



Terwilliger Center for
Innovation in Shelter

Sustainable solutions in incremental construction



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Av. José Pardo Nro. 434 Piso 16, Miraflores, Lima, Peru Email: info@ctivperu.org

Website: www.ctivperu.org

Consultancy team: Heidi Rodrich (social specialist), Nurymar Feldman (development communications specialist), Adriana Sanchez (layout and design assistant), Samantha Castaneda (research assistant), Walter Vasquez (sustainable construction specialist) and Juan Carlos Rodriguez Armas (team leader).

Editorial and supervisory team: Gema Stratico, Norma Rosas, Rosario Reano, Paola Resoagli and Yoselin Huaman (HFHI).

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01. INTRODUCTION

One of the most challenging social problems faced by our countries most vulnerable families is the housing deficit. In both qualitative and quantitative terms Peru's housing shortage has become particularly dire. This is true in both major cities and the peri-urban neighborhoods of Lima's sprawling metropolitan area due to vulnerability to climate change and natural hazards such as earthquakes.

Although the Peruvian government has undertaken a series of initiatives, its social interest housing programs (programas de vivienda de interés social, or VIS) have limited coverage, and owner driven construction persists. While owner driven construction helps meet the country's growing demand for housing, sustainability practices to mitigate environmental impacts and improve the quality of life for their end users are scarce.

This led Habitat for Humanity, through the Terwilliger Center for Innovation in Shelter (TCIS), to conduct a study on the potential of adopting sustainable practices in housing construction projects for vulnerable populations in Metropolitan Lima, with the aim of identifying both the barriers to their implementation in peri-urban neighborhoods and the opportunities these might entail.

Taking a comprehensive perspective, the study considers the potentialities of scientific and technological advancements in the housing sector alongside the knowledge and tools offered by the social sciences and communications arts. Its goal is to propose solutions that can feasibly be implemented in the short, medium and long term. This includes a rigorous review of secondary sources, as well as interviews with key stakeholders in the housing ecosystem and focus groups comprising construction workers and user families residing in the community of La Ensenada, Puente Piedra. A comprehensive mapping and subsequent analysis of a specific set of sustainable solutions (SS) was carried out, based on the criteria of relevance, practicality, affordability, and complementarity.¹

This led to the following conclusions:

- One of the main challenges for the gradual incorporation of SS is the need to boost an effective demand.
- There is great potential to strengthen the coordinated actions of the various actors in the housing construction ecosystem within the framework of their respective competencies and roles.

Based on this SS analysis, this document proposes the SS models most likely to be adopted, covering various types of construction and including the four housing types (A, B, C, and D) established by HFHI,² as well as Peru's VIS model. Specific recommendations are provided to help each category of actor in the housing construction ecosystem meet the challenge of promoting and strengthening an effective demand for SS. Also included recommendations for public entities such as national and municipal government bodies, private companies, development banks, international agencies and non-governmental organizations that provide technical assistance services, technical entities, and providers of financial services.

¹ Findings from the study "Feasibility assessment of the digital channel of purchase and sale of materials for the construction of Social interest housing in Peru" (commissioned by HFHI, CAPECO and APET and conducted for HFHI in 2021) have also been incorporated.

² TCIS (2018). "Housing situation for the base of the pyramid in Metropolitan Lima". Published by Habitat for Humanity's Terwilliger Center for Innovation in Shelter. Recovered September 2023 from:

https://www.ctivperu.org/wp-content/uploads/2019/03/ENG_informe_viviendabdp_SJL.pdf

02. GLOSSARY

PASSIVE DESIGN

Architectural design strategy that takes advantage of natural resources such as sunlight, wind and vegetation to improve the thermal comfort and lighting of a house, limiting the need for artificial energy, reducing the building's carbon footprint, and improving the quality of life of its inhabitants.

SUSTAINABLE SOLUTIONS (SS)

Design and construction strategies applied to the sector with the aim to reduce the industry's impact on the environment, mainly in terms of the carbon footprint of building materials and water and energy consumption throughout the life cycle of a project.

SUSTAINABILITY

The ability to meet the needs of present generations without compromising those of future generations. In the context of progressive housing, this includes design and construction strategies that, within a framework of technical, economic and social viability, allow families and their generations to enjoy decent housing.

03. HOUSING SITUATION IN METROPOLITAN LIMA

According to Peru's Ministry of Housing, Construction and Sanitation (MVCS), the country's growing deficit in the housing supply and the presence of inadequate housing conditions in sectors with fewer economic resources and reduced access to infrastructure services and urban equipment has the following root causes:

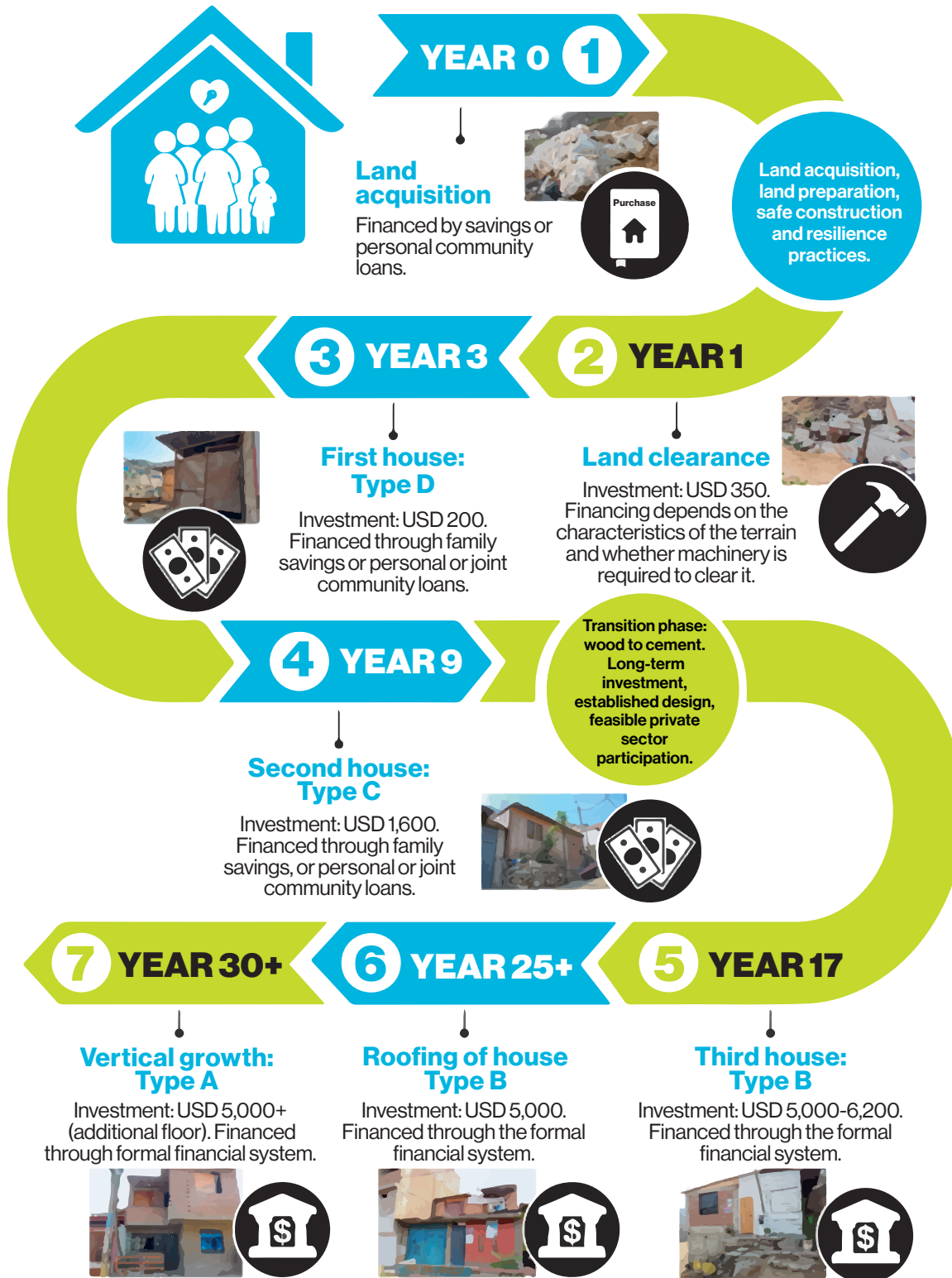
- Poor social legitimacy and authority among urban and territorial planning instruments.
- Inefficient and unsustainable development and occupation of land.
- Limited and inequitable access to adequate housing solutions.

Additionally, several HFHI studies have shown that state measures have been unable to resolve the quantitative and qualitative gaps in access to housing for vulnerable families, highlighting two key factors:

- The lack of legal titles for land and the inability of low-income families to obtain them, which represents a major constraint on access to state housing and credit programs.
- The absence of land management mechanisms and financing for urban infrastructure, which leads to successive appraisals that raise the cost of projects and, consequently, of housing units, making them unattractive to low-income sectors.

The MVCS estimates that roughly 68.5% of the homes built in Metropolitan Lima between 2007 and 2014 are informal; that is, they have been built in inappropriate locations, without construction permits, with low quality materials, and without the support of technical assistance from construction professionals. Furthermore, according to Espinoza and Fort (2020), in the last two decades Peru's largest cities have expanded by some 50%, mostly informally, in that approximately 93% of urban expansion corresponds to settlements created without full habilitation. According to the International Labour Organization (ILO), in the long run, incremental construction costs a family 40% more than a professionally built home.³

³ International Labor Organization (2019). "Decent work and adequate housing for households at the base of the pyramid (BOP)". Recovered Sept 2023 from: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/documents/publication/wcms_706883.pdf





TYPE A

High-quality materials, two or more levels, located on flat terrain, no finishings, significant access to basic services, multiple rooms, inhabited by one or two families.



TYPE B

High-quality materials, one level with plans for more, located on flat terrain, no finishings, significant access to basic services, multiple rooms, inhabited by one or two families.

SOCIAL INTEREST HOUSING (VIS)

Incremental construction that coexists with the VIS model promoted by the state and having, at minimum, a multipurpose environment, a kitchen, a bedroom with a door, a bathroom with a door, a laundry area and, if applicable, external enclosures.⁴



Temporary materials, one level, located on sloped terrain, no finishings, limited access to basic services, one or two multi-use rooms, inhabited by one family.

TYPE C



Temporary materials, one level, located on sloped terrain, no finishings, extremely limited access to basic services (especially electricity and drainage), one multi-use room, inhabited by one family.

TYPE D

⁴ As of 2020, the maximum value that a dwelling can have to be considered social interest housing (thus eligible for Peru's housing subsidy program) was established at S/ 85,700 for a single-family home and S/ 107,000 for a multi-family home. This includes the following modalities: new house acquisition (AVN), geared toward enabling families to purchase land; building on one's own cite (CSP), geared toward helping families who own land or are publicly registered as independent heirs; and housing Improvement (MV), geared toward the improvement or expansion of a publicly registered home. With AVN, the expandable VIS design should allow for incremental horizontal and/or vertical growth and have a minimum roofed area of 25 m². The issues with incremental construction persist in the expansion processes that families carry out on their own. Source: Ministry of Housing, Construction and Sanitation (2020). Decree N°009-2020-VIVIENDA, which updates the maximum values for social interest housing in the AVN category. Lima, Peru.

04. SUSTAINABLE DEVELOPMENT AND THE CONSTRUCTION SECTOR

Quality housing and the SDGs

Sustainable development is a paradigm that has been solidly established in the global debate on human development, and extends to just about any economic, commercial, financial or industrial activity carried out by modern societies. In this context, various efforts by international cooperation agencies, academia, and national governments have enacted a series of goals to define the concept of sustainable construction.

Eighty percent of the population in Latin America and the Caribbean (LAC) resides in urban areas, with four out of every five urban dwellers living in unplanned settlements. This makes owner driven construction in peri-urban areas a key aspect of seeking sustainable development models around the world. Of any global industry, the construction sector has some of the greatest impacts on environmental wellbeing. In 2021, the construction industry (encompassing all the processes associated with physical assets) was responsible for 37% of carbon emissions and 34% of global energy consumption, reaching an all-time high despite increased global investments in energy efficiency.

Addressing sustainable construction furthers the achievement of at least 10 Sustainable Development Goals (SDGs), which comprise the global agenda to combat climate change. Adequate housing generates resilience and reduces vulnerability (SDG 1); lowers the occurrence of lung and respiratory diseases (SDG 3); protects women from discrimination (SDG 5); encourages safe and healthy households with access to potable water and sanitation (SDG 6); contributes to cost savings and reduces air pollution and the effects of climate change, thereby employing energy efficient housing systems (SDG 7); creates employment opportunities in inclusive businesses (SDG 8); promotes innovation for sustainable industrialization (SDG 9); creates safe, resilient and sustainable cities (SDG 11); promotes waste reduction, recycling and reuse (SDG 12); and directly contributes to reducing GHG emissions (SDG 13).



05. DEVELOPING A MARKET FOR INCREMENTAL HOUSING CONSTRUCTION IN METROPOLITAN LIMA

Summary of actors involved and determination of causes

Ultimately, incremental construction (which includes the owner-driven construction of private homes and in areas of horizontal and/or vertical expansion made possible by state-promoted VIS), is far from having adequate quality and safety standards and being favorable to the environment. This is due to several factors that do not allow the supply of goods and services for sustainable construction—including SS—to reach families.

Analyzing this problem and identifying potential solutions requires accounting for the role played by all actors involved in Peru's housing construction ecosystem to strengthen its coordination. These include government entities (mainly the MVCS, the MiVivienda Fund and local municipalities), private companies (mainly those engaged in construction and marketing activities), technical entities (those that execute MiVivienda Fund projects), construction workers, financial institutions, and user families. Taking Metropolitan Lima's "low level of development of a market for sustainable incremental construction in vulnerable population segments" as the central issue, the following causes were identified:

Insufficient development of sustainable solutions by private enterprise and the state

- Inadequate regulatory framework and communication strategies in state programs.
- Insufficient development of technological innovations geared toward sustainable incremental construction.
- Weak inclusion of sustainable solutions in VIS housing programs by the MVCS and subnational government initiatives.
- Weak implementation of the sustainable construction code (the state system that regulates the design and construction of sustainable buildings and cities).
- Limited development of capacities for research, development and innovation in the construction sector in terms of sustainable incremental construction.

Low level of demand for sustainable solutions on the part of vulnerable populations

- State programs and private companies provide little information to users about the costs and benefits of implementing sustainable solutions.
- Users have little awareness of the advantages of implementing sustainable solutions (improved health and safety, for example) in family building projects.

Weak coordination between supply and demand for sustainable solutions due to limited development of specialized technical and financial services

- Limited access to technical assistance for sustainable housing construction.
- Limited access to financial resources for sustainable housing construction.
- Scarce supply of vocational and/or technical training in sustainable incremental construction..
- Weak development of financial services geared toward vulnerable populations and sustainable incremental construction.

The interviews with representatives of key entities in Metropolitan Lima's construction ecosystem, as well as families and construction workers, along with focus groups with residents of La Ensenada, revealed various limitations that may hinder efforts to close the quantitative and qualitative gaps in access to housing for vulnerable families, consolidate incremental construction processes, and incorporate incremental SS:⁵

- **Informality** remains a structural problem in Latin America (Clichevsky, 2000, 2003).⁶ In Peru, particularly in Metropolitan Lima, informality continues to reduce the housing system's capacity to generate quality deliverables for families—especially the most vulnerable—and involves the work of the country's three levels of government: central, regional, and local.

“The formal supply has suitable land; they come in with proper zoning and a building permit. The situation with informal occupation is very bad; the construction processes are much slower and create a lot more pollution. Producing formal housing is much more profitable for the planet, for society, and for everyone. It is essential to promote formal occupation in order to gradually incorporate sustainability” (entity representative)

- There is a **lack of comprehensive urban planning** from a medium- and long-term perspective, as well as discrepancies between supply and demand among the actors in the construction ecosystem.
- **Scarce supply and inadequate financing mechanisms** for the most vulnerable families, who are outside the target population of the MiVivienda and Techo Propio programs and end up using consumer loans with high interest rates.
- **Heterogeneity and insufficient training for construction professionals**, creating challenges in terms of technical knowledge and management skills. The supply of construction workers has a wide variety of quality and costs, so many contractors and families opt for low-cost workers with suboptimal performance.
- **Insufficient momentum for the incorporation of SS**: Neither the state nor the private sector has a comprehensive view of sustainability, and various real estate projects only give importance to specific aspects (e.g., LED lights, low-energy elevators, and other aspects linked to specific certifications).

“Sustainability isn't just green roofs; it doesn't just mean you occupy more land on the periphery. Sustainability means understanding housing and the city as a physical space—as comfort. We must think about sustainable construction processes and work in coordination with the construction guilds” (entity representative).

⁵ These findings corroborate, deepen and/or complement previous studies, including: ILO and HFHI (2019). “Decent work and quality of housing for families at the base of the pyramid: Are there market opportunities to address the housing deficit?” Geneva: International Labour Organization (ILO). Recovered Sept 2023, from: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/documents/publication/wcms_706883.pdf; and Rodriguez, Juan Carlos (2021). “Barriers to access to housing subsidy programs in Peru: Study and proposals for innovations in public policies. Lima: Habitat for Humanity international”. Recovered Sept 2023, from: https://www.ctivperu.org/wp-content/uploads/2023/02/Estudio-Barreras-HFHI-14_ENG.pdf

⁶ Clichevsky, N. (2000). “Informality and urban segregation in Latin America: An approximation”. Santiago de Chile: Economic Commission for Latin America and the Caribbean (ECLAC). Recovered Sept 2023, from: <https://www.cepal.org/es/publicaciones/5712-informalidad-segregacion-urbana-america-latina-aproximacion>; and Clichevsky, Nora (2003). “Poverty and access to urban land: Some questions about regularization policies in Latin America”. Santiago de Chile: Economic Commission for Latin America and the Caribbean (ECLAC). Recovered Sept 2023, from: <https://www.cepal.org/es/publicaciones/5780-pobreza-acceso-al-suelo-urbano-algunas-interrogantes-politicas-regularizacion>

- **Contractors and construction workers do not have enough information** about the characteristics, costs and benefits of SS. Deficits exist in training and access to information for construction workers.
- **There is a lack of knowledge**, mainly on the part of local governments and construction workers, about the land surveys available in the Information System for Disaster Risk Management (SIGRID).

Access barriers on the demand side

- From the perspective of the families and construction workers who participated in the focus groups, **the scarcity of resources (and the constraints to accessing them)** is the main reason they are unable to build their homes in shorter periods of time and with the appropriate quality criteria. Likewise, the focus group participants reported that the children of families that have built with the MiVivienda Fund's Techo Propio program take time to build the second floor of their home because independence is expensive and is a requirement for accessing this financing mechanism a second time.
- **There is mistrust in financial institutions.** In many cases, families choose not to access credit, because they find the interest rates offered to be very high, or because they lack confidence in formal institutions (e.g., in the documentation they must file with a notary, linked to guarantees in mortgage lending).⁷
- **There is mistrust in municipal authorities and employees**, in that families report that they do not receive precise information, the processes are cumbersome, or they are asked to repeat certain procedures due to staff turnover.
- **Incremental construction is carried out without plans and without the appropriate professionals** (i.e., engineers, architects, etc.) at each stage of the process, generating difficulties such as in selecting the most suitable technologies and materials, including SS.
- **Families have limited technical skills**, which makes it difficult to properly select architects, engineers and construction workers and to demand that these use higher quality materials and procedures.
- **Construction is carried out without following the guidelines set forth by the National Building Regulations (RNE)** for ventilation and lighting, which subsequently generates complications in standardizing municipal procedures.
- **In areas with inadequate terrain (such as La Ensenada)**, families have difficulty developing optimal construction processes and their expenses increase due to the need to buy land.
- **Limited access to information**, including i) during the various stages of the owner driven construction processes; ii) in the operation and requirements for access to the Techo Propio program; iii) on SS options and their potential benefits.⁸

⁷In a recent study by the Peruvian Institute of Economics (IPE, 2022) on informal (non-formal) loans, it was found that 49% of these have interest rates 500% or more and that the annualized rate of these credits is at least 10 times more expensive than in the formal financial system. Likewise, 79% of those who resort to informal credit pay rates higher than the ceiling set by the financial system.

⁸According to Swisscontact (n.d.), families report that they receive little information from construction workers (and that, in various cases, a machismo culture prevails in which even less information is provided to women). Regarding the type of information families would like to receive from construction workers, the following was mentioned: i) daily progress reports, ii) guidelines and proposals for selecting materials and/or construction providers, iii) identification of materials needed (to be purchased in advance), iv) accurate information on expenses to be incurred and the overall construction budget, v) information on potential errors by architects and/or engineers.

- **There is resistance to change on the part of families**, which usually place higher value on the methods currently being used by people in their community.⁹

Opportunities to enhance the gradual incorporation of sustainable solutions (SS) in peri-urban areas of Metropolitan Lima

In a context of widespread informality, where there are still large quantitative and qualitative gaps that mainly affect families with limited resources, high levels of vulnerability, and a deteriorating quality of life, the gradual incorporation of SS is a challenge that requires strengthening such complex process as activating a real demand and coordinating all actors in the housing construction ecosystem. Likewise, the adoption of SS should consider the short-term expectations of families, as the potential to adopt these solutions depends on aspects such as cost savings from the use of new materials, the acquisition of easy-to-use technologies that are easy to maintain and do not disrupt daily life, the aesthetic improvements of low-cost modernity-oriented designs, etc. Based on the interviews and focus groups, we identified the following opportunities:

- Peru's three levels of government and all relevant entities must promote access to quality housing, viewing it as the right of all citizens, and should recognize that investing resources in subsidies that promote access to housing stimulates the economy and boosts employment, mainly among construction workers and suppliers.¹⁰ Likewise, it helps broaden the tax base and gives families higher levels of health and safety, which in turn helps reduce household expenses and curbs public spending.
- Sustainability must be holistically addressed in all stages, right from the process of formalization and planning.
- Housing must be understood as a space that provides comfort and safety and, in many cases, also constitutes a site for the production of livelihoods, particularly for entrepreneurs and micro-entrepreneurs.
- Evidence must be generated and analyzed for decision-making in specific interventions in order to close gaps. Agenda items include: i) gender inequality in access to housing; ii) alternative ways to evaluate access to financing; iii) the standardization of how vulnerability is defined by private and public entities in terms of access to housing; iv) successful experiences in the use of SS in contexts of vulnerability.
- Criteria must be proposed for the reassessment of areas that have been classified as non-mitigable risks and the feasibility of making investments to mitigate risks in order to reduce the potential impact of disasters must be analyzed.

⁹This corroborates the report by CTIV-HFHI (2019) that families are reluctant to be the first to test new materials or technologies.

¹⁰With respect to the impact of urban expansion, Espinoza and Fort (2020) report that each year, economic activities directly related to urban expansion represent approximately 2% of the national GDP. Source: Espinoza, M. Fort, R. (2020). "Mapping and typology of urban expansion in Peru". Lima: GRADE; ADI. Recovered Sept 2023, from: http://www.grade.org.pe/wp-content/uploads/EspinozaFort_GRADEADI_expansionurbana.pdf

- We must learn from successful experiences in other countries in terms of the type of SS used, the implementation model, and the mechanisms that enabled their successful incorporation into the market (including family responsiveness).
- We must generate financing options for the acquisition/construction of housing, considering the implementation of pilot projects in: i) qualification criteria and the use of other sources of information to expand access to credit for individuals/families with the capacity to pay but lacking income or credit history, with an emphasis on single-parent women heads of household; ii) rent-to-own mechanisms to reduce the initial expense or replace significant expenditures during the early stages of construction; iii) relocation alternatives for families residing in areas considered non-mitigable; and iv) viable VIS projects in which land ownership continues to be owned by the state.
- Promote the strengthening of financial education in order to increase the possibilities of access to credits with better interest rates.

"In the [housing construction] sector, the further we descend in the economic pyramid, the greater the need and the greater the value placed on having a home of one's own [...] If you tell someone that by doing this they'll be able to afford that 45m2 apartment, they're going to be motivated to do more. But first you must explain what's possible. If you're just going to tell me I'll never get a loan, then I'll keep behaving as I please financially. But if someone says, 'Listen, you don't qualify now, but this will help you qualify later,' I think it's viable path" (entity representative).

- Enhance the offer supplied by real estate developers in areas of greater vulnerability, which are currently not seen as market opportunities.
- Generate innovative mechanisms to provide accurate information to end users about: i) the roles of engineers, architects and construction workers, ii) the estimated budget of the entire construction project, iii) financing options, iii) common errors during incremental construction processes, iv) available land surveys, and v) the importance of incorporating SS.
- Promote technical assistance initiatives for the construction of homes by/for vulnerable families, linked to construction plans, land surveys, procedures, etc.¹¹
- Strengthen the technical skills of construction workers, expanding the training provided by companies that commercialize SS and generating alliances with the civil construction guild.
- Develop and distribute a database of construction workers, incorporating information on good practices and performance.¹²

¹¹This is because participants in the focus groups appreciate the importance of having land surveys, blueprints, and sturdy columns and beams. This is in line with what has previously been stated by Swisscontact (n.d.), which identified the importance that families have the following elements for the construction of safe housing: i) adequate foundations, ii) weight-bearing columns and beams, iii) construction plans, iv) participation of construction workers with knowledge and experience, and v) quality materials. Source: Swisscontact (n.d.). "Characterization of families in the dynamics of owner driven construction in Lima". Lima: Swisscontact. Recovered Sept 2023 from: https://www.swisscontact.org/_Resources/Persistent/0/c/b/5/0cb52d715996145a254d736c892376f243e56c67/Informe%20Familias%202021%20Final.pdf

¹²This finding complements the point made by Swisscontact (n.d.), which highlighted the need for families to catalog the prior work they have done to assess their level of experience before hiring them (pp. 13).

- Incorporate passive design solutions in construction processes aimed at different types of markets, including those related to the construction of homes by/for vulnerable families.

“In Peru, and specifically in Metropolitan Lima, we don’t have such extreme winters or summers [...]. So bioclimatic (passive) design could easily be applied if there’s already decent urban habilitation. I can envision solar panels on the front of the facade, for example, or the best place to put the windows, etc. There are a lot of possibilities there, but we must promote the formal occupation of land. If we have a lot of informal occupation [...] it becomes more expensive and more complicated, which reduces my ability to provide a better deliverable for the family” (entity representative).

- Promote behavioral-economics-based initiatives that encourage the use of SS in incremental constructions.¹³
- Expand the issuance of mandatory standards for the incremental incorporation of SS, generating more regulations that promote the use of SS in social interest housing as well as in constructions of a purely private nature.¹⁴

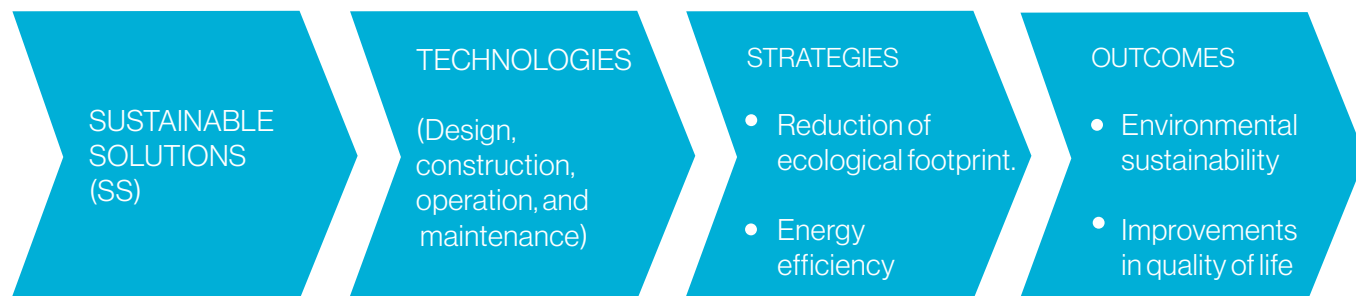
¹³ Three examples of SS were given during the focus groups for the purpose of explaining their characteristics to the participants (families and construction workers) and investigating their potential use. In general, the participants were in favor of using them once they recognized the benefits related to health, comfort, and the environment.

¹⁴ Similarly, a study on the feasibility of having a digital channel for the purchase and sale of VIS-related construction materials in Peru, surveyed representatives cited legal certifications and ISO certifications, as well as validation from the National Training Service for the Construction Industry (SENCICO), as minimum requirements.

06. IDENTIFICATION OF SUSTAINABLE SOLUTIONS (SS) IN METROPOLITAN LIMA

As part of the study on the potential to adopt sustainable practices in the construction of housing for vulnerable populations in Metropolitan Lima, an inventory of SS was carried out, comprising forty (40) products (goods) introduced by the construction industry. These include technologies that mitigate negative impacts on the environment, promote the sustainable use of resources, and improve the quality of life of users.¹⁵ The list includes both new goods and services and significant improvements to the function or characteristics of existing ones.¹⁶

The SS included are geared towards the markets involved with state-promoted VIS and incremental construction, in so far as they enable strategies that mitigate the industry's negative impacts on the environment through aspects such as designs and guidelines for energy efficient and resilient construction, operation and maintenance; reductions in the use of materials; the generation, collection and storage of energy and/or water resources on site to diminish the ecological footprint; and others. In this sense, each SS is expected to reduce the carbon footprint, mainly with respect to greenhouse gas (GHG) emissions.



Based on this analysis, four (4) solutions with high potential for implementation were selected in the established typologies. These solutions meet the following characteristics:

¹⁵ This definition is linked to the concept of product innovation as set out in the third edition of the Oslo Manual (<https://www.madrid.org/bvirtual/BVCM001708.pdf>), to the extent that the mapped SS meant new or significantly improved goods at the time of being introduced into the markets of the construction industry. Product innovations include both the introduction of new goods and services and significant improvements in the functional or use characteristics of existing goods and services. This includes passive designs that can also be considered technological products.

¹⁶ The mapping was based on information on the public domain: institutional web portals of entities that finance or promote the technological solutions, as well as information published by the media, specialized forums, among others.

- a) **Relevance:** Solutions with implementation experience at national or regional level, as well as with potential usefulness to and escalation of incremental construction and/or social interest housing.
- b) **Practicality:** Easy to understand solutions that are easy to operate and maintain and have limited disruptions to daily life.
- c) **Affordability:** Solutions with reasonable cost of acquisition for families, suppliers and builders.
- d) **Complementarity:** Solutions with the potential to link to financial products and other solutions geared toward the same target population

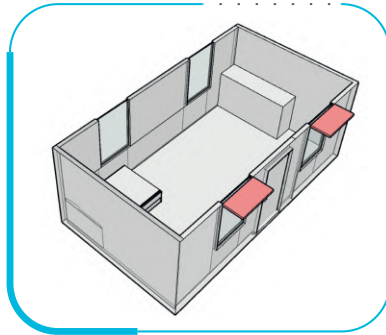
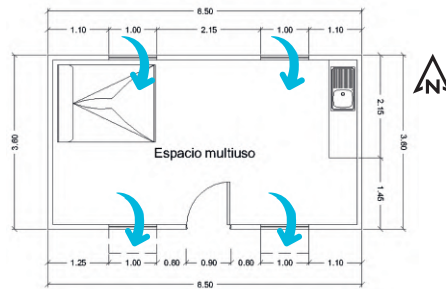
This map provides an innovative input that can be used by manufacturers, suppliers, distributors, construction workers, government representatives and other actors involved with introducing technological solutions into the market. It also represents a key initial effort that can be further enriched by complementary information from the relevant actors.

Considering the above criteria, four (4) solutions with high implementation potential were identified, according to their implementation for the housing typologies. Seventeen (17) solutions with moderate potential were also found, for which we highly recommend analysis by the actors involved with supply and demand.

Table 1: SS with high implementation potential


N°	Sustainable Solutions (SS)	Potential implementation in typology					Score
		VIS	A	B	C	D	
1	Natural lighting (passive design)	⊗	⊗	⊗	⊗	⊗	15
2	Cross-ventilation (passive design)	⊗	⊗	⊗	⊗	⊗	15
3	Added concrete	⊗	⊗	⊗			15
4	Biodegradable concrete bag (EcoSaco)	⊗	⊗	⊗			14

Below are the volumetrics and ground plans for the four high potential solutions in the corresponding typologies:

TYPE D: 3D**TYPE D: FLOOR PLAN**

Type D houses consist of a single, multi-use space. The SS model improves thermal comfort inside the home by incorporating passive lighting elements on the northern facades (those that receive the greatest amount of sunlight in Peru) and cross ventilation from the south (the prevailing wind direction in Metropolitan Lima), as well as aluminized steel roofing as an alternative to corrugated tin.

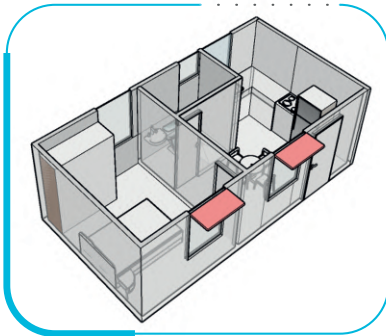
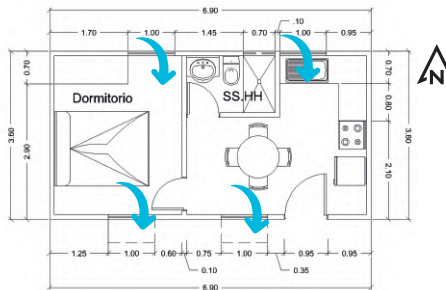
LEYENDA

 Passive lighting (floor plan).

 Passive lighting (3D).




Cross ventilation (floor plan).

TYPE C: 3D**TYPE C: FLOOR PLAN**

Type C houses have more developed spaces, with differentiation bedrooms, bathrooms and kitchen-dining rooms. Similar to type D houses, the SS model improves thermal comfort through passive lighting elements on the north facades and cross-ventilation from the south.

LEYENDA

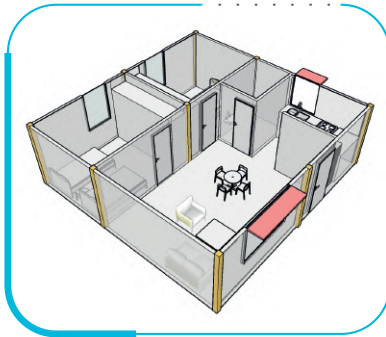
 Passive lighting (floor plan).

 Passive lighting (3D).

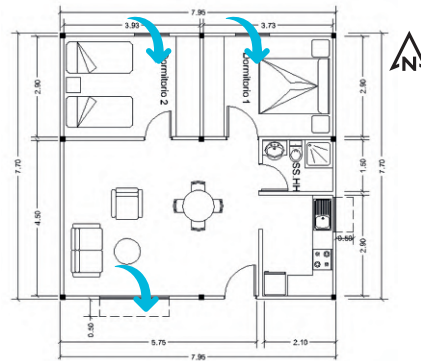


Cross-ventilation (floor plan).

TYPE B: 3D



TYPE B: FLOOR PLAN



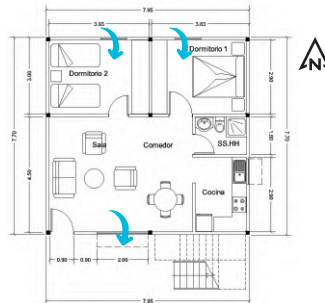
Added concrete / biodegradable concrete bags (3D).

Passive lighting (floor plan).

Passive lighting (3D)

Cross-ventilation (floor plan).

Type B houses have multiple areas: more than one bedroom, a bathroom, a closed kitchen space, and a living-dining area. As in type D and C houses, SS models improve thermal comfort by incorporating passive lighting from the north and cross-ventilation from the south. The model also proposes the use of additional concrete and/or biodegradable concrete for structural elements such as slabs, columns, and confinement beams to help reduce the building's carbon footprint.

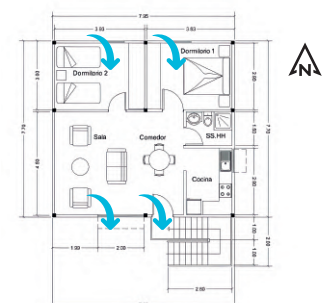
TYPE A: 3D
(1ST FLOOR)TYPE A: FLOOR PLAN
(1ST FLOOR)

Added concrete / biodegradable concrete bag (3D).

Passive lighting (ground plan).

Passive lighting (3D)

Cross-ventilation (floor plan).

TYPE A: 3D
(2ND FLOOR)TYPE A: FLOOR PLAN
(2ND FLOOR)

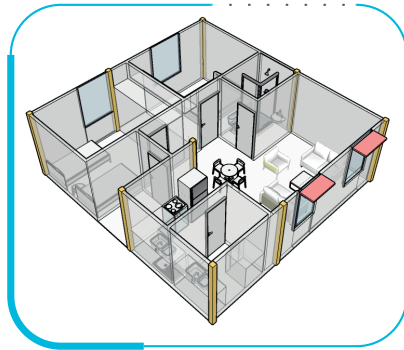
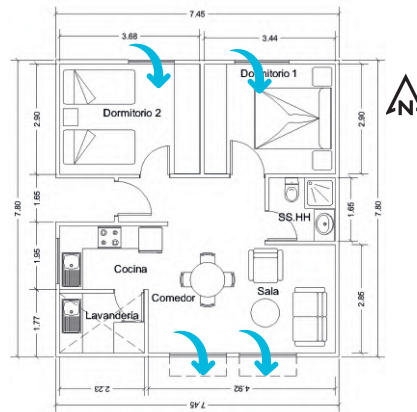
Added concrete / biodegradable concrete bag (3D).

Passive lighting (floor plan).

Passive lighting (3D)

Cross-ventilation (floor plan).

Type A houses refer to dwellings with multiple living spaces on two to more floors. Similar to the previous typologies, the SS model improves thermal comfort by incorporating passive lighting and cross ventilation. As with type B houses, added concrete and/or biodegradable concrete bags are used for structural elements, helping to reduce the building's concrete footprint.

VIS MODEL: 3D**VIS MODEL: FLOOR PLAN****LEGEND**

- Added concrete / biodegradable concrete bags (3D).
- Passive lighting (floor plan).
- Passive lighting (3D).
- Cross-ventilation (floor plan).

The VIS model is a single-family home with two bedrooms, a bathroom, a living-dining room, a kitchen and an open laundry area (without roofing). As with the above housing types, the model incorporates cross ventilation and passive lighting. If the house is built with traditional masonry, added concrete or biodegradable concrete bags would be used.

Total cost of housing after the implementation of sustainable solutions (SS)

Once we identified the SS with the highest potential for adoption, we proceeded to estimate the cost (per square meter) of its possible implementation, depending on whether it applies to incremental and/or social interest construction. As such, we estimated the baseline for each housing type, the economic estimate of the implementation of the solutions was developed, and then the total cost per square meter, including the incorporation of the SS for each. It should be noted that these are conservative estimates.

Table 2: Cost estimate per square meter of social interest housing (VIS)

Project	Location	Cost (PEN)	Cost (USD)	Area (m ²)
Cipreses Condominium	SJL	PEN 120.300	\$ 31,825	40.85
Santa Maria multifamily housing I	Carabayllo	PEN 120,000	\$ 31,746	42.00
Valle Grande 2 stage III	Carabayllo	PEN 109,200	\$ 28,889	54.77
Valle Grande 3	Carabayllo	PEN 109,200	\$ 28.889	54.77
Mariana housing complex I	Santa Rosa	PEN 70.000	\$ 18,519	40.08
Santa Rosa housing complex	Santa Rosa	PEN 85,000	\$ 22,487	43.57
Santa Maria II multifamily housing, stage VI	Carabayllo	PEN 120.000	\$ 31,746	41.00
Los Parques de Comas, Los Geranios	Comas	PEN 120.300	\$ 31,825	49.55
	Minimum		\$ 18,519	40.08
	Lower quartile		\$ 24,087	40.08
	Average		\$ 28.241	45.82
	Upper quartile		\$ 31,806	53.47
	Maximum		\$ 31,825	54.77

¹⁷To estimate the cost per square meter of the VIS, information was gathered from the MiVivienda fund pertaining to projects in Metropolitan Lima developed under the new house acquisition (AVN) modality, with the possibility of horizontal and/or vertical growth.

Table 3. Baseline cost estimate per square meter and housing type¹⁸

	VIS	A	B	C	D
Build area (m2)	53	168	84	100	30
Investment (USD)	\$ 31.806	\$ 21.200	\$ 11.200	\$ 1.600	\$200
Cost of housing unit (USD/m2)	\$ 595	\$ 126	\$ 133	\$ 16	\$ 7

The cost per square meter of the SS per housing typology represents a conservative estimate.

Table 4: Cost estimate per square meter to install sustainable solutions¹⁹

N°	Sustainable Solutions (SS)	VIS	A	B	C	D
1	Passive lighting	\$ 0.3	\$ 0.2	\$ 0.2	\$ 0.2	\$ 0.2
2	Cross-ventilation	\$ 3.8	\$2.4	\$2.4	\$ 2.9	\$ 3.4
3	Added concrete	\$ 3.9	\$ 3.1	\$ 3.1		
4	Biodegradable concrete bag (EcoSaco)	\$ 3.2	\$ 2.6	\$ 2.6		
STCS implementation cost (USD/m2)		\$ 11	\$ 8	\$ 8	\$ 3	\$ 4

¹⁸ To estimate the cost per square meter of incremental construction (types A, B, C and D), information concerning the size and approximate investment was extracted from the report "Situation of housing for the base of the pyramid in Metropolitan Lima," conducted by Habitat for Humanity in 2018.

By estimating the total cost per square meter of the five housing types after the SS implementation, the following conclusions apply:

- Passive design strategies represent an increase in cost reductions for all types of housing and allow for considerable benefits in thermal comfort for end users.
- The cost of implementing SS is proportionally low to the amount of baseline capital, which facilitates financing options, particularly for the VIS model, type A, and B, where the increase is 2%, 7% and 6%, respectively.
- For housing types C and D the increase is greater, suggesting that including this type of SS should mainly be promoted in type A and B housing, where most families are expected to reside.

Table 5: Total cost per square meter after the implementation of sustainable solutions

	VIS	A	B	C	D
Cost of housing unit (USD/m ²)	\$ 595	\$ 126	\$ 133	\$ 16	\$ 7
STCS implementation cost (USD/m ²)	\$ 11	\$ 8	\$ 8	\$ 3	\$ 4
STCS housing unit implementation cost (USD/m ²)	\$ 606	\$ 134	\$ 141	\$ 19	\$ 11
Percentage change (%)	2%	7%	6%	19%	53%

¹⁹ The calculation of the measurement and unit price for each solution takes into account the following: Passive lighting: solar daylighting elements were contemplated in all the windows of the north façade, considering coverage with equivalent material, heading "OE.3.6.9.11 Tecnomix e=2" (2.40 x 1.20m) s / Finishes Supports @0.60m" of Costeros magazine, May 2023 edition. Cross-ventilation: A conservative estimate was made of incorporating two new windows on the opposite side of the facade for all house types, considering the item "OE.3.7.2.11 wooden windows with leaves, cedar" of Costeros Magazine, May 2023 edition. Added concrete: Estimate of the headings "OE.2.3.7.36 Concrete f'c 210 kg/ cm2 column", "OE.2.3.8.36 Concrete f'c 210 kg/cm2 beams" and "OE.2.3.9.2.36 Concrete f'c 210 kg/cm2 lightened slab" of Costeros Magazine, May 2023 edition. Quote for added UNACEM concrete. Biodegradable concrete bags: Estimate based on "OE.2.3.7.36 Concrete f'c 210 kg/cm2 column", "OE.2.3.8.36 Concrete f'c 210 kg/cm2 beams" and "OE.2.3.9.2.36 Concrete f'c 210 kg/cm2 lightened slab" of Costeros Magazine, May 2023 edition. Pacasmayo's biodegradable concrete bags are sold in the cities of Trujillo, Cajamarca, Chimbote, Piura, and Chiclayo. Local quote.

07. CONCLUSIONS

- Owner driven construction has developed a broad market for goods and services and has become the default option for families from vulnerable populations in peri-urban neighborhoods of Metropolitan Lima.
- The problem of owner driven construction is both a quantitative and qualitative housing deficit, leading to precarious health and safety conditions.
- This study only represents the owner driven construction segment in Metropolitan Lima, based on HFHI studies as of 2019 of 1 million 311 thousand homes, 13,800 neighborhood hardware stores offering materials in this market and more than 262,734 construction workers.
- Peru's various levels of government have not managed to solve this problem comprehensively and efficiently. Although it has made key advancements in terms of resolving the housing deficit, critical aspects related to living conditions remain.
- There is a limited supply of decent and adequate housing for middle and low-income families, which face varying levels of vulnerability. Likewise, quality public spaces and urban facilities remain scarce.
- The vulnerable populations residing in the peri-urban areas of Metropolitan Lima base decisions for the construction of their homes on sociocultural approaches, previous experiences (whether their own or that of their close circles), and knowledge—which is still scarce in our country—of the advantages and opportunities of SS.
- Likewise, as in the homes of families from different socioeconomic levels, decisions and actions are affected by “social capital,” meaning that networks and community ties influence housing construction processes.
- The gradual incorporation of SS requires a series of economic and financial, as well as social and cultural, conditions. The use of behavioral science tools such as the SAST²⁰ approach are essential to increasing the possibility that SS will be adopted by vulnerable families.

²⁰Based on EAST—Easy, Attractive, Social and Timely—developed by The Behavioural Insights Team (n.d.).

08. RECOMMENDATIONS

For national government entities, particularly the MVCS and the MiVivienda Fund

- In alliance with local entities, identify needs and opportunities in specific territorial spaces in order to promote the incorporation of the SS with the greatest implementation potential.
- Strengthen technical training for personnel in direct contact with citizens, so that they can provide more precise guidance on the requirements related to available subsidies.
- Promote, in coordination with the National Center for Disaster Risk Estimation, Prevention and Reduction (CENAPRED), a greater dissemination on the availability and potential use of information from the Information System for Disaster Risk Management (SIGRID).
- Evaluate the relevance of generating standards that regulate the incorporation of SS with a mandatory incremental character, as well as the implementation of certifications.
- Extend the application of the mandatory compliance of the Technical Code of Sustainable Construction to projects in peri-urban areas, particularly in spaces of horizontal and/or vertical expansion of state-promoted VIS.
- Promote the approval of an operational definition of multidimensional poverty and vulnerability in terms of access to housing, establishing recurrent measurements from the National Institute of Statistics and Informatics (INEI) to better focus the strategies implemented by the different actors in the housing construction ecosystem.
- Conduct studies on the impacts of VIS programs, identifying potential improvements.
- Generate specific interventions aimed at promoting access to housing for families in the most vulnerable situations.
- Implement financing alternatives for the acquisition/construction/expansion of homes, adapting their characteristics of vulnerability (qualification criteria for access to loans, rent-to-own mechanisms that reduce the initial investment cost, etc.).
- Generate a financing mechanism similar to the MiVivienda Green Housing Voucher in the new house acquisition (AVN) and building on one's own site (CSP) categories in order to align incentives between the parties involved.
- Evaluate the feasibility of generating some kind of financial or tax benefit to companies promoting microcredits that incorporate the use of SS.
- Enhance transparency and traceability in granting subsidies, strengthening records and information mechanisms on beneficiary families, home purchases, and costs.

For municipalities

- Promote the establishment of alliances with grassroots social organizations and other entities that carry out work in the localities in order to strengthen planning and monitoring activities and identify mechanisms to incorporate potential improvements in incremental construction processes in Metropolitan Lima.
- Strengthen the information mechanisms that are provided to families on construction-related processes, procedures and requirements, identifying unmet needs and potential areas for improvement.
- Strengthen technical training for municipal workers who are in direct contact with citizens so that they can provide more precise guidance.

For private companies

- Design communications campaigns based on concepts of behavioral economics that encourage the use of SS in vulnerable populations; highlighting its short-term benefits to health, safety, family dynamics, comfort, the environment, as well as in the immediate savings (to electricity and water, for example), derived from the potential implementation of SS.
- Recognize the participation of women, who usually occupy a leading role in the processes of incremental construction, so they can be considered key stakeholders in evaluating the benefits of adopting SS.
- Disseminate the potential benefits of using SS in VIS, prioritizing those that are the easiest to implement (i.e., the least disruptive).
- Carry out (and encourage the realization of) training for construction workers to help strengthen their knowledge and technical competencies for the implementation of SS. To do this, it is recommended to evaluate the feasibility of generating partnerships between private companies and the civil construction guild.
- Generate spaces of incidence that allow construction workers to have clarity on the concrete benefits that can provide them with greater technical knowledge and better performance.

For development banks, international agencies and non-governmental entities providing technical assistance services

- Continue to promote the establishment of synergies and learning spaces between the different actors of the housing construction ecosystem; as well as promoting the generation of alliances between public entities at Peru's three levels of government and private companies, startups, FINTECH, academics and other entities in order to concretize specific mechanisms for the implementation of SS.
- Promote, preferably in alliance with the corresponding governmental entities and taking as reference successful experiences from other countries, the implementation of pilot projects that generate alternatives related to: i) non-traditional criteria for access to credit, ii) rental-sale mechanisms, iii) relocation alternatives for families currently residing in non-mitigable areas.

- Promote, preferably in partnership with technical entities and private companies, the development of an information system for construction workers, including references on previous work and performance.
- Promote financial education so that families have better criteria to analyze their financing alternatives and generate conditions that allow them to access better financing mechanisms.
- Develop research activities to enrich technical or vocational training programs.

For technical entities

- Promote the training of construction workers and the hiring of those with better performance while enhancing projects' ability to scale and increasing profit margins.
- Enhance transparency and traceability mechanisms, increasing the confidence of contractors and potential users.

For entities providing financial services

- Develop financial programs and services geared toward vulnerable populations and sustainable incremental construction. To do this, it is necessary to collect primary information to characterize potential users and evaluate the possibility of generating products with appropriate rates and qualification criteria.
- Strengthen financial education capacities so that potential VIS users can increase their chances of accessing credit and/or obtain lower interest rates.
- Evaluate the feasibility of generating alliances between microfinance and FINTECH, in order to make a more efficient evaluation of certain population groups (such as women entrepreneurs and from credit generation stage), in order to provide them with better credit alternatives.
- Evaluate the feasibility of generating benefits in granting loans for real estate projects or to users that incorporate SS. To do this, it is necessary to identify the lines that finance the incorporation of this type of solution.



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