The Housing Market Value Chain: An Integrated Approach for Mitigating Risk in Informal Residential Construction in Haiti

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Abstract: Access to dignified housing represents a critical challenge for many low- and middle-income countries (LMICs). Technical and economic constraints frequently lead homeowners in these countries toward incrementally-constructed homes, which are often proven deadly when exposed to seismic or meteorological hazards. This paper offers a holistic analysis of the informal residential construction industry contextualized in Léogâne, Haiti, the effective epicenter of the 2010 Haiti earthquake, and offers an implementation framework geared towards integrating the housing delivery process to accommodate more resilient typologies. First, the concept of the housing ecosystem is introduced, and a thorough analysis of the technical, economic, and political factors that constrain this ecosystem in Haiti is presented. The defining elements of the resulting residential construction industry are then discussed: An informal blend of Design-Build and Master Builder methods of project delivery for incrementally-constructed (and largely masonry) permanent homes. The housing ecosystem is then redefined as a seven-step housing market value chain, and interventions to further strengthen and integrate this value chain are presented for each of the seven steps. Interventions are grounded in analogous contexts and refactored specifically for the Haitian case study scenario through extensive co-creation with stakeholders in Haiti. Particular focus is given to the Léogâne Community Building Fund, a concept designed to democratize housing finance for low to middle-income groups. When implemented in an integrated fashion, risks across this housing market value chain are effectively mitigated to sustainably deliver dignified housing through a market-based approach suitable for Haiti and extensible to other LMICs.

Keywords: housing market value chain; low- and middle-income countries; housing markets; Haiti; resilient housing; market-based solutions

1. Introduction

It is estimated that 1.6 billion people worldwide lack adequate shelter [1]. The risk to human well-being posed by this massive deficit is only further exacerbated by climate change and trends in human migration, both forced displacements as well as a progressive influx of rural populations into urban centers. With more frequent damaging tropical storms due to anthropogenic warming and sea-level rise [2], coastal and low-lying settlements are particularly vulnerable to flood and wind hazards. Coastal populations are also especially susceptible to seismic hazards, as the majority of major fault lines lie along coastal boundaries [3]. Despite these risks, humans are increasingly migrating towards coasts [4] and densely-populated urban centers [5]. This rapid urbanization, particularly in
low- and middle-income countries (LMICs) without strong, regulated housing markets, leads to the widespread construction of substandard housing units, which have again and again proven deadly for those who, out of necessity, take residence in them [6–9]. Thus, there is a demonstrated global need for advancements in resilient urban housing, particularly in LMICs exposed to extreme natural hazards, such as Haiti, the focus of this study.

Located on the western half of the island of Hispaniola, the Republic of Haiti is exposed to both significant seismic and hurricane risk. In 2010, a 7.0 Mw earthquake killed an estimated 230,000 people, injured 300,000, and displaced an additional 1.2 million [10]. In 2018, Hurricane Matthew made landfall as a Category 4 storm and destroyed tens of thousands of homes [9]. In addition to its multi-hazard risk, Haiti also faces countless political and economic challenges, ranking 168th (out of 189 nations) on the Human Development Index [11] and 182nd (out of 190 nations) on the World Bank’s Ease of Doing Business Index [12]. In particular, Léogâne, located near the epicenter of the 2010 earthquake, presents a stage ripe for investigations of post-disaster housing recovery. In the 2010 earthquake, 93% of buildings in Léogâne collapsed or were severely damaged [13]. Haiti—and in particular the community of Léogâne—with its multi-hazard risk, fragile political and economic environment, and housing deficit, presents an optimal case study for research seeking to increase the resilience of residential construction.

The quality of a nation’s housing stock can be attributed to the effectiveness of the various industries and processes which constitute the “housing ecosystem” (see Figure 1), defined as the “totality of markets, laws, resources, participants, and inventory that make up housing delivery and housing finance” [14]. Each country’s housing ecosystem is unique and “rooted in geography, climate, history, culture, national government, legal structure (including original laws, if the country was colonized), economy, the macro-economy (including inflation and interest rates), taxation, and existing political and governmental systems” [14]. The output of the ecosystem is housing, and an ecosystem’s ability to provide quality housing is dependent on the strength and cohesion of its components. Similarly, one must consider every component, as one underdeveloped subsystem will limit the output of the entire housing ecosystem. The term “ecosystem” itself implies that each component directly and indirectly influences every other component in the system, and that the entire system evolves in relation to a change in a single subsystem.

![Figure 1. Generalized system map of functional housing ecosystem.](image-url)
In regions with significant seismic or hydro-meteorological hazards, an effective housing ecosystem mitigates disaster risk accordingly in each individual component. For example, engineers and architects design for lateral loads created by these hazards, materials are strong enough to resist the expected demands, and laborers and contractors construct the home with well-documented quality control and engineering oversight. Unfortunately, the residential construction industry in LMICs such as Haiti often faces significant technical, economic, and political challenges that restrict the development of these individual components. Consequentially, the resulting housing stock that rises from these deficient industries is exceptionally vulnerable to natural hazards and poses a significant risk to residents, particularly those at the bottom of the socioeconomic pyramid. Furthermore, the co-dependent relationships of the housing ecosystem demonstrate that independent mitigation efforts which only focus on a single component of the ecosystem (e.g., training of construction laborers) will fail to sustainably reduce risk [15]. Instead, these failures indicate that in markets that cannot sufficiently mitigate risk at each individual component of the housing ecosystem, one must integrate these efforts into the housing delivery process.

This paper will analyze the factors likely to restrict the market viability of resilient housing in Haiti and offer integrated responses with the three-fold purpose of: (1) Mitigating risks to natural hazards, (2) ensuring compatibility with local technical capacity and supply chains, and (3) holistically considering requirements and constraints necessary for market-based solutions capable of facilitating sustainable delivery of homes in Haiti. After establishing the methodology in Section 2, a landscape analysis will define the technical, economic, and political constraints of the Léogâne, Haiti case study scenario (Section 3). This is followed by a discussion of the resulting informal residential construction industry (Section 4). The remainder of the paper uses the authors’ seven-step housing market value chain, introduced in Section 5, as unifying framework, with Sections 6–10 sequentially presenting interventions responsive to the identified contextual constraints. Discussion and conclusions then follow (Sections 11 and 12).

2. Methodology

This paper adopts a mixed-methodological approach that draws upon the ten years of field-based research in Léogâne, Haiti, conducted by the second and third authors in collaboration with Haitian field staff. This research initiated with multiple rounds of forensic investigations, beginning approximately six weeks following the 2010 earthquake through 2016’s Hurricane Matthew, documenting recurring vulnerabilities and common construction practices [8,9]. This was followed in late 2010 by a survey of over 1000 displaced persons to identify housing preferences and recovery trajectories. Additional market research, repeated annually between 2011 and 2019, mapped supply chains and vendor pricing for primary construction materials, which informed the authors’ design of hazard-resilient housing solutions [16], which were subsequently peer-reviewed and implemented in Léogâne in 2014 [17]. The barriers to sustainable delivery of this and other housing solutions were then systematically investigated between 2014 and 2019, through additional contributions of the first author, in collaboration with Léogâne-based Innovation Clubs. This process entailed analysis of relevant case studies, both from Haiti and from other LMICs. The findings of this background research informed a barriers analysis and mapping of corresponding solutions drawn from analogous contexts in the case studies. Any viable solutions were further developed by local Innovation Clubs: Teams of creative local leaders formed in 2014 to foster greater stakeholder participation in the research. More details on the selection and training of these individuals can be found in [18]. These Innovation Clubs employed Design Thinking methodologies (see Figure 2), working with the authors to further incubate potential solutions into the interventions presented in this paper. As noted by other teams engaging in collaborative research in Léogâne during this same time [19], such intentional incorporation of local voices are essential to ensure local needs and perspectives are considered. Participating local staff and Innovation Club members are listed by name in the acknowledgements. During this same period, the second and third authors coordinated a randomized sampling of 552 households, which was conducted in Léogâne in 2017 to
establish drivers of risk awareness, mitigation decisions, and recovery timelines among households whose homes sustained damage in the 2010 earthquake (referred to herein as the Household Recovery Study) [20]. Descriptive statistics from this survey are referenced throughout this paper.

Figure 2. Authors and Innovation Clubs co-design (a) sanitation solutions, (b) the housing market value chain, and (c,d) tools for financial empowerment.

Recognizing the importance of local perspectives in engineering design processes [21], a number of stakeholders within the housing market system in Léogâne were engaged throughout this extended fieldwork. Key informant interviews included local civil engineers/architects, construction laborers/masons, representatives of humanitarian organizations focused on shelter delivery, construction material producers/vendors, lawyers/notaries dealing with land tenure issues, and civic leaders. More importantly, heads of households at various income-levels were engaged in the aforementioned surveys as well as focus groups and co-design activities throughout the ten years of field work to ensure their perspectives were represented in the interventions presented herein.

3. Constraints of the Haitian Housing Market

Despite the recent 10-year anniversary of the 2010 Haiti earthquake, the Household Recovery Study indicates that, as of 2017, 61% of respondents whose homes were completely destroyed in the earthquake have not yet started rebuilding [20]. Of those who have started rebuilding or repairing their homes, only 33% have completed the reconstruction of their walls, and only 26% have completed the reconstruction of their roofs [20]. Moreover, years after the earthquake, many displaced Haitians have been observed still living in temporary shelters distributed by aid organizations after the earthquake, which they have since modified into permanent homes. This slow process of reconstruction, reflective of a systemic lack of resiliency and the ineffectiveness of both the pre- and post-earthquake housing sectors, can be attributed to a variety of technical, economic, and political factors.

3.1. Technical Constraints

Cast-in-place concrete and locally produced concrete masonry units (CMU) are the primary building materials in Léogâne. CMU blocks and poured concrete rarely achieve high compressive
strengths, as described in [8,22,23], resulting in structures with high seismic mass yet delivering little resistive capacity. Despite posing significant risks in earthquakes, concrete is highly valued among homeowners for cultural, environmental, and security reasons [16]. Moreover, cementitious materials are the only viable construction material in the market in this heavily deforested nation [24]. Timber’s resulting cost and the aforementioned cultural expectations of a proper home results in its limited use in urban areas such as Léogâne.

In combination with the poor quality of construction materials, houses in Haiti are generally constructed incrementally [8,25]. Incremental construction of a home, necessitated because of the economic constraints discussed next, often takes ten or more years. This not only leaves families exposed throughout the construction process, but many times also after, as the high variability in materials and workmanship can render an incrementally-constructed home more vulnerable to natural hazards [8]. In Léogâne, the residential construction industry is segmented into a large informal sector, where masonry homes are constructed by individuals with no formal training, a modest-sized formal sector of skilled artisans who have apprenticed and now practice based on experience (without training in engineering design principles), and a limited number of formally-educated engineers/architects who operate as small firms or as independent contractors, applying engineering design principles in their work, including the authors’ implementing partner Magepa S.A. However, these engineers/architects are normally contracted only for major construction projects like schools or businesses, and less often for residential projects due to the cost of their services. Given that the vast majority of homes are built by informal laborers or apprenticed artisans who are not trained in aseismic construction, they are unlikely to provide sufficient transfers between incrementally constructed elements or the detailing needed to facilitate a ductile response during an earthquake. Moreover, even when apprenticed artisans are properly trained in aseismic confined masonry construction, they often fail to completely implement this guidance due to economic constraints [9,15].

3.2. Economic Constraints

As of 2018, 42.2% of the Haitian population lives on less than US$3.20 per day, when adjusted for purchasing power parity (PPP) [26]. The Household Recovery Study further suggests that 40% of households in Léogâne (of which the average size is five persons) earn less than 1000 HTG per week, while 32% of households earn between 1000 and 2500 HTG per week [20]. Considering the August 2020 exchange rate of US$1.00 to 109.6 HTG [27], this indicates that 72% of households in Léogâne earn less than US$23 per week (not adjusted for PPP).

The challenges associated with such exceptionally low income are only heightened by the uncertainties associated with the informal economy. In Léogâne, only 19% of 550 randomly-sampled respondents of the Household Recovery Study reported working for a Haitian or foreign employer, while 50% responded that they own or operate their own business [20]. Considering that an estimated 2/3 of Haiti’s workforce is informally employed [14], it is reasonable to assume that the majority of Léogâne’s entrepreneurs operate in the informal sector. The inconsistent and fluctuating income associated with informal employment and entrepreneurship often makes long-term financial planning and saving difficult.

Constant exposure to natural hazards and political unrest further exacerbates these economic constraints by creating significant disruptions in the Haitian economy that disproportionately affect the low-income population. In addition to killing or injuring people and destroying personal property, these events can also destroy sources of sustenance and revenue generation. For example, Hurricane Matthew, which swept through Haiti’s Tiburon Peninsula in 2016, snapped or uprooted countless fruit trees, which will take decades to regrow [9]. Similarly, heavy rains, post-hurricane disease, and saltwater inundation due to the storm surge destroyed much of the region’s subsistence crops.

Haiti’s ratio of private sector credit to GDP, a measure of the robustness of a country’s financial sector, at only 12%, is among the lowest in the world [28]. Thus, it is no surprise that in the Household Recovery Study, 78% of respondents reported never receiving a loan from a bank, cooperative, or credit
union [20]. While such lack of formal financial services hinders Haitian economic development across all sectors, its impact on the housing sector is specifically devastating. In addition to low informal household income, the volatile political and economic conditions, the inability to assess the credit history of borrowers, and a limited supply of affordable housing are key barriers to mortgage lending [14]. These conditions mean that incremental construction is the only solution for many families.

Even with adequate financial capabilities, the documentation required for mortgage financing is also onerous, as banks usually require proof of multiple years of formal employment and land title, which the majority of Haitians cannot provide [14,29]. In total, fragile financial capacity coupled with the aforementioned barriers to housing finance limits the construction of safe homes to the wealthy minority. Unfortunately, Haiti’s political system does little to reduce this inequity.

3.3. Political Constraints

Article 22 of the 1987 Haitian Constitution “recognizes the right of every citizen to decent housing” [30]. Yet even before the 2010 earthquake, it was estimated that 86% of Haiti’s urban population lived in informal settlements [31]. Likewise, Oxfam’s 2013 research report on Housing Delivery and Housing Finance in Haiti found that “urban management and planning mechanisms are unstructured, dysfunctional, or nonexistent” [14]. Government policy is critical to the housing sector, even in the world’s wealthiest nations, with institutions documenting land tenure, legal systems settling disputes and enforcing contracts, monetary systems backing mortgages tied to code-compliant construction, and public funds subsidizing housing for low-income households. Unfortunately, in Haiti, these systems are effectively nonexistent.

It takes an average of 301 days and five procedures to register property in Haiti, a process that will cost the owner 6% of the property value [32]. Furthermore, private owners cannot purchase public lands because of an “antiquated legal hurdle that requires the authorization of a non-existent municipal assembly” [14]. Even when titles are issued and possessed, they are often disputed, and poor record keeping and ineffective legal procedures makes it difficult to settle such disputes. These constraints make it difficult for banks to trust land as collateral, reduce the supply and thus drive up the cost of buildable land, and prevent developers from investing.

A lack of enforcement for non-repayment also hinders the development of the mortgage industry. Legal proceedings for foreclosure are expensive and complex, making Haitian banks “extremely risk averse” [14]. In fact, housing institutions such as Habitat for Humanity and Enterprise Publique de Promotion de Logements Sociaux (EPPLS)—a public housing project administered by the Government of Haiti—have often failed to evict their borrowers who cannot pay rent and instead simply accept the financial loss [14]. Without proper protections for lenders who are not repaid and sufficient incentives for borrowers to repay, for-profit financial institutions are unlikely to accept the financial risks associated with lending to low-income households.

Even if executed perfectly, the systems (or lack thereof) described above would prove ineffective in providing the stability and structure needed for a prosperous housing industry. Unfortunately, the capacity of these systems is further reduced by an uncoordinated, and often corrupt, government. A 2013 investigation found that many of the actions needed to implement Haiti’s 2012 Politique National du Logement (National Housing Policy) were split among the responsibilities of a variety of government ministries, resulting in uncoordinated and inefficient implementation [14]. Likewise, Transparency International identifies Haiti’s Corruption Perceptions Index as a mere 18/100, which places it among the most corrupt nations in the world (tying with Libya, and one point ahead of North Korea) with an overall rank of 168th among the 180 nations considered [33].

4. Residential Construction in Haiti

As discussed above, the residential construction industry in Haiti and other LMICs faces significant technical, economic, and political challenges that hinder resilient housing development. Combinations
of these factors have led to two prevalent attributes that distinguish the urban residential construction industry in LMICs from the industry in high-income nations:

1. An informal blend of Design-Build and Master Builder methods of project delivery.
2. Non-engineered, incrementally-constructed (and largely masonry) permanent homes.

   Design-Build is traditionally defined as a “project delivery method in which the owner provides requirements for the specified project and awards a contract to one company who will both design and build the project” [34]. This method has its roots in the traditional Master Builder construction process (described below), which was how nearly all structures were built up until the 20th century [35,36]. This contrasts with the currently more common method of Design-Bid-Build, in which the owner first solicits design services which later form the basis of the requirements for the contract with a separate construction company [34]. Although Design-Build is also common in the United States, particularly for single-family residential construction, and was spurred by a push for more efficient and cost-effective project delivery, the informal Design-Build method for residential construction in LMICs was born out of necessity in these highly constrained markets and lacks the regulation and formality of its US counterpart.

   Design-Build companies in the residential construction industry in LMICs are often led by a Master Builder. This individual generally serves as a surveyor, architect, engineer, project manager, procurer, foreman, and inspector. Although increased project complexity has outstretched the capabilities of a single individual in high-income nations [36], the perceived simplicity of designs and lack of general regulation has not yet pressured a similar change in the residential construction industry in LMICs. Without a strong institutional infrastructure regulating and enforcing design reviews, building codes, third-party inspections, site safety, professional accreditation, or laborer training, informally trained Master Builders operate under few regulations and requirements; thus, they rely heavily on experience. With the exception of occasionally securing a construction permit, there is often zero third-party involvement in the process. The resulting design decisions are often driven by cost-effectiveness and convenience, rather than structural integrity and risk reduction.

   The management of risk in single family residential construction is generally challenging in all contexts. Though rarely engineered, in high-income countries like the United States, residential building codes are enforced to at least ensure safety. As these codes are tied closely to permitting, inspection, and lending processes, they are enforced even though the average homeowner has little understanding of the design features ensuring the safety of their family. The opposite is true in LMICs, where homeowners not only have significant input into design decisions, but may even participate in or lead the construction process, without any formal training or appreciation of the risks created by design decisions. Even when working with a local builder, homeowners in LMICs have a strong influence on the design process and often procure the materials. As a result, builders may defer to homeowners against their better judgement and experience. For example, homeowners in Caribbean communities may select the cheapest materials to minimize costs or select features, e.g., a concrete slab roof for its performance in seasonal hurricanes, without properly understanding the resulting seismic risk [9]. Thus, while there is a need to improve the risk awareness of homeowners even globally, it can be argued that this is especially urgent for homeowners in LMICs.

   The second distinguishing attribute of the informal residential construction industry is the prevalence of masonry typologies. Masonry can be hand produced, assembled incrementally with little formal training, and requires minimal equipment. For these reasons and others, masonry has become the primary building material of informal urban residential construction in many LMICs [37]. Although not permitted in high-seismic regions by many international building codes, including the US [38], both unreinforced masonry (URM) and confined masonry are common residential typologies in LMICs. While URM fails to deliver adequate lateral capacity against seismic loads and even strong winds, well-executed confined masonry has been documented to perform well in seismic events [39,40]. Thus it has been promoted by numerous international organizations [41–43] as well as foreign building
codes [44,45]. However, poor implementation often results in undersized confining elements at wall boundaries and a failure to confine perforations for windows, leading to disastrous performance in seismic events [8,9,25].

An alternative structural typology that relies on the same technical skills and materials as confined masonry is the reinforced concrete moment resisting frame (RC frame). These can deliver even greater resistance to lateral loads and can be constructed to codified standards by local crews [17] at comparable cost [46]. However, this typology cannot be constructed incrementally and requires a higher degree of quality control, as the strength/ductility of the structure is concentrated in a few critical frame elements. Thus, in order for codified RC frames to compete in the open market in Haiti, various components of the supporting housing ecosystem require strengthening, formalization, and integration. The remainder of this paper will focus on how this can be achieved for reinforced concrete frames, although many of the recommendations are typology-agnostic.

5. Integrating the Housing Ecosystem

Meeting the post-earthquake deficit in Haiti will require the construction of 500,000 homes over the next 10 years [47]. This need is far beyond the capabilities of governments or private philanthropists, and major aid organizations are shifting their focus away from the direct provision of housing and toward market-based approaches that can support self-recovery among displaced households. This is perhaps best summarized by a 2013 Oxfam report: “Positive examples of permanent housing solutions are scant. Too much focus has been placed on the construction of physical structures rather than on setting up the sustainable delivery mechanisms that will stimulate the creation of sustainable communities and private investment in the sector” [14]. For example, the US Agency for International Development (USAID) is helping “financing institutions and housing developers play a greater role in housing construction” in Haiti [47]. Similarly, Habitat for Humanity’s Haiti Property Law Working Group is “working to clarify Haiti’s land law in an inclusive and transparent manner” [48], while organizations such as Build Change are training laborers in resilient construction practices [49]. Each of these represents investments in strengthening not homes themselves, but the institutions and services that comprise Haiti’s housing ecosystem.

Bolstering access to finance, strengthening land tenure systems, and building technical capacity are all equally necessary to promote the adoption of more resilient typologies, such as the RC frame discussed in the previous section. Finance enables single-phase (non-incremental) construction, and well-documented land tenure and quality control procedures (verifying the resiliency of the constructed home) ensure this loan can be collateralized. Thus, the components of the housing ecosystem not only require individual strengthening, but also must be integrated so that the systems can efficiently work together to deliver resilient residential construction and diversify the material and typology choices available in the market.

In order to better organize recommendations for the complex housing ecosystem, the interconnected network shown in Figure 1 is reorganized linearly into a seven-point housing market value chain (HMVC), shown in Figure 3. Like the system map in Figure 1, this chain is generalizable to all housing ecosystems, with each component likely to uniquely manifest in different contexts. It is important to note that both representations are greatly simplified, as it is not possible to capture the influence of government processes and regulations that are critical to every component of the ecosystem, e.g., this omits the critical role of the insurance industry in protecting investments and reducing risk for the lender and homeowner.
As expressed above and shown in Figure 3, when not integrated with other equally strong components in the housing market value chain, such as land tenure, quality assurance, or financing, even a properly engineered structural design cannot be effectively or sustainably implemented. The following sections will address each point of the HMVC individually and will offer possible interventions for the effective implementation of resilient housing in LMICs. While they will be discussed individually in the following sections, each intervention was conceived within the integrated context of the entire housing ecosystem using the field-based methodologies discussed in Section 2.

6. Land Tenure

The first step in the HMVC is documenting land tenure. As noted previously, this process is a major challenge in Haiti, taking nearly a year on average. Simply put, Haiti “lacks a comprehensive, functional system for recording land ownership” [50]. The Haiti Property Law Working Group [48] identifies some of the specific challenges of the legal system that make it so difficult, including unclear requirements and complex procedures that involve multiple government agencies, charging high fees, and operating under inheritance laws that give shared property rights to heirs. Due to these ineffective government policies, which are further challenged by the rapid urbanization of a historically rural society founded upon the traditional lakou system, in which related families occupy homes on a shared plot of land [51], few landowners possess a legal title or transaction receipt. Before the 2010 earthquake that devastated a significant portion of the Haiti’s capital city of Port-au-Prince, only 38% of property owners in the metropolitan area possessed documentation of their tenure [48]. Then, the earthquake destroyed 300,000 homes, left 1.5 million people homeless, and even badly damaged the office of the Direction Generale des Impôts (DGI), the office responsible for maintaining and updating land registration records [52,53]. Through its widespread devastation, the earthquake quickly exposed this weakness in the launch point of the HMVC. As proper collateral is almost always required when seeking mortgage financing and non-governmental organizations (NGOs) avoid the legal risk of providing shelters for undocumented plots of land, land tenure is a major obstacle not only to reconstruction, but even to post-earthquake shelter aid.

Any individual or organization, whether government, business, or NGO, that seeks to reduce the housing deficit in Haiti must take the necessary steps to formally register the land used for all projects, and if applicable, legally transfer the title to the new homeowner. In all programs, clear procedures must be defined for applicants and participants to meet minimum standards to collateralize land during a prequalification process. However, the specifics and suggestions for reform of this complex legal process are beyond the scope of this paper, though systematic analyses [53] and guidelines [48] are publicly available.
7. Basic Services

The next component of the HMVC is basic services, which includes water, sanitation, and energy systems, critical to quality of life in constructed homes. Nationally, only 58% of Haitians have access to clean water [54]. In Léogâne, residents used to obtain their water from a centralized water distribution system built with international aid money in the early 1980’s, but it has been inoperable since the 2008 hurricane season [55]. Without a centralized system, residents are forced to use a variety of decentralized water sources, many of which must be treated prior to consumption. Most prefer water piped to their property [55].

Similarly, dignified sanitation is also exceedingly rare, with only 19% of Haitians having access to improved sanitation facilities [54]. Even in urban areas, wastewater collection systems are “practically nonexistent,” as stated by the Government of Haiti’s Ministry of Public Health and Population (MPHP) in its National Plan for the Elimination of Cholera in Haiti [56]. Septic tanks and outdoor pit latrines are the main systems used to contain wastewater, but the collected sludge is generally disposed of, untreated, into “ditches” or the “natural environment.” This can amount to serious public health problems, clearly evident by the post-earthquake outbreak of cholera. The Innovation Clubs’ surveys of residents in Léogâne affirmed the unanimous preference for indoor toilets, with focus groups affirming strong preference for flushing systems over composting toilets.

Unlike water and wastewater, there is a centralized electrical grid in Léogâne connected to nearly all homes in the city. However, it is often unreliable, and those who can afford it will supplement their energy system with a generator and/or solar panels.

These preferences surrounding basic services should be considered early in the conceptual design phase of the home. Considering the above context, collaborations with the Innovation Clubs and engineers at Magepa S.A., the implementing partner in Léogâne (Figure 2b), developed three tiers of options for both off-grid and on-grid integrated utilities (Table 1). The three tiers represent different levels and price points, and provide homeowners with options to meet both their individual needs and their budget constraints. Diversifying standardized options offers clear advantages as described in later sections, while offering clear choices aids consumers navigating poorly regulated markets. It is also important to consider extended household dynamics when advising on basic services, e.g., utilities and facilities for a home on a traditional lakou may possibly serve multiple families and should be selected and designed accordingly.

Table 1. Tiered standardized options for basic services.

| Electricity                     | Water                      | Sanitation                        |
|--------------------------------|----------------------------|-----------------------------------|
| Tier 3 Grid connection and     | Fully functioning on-site  | Septic tank and fully            |
| installed solar panel and/or   | system, including plumbing,| functioning bathroom              |
| generator system               | well, pump, and           |                                   |
|                               | treatment system           |                                   |
| Tier 2 Grid connection and     | Plumbing for future        | Framing and plumbing for future   |
| conduit for future system      | system installation        | bathroom installation and/or      |
| installation                    |                           | low-cost option (urine diverting  |
|                                |                           | toilet [57], composting toilet    |
| Tier 1 Grid connection         | None; collected onsite     | Outdoor pit latrine               |
|                                |                           |                                   |

8. Financing

The third step of the HMVC, financing in the form of whole-house mortgages, is exceptionally important in the Léogâne context, as the experiences of the 2010 earthquake affirm the vulnerabilities of the pervasive incremental masonry construction. The design of a mortgage program suitable for the fragile market conditions of Léogâne engaged the Design Thinking referenced in Section 2, with particular attention to the constraints within the local housing market described in Section 3. The following sections will present the case studies analyzed to initiate the Design Thinking process.
(including a discussion of housing microfinance), the identified barriers, and the resulting community housing fund model co-designed by the Innovation Clubs in Léogâne.

8.1. Background: Housing Finance in Haiti and Similar Contexts

As of 31 March 2011, housing loans make up only 8.3% of Haiti’s banking sector’s loan portfolio [28]. In contrast, the loan portfolios of the top five largest banks in the United States consist of 28% mortgage loans, on average. USAID estimates that even SOGEBEL, the leading lender for housing in Haiti, provides less than 100 mortgage loans per year [59]. Although rare, some of Haiti’s largest banks do offer mortgages, including the Banque Nationale de Credit (BNC), Banque de l’Union Haïtienne (BUH), and Sogebank [29,60,61]. However, it is important to note that these programs are far beyond the reach of most Haitians due to the loan requirements, which include multiple forms of official personal documents, life insurance, proof of sufficient income, and valid land title. Moreover, their websites and applications are all written in French, which is only spoken by 42% of the Haitian population and read by even fewer [62].

Given the risk-aversion of these institutions, many non-profit and for-profit organizations in LMICs like Haiti have turned to housing microfinance: Short term, relatively small, housing-focused loans that target low-income, yet economically active, households who have limited access to traditional forms of financing [63]. By offering loans with more affordable terms, the lending also becomes less risky and more financially viable for the lending institution as well. The amount of a housing microfinance loan varies widely, as does its use. In global surveys of dozens of microfinance institutions (48 and 101 institutions, respectively) in 2015 and 2017, Habitat for Humanity’s Terwilliger Center for Innovation in Shelter found that approximately 60% of housing microfinance loans are under US$2,000 [64,65]. Because of these relatively small loan values, only 14% were used toward full house construction, and only 6% were used towards securing land. The majority (57%) were designated as home improvement loans used for tasks such as tiling, plastering, or roofing, while another 23% were designated as small construction loans and used for adding rooms or basic services, such as latrines or solar panels.

One particularly successful housing microfinance program is Banco Solidario (BancoSol) in Bolivia. Initially started as an NGO in 1986, BancoSol became the world’s first regulated microfinance bank in 1992 [66]. In its first 22 years, the bank dispersed US$4.6 billion to over two million micro-enterprise projects. They later introduced housing microloans, which accounted for a growing 7% of their total portfolio in 2004. In order to accommodate the significant number of entrepreneurial Bolivians, these housing loans have a unique set of qualifying criteria for both salaried clients and microentrepreneurs [63]. Another example of housing microfinance is Guatemala’s Génesis Empresarial, which offers loans to homeowners for major improvements and additions. This program, a collaboration between the Guatemalan government and the Swedish International Development Cooperation Agency, also supports various points on the housing market value chain by offering construction assistance, basic design services, budget verification, guidance on procurement of materials and labor, assistance with permits and legal requirements, and construction oversight [67]. A detailed analysis of the program concludes that “housing microfinance should not be provided without [construction assistance],” as it increases the quality of housing, and therefore the homeowner’s financial well-being and quality of life, as well as reduces corruption by ensuring proper use of loan funds [67].

There are some other specialized programs that bridge the gap between mortgages and housing microfinance. Three of them are briefly reviewed, as they will form the basis for the proposed interventions. The first such program is the Evangelical Social Action Forum (ESAF) Small Finance Bank. Located in India, this bank’s Micro Housing Loan bridges the gap between microfinance and mortgage financing, offering loans up to approximately US$27,000 with repayment periods up to 20 years [68]. These loans can be used to fund up to 80% of the cost of the project and can be used for purchase of an existing home, construction of a new home, renovations, or extensions. ESAF
requires the applicant to secure a co-applicant and a comprehensive set of documentation, including construction plan and estimate, copies of the title deed, permits, and proof of income. The Government of Haiti also offers a subsidized public housing program, EPPLS. Funded by the Haiti Reconstruction Fund, these homes are offered on a lease-to-own basis, with the title transferred to the occupant after five years of consistent monthly lease payments [69]. The EPPLS program has constructed several housing projects across the nation and also acquired others built by foreign donors (Inter-American Development Bank, Food for the Poor, the Venezuelan government, and USAID) following the 2010 earthquake, including Morne-a-Cabrit and Zorange near Port-au-Prince and the Caracol Industrial Park near Cap-Haitien [14]. Unfortunately, this program has been notably unsuccessful, with many of the projects constructed far from employment opportunities, numerous homes in disrepair, and 84% of residents not paying their rent [14]. The final program considered is Cordaid’s housing initiative in the Foyer Sainte Marie community in Port-au-Prince [70]. Instead of constructing a large community of homes in an open area, often far from the city and therefore employment opportunities, Cordaid invested heavily in a single existing community. Working with a local contractor, they constructed “durable earthquake-resistant housing with basic utilities” and coordinated long-term leases for the homeowners. The project was subsidized by grant funds, but participants were required to make monthly payments, estimated at 30% of their monthly income, for up to 10 years. The program participants were also organized into a savings cooperative and “supported towards achieving more self-reliance, independency, and ownership of homes” [70]. At the time of writing, this program is still progressing, and thus data regarding project outcomes is not presently available.

Housing microfinance institutions have the potential to improve the quality of housing for those with limited access to traditional financing. Such a loan could be incredibly useful for a family seeking to make repairs or install water, sanitation, or electrical systems to improve their quality of life. Likewise, with proper technical oversight, housing microfinance loans could be used to seismically retrofit vulnerable homes in earthquake-prone regions. Furthermore, organizations looking to increase the accessibility or effectiveness of their mortgage loans could borrow analogous concepts from housing microfinance institutions, such as BancoSol’s accommodation of non-salaried workers or Génesis Empresarial’s construction assistance. However, housing microfinance, by promoting incremental construction, precludes the adoption of potentially more resilient typologies. While microfinance-supported incremental construction is potentially appropriate in aseismic settings and/or where homes are constructed of light-weight materials, mortgages can promote new typologies, including RC frames, and avoid the dangers associated with varying quality of materials and craftsmanship across the different stages of incremental construction. Therefore, like the aforementioned ESAF, EPPLS, and Cordaid programs, the housing finance structure proposed in the next section borrows elements of both traditional mortgages and housing microfinance to expand access to full construction financing.

8.2. The Léogâne Community Building Fund

Table 2 defines the barriers identified in the Léogâne context, with corresponding responses, as well as specific details from the analogous contexts in which these responses were developed, along with the US-equivalent. These informed the aforementioned Design Thinking methodology (Figure 2c,d), which then resulted in a community-based housing finance program for Léogâne that overcame these barriers: The “Léogâne Community Building Fund”. This fund integrates approaches of Cordaid, EPPLS, and Génesis Empresarial with elements of housing microfinance to increase accessibility to financial services without sacrificing the safety afforded by a well-constructed, hazard-resilient home. Initially seed funded by donors but managed locally, this fund offers lease-to-own housing loans to those who meet specific qualifications. As they re-pay their loans, the fund replenishes, and more housing loans can be offered to other community members. In a country with widespread distrust and dislike of both banks and the government, compounded by weak enforcement policies, the fund’s defining element is its social incentive to make payments so that one’s peers can benefit from new
loans as the fund is replenished. This social incentive is not likely to manifest in a relationship with a large corporate bank or the Government of Haiti, as EPPLS’ 84% non-repayment rate demonstrates.

Table 2. Barriers to housing finance in Léogâne, Haiti with corresponding responses.

| Barriers                                                      | Response                        | Example from Analogous Contexts               | US-Equivalent          |
|---------------------------------------------------------------|---------------------------------|------------------------------------------------|------------------------|
| Low personal savings                                         | Financial education and savings groups | Cordaid placed residents in a savings cooperative which provided support and financial assistance [70] | Personal financial counseling |
| Wide gap between high “cost of safety” and low financial capacity | Low interest, long-term loans | Evangelical Social Action Forum (ESAF) offers a fixed interest rate and loan repayment periods of up to 20 years [68]; Also see [70] | Mortgage |
|                                                              | Subsidies                       | Cordaid secured initial funding through grants [70]; Enterprise Publique de Promotion de Logements Sociaux (EPPLS) is also subsidized by the government [14] | HUD Voucher Program |
| Lack of personal financial history                           | Cosigners and community-based approval process | ESAF requires a co-applicant for each loan [68] | Co-signer |
|                                                              | Clients must meet certain qualifications | EPPLS required clients to be of Haitian nationality, have a job, and have a clean judicial [69]; Also see [29,66,68] | Credit report, credit score |
| Political/enviro. instability                                 | Flexible loan payment plans     | USAID suggests “flexible payment approaches” for lower and mid-middle class families [59] | Grace period, refinancing, home equity line of credit |
| Variable income                                               | Engineered design and quality control | Génesis Empresarial offers construction assistance, in addition to many other education programs, to its clients [67] | Building codes and regulations |
| Low technical knowledge and capacity                          | Alternative methods to prove land ownership | Habitat for Humanity accepted purchase agreements or utility bills as proof of ownership [71] | Deed and title |
| Minimal proof of land ownership                               | Rent-to-own payment plans       | EPPLS had clients pay 1500 HTG per month for five years [69]; USAID also suggests “lease-purchase-based rentals” [59] | Mortgage |
|                                                              | Direct housing loans            | Cordaid offered subsidized loans directly to their borrowers [70] |                        |

To further incubate the fund concept into a program outline, six Innovation Club members were selected from across different zones of Léogâne. The team was presented with the concept and some of the expected challenges, such as selecting families for the program, encouraging truthful disclosures on applications, creating trust and transparency in all processes, and ensuring repayment. The team was also asked to consider the practices of analogous businesses and services in Léogâne, as well as features necessary to garner credibility with local banks and NGOs, in the hopes of eventually collaborating and expanding the fund’s reach.

Through a process of discussions with other members of the community, collaborative design sessions, individual conceptions of the fund’s design, and collective negotiation of these conceptions into a unified strategy, the team conceived Kredi Lojman Kominote Léogâne (KLKL), which translates from Haitian Creole as the “Léogâne Community Building Fund”. The target population is middle-income residents of Léogâne who already own land, either alone or shared with extended family, and currently rent homes or live with relatives. The Household Recovery Study found that 77% of Léogâne residents live on their own land or family land [20]. Likewise, renters are accustomed to making regular housing
payments, while many living with family have been saving money to rebuild their homes destroyed in the 2010 earthquake. Table 3 summarizes the qualifications required for KLKL applicants.

**Table 3.** Kredi Lojman Kominote Léogâne (KLKL) pre-qualification criteria.

- At least 18 years old;
- valid ID and two ID photos;
- proof of employment, through either an employment contract (verified by institution’s director) OR registration of business ownership (verified with General Direction of Taxes);
- verification of sufficient income to cover family expenses and monthly housing payment;
- two local cosigners within the family who meet all of the above criteria OR one diaspora cosigner (preferred) who can meet and verify the local equivalent of the above criteria;
- two witnesses to also serve as character references;
- valid title to property in Léogâne, signed and verified by the notary’s office;
- construction permit.

If initially approved, KLKL staff would visit the land and evaluate the site. They would also meet with the family to design their home (more details in the following sections) and coordinate the specifics of the loan. Prior to construction, they would also verify that a building permit has been obtained. Then, a certified local contractor would construct the house for the family (more details in the following sections). It is also important to note that while many international housing projects opt to build a large number of homes on one cleared plot of land, these communities disrupt cultural norms [16]. In order to differentiate KLKL’s emphasis on self-recovery from charity programs and facilitate a sustainable, market-driven approach, KLKL homes are constructed on the applicant’s plot of land, harnessing the value of unused land as collateral to drive the mortgage industry for Léogâne’s middle class.

KLKL requires monthly payments for 15 years, starting one month after residency initiates, with a 1% late fee penalty, and down payment of 10–20% of the total construction cost. Akin to traditional mortgages, the applicant assumes ownership of the home with title transferred upon the full repayment of the loan. However, the social contract with the community governs other aspects of the agreement, e.g., prior to assuming full ownership, the family cannot sell the house without the written consent of KLKL and a public foreclosure of the property for payments lapsing by 6 months. To further amplify the social consequences of non-payment, payment histories are carefully monitored and publicly disclosed by the fund. As reputational harm and social standing are critical collateral in Haiti, this level of transparency carries far greater consequences than the threat of weakly enforced foreclosure by banks, NGOs, or the government. Another key element of the fund is the utilization of Haiti’s global diaspora network. Remittances from the Haitian diaspora make up an estimated 31.2% of Haiti’s GDP [72]. Diaspora capital is leveraged in two ways: As a form of charitable giving, KLKL taps diaspora networks in Haitian American communities interested in addressing Haiti’s housing gap to solicit subsidies for lower income families; (2) applicants who already receive remittances are prioritized in the pre-qualification process if the diaspora serve as co-signers, agreeing to send their funds directly to KLKL each month to offset the required payment, providing year-round stability to those with fluctuating incomes. According to the Household Recovery Study, 35% of respondents would benefit from the policy [20], and it is expected to encourage other homeowners to solicit support from abroad to benefit from such prioritization. Importantly, the quality assurance associated with KLKL homes (discussed shortly) instills greater confidence in diaspora that their funds are promoting safe and dignified housing in their home country.

9. Design and Construction

The design and construction process, the next step once financing has been secured, can be broken down into its three constituents, which correspondingly make up components four through six of the HMVC: Labor and material supply chains, design and engineering services, and construction and
quality assurance. Like all components of the HMVC, these steps are interdependent. The design and engineering process requires a basic knowledge of the locally available materials and their engineering properties, and an understanding of local construction techniques and the technical capacity of the workforce. Likewise, the quality assurance process is intimately tied to the adopted design and is critical to ensuring this local labor achieves as-built details that deliver the required capacity. These three components are now discussed.

9.1. Labor and Material Supply Chains

As previously noted, the quality of concrete and CMU in Léogâne is subpar. Similarly, there is also a deficit of laborers formally trained in aseismic construction. These deficiencies severely hinder the HMVC because even if all other components are effective, weak materials and laborers that fail to properly follow detailing requirements will render even a carefully engineered design vulnerable to seismic demands. As noted in past studies [9,15], training of masons in hazard-resistant construction is not necessarily effective, as other factors (such as cost, pre-existing habits, and a lack of thorough understanding of design principles) may prevent the skills learned through training from being applied in full. As these deficits point to systemic issues in educational pipelines and underdeveloped construction material market systems, they are challenging to address at their root cause, though the risks posed by these limitations within local labor and material supply chains can be managed as long as they are carefully considered in subsequent elements of the HMVC, as demonstrated later in the section on construction and quality assurance.

9.2. Design and Engineering Services

The exposed vulnerabilities of Haiti’s informal residential construction practices [8,9,25] make it obvious that any housing initiative must promote structures that meet contemporary design standards, particularly for seismic hazards. While confined masonry has yet to be formally codified by major international standards, it is possible to create standardized, code-compliant designs for regions of high seismicity by adopting masonry-infilled RC special moment frames [17]. These employ basic construction techniques similar to confined masonry and at comparable cost [46], but even when implemented using standardized designs with specific floorplans, they are inherently more flexible in the finishes and layout by removing the onerous demands to confine every perforation in the walls. Thus, by concentrating the structural capacity in a standardized frame while still affording the flexibility to customize the partitioning, window placement, and finishes, this typology can deliver consistent levels of safety while still accommodating the architectural preferences of the homeowner. This typology is also highly attractive for financial institutions, as evidence of increased resilience reduces risks of catastrophic losses to the property during the terms of the loan. This has similarly resulted in the promotion of resilience considerations within lending processes in high-income countries [73].

One must not discount the importance of architectural preferences in a market-based approach. In order to develop a sustainable mechanism for housing delivery, one must offer a desirable product in which a consumer is willing to invest significant resources. The benchmark for such architectural considerations (e.g., size, layout, finishes) should be the homes that are being delivered by the local market in Léogâne, not what aid organizations are providing for free or with heavy subsidies. There is a significant difference between what beneficiaries will accept when given for free and what they aspire to have if they pay for it, and any long-term sustainable market-based program needs to have the latter guide its effort [17]. Furthermore, it is important to involve the homeowner in the design process to foster a sense of ownership from the outset, valuable emotional capital that can be harnessed to motivate repayment. One method for facilitating this is through risk-informed, multi-criteria decision making, a strategy which gives consumers the autonomy to make their own design decisions balancing risk and cost constraints through the objective presentation of tradeoffs. An unbiased performance assessment, when presented alongside other factors such as cost, aesthetics, and security, can empower homeowners to make better risk-informed decisions that are truly in the best interests of their family.
Recognizing the importance of both architectural preferences and safety demands and the limited local capacity to provide custom services, the authors propose providing homeowners with a suite of standard models that support modest levels of customization. The base structural designs are guided by considerations of cost and structural resiliency, as informed by the multi-criteria parametric design process discussed in [46], with both considerations clearly outlined in the risk-informed decision process. The models each offer suites of possible interior layouts, a flexibility again afforded by adopting RC frames that decouple the walls from the load path of the structure in contrast with confined masonry, along with tiered options for doors, windows, fixtures, and finishes. This approach reduces the overall implementation cost, time, and demands for custom design services, and also streamlines construction and quality assurance, as standardized designs ultimately allow for templated quality control processes and paraskilling, simplifying the overall construction process and resulting in fewer construction errors through the repetition afforded by standard details.

9.3. Construction and Quality Assurance

As discussed in Section 4, the construction of RC frames requires proper detailing of critical regions of the beams and columns [17,74]. Although the primary construction skills and processes required (e.g., mixing and pouring concrete, tying rebar cages, and laying masonry for infill) will not be new to any experienced Haitian construction laborer, some details and practices critical to the integrity of the frame structure may be unfamiliar, such as the relatively large cross-sectional dimensions and amount of longitudinal and confining steel in the beams and columns, the detailing in beam-column connections, and the overall sequencing that requires the frame be poured before laying courses of CMU. Guidance will be needed to actively promote such behavior change at all personnel levels, from artisans/masons to site foremen/boss masons to the head contractor/project manager. Effective construction practices will not only ensure that the home is constructed as designed, but will also continually verify and document the process throughout to instill confidence in the collateral value of the home. However, this transition is not expected to be simple and will require a specific behavior change framework.

Drawing upon analogous construction manuals related to residential construction in Haiti [75,76], guiding documents for confined masonry construction [23,77], and Bridges to Prosperity’s Bridge Builder Manual [78], which has been translated into three languages and used to build hundreds of pedestrian bridges in LMICs across the globe, various insights were evaluated within recommended practices for promoting behavior change in the workplace [79]. The strategies and examples identified from these analogous contexts were grouped and organized into four themes, under which a series of generalized recommendations is offered. The resulting guiding principles for quality assurance are presented in Table 4 with corresponding examples.

A construction manual specific to RC frame construction was then developed from these principles, following the field-validated processes implemented by teams working with the second and third authors [17], as shown in Figure 4. Draft versions of the chapters dedicated to Site Preparation, Concrete Mixing, Foundation, and Frame construction, in both English and Haitian Creole, are available in [46]. It is important to note that these drafts have not yet been thoroughly tested in the field, and thus require thoughtful application, evaluation, and iteration in the future, as chapters for other construction stages, e.g., masonry walls, roof, and finishes, are added.
Table 4. Guiding principles for quality assurance.

| Theme     | Recommendation                                                                 | Example                                                                 |
|-----------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Simplicity| Shrink daily tasks                                                              | Minimize number of required forms, reports, and photos                  |
|           | Create a space for the process                                                  | Define a specific role and/or time of day to complete forms             |
|           | Simplify complex procedures                                                    | Provide simple, step-by-step instructions                               |
| Clarity   | Utilize visuals                                                                 | Utilize checklists, photographs, diagrams, and 3D models                |
|           | Define practical goals                                                          | Prepare realistic timelines and contingency plans                       |
|           | Provide key instruction                                                        | Host workshops and tutorials on the most critical steps                 |
|          | Find what works                                                                 | Consider quality control practices already in use in local             |
|          |                                                                                 | analogous situations, such as hospitals or manufacturing               |
| Localization | Leverage social structure                                                     | Compare quality control to very honorable profession and give hats,     |
|           |                                                                                 | shirts, or certificates to those with special training                 |
|           | Inspire from within                                                            | Empower local leaders to foster a sense of identity within construction teams |
|           | Create family–builder connection                                               | Harness emotion by introducing workers to family whose home they are building |
| Tangibility | Envision success (and failure)                                                  | At relevant construction stages, share photographs of buildings that    |
|           |                                                                                 | did and did not fail during the 2010 earthquake and explain why or why not |
|           | Inspire and sustain responsibility                                              | Foster a sense of pride among workers and create systems of accountability |

Figure 4. (a) A quality control engineer using a visual checklist for concrete production, and (b) concrete cylinders prepared to demonstrate strength of design concrete mixes to crews.

10. Maintenance and Homeownership

It is imperative that support for homeowners does not end with the completion of construction. If a homeowner fails to make loan repayments, they will lose their home. Alternatively, if they are unable to recognize damages and perform (or hire someone else to perform) routine maintenance on their home, their investment could depreciate or become unsafe. Thus, the last component of the HMVC (maintenance and homeownership) is as critical as any other component, and skills such as home maintenance and personal finance should continue to be developed throughout the repayment process. One mechanism for maintenance knowledge transfer is through a support agreement with the contractor. For example, the contractor could continue to meet with the buyer quarterly for a period of two years to advise the buyer on maintenance and repairs. KLKL program participants are
also encouraged to form a support group and meet monthly to discuss any home maintenance issues. In addition to maintenance skills, it is critical that the financial well-being of each participant also be supported.

Unlike most households in the United States, the majority of Haitian families do not operate on monthly budget cycles due to the fluidity of their income. Even regular expenditures, such as school fees and rent, are often paid on a bi-annual or annual basis [14]. Furthermore, an insufficient safety net of savings means unexpected costs like medical treatment or funerals can often become financial emergencies. With limited access to formal credit (only 19% of those surveyed in the Household Recovery Study have borrowed from a bank), these shortfalls are often met through informal borrowing among family members, friends, and street lenders. In fact, 42% of those responding to the Household Recovery Study have leveraged such informal lending, and focus groups led by the first author suggest the number of informal loans in the community may be even higher. Given the above details, it is clear that low- and middle-income families in Léogâne who are given housing loans face potential cultural and behavioral obstacles that could significantly hinder their ability to make monthly housing payments. Therefore, it is recommended that a personalized financial education program be administered to continuously support this shift and assist families in meeting their required KLKL repayments. These recommendations are developed based upon past financial literacy studies, particularly randomized controlled trials, throughout a variety of LMICs in Africa and Latin America [80–84]. These concepts were further contextualized through focus groups facilitated by the authors and Innovation Clubs in Léogâne (see Figure 2c,d). Through worksheets, discussions, brainstorming activities, and skits, these focus groups revealed the extent and complexity of informal lending, reinforced the importance of community perceptions that anchor the KLKL social contracts, and identified context-specific motivational triggers. Table 5 provides a mapping between recommended strategies from the literature and contextual adaptations for Léogâne.

Table 5. Mapping of financial literacy strategies to contextual adaptations.

| Recommended Strategies                                                                 | Contextual Adaptations                                                                 |
|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Focus should be on main ideas, simplification of complex topics, and the “rule of thumb” education format [81,82] | • Rely heavily on “rule of thumb” learning  
• End with catchy summary phrases and jingles |
| Numeracy skills are vital to financial literacy, but are not effective when taught alone [83,84] | • Basic mathematics via budgeting worksheets  
• Utilize familiar denominations, presenting mathematics in a literal, monetary manner |
| Must consider the education level of participants [81,84]                             | • Rely on simplified, activity-based learning rather than text or lecture-heavy delivery  
• Disregard complicated calculations (i.e., compound interest, present value) |
| Must be a sustainable balance between education, action, and empowerment [80,83]      | • Utilize both passive and active classroom sessions for introduction to topics and brainstorming activities (Education)  
• Establish direct partnership with local bank and open savings accounts for participants (Action)  
• Weekly/monthly personal counseling requires full commitment and accountability of potential homeowner (Empowerment) |
### Table 5. Cont.

| Recommended Strategies                                                                 | Contextual Adaptations                                                                                                                                                                                                 |
|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Direct access to financial products is vital and should be either offered on site or, better yet, involve individualized educational field trips to a bank, insurance office, notary office, etc. [80,83,85] | • Establish direct partnerships with local institutions  
• Provide detailed action plans for obtaining financial products or supporting processes (e.g., land tenure)  
• Use skits and mock scenarios                                                                                                                                 |
| Personalized counseling and tutoring in the home are vital and should be provided monthly at a minimum [80] | • Weekly/monthly in-home active management sessions monitor progress and maintain commitment  
• Designate sipo (peer support network) to increase accountability                                                                                     |
| Goal setting, both short-term and long-term, should be included [80]                   | • Weekly/monthly counseling includes establishing short-term goals and identifying and breaking down long-term goals, as well as tracking progress                                                                                  |
| Teach children about financial literacy and social education [85]                     | • Counseling conducted in home in the presence of extended family members, activities involving family members in natural roles  
• Stress importance to parents that their children, family, and friends will be mimicking their financial habits                                                                 |
| Specific training for employees and entrepreneurs [82]                                | • Course dedicated to enhancing employability and entrepreneurial skills  
• Teach general behaviors that increase value to employer, customers                                                                                                                                                  |
| Inspire participants to assess and apply personal emotional motivation for success [86] | • Pose personal questions to provoke emotional commitment  
• Emphasize goal setting and effectively track successes and failures  
• Utilize family relationships in discussion                                                                                                                                 |
| Establish a system for support, mentorship, and accountability [87]                   | • Oversee establishment of a sipo (support) network for each participant  
• Create an environment of accountability within classroom/counseling sessions                                                                                                                                      |
| “Rigorous self-evaluation” is vital to improvement and continued success of educational program [88] | • Must establish internal assessment process for determining success and adapt accordingly  
• Examine metrics from participants                                                                                                                                                                                   |

11. Discussion

The presented procedures, concepts, and frameworks share several common themes. The first and foremost is the application of Design Thinking to foster a human-centered approach, which aims to keep the homeowners’ needs and desires at the core of the design process. Application to the Léogâne, Haiti case study scenario required further contextualization through thorough market research, case study analysis, and study of cultural norms. Another consistent theme is the focus on decentralization and localization. For example, the Kredi Lojman Kominote Léogâne (KLKL), or Léogâne Community Building Fund, promotes use of existing family land distributed across the community rather than constructing a block of homes in a new development divorced from the community’s social fabric. Similarly, KLKL extends loans from a locally-managed community housing fund with greater potential to enforce repayment through social contracts as opposed to distrusted top-down, national systems.
This consistent focus on localization uses the community’s strengths to create a more sustainable local housing ecosystem capable of producing resilient and dignified housing solutions, and is aligned with the aid community’s realization that housing deficits can only be sustainably closed through investments in market-based systems. Lastly, as noted throughout the paper, the entire housing market value chain was considered while designing each of its underlying components. Although conceptualized in a chronologically linear manner, the codependence and interoperation between these components is far more complex. This unifying theme of integration is central, as an intervention at any single step at the neglect of other steps in the housing market value chain is extremely unlikely to contribute to sustainable advancements in resilient housing design and delivery. With that being said, integrated approaches are inherently more complex and require sustained effort across a multiplicity of sectors and actors, which often transcends the mandate or capacity of a single implementing organization, requiring well-coordinated partnerships to align efforts to achieve integration at scale.

Regarding the limitations of this study, it is important to first note that although developed through an integrated research effort that builds upon a decade of field-based research in Haiti, these concepts and procedures will benefit from further implementation and refinement in the field. While highly localized its details for the unique context of Léogâne, the guidance offered is generalizable and can be adapted to other similar contexts. Given the extreme technical, economic, and political constraints on the Haitian housing industry, if proven successful in Haiti, they are likely adaptable to increase the resiliency of residential construction in many other low- and middle-income countries.

12. Conclusions

This paper explored the technical, economic, and political constraints that have shaped the informal residential construction industry in Haiti, making the case for an integrated approach to improving the housing ecosystem. The complex interconnectedness of the housing ecosystem was simplified to the seven-step housing market value chain, whose components were sequentially analyzed in this paper. Corresponding interventions and recommendations responsive to the Haitian context were then designed for each of these components, with local stakeholder engagement. The primary conclusions of this research as follows. As donor funding is insufficient to meet the housing deficits globally, sustainable housing delivery must ultimately adopt market-based approaches. Such approaches inherently must place the homeowner, the consumer, at the center of the design process to ensure housing models meet their architectural preferences, cultural expectations and financial capacities, while providing clarity of choice when navigating the complex decisions that guide the home design process in these poorly-regulated markets. These approaches must similarly be highly contextualized to account for the limited capacity of local institutions, practices, and processes to manage risk and overcome systemic barriers. This implies the need for a holistic and human-centered design process, one that adopts a systems approach that integrates all elements of the housing market value chain. This case study in Léogâne, Haiti illustrates such an integrated, market-based approach to sustainably deliver housing in response to the growing housing deficit in Haiti and across the globe.

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