been recognized by ongoing and previous subsidized home improvement programs, including against the impacts of climate change.

With the launch of CDVD, the structural vulnerability of housing is being formally addressed within the national policy and legal framework for the first time.

FIGURE 29 RHEAT™ indicators, "People"—Colombia

PEOPLE/POLICY	Pre-2014	2015–2019	CDVD
National Policy and Legal Framework			
Acknowledgment and Framing of Problem			
Building Codes and Regulations			
Local Level Implementation Framework			
Homeowner Perception and Participation			

KEY

- Initial stages (Inexistent or not working)
- Getting ready (Existent, needs fixing)
- On the road (Working, needs fine-tuning)
- At desired level (All good)

Acknowledgment and Framing of Problem

The acknowledgment of a need to increase resilience is often most observable in the wake of a major event. As time passes, the sense of urgency may wane, and national priorities are redirected. This is true for Colombia, where, following the Armenia earthquake of 1999 and the substantial loss of life and financial losses that resulted, the need for buildings to be structurally upgraded was high on the public agenda. Finance was allocated toward the structural upgrading of approximately 3,000 homes, and new legislation was put in place to make this possible. In spite of this, only a few of these structural upgrades took place, most of which involved completely rebuilding the home. In the years that followed, the legislation laid dormant and the associated funding was diverted to other non-structural upgrades.

Rather than waiting for another earthquake to bring national attention back to vulnerable housing, Build Change and partners set to work to revive the conversation and place the urgent need to upgrade substandard housing firmly on the public agenda once again. This has been achieved by treating the issue of substandard housing as a public health emergency, thus assigning it the urgency it deserves, and by bringing together stakeholders globally, nationally, and locally, to raise awareness around the issue of substandard housing, present tangible solutions, and create demand for resilient housing.

While work is ongoing, and there are many more areas where progress is needed, bringing national stakeholders together around this issue and demonstrating the feasibility and affordability of structural home improvement work have been integral to programs such as CDVD and *Plan Terrazas*.

Building Codes and Regulations

Dedicated offices for disaster risk management and climate change exist, such as the National Unit for Disaster Risk Management (UNGRD), and IDIGER in Bogotá. The Colombian Association of Seismic Engineering (AIS) is the seismic code body that supports the continued development and integrity of building engineering technology in order to mitigate the risks of earthquakes.

Building Codes and Regulations are overseen by the Building Code Authority, the Permanent Advisory Committee for Seismic-Resistant Construction.

Building codes exist for new, disaster-resilient construction.[7] However, prior to 2015 there were no code-compliant

Maria Amalia Suárez in front of her newly strengthened home in El Amparo, Kennedy, Bogotá. Maria's home was the first permitted upgrade carried out by Build Change in Colombia.

7 NSR-10, the current construction code which is categorized as a National Regulation as described in Law 400 of 1997.

Camargo family home, Bogotá, Colombia

Added ring beam, confining elements, and plaster, and improved roof and sanitation

Díaz family home, Medellín, Colombia

Added ring beam, confining elements, plaster and mesh plaster, upgraded roof, and improved sanitation

guidelines with regard to making structural improvements to existing informal housing. Several key milestones in this area have since been reached:

- Build Change developed the first code-compliant evaluation and retrofit design method for retrofitting existing masonry housing up to three stories high in Colombia.
- This was then further developed into a Retrofit Manual for the National Vocational Training Service (SENA) in 2015, to expand their builder-training curriculum to include retrofitting of existing housing.
- In 2015, the manual was approved by the Colombian Construction Code Commission.

Build Change has since been working closely with AIS to produce an AIS-owned version of the manual that will make it the official guidance document for retrofits in Colombia for masonry buildings of up to three stories high and will inform public policy.

Local Level Implementation Framework

Colombia is a regional leader in urban land regularization programs, and continues to invest in this area. Land tenure is the first step in the homeowner journey to home improvement in Colombia, providing a pathway for neighborhood infrastructure investment, site risk reduction, and home improvement.

Legislation introduced following the Popayán and Armenia earthquakes has been beneficial in terms of progress toward resilient housing as certain measures for dealing with informal housing were already in place. This includes the Act of Recognition and a retrofit permit.

Build Change and IDIGER have been using street theater in neighborhoods where informal housing is prevalent in Bogotá. This has been helping to engage people in understanding the factors that make their homes vulnerable to earthquakes, and raise awareness about safer building practices.

- **Act of Recognition:** For families living in self-constructed/informal housing who wish to apply for home improvement subsidies, such as those offered through CDVD or *Plan Terrazas*, the Act of Recognition offers a special "fast track" through which their home can be formally "recognized" and, once the minimum structural requirements are met, given legal building status by the local authority.
- **Retrofit permit:** Home improvement that does not change the use or the structure of a house does not need permitting in Colombia. However, for any modification that creates new space, modifies use, or involves adapting the structure in any way, a construction license (or "retrofit permit") must be obtained. The process for this is specific to each city. Additionally, the proposed intervention will need to follow municipal planning regulations in force for the zone, and the design must be approved by a licensed professional.

Build Change has been working with partners to facilitate and simplify homeowner qualification processes, design, and construction permit regulations for the implementation of resilient housing. The objective has been to reduce bottlenecks and eradicate unnecessary barriers for the most vulnerable to improve their homes. In our experience, these obstacles can discourage common-sense structural retrofits and deter or prevent people from taking action.

Substantial progress has been made in updating legislation, simplifying procedures, and increasing accessibility for low-income families. One example of major regulatory reform in this area in response to Build Change's advocacy work is the *Curaduría Cero* (Zero Curatorship) initiative. Under *Curaduría Cero*, the assessment, design, and permitting processes of informal housing have been reclaimed from private agencies and placed back into the hands of local government. This will ensure that permits for existing, informal housing in cities are provided free of charge to those who are most vulnerable.

Homeowner Perception and Participation

As has been discussed in depth in Part 2 of this guide, both demand for resilient housing and its supply are determined by homeowners wanting to improve their homes, and having access to the necessary awareness and financial and technical resources with which to achieve this. Subsequently, progress in terms of homeowner perception and participation cuts across all three areas of People, Money, and Technology.

Demand for resilient housing increases when governments choose to prioritize it. Further progress can be made by continuing to build awareness among homeowners regarding their exposure to hazards, and educating people about the structural vulnerability of their homes, safer building practices, and the available resources. Increasing homeowner awareness with regard to applicable building codes and regulations is also

necessary to encourage compliance as new homes are built or as home improvement work gets underway.

As will be discussed later in this section, dedicated technical assistance for homeowners and the local workforce is helping to support the supply of resilient housing in Colombia. Continued technical assistance will be critical to making sure families receive essential guidance throughout the application, permitting, design, and construction phases. Increased homeowner engagement can help to raise awareness of the technical support that is available, and ensure it is widely accessed. Technical assistance can also increase demand for resilient housing among homeowners, by taking a holistic approach toward home improvement that can address families' wider needs. **» Go To: Part 2, Don't Just Save Lives—Improve Lives**

Money (M)

"Money" relates to ensuring there is adequate financing for resilient housing.

National Budget Allocation

Prior to 2019, the national budget for housing in Colombia was being directed almost exclusively toward new construction. Following a change of administration in 2018, the new government was convinced to divert funding away from new construction in favor of home improvement. The government's updated housing plan would later be approved by Congress, and written into the National Development Plan, thereby ensuring the current funding commitments. Additionally, financing of $136.7 million announced by the World Bank in May 2021 will be used to support resilient housing initiatives in Colombia over the next five years.

In cities such as Bogotá and Medellín, funding had previously been allocated at local level toward structural improvement work following the Armenia earthquake. However, this funding had laid dormant, without the policy and technological framework in place to support its use. Work by Build Change and partners to mobilize investment, such as the proofs of concept in Bogotá and Medellín (Box 5.2), has helped to change this.

Additionally, data analysis and modeling has helped to attract the attention and investment of both national and local government and drive reforms across all areas of People, Money, and Technology.

- Cost-benefit studies conducted by Build Change have helped to demonstrate the huge cost saving of retrofitting when compared to new construction and new social housing. In Bogotá, structural upgrades of one-story homes following our methodology are being completed with an average materials and labor cost of COP 17 million (USD 4,533). This is approximately 32% of the cost of building a new house of the same size, and 40% of what it costs to build a new social housing unit in Colombia.[8]
- Further analysis has provided a compelling argument for investment in structural strengthening to prevent loss of life and assets in the event of a major earthquake. Preliminary modeling by Risk Management Solutions (RMS) showed how upgrading existing informal housing in just four neighborhoods in Bogotá following the methodology proposed by Build Change could save up to an estimated 120,000 lives and $2.8 billion in losses.[9]

FIGURE 30 RHEAT™ indicators, "Money"—Colombia

MONEY	Pre-2014	2015–2019	CDVD
National Budget Allocation			
Government Subsidized Home Improvement			
Money for Technical Assistance			
Private Sector Lending for Home Improvement			
Homeowner Participation			

KEY

- Initial stages (Inexistent or not working)
- Getting ready (Existent, needs fixing)
- On the road (Working, needs fine-tuning)
- At desired level (All good)

8 The equivalent materials and labor cost of building a new house of the same size is estimated to be over COP 54 million (USD 14,400). Social housing here refers to Priority Interest Housing, which are the lowest-cost new social-interest homes.

9 This preliminary analysis modeled a 200-year return period earthquake event and studied retrofitting in four neighborhoods of Bogotá over a ten-year period. The study was based on Build Change retrofit methodologies and existing government subsidy systems. The direct effects of retrofitting conducted by Build Change were modeled by RMS in terms of costs, cost savings, reduction of losses, and reduction of injury and deaths.

Box 5.2 The proof of concept for home strengthening in Colombia

The successful execution of multiple proofs of concept has been a major catalyst for progress toward resilient housing in Colombia. Initiatives in Bogotá and Medellín have demonstrated how relatively simple solutions can increase the resilience of a typical informal home in urban Colombia, within the current government subsidy amounts. This has led to greater demand and investment for structural home improvements, and critical regulatory reforms for achieving these at scale.

The first housing upgrade was completed in Bogotá in 2014, and implemented in collaboration with Swisscontact and SENA. This work preceded the current permitting mechanisms in place for structural improvements to existing housing. Through this first project, Build Change established a new evaluation and retrofit design method for common housing types of up to three stories.

Following this, the City of Bogotá opted to expand the program to more homes. Build Change worked alongside the City to obtain the first permits for upgrading existing informal homes in accordance with the new evaluation and retrofit design method.

Through this larger proof of concept, Build Change evaluated, designed, built, and funded the first ten permitted structural home improvements in Bogotá, and would later oversee the structural upgrading of five homes in Medellín (with the support of Arup, RMS, Swisscontact, and other donors). ***These were the first funded, permitted structural upgrades using a code-compliant method for existing informal housing since the Armenia earthquake reconstruction effort in 1999.***

These proofs of concept clearly demonstrated how structural interventions could be combined with habitability improvements (such as to lighting, sanitation, and security) to incentivize home strengthening while giving families access to healthier and safer homes. They succeeded in attracting the attention of both national and local government—thus helping to drive investment and regulatory reform.

Jorge Prada (pictured) is a builder who took part in the structural upgrading of his own home with the support of Build Change and Swisscontact in Bogotá, 2014

Another of the first home strengthening initiatives supported by Build Change, in Usme, Bogotá

Government Subsidized Home Improvement

Subsidized home improvement programs exist, but have typically focused on new construction or habitability improvements. Where relevant policies do exist, they may be restrictive or outdated, preventing public subsidies from being used for home strengthening.

Developments and innovations in the amounts of subsidies available and how they are allocated has been a major achievement on the path to systems change in Colombia.

At national level, the government has committed to making subsidies available for both habitability and structural improvements through the CDVD program (Table 4).

Furthermore, a co-financing model hopes to encourage more cities to join the program. Local municipalities who wish to participate must contribute 20% of the financing, with the remainder provided from national level.

Subsidy reform is also taking place at local level. Following the first ten home improvements with the City of Bogotá, the City was convinced to reform its subsidy policy as follows:

- The amount given to homeowners was increased by 45%, from 18 to 26 x MMW.
- The structural retrofit subsidy (26 x MMW or approximately US$6,000) can now be combined with the non-structural improvement subsidy for sanitation and finishes (18 x MMW), with the total potential allocation coming close to US$10,000 per intervention.

The City of Bogotá continues to update its subsidy policy to offer greater flexibility in the range of subsidies available for structural improvements, retrofitting, and expansion.

The City of Medellín has taken a similar approach and has been successful in implementing improvements using their own funding in a way that integrates habitability, sanitation, and structural upgrading to improve living conditions and reduce vulnerability.

Progress in terms of the reforms to the allocation and administration of subsidies is a direct response to the work of actors such as Build Change who have been advocating to ensure that preventative, structural home improvements are firmly within the reach of low-income families. The need for subsidy reform has since been supported by more than 100 designed and costed housing upgrades in Bogotá and Medellín.

Subsidy reform is incentivizing many more cities to think about home strengthening. It reflects how mindsets are changing, as cities are being convinced to take a more holistic approach toward home improvement, to contribute their own funds to do this, and to facilitate housing upgrades for low-income families living in substandard housing.

Subsidy policies can continue to be developed to offer greater flexibility, in terms of how much financing can be made available, who is eligible, and what it can be used for.

Further progress is possible through raising homeowner awareness around access to funding, and developing innovative mechanisms through which homeowners can fund their own retrofitting. This may be achieved in future through new credit instruments that offer preferential financing options for inhabitants of the most vulnerable homes.

Money for Technical Assistance

Technical assistance here refers to supporting program implementers, homeowners, and the workforce to deliver resilient housing. Governments must commit to funding dedicated technical assistance for these groups to ensure the success and longevity of any program.

Prior to 2014, some funding was available for providing technical assistance to the workforce, but funding for providing technical assistance to key stakeholders such as implementers and homeowners was limited.

While work in Colombia is in its early stages and there is much still to be achieved, there has been substantial progress at both national and local levels in this area. The MVCT has started funding technical assistance, which is being provided to cities through private operators. Progress is also evident locally in the example of *Plan Terrazas*, where the City of Bogotá is investing their own funds to hire engineers and implementers in order to provide assistance to homeowners. The fact that national and local governments are now funding this assistance is a major step forward on the road to resilient housing.

Private Sector Lending for Home Improvement

The future participation of the private sector is an area that is to be encouraged and developed as one of many “next steps” in Colombia. A proposed pathway for this is through blended financing strategies that use lending from the private sector to supplement public subsidies. Market sector studies by Build Change in Colombia have demonstrated significant demand for affordable home improvement loans among low- and middle-income families, to increase the resilience of what—for most families—is their most valuable asset.

One notable area of progress has been through the Association of Family Compensation Funds (ASOCAJAS) which provides housing subsidies through the Social Housing Fund (FOVIS). This fund is aimed at low- and middle-income Colombians to supplement contributions made by its members, and can be paired with loans. Use of the FOVIS fund is directed by the national government. Whereas typically it has been directed toward the construction of new homes, it is increasingly being directed toward enabling its members to improve or repair their homes.

Technology (T)

"Technology" relates to the supply of resilient housing, including assessments, design and construction, and workforce development.

To support the key areas listed in Figure 31, Build Change has been refining and adapting its digital workflows to increase the scope of what is possible, improve efficiency, and generate major cost savings in order to help the government achieve vulnerability reduction at scale (Box 5.3).

Developments in digital technology are being supported by extensive training and technical support to stakeholders at all levels, to ensure that technology is widely accessible and effective, and to integrate it within existing workflows and systems. Sustained innovation is essential to ensuring the continued relevance of tools to those who use them, and to make home strengthening more cost effective. **» Go To: Part 2, Use Digital Technology for Scaling**

Box 5.3 Increased efficiency through digital technology

Digital technology is being leveraged to great effect in Colombia, and is increasing efficiency in some of the following ways:

- **Facilitating site visits, data collection, and decision making:** Data capture tools enable actors working in the field to categorize, evaluate, design, and prioritize interventions during a single site visit.
- **Assisting the design process:** The use of Building Information Modeling (BIM) tools has reduced design production times by up to 75%.
- **Simplifying approval procedures and reducing errors:** A reduced number of forms are automatically generated and can be quickly distributed and updated.
- **Increasing transparency and accountability:** Enhanced data management is improving construction supervision, quality control, and feedback mechanisms.
- **Improving communication:** Homeowners and the workforce can access up-to-date information, designs, and regulations, perform simple quality checks, report concerns, and access support.

Assessment and Mapping

Vulnerable housing inventory and mapping

A methodology for massive rapid assessments has been created and piloted by the World Bank's Global Program for Resilient Housing, assisted by geospatial tools such as Geographic Information Systems, street view imagery, and drones, to screen large numbers of homes in high- and medium-risk seismic zones, and quickly calculate their basic level of vulnerability. The idea is for governments to adopt this methodology to perform their own vulnerability assessments. Assessments such as these support a greater understanding of risk, which can help public bodies to generate mixed strategies for private financing, credits, and subsidies for the mitigation work that is needed in each case.

Build Change has been leveraging existing digital data, software, and digital tools to make use of the latest mapping data, allowing the rapid capture and processing of detailed information from homes where intervention is necessary. Google Street View surveys have proved a simple, quick, and cost-efficient way of doing this (Box 5.4). Images and data from Google Street View have helped to raise awareness among government decision makers with regard to the issues faced by people in secondary cities and more remote areas, with the results of our analysis leading to the deployment of substantial financing and technical assistance.

Structural vulnerability assessments

Build Change has worked with partners to establish differential

FIGURE 31 RHEAT™ indicators, "Technology"—Colombia

TECHNOLOGY	Pre-2014	2015–2019	CDVD
Assessment and Mapping			
Building Permitting, Licensing, and Quality Control			
Design and Construction			
Technical Capacity of Construction Workforce			
Homeowner Perception and Participation			

KEY

- Initial stages (Inexistent or not working)
- Getting ready (Existent, needs fixing)
- On the road (Working, needs fine-tuning)
- At desired level (All good)

Box 5.4 Rapid assessments using Google Street View

Build Change used Google Street View to capture images of 274 neighborhoods in thirteen municipalities in Colombia. This technology enabled basic information about buildings and neighborhoods to be collected rapidly, for example, construction type, number of stories, and the presence or absence of steep slopes. Google Street View images were available for 70% of neighborhoods on the list provided by the government, and helped to give a quick, initial indication of the potential eligibility of houses for improvement work as part of the CDVD program.

methodologies for the broad concept of (structural) vulnerability, and to develop and implement a screening process for categorizing homes according to the level of intervention required: Category 1 (Light), Category 2 (Intermediate), and Category 3 (Heavy).

The concept of structural screening and categorization of buildings based on structural vulnerability is a new development which has since been written into national policy. It is a central facet of CDVD and helps to determine subsidy amounts, while providing a clear prioritization mechanism (Table 4). Categorization also helps with identifying houses that can be retrofitted quickly and more easily, at lower cost, and to enable easy-to-implement, pre-approved design criteria to be developed for these homes. This is in line with the recommended approach for smarter risk management, as discussed in Part 2 of this guide. **» Go To: Part 2, Smarter Risk Management**

Furthermore, a home screening tool developed by Build Change has enabled non-specialists with basic construction knowledge to quickly and easily determine the category of a house. This is saving time and cost, and helping to overcome challenges associated with geography and workforce availability. Over 67% of homes evaluated through the CDVD program to date have used our digital home screening tool, and there is growing demand for use of the tool from participating municipalities.

Building Permitting, Licensing, and Quality Control

Innovation in areas of digital technology in the form of field data capture tools and BIM have transformed the design and documentation processes for home improvement work, with subsequent improvements for permitting and quality control processes.

Workforce development is being promoted at all levels, to give authorities greater control over construction processes. Through institutional capacity building, Build Change has been enabling the MVCT to successfully conduct structural evaluations and classifications across the country, training operators in cities where programs are underway, and supporting the integration of new processes within existing government systems.

Design and Construction

Much progress has been experienced in the areas of design and construction since 2014, with a range of new technology developed to support these processes across all stages of the construction value chain.

Build Change has been influencing and training stakeholders, their partners, and contractors, to better understand existing housing vulnerability, and to design and execute prescriptive improvements. Stakeholders have included SENA, the Social Housing Institute of Medellín (ISVIMED), *Caja de la Vivienda Popular*, Global Communities, and EAFIT University in Medellín.

Initially, various proofs of concept on real buildings (Box 5.2) provided field validation for the new technology. The structural home improvements that have been carried out since are supporting continued technological innovation.

Simple, scalable engineering designs for structural improvement

After hundreds of detailed retrofit designs and cost estimations, and dozens of actual retrofits performed, Build Change has found that targeted, prescriptive interventions in a large subset of homes can reduce costs, and can also improve structural performance to a level where a more detailed analysis becomes redundant.

Cost-effective, prescriptive engineering solutions already exist for the majority of informal housing types in Colombia (Appendix 1). Work is underway to develop easy-to-implement, pre-approved evaluation and design criteria for a range of different housing types. By making engineering solutions widely known and easily accessible to those involved in design and construction, we are facilitating simpler adoption of these solutions and incentivizing wider participation in home improvement programs. In doing this, we continue to create awareness and change the mindsets of policymakers, technical bodies, engineers, builders, and homeowners around the scope of what is possible.

The Build Change Retrofit Manual

A major milestone in our work in Colombia has been the formal adoption of our Retrofit Manual for the *Plan Terrazas* program. Through our continued work with AIS, the Retrofit Manual is being further developed to support the structural upgrading of more homes, different building types, and more complex retrofits (such as Category 3 homes) as part of the CDVD program.

Workforce

The capacity of Colombia's construction workforce is high, compared to other middle- and low-income countries in the region, with an available skilled workforce for new construction. However, prior to 2014, efforts were needed to develop a skilled workforce for resilient housing. Build Change partnered with Swisscontact to help SENA expand their builder-training curriculum to include retrofitting of existing housing, including through the creation of the Build Change Retrofit Manual for this purpose.

Development of the workforce has continued since then, with the aim of further improving the skills both of those working in construction and of those in wider field operations for resilient housing. Continued capacity building is essential to ensure that workers are trained in the latest approved construction methods and technologies, and in accordance with the latest codes and regulations. There are many more opportunities to be explored in terms of engaging with and making use of the local knowledge base. For example, collaboration with universities can help to build relevant retrofit capacities in their students, to enable easily deployable task forces in the field.

5.4 Lessons Learned

While significant progress toward resilient housing has been made in Colombia in recent years, there are many challenges still to be overcome and opportunities for further expansion. The following lessons from Colombia can be applied more widely, to support global efforts toward resilient housing.

- **Governments must want resilient housing.**
  Housing systems cannot change without government endorsement. The government must believe that change is possible and prioritize it as part of the public agenda. In Colombia, the change of administration has opened up possibilities that did not exist before, and has led to the transformation of housing systems within a matter of years.

- **Meet homeowners where they are.**
  Governments and practitioners should understand and respond to homeowners' existing reality, rather than trying to impose solutions. This will help to deliver holistic and lasting solutions, support community engagement, and create greater demand for resilient housing.

- **Tangible proofs of concept can be highly impactful.**
  The feasibility and affordability of simple home strengthening solutions are most clearly demonstrated through actual houses being built. These can be a powerful and effective means to drive investment, generate momentum, and create demand for resilient housing from governments, homeowners, and funders.

- **Simplify processes to incentivize home improvement.**
  Complex, lengthy, or costly procedures will exclude those most in need of home improvement and act as a disincentive. Resilient housing at scale should be accessible to the most vulnerable homeowners. Expediting design, costing, and building permit application processes will go a long way to supporting this. Further efficiency savings through the use of simple digital tools can transform field operations and information management.

- **Leverage existing expertise.**
  There are many ways through which expertise in the existing workforce can be leveraged, in order to increase economic opportunity and create new employment opportunities in housing upgrades. Compared with other middle- and low-income countries in the region, the capacities of Colombia's construction workforce are high. Through collaboration with vocational training providers like SENA and universities, relevant retrofit capacities can be developed in order to build an easily-deployable workforce.

- **Combine home improvement subsidies.**
  Subsidy allocation should reflect a holistic approach toward home improvement that integrates habitability and structural upgrading to reduce risk, improve living conditions, and provide opportunities for growth or expansion. By enabling subsidies from national and local levels to be combined, the amount available for home improvement can be increased. Coupling subsidies for structural reinforcement with options for improving habitability has also proven an effective way to convince homeowners to make structural upgrades, where they may not otherwise have done so.

5.5 An Overview of the *Casa Digna, Vida Digna* Program[10]

Summary

Casa Digna, Vida Digna (Dignified House, Dignified Life, CDVD) has national coverage in Colombia and seeks to benefit 600,000 low-income households by providing home improvement subsidies, titling, neighborhood upgrades, and public infrastructure.

Three government agencies are overseeing its execution: the Ministry of Agriculture and Rural Development, the Department for Social Prosperity, and the Ministry of Housing, City, and Territory (MVCT) (Table 5).

The program has three main funding streams:

- The National Housing Fund (Fonvivienda)
- Co-financing from participating municipalities
- The National Oil Revenue Fund (Regalias)

Key Stakeholders

As a program with national reach, CDVD involves multiple stakeholders. Figure 32 provides a breakdown of the main stakeholders, grouped by People, Money, and Technology.

Homeowner Qualification

Home improvement subsidies provided through the CDVD program will benefit eligible households in the most vulnerable areas of selected municipalities, whose property value is not more than 135 x MMW (US$31,600). Eligible households do not receive the subsidies directly but benefit through home improvement works.

The main requirements for a household to qualify for subsidies through the program are listed below.

- The total household income is less than 4 x MMW.
- The house is determined as in need of improvements to living conditions.
- The homeowner has not previously received a national family housing subsidy.
- The house is located in an area that has been approved for the program, i.e. in a formally-recognized neighborhood, not in a high-risk area, and not on land that is either designated as being unsuitable for housing, protected, or located in public space or conservation areas.
- The property must have been owned or legally occupied by the applicants for at least five years.

Program Structure

As discussed elsewhere in this guide, there is no single route to achieving resilient housing at scale, and therefore the funding and delivery models of individual housing programs will vary. Figure 33 provides a summary of the key actors involved in the program and their responsibilities, from a functional implementation standpoint.

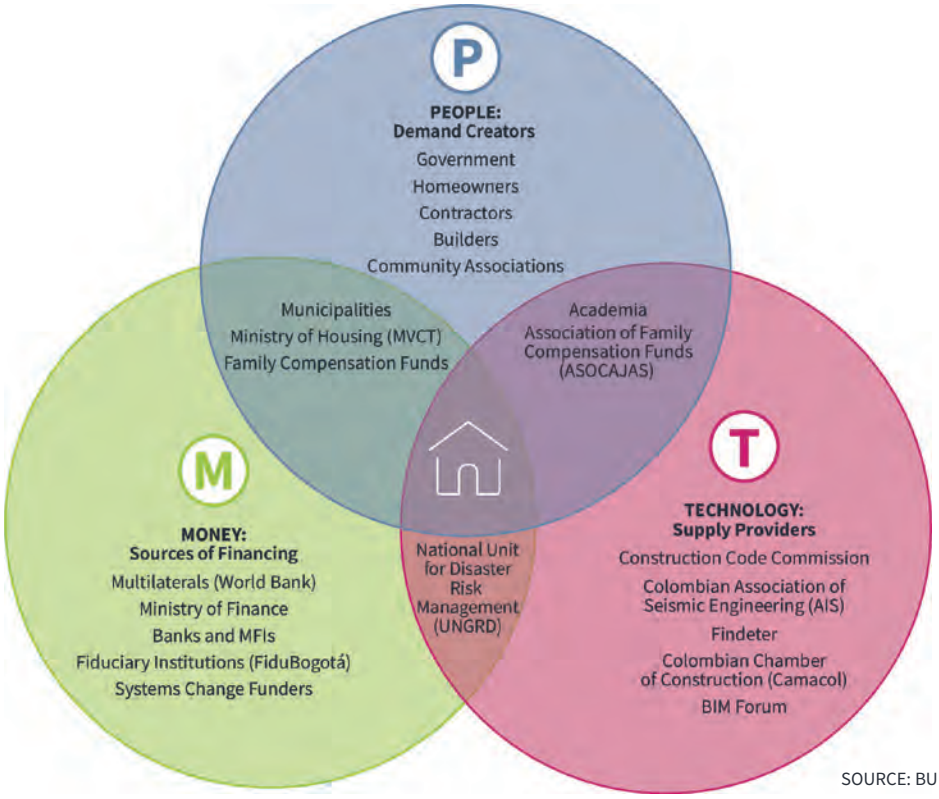
Under this model, resources from the National Housing Fund (Fonvivienda, an affiliated entity of the MVCT) are managed by a designated **trust fund manager**. The trust fund manager administers the resources through an autonomous trust, and is also responsible for managing contributions from third parties, such as co-financing from participating municipalities.

TABLE 5 Executing agencies: *Casa Digna, Vida Digna*

	Land tenure regularization/Issuing of titles	Home improvements (no. of units)	Neighborhood improvements (no. of units)	Total units to be improved/upgraded
Ministry of Agriculture and Rural Development	38,600	11,400	-	50,000
Department for Social Prosperity	-	247,412	77,588	325,000
Ministry of Housing, City, and Territory (MVCT)	56,600	112,590	55,810	225,000
				600,000

10 This section draws on material from The World Bank's Global Program for Resilient Housing, *Roadmap for Resilient Housing: The Path to Livable, Disaster and Pandemic Resilient Housing*, (2020).

FIGURE 32 Key stakeholders: *Casa Digna, Vida Digna*



SOURCE: BUILD CHANGE

FIGURE 33 Key implementing actors: *Casa Digna, Vida Digna*

SOURCE: BUILD CHANGE

The role of the **operator** is to oversee the execution of the CDVD program at national level, and ensure that home improvement work is carried out according to all applicable technical, legal, social, financial, and administrative conditions. The operator must also respond to requests for social support made by all implementing actors, and discuss the works to be carried out with homeowners.

Municipalities are responsible for neighborhood selection, the open call to homeowners to apply for the program, and initial homeowner screening. Additionally, municipalities must certify that selected housing units are located in areas that have been approved for the program. Municipalities are also required to provide co-financing for program expenses.

Contractors are responsible for field operations. This includes evaluating and categorizing homes, and designing and building home improvement interventions.

Third Party Reviewers supervise the contractors and are responsible for following up on the technical, legal, social, financial, and administrative components of the home improvement interventions to be carried out.

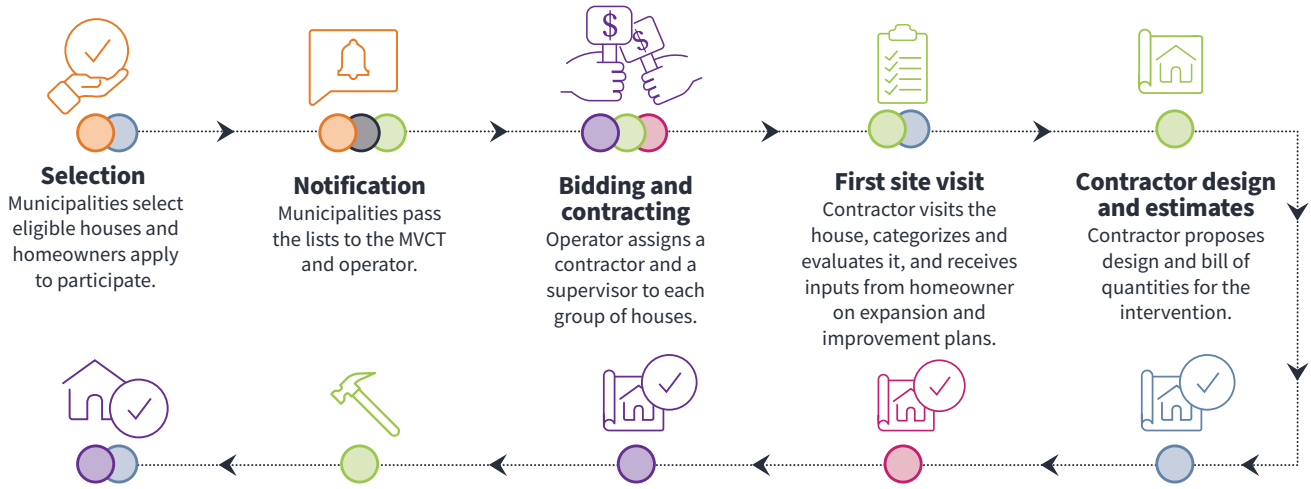
Homeowners respond to calls from municipalities to express their interest in participating in the program. While homeowners do not receive subsidies directly, they retain control over the work that will be carried out, and are required to give final approval on any decisions regarding modifications to their home.

Implementation Process

The implementation process begins with municipalities submitting proposals to the MVCT and Fonvivienda to state their desire to participate in the CDVD program. If they meet the required conditions, cooperation agreements are signed between municipalities and the MVCT with the purpose of joining administrative, technical, and financial efforts for the execution and monitoring of activities.

An overview of the subsequent implementation stages for Category 1 houses is shown in Figure 34.[11]

FIGURE 34 Implementation stages for Category 1 houses: *Casa Digna, Vida Digna*

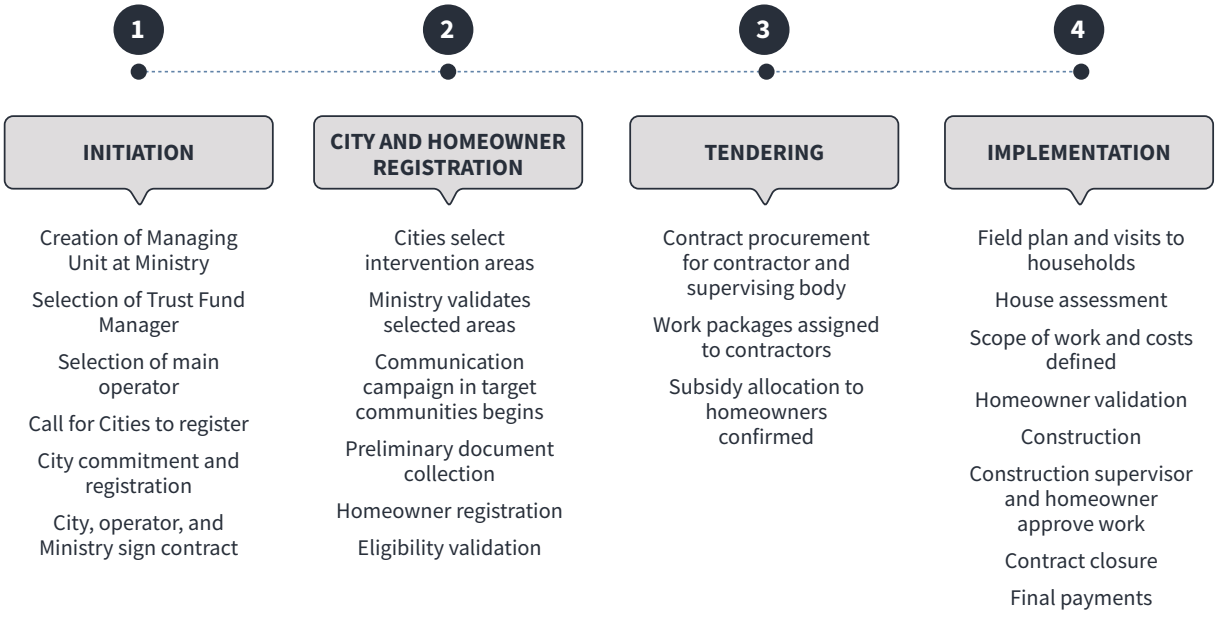


SOURCE: BUILD CHANGE

11 At the time of publication, the processes for Category 2 and Category 3 houses were still being defined. Subsequently, the implementation stages discussed here refer to the established process for Category 1 home improvement interventions.

Figure 35 provides more details on the different implementation stages specifically from the point of view of the government, while Figure 36 shows the program from the perspective of a homeowner moving through each of the stages.

FIGURE 35 Government journey to resilient housing: *Casa Digna, Vida Digna*



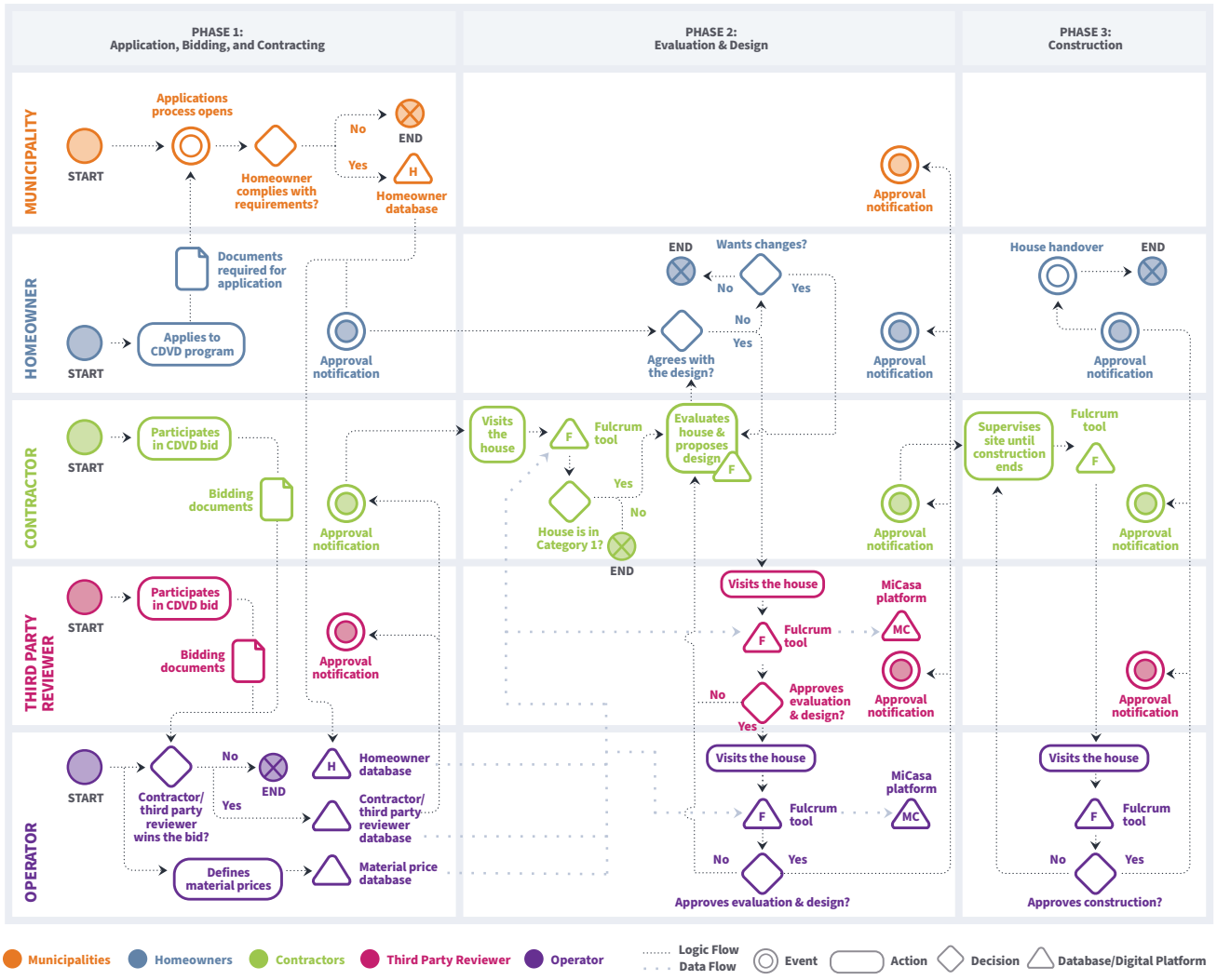
SOURCE: BUILD CHANGE

FIGURE 36 Homeowner journey to resilient housing: *Casa Digna, Vida Digna*

SOURCE: BUILD CHANGE

Figure 37 provides a more detailed overview of the implementation journey for each of the key actors in relation to one another, across the three main phases of the CDVD program. It also shows how the use of digital technology is integrated into the overall workflow. Migration from a paper-based workflow in favor of digital tools and platforms has allowed the collection and management of data to be streamlined throughout the different implementation stages. This progress has supported the government to substantially increase efficiency, reduce costs, and achieve greater scale.

FIGURE 37 Key implementing actors' journey to resilient housing: *Casa Digna, Vida Digna*



SOURCE: BUILD CHANGE

Appendix 1: Common Housing Types and Vulnerabilities in Colombia[12]

One-Story Houses

A typical one-story home in Medellín

Typology Description

- Typical size: Area of 70–80 m^2; front length of 5–8m
- Foundations: Shallow, small strip foundations and/or small spread footings at columns
- Walls: Masonry walls support the roof; masonry is typically unreinforced or insufficiently confined. The most common type of masonry is horizontally perforated hollow clay blocks in cement mortar. In some regions solid clay bricks or concrete hollow blocks are used, but this is minimal.
- Roof: Roofs are either framed with light material, such as timber or metal, or built out of concrete (e.g. cast-in-place reinforced slabs).[13]
- Level of design and construction: Houses are typically designed and built by unskilled or informally-trained builders with input from homeowners.

Typical Disaster-Resilience Deficiencies

Configuration:

- Does not have minimum number of walls required (at least one on each side, in each direction). This is particularly common in the case of open-front houses facing onto the street.
- Wall spacing is too far apart.
- Lack of support or bracing at top of wall, such as a ring beam, particularly when light-framed roofs are present.
- Heavy gable walls are not well connected or braced.

Connections:

- Lack of connection between walls and roofs i.e. ring beams are often missing.
- Connections between structural elements are deficient or missing, e.g. at wall intersections.

Construction Quality:

- Slender walls
- Low-strength masonry
- Some/all walls are not fully rendered with cement plaster

Typical Structural Condition Deficiencies

- Corroded and spalling reinforced concrete slabs
- Damage to masonry blocks in walls

Typical Habitability Deficiencies

- Water and sanitation
- Electrical wiring safety
- Lighting and ventilation
- Space and distribution
- Kitchen facilities and fittings
- Accessibility and egress
- Fire safety
- Water intrusion, from leaking roofs or inadequate drainage

Typical Opportunities for Finishings and Growth

- Wall plaster and paint
- Vertical expansion

12 From a study by Build Change for The World Bank Group, *Maximizing the Impact of Structural Retrofit Projects on Housing in Densely Populated Cities of Colombia*, October, 2018.

13 Cast-in-place concrete refers to walls and slabs of the buildings that are cast in the formwork on site. This differs from precast concrete technology, where slabs are cast elsewhere and then brought to the construction site and assembled.

Two-Story Houses

A two-story home in Bogotá

Typology Description

- Typical size: Area of 140–160 m^2; front length of 5–8m
- Foundations, walls, and roof: As for one-story buildings, above.
- Floors: Raised floors are built out of concrete systems, cast-in-place, or with prefabricated elements, such as *placa fácil* (a slab system comprising prefabricated metal joists with ceramic void forms)
- Level of design and construction: Houses and expansions are typically designed and built by unskilled or informally-trained builders with input from homeowners.

Typical Disaster-Resilience Deficiencies

Configuration:

- Deficiencies include all those noted above for one-story houses, plus
  - Vertical discontinuities, such as a soft story at the ground floor, or overhanging living areas.

Connections:

- Deficiencies include all those noted above for one-story houses, plus
  - Lack of connection of columns through floors.
  - Lack of connection of slab to walls for *placa fácil*.

Construction Quality:

- Deficiencies are the same as those noted above for one-story houses.

Typical Structural Condition Deficiencies

- Corroded and spalling reinforced concrete slabs
- Damage to masonry blocks in walls

Typical Habitability Deficiencies

- Deficiencies include all those noted above for one-story houses; lighting and ventilation is worsened by second story covering 100% of the first.

Typical Opportunities for Finishings and Growth

- Wall plaster and paint
- Vertical expansion, or terrace

Three- (or More) Story Houses

A three-story home in Bogotá

Typology Description

- Typical size: Area of 180–250 m^2; front 5–8m
- Vertical expansion may be up to six stories.
- Multi-family buildings, of mixed use. A shop is frequently present on the ground floor, increasing issues resulting from a lack of solid walls in the façade.
- Houses have structural and architectural deficiencies that are complex to remediate.

Typical Disaster-Resilience Deficiencies

Configuration:

- Deficiencies include all those noted above for one- and two-story houses, plus
- Additional cantilevers may be present over a cantilevered second floor, increasing the problem.

Connections:

- Deficiencies are the same as those noted for one- and two-story houses.

Construction Quality:

- Deficiencies are the same as those noted for one- and two-story houses.

Typical Structural Condition Deficiencies

- Deficiencies are the same as those noted for one- and two-story houses.

Typical Habitability Deficiencies

- Deficiencies are the same as those noted for one- and two-story houses.

Typical Opportunities for Finishings and Growth

- Wall plaster and paint
- Roof improvements, drainage, and ventilation

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A construction worker tying steel reinforcement in Nepal

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>
> *Dr. Elizabeth Hausler, February 2017*

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