

Technological design and participatory process for the retrofitting of informal settlements in Colombia

Diseño tecnológico y proceso participativo para la rehabilitación de asentamientos informales en Colombia

Adolfo Francesco Lucio Baratta (*), [Laura Calcagnini](#) (**), Fabrizio Finucci (***) , Antonio Magarò (****) , Hector Saul Quintana Ramírez (*****)

ABSTRACT

The contribution presents the results of a three-year research about the regeneration of spontaneous settlements in conditions of social, economic, environmental and technological inadequacy. The research develops within an agreement between the Department of Architecture of the Roma Tre University (Italy) and the Faculty of Architecture, Design and Urbanism of the University of Boyacá in Sogamoso (Colombia). The research was aimed at developing procedural strategies and design solutions capable of regenerating spontaneous settlements. With this aim, a system of solutions for informal and degraded housing has been designed for a total of forty case studies in the urban marginal areas of Sogamoso in Colombia. The strategies adopted contributed to reducing the perception of housing insecurity by increasing the cohesion of the community. The results show the multidisciplinary character and the trans-scalar nature of the research, for favoring integration, for operating on technological reconfiguration, and for involving the local community.

Keywords: informal cities; marginal urban settlements; housing emergency; building performance improvement; technological design.

RESUMEN

Este artículo presenta los resultados de una investigación de tres años sobre la regeneración de asentamientos espontáneos en condiciones de insuficiencia social, económica, ambiental y tecnológica. La investigación se desarrolla dentro de un convenio entre el Departamento de Arquitectura de la Universidad Roma Tre (Italia) y la Facultad de Arquitectura, Diseño y Urbanismo de la Universidad de Boyacá en Sogamoso (Colombia). La investigación desarrolla estrategias procedimentales y presenta soluciones capaces de regenerar asentamientos espontáneos. Con este objetivo, se ha diseñado un sistema de soluciones para vivienda informal, sin estructuras resistentes y degradada para un total de cuarenta casos de estudio en las zonas marginales de Sogamoso. Las estrategias contribuyeron a reducir la percepción de inseguridad habitacional al incrementar la cohesión de la comunidad. Los resultados muestran el carácter multidisciplinar de la investigación, para operar en la reconfiguración tecnológica y para involucrar a la comunidad local.

Palabras clave: ciudades informales; asentamientos urbanos marginales; emergencia habitacional; mejoramiento del desempeño de edificios; diseño tecnológico.

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1. INTRODUCTION

The general objective of the research was to identify, deepen and apply, procedures aimed at making informal settlements more inclusive, safe, and sustainable, as enshrined in the eleventh goal of the sustainable development goals relaunched by Agenda 2030, the Action Program signed in September 2015 by the governments of the 193 UN countries (1). The research applied in the geographical, cultural and social context of the South American cities and, in particular, in the Colombian ones, characterized by informal urbanization processes. These processes represent a critical aspect of urban development, because, taking place in the absence of planning mechanisms (2) (strategic, general or local), they give rise to insecure, marginal urban sectors characterized by very low quality of life. Poverty, social imbalances, fragmentation of the urban space and economic inequalities are characterizing elements of informal urbanizations and identify a social and housing problem of serious urgency (3-7). To answer the problems connected to informality, the research applies a rigorous methodological sequence (figure 1) which has foreseen: the understanding of the characteristics and the in-depth analysis of the context problems (see paragraph a), the definition of the specific objectives and intervention strategies (see paragraph b), a series of resolute design solutions (4), finally reaching application on selected houses in the informal settlements of Sant’Ana and Santa Barbara in Sogamoso.

1.1. Informal urbanization in Colombia

The reports issued by the UN in 2018 (1) indicated that, in 2020, many cities all over the world would face the challenges of managing a rapid urbanization in order of ensuring adequate housing and infrastructure, supporting population growth, addressing the environmental impact of widespread urban sprawl and reduce vulnerability to disasters.

In particular, although between 2000 and 2014 the percentage of the global urban population living in slums decreased from 28.4 to 22.8%, the actual number of people living in slums increased from 807 million to 883 million (1); more-

over, damage to houses attributed to natural catastrophes shows a statistically significant increase from 1990 onwards.

The contemporary Colombian city development is linked both to historical-typological development and to political, administrative, demographic, economic, social and cultural issues (8). The exceptional nature of these conditions characterizes urban development in an almost univocal way, if compared to informal South American urbanizations.

The informal urban expansions are caused by several reasons, the main ones are the internal and external migrations, the demographic explosions, the internal conflicts and, in particular, the internal forced displacement (the so called *desplazamiento forzado*) (8). Defined in 2009 as “migration directly or indirectly caused by armed groups” (9) and, in recent times, as that “mechanism of self-protection of the population that has suffered massacres and the escalation of acts of violence and repeated fighting” (10), the phenomenon is recognized as that condition in which “people are forced to flee or leave their homes particularly in situations of armed conflict” and that “are generally subject to heightened vulnerability” (11). In Colombia the phenomenon assumes an unsustainable dimension, in the first half of the twentieth century. In fact, at the beginning of the last century, with the aim of financing the infrastructural network to support territorial development, the Colombian government issued a large amount of government bonds, purchased from the local landowning oligarchies. These oligarchies, upon bonds could expiry, requested their conversion into land to be cultivated, the same that many farmers, called *campesinos*, had made fruitful, even if they occupied it illegally: it had inevitably turned into a social and territorial conflict (12).

However, the phenomenon of *desplazamiento forzado* does not only concern the question of the *campesinos* or the historical issue of the conversion of large estates but is also connected with the years of violence (1948-1964) which led to a second wave of migration and the birth of the Revolutionary Armed Forces in Colombia – People’s Army (FARC) and other armed groups. It is in this period that over 2 million of displaced people (which at the time represented 10% of the total

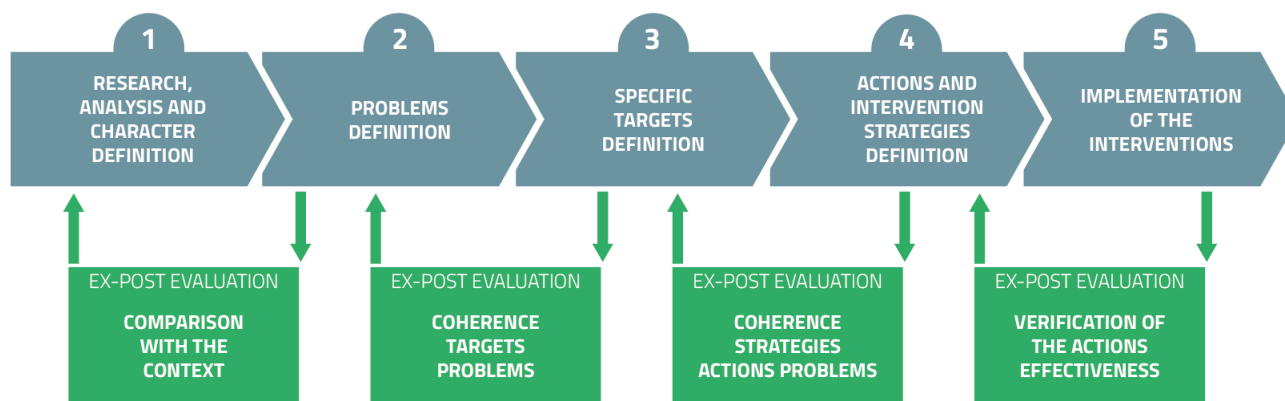


Figure 1. Characteristics and issues related to the context.

population) move to the big cities: in 1964, 71% of the men of Bogotá were immigrants from other areas of Colombia (13).

The internal forced displacement and the conditions of poverty and economic hardship of the population have pushed towards the phenomena of “neo-urbanism” (14) which see the massive migration from the countryside to the cities.

Latin America is one of the regions of the world in which a large number of people live in informal settlements (15). The informal urbanizations that result from the complex social phenomena of conflicts, migrations and internal forced displacement, take different shapes in cities like Bogotá compared to other cities (16). In Bogotá, for example, the predominant type of informal urbanization comes from pirate district (barrio pirata) or settlements carried out with informal negotiations without legal legitimacy; it is different in large cities such as Medellín, where informal urbanizations take on the invasion district (barrio de invasión) character: it is a temporary occupation of large areas of public property close to the city center or to large infrastructures without intermediaries (4). In most cases, the invasion district tend to consolidate on public land (residual areas or zones of lack of urban planning) while, the pirate district occupy mainly private land, fragmented residues of old estates, once large, without any control by the owners (4).

In smaller cities such as those of the Department of Boyacá, these phenomena can be observed in its primary phase and, consequently, it is possible to intervene more effectively (3).

During the 1990s, the legislator tried to intervene by making informal subdivisions compliant with urban planning standards (Minimum Urbanization Standards). The further popular housing policies conducted by the Colombian government, especially since 2014 when the reduction of housing problems in the country is a priority, lead to the definition of new tools: the Housing with Social Interest (Vivienda de Interés Social or VIS) and the Housing with Priority Interest (Vivienda de Interés Prioritario or VIP). These tools represent the strategy of the Colombian government for a global response to the multidimensionality of extreme poverty (3, 4). The extreme poverty is measured in 2008 by the Unmet Basic Needs and corresponds to at least two of the following factors: lack of education for children under 12; low level of economic independence; accommodation made with inadequate materials; lack of access to water and sewers. The VIS and VIP tools are intended precisely for people in such conditions, for those who have lost their homes due to natural or political causes, environmental disasters and to the victims of the internal forced displacement (recognized by the Colombian legal system with Law n. 387 of 1997).

The difference between the two instruments is that the VIPs do not foresee any contribution from the final recipient while the VISs are partially subsidized (Law n. 1537, 20 Jun 2012, by which rules are issued to facilitate and promote urban development and access to housing and other provisions are issued) (3).

The market trend from 2011 to 2017 describes how the mentioned tools had an initial effectiveness but a subsequent decrease in this effectiveness (noticeable in the case of VIP and less in the VIS) when these tools became part of the stable

policies in the country. In the fourth quarter of 2018, 27.2 million m² of housing were built in Colombia. Of these, 23.3% (6.3 million m²) are for VIPs and VISs. The number of people currently living in conditions of housing deprivation is difficult to quantify, due to both the absence to a census of people living on the verge of legality and to the instability typical of housing temporality conditions, in particular for the victims of internal forced displacement. The latter were granted legal status with the aim of protecting them and monitoring the socio-demographic and urban changes caused by internal forced displacement (4). However, the numbers provide a measure only indicative of the huge amount of people who may be attracted to the housing mechanisms of informal urbanizations. In fact, only the displaced population from 2010 to 2017 present in each district amount to between 1.000 and 60.000 (figure 2); this number is not exhaustive but contributes to the construction of an overall general and dimensional picture of the housing issue in Colombia.

1.2. Different perspectives to address informal urban settlements

In recent years, the scientific community has undertaken a series of interdisciplinary studies on spontaneous urban settlements, aimed both at understanding the phenomenon of informality, and at defining intervention and practices for the requalification (social, environmental, cultural, building, urban, etc.) and the inhabitants' quality of life improvement.

In early 1980s, these studies began comparing two schools of thought (17): the first one argues that it is not possible to elaborate a general theory that can explain the processes of informal urbanization in the sub-continent and, consequently, qualifies them as merely local phenomena; the second one, aimed at the formation and support of supranational acts, tends to simplify and homogenize logics of informal Latin American settlements and to allow the development of general theories.

What determines the substantial difference between the two schools is how they address the phenomenon of informal urbanization, the first by framing the theme with an international theoretical approach, the second by considering the practical dynamics of the territories and then the possible definition of a theory that supported them. Currently (18), the international scientific community is aimed at considering both the local point of view, with the peculiarities of each type of informal settlement, and the causes of international scope that feed the problem.

The method applied in this research is in line with this latter orientation. The research identifies the Colombian context as a socio-political area of investigation and the informal settlements that insist on the territory of Sogamoso as a special case. These settlements are identifiable as informal by the United Nations criteria (19). The formation and consolidation processes of housing within the informal settlements of Sogamoso are characterized by progressive traits (20) and the use of unskilled labor in a family self-construction. This means that the houses have poor construction and spatial quality, are unhealthy, made with unsuitable materials and without systems that can guarantee situations of living comfort (figure 3).

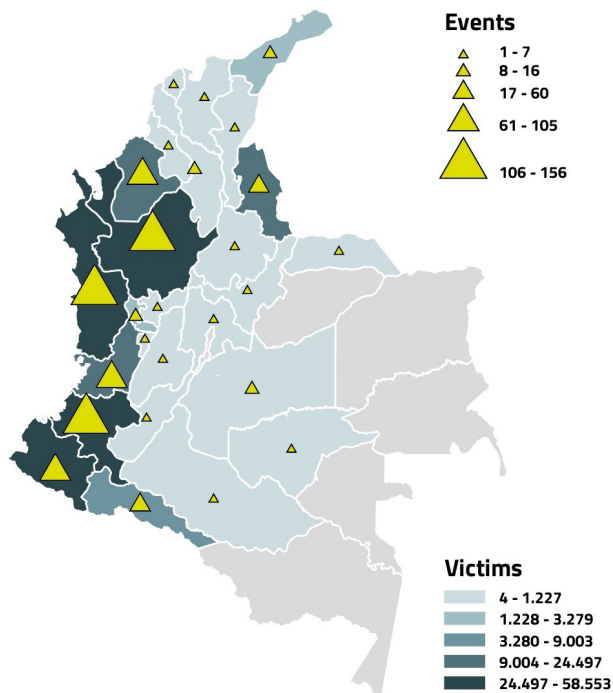


Figure 2. Events and victims of the forced displacement in recent years (2010-2017) [Credits: Elaboration of the authors on Codhes data, 2018].

In general, the house originates from a single non-specialized space, a rectangular basic cell, where mainly night and

shelter functions are performed. As in the typical processes of incremental construction, house progressively evolves its minimum characteristics, which until then had ensured the essential needs of housing, then improved with the financial capacity of families. The construction techniques used and the materials are those of the local tradition of the occupants, therefore they can come from places even very far from the large city on whose margins they stand.

1.3. Research objectives

The general objective of the research was to solve housing problems by defining, with a deductive approach, the critical conditions of general housing and the international reference standards. With an inductive approach also, the research focused on the requirements and strategies replicable and implementable for the housing improvement and for the mitigation of buildings vulnerability.

The specific targets, which derive from the evaluation of the place’s physical scenario, identifying the direction of the research itself, can be traced back to three areas of trans-scalar and interdisciplinary nature:

- urban scale; promoting integration and, making passable the physical barriers that typically isolate the informal settlement through the enhancement of the main routes and services, mitigating the seismic and hydrogeological risk.
- building scale; work on structural improvement, safety and hygiene and morphological and technological reconfiguration of buildings.



Figure 3. Typical informal urbanization of the Department of Boyacá. The houses lack constructional and spatial quality.

- social scale; triggering virtuous processes of economic and social recovery, strengthening the sense of identity and belonging of local communities, eliminating the social segregation of inhabitants and involving the local community in regeneration processes.

2. STRATEGIES, METHOD, AND IMPROVEMENT ACTIONS

2.1. Diagnosis of problems

At the urban scale it has been observed that the regularity of the settlement is determined by illegal subdivisions of large free areas adjacent to the consolidated urban settlement (figure 4): they are rarely residues of old abandoned latifundia and more generally areas that cannot be cultivated and cannot be converted into income. These areas are characterized by high slopes and therefore not very attractive for a building market that prefers regular expansion in flat areas: however, they are ideal for the consolidation of a clandestine market of low-cost areas. The size of the lots descends not only from the position and the morphology of the land, but also from the progressive occupation of the same. Therefore, those linked to the first settlements are the largest up to, for example, in Bogotá, in lots of 10x5 m, which are however completely saturated (20). In the flat areas or with a regular course, the lots have larger dimensions, while in areas with steep slopes, the dimensions decrease.

At the building scale, the informal neighborhoods of the main Colombian cities (20) show that, in general, the first specialization, starting from an undifferentiated cell and with daily activities that take place exclusively outside, is the separation of the sleeping area from a living one. Subsequently, the services are defined, first the kitchen and only as the last the toilet. This feature demonstrates that hygiene requirements are not a priority.

This is mainly justified by the difficulty in construction investing of immovable and expensive plants with uncertain ownership. As a first modification, 57.7% of the inhabitants specialize the primitive cell with the separation between the living area and the sleeping one, only 11% separate the toilet from the compartment intended for daily activities and even

less separate the kitchen area. The second most compelling change is that relating to the toilet, which takes a quarter of the houses that have already carried out a specialization. In any case, between the toilet and kitchen, almost 40% of homes see this further specialization completed (20).

The improvement of the construction materials and the wall structural consolidation remain the last intervention priorities. The houses have no spatial quality, there are no thermal neither acoustic insulation, moreover, the lighting and natural ventilation are scarce or absent. For climatic reasons, thermal insulation is not a priority and is not governed by any legislation. As it happens also for many of the formal settlements, the socialization space is on the street. Even when planning VIS settlements, the function of "relationship space" is entrusted to an open space. However, due to the growing contraction, there is no patio, courtyard or garden and it is the street that takes on a social role, even when it does not exist or is not structured.

At the social scale the marginal areas have highlighted the existence of an economic micro-fabric, not only illegal or submerged but based on the weak attempt to enhance local activities, such as food or artisan type, which should be protected because often generated by the lack of access the formal economy and by unsustainable tax pressures. From the social inclusiveness point of view, there are areas with strong communities and representatives, attentive and inserted in more or less structured paths of social participation in the urban transformation. On the contrary, there are so isolated cases where the community is lacking or does not exist as in the case of some areas in Sogamoso. In the latter cases, the subjects to which the research has turned its attention, are strongly marginalized and excluded and with difficulty manage to be included in structured processes. The issues to be addressed concern both the individual problems and the collective ones (21).

The informality of housing is closely related to the informality of work occupations because of both the impossibility of accessing the housing right and the impossibility of accessing the formal labor market (due to lack of experience or discrimination) or find greater benefits in the irregular one (14). The housing size and character of the settlements in the



Figure 4. Blocks from the Santa Ana and Santa Bárbara neighborhoods, near the center of Sogamoso, with the presence of informal housing: on the right, property subdivision (in blue) and occupation of the buildings (in black). During the field visits, informality was found in the property titles in some of the houses, a condition for which they were discarded from the group of buildings to be intervened for non-compliance with this regulatory requirement.

Sogamoso area reveals that the informal neighborhoods are located adjacent to the historical fabric, represented by the typical regular grid (*cuadrícula*), or rather, the urban grid of the Spanish-based cities.

Due to the impervious orography of the city that rises on the peaks of the Andes mountain, some routes tend to orient themselves along the contour lines, thus agreeing not to planning but to the greater force of the nature, while the orthogonal paths to them face dizzying slopes, in some cases maintaining the primordial geometric structure but losing their functionality. This condition led to an expansion of the city in limited directions.

The morphological characteristics of the lots, generally impose distribution conditions within elongated rectangular lots in which, often, only the narrow road front remains free, highlighting numerous critical issues relating to lighting conditions and internal ventilation.

2.2. Defining a retrofitting process: strategic actions

In light of the critical issues represented at the various scales, and in order to define and apply retrofitting actions on a sample of buildings in Sogamoso, the research group aims to not delineate a retrofitting “project” but of a retrofitting “process”, considering the involvement and participation of local actors. They were essential for acting with effectiveness: the inhabitants have participated with contributions of labor and materials, logistical support, validation of the diagnosis and of the proposals; Fonvisog, the municipal entity in charge of managing housing improvement emergencies, has provided information from the databases, control of regulatory aspects, availability of human resources, technicians and construction materials.

The construction characters of the houses contemplate the adoption of raw earth bricks or hollow bricks used in confined masonry with vertical stiffeners (more rarely horizontal) in weakly reinforced concrete, as required by Colombian anti-seismic regulations but hardly well made. Brick blocks are often reused, of low quality and of different productions; sheet metal or corrugated asbestos cement sheets are generally used for roofing.

The strategic actions are:

- to identify the criticalities of settlements in the informal area at the building and urban scale.
- to highlight the performance requirements necessary for the improvement of the physical and environmental conditions of the building environments.
- to involve stakeholders in the development of programs for the improvement and redevelopment financing. In fact, the problem of adjusting housing standards in informal settlements is not only related to the lack of economic support but also to the lack of adequate technical support (22), moreover, re-establishing living conditions is a priority of many municipalities (23).
- to start a participatory process with the local scientific community, in particular with the Faculty of Architecture,

Design and Urbanism in Sogamoso, to determine the definition of the intervention strategies. Through the on-site laboratories activation, aimed at the exchange of information, technical knowledge and local regulatory references. This action has conferred quality to the process by allowing the comparison of the European technological thinking with local technical knowledge and practice, and transfer of knowledge locally to evaluate housing quality requirements as recognized in the international standards.

In addition to the Italian and Colombian university institutions, the design process of the strategic research phases (figure 5) involved the cultural association Architecture Emergency Development (AES), which operates in the field of economic, social and cultural promotion and for the international cooperation, and the National Social Housing and Urban Reform Institute. (FONVISOG), a decentralized public authority of Sogamoso that encourages and contributes to the construction of housing for eligible citizens, through the management of national, departmental, municipal and private resources.

With the aim of “reducing the housing deficit of the community for improving the quality of life (23)” the two subjects have played an important role for financing.

2.3. Methodology

The methodology used in the participation process was based on retaking and implementing constructive progressivity, this being the typical mode of operation through which families self-manage the construction of their homes; the researchers provide technical advice to said progressivity, strengthening decision-making during the conception, management, construction and evaluation of the interventions.

The sample of buildings was selected identifying specific criticalities for housing quality related to technological and environmental aspects after the definition of the cultural and social strategies and the identification of the actors for the operational phase of the research.

For the evaluation of the interventions, the buildings were classified by using a dichotomous function based on the severity of the problems relating to the following characteristics:

1. lack or incorrect functionality of the construction elements;
2. deterioration or inadequacy of building components;
3. unhealthy living spaces.

Furthermore, the structural criticalities were assessed, and each building analyzed has showed poor seismic resistance (4).

The analysis results are synthetized in a map of interventions for the housing performance improvement.

This map is integrated through the participation of the inhabitants to whom a questionnaire was administered to establish their real housing needs. This questionnaire was used as a project tool for detecting and proposing interventions and

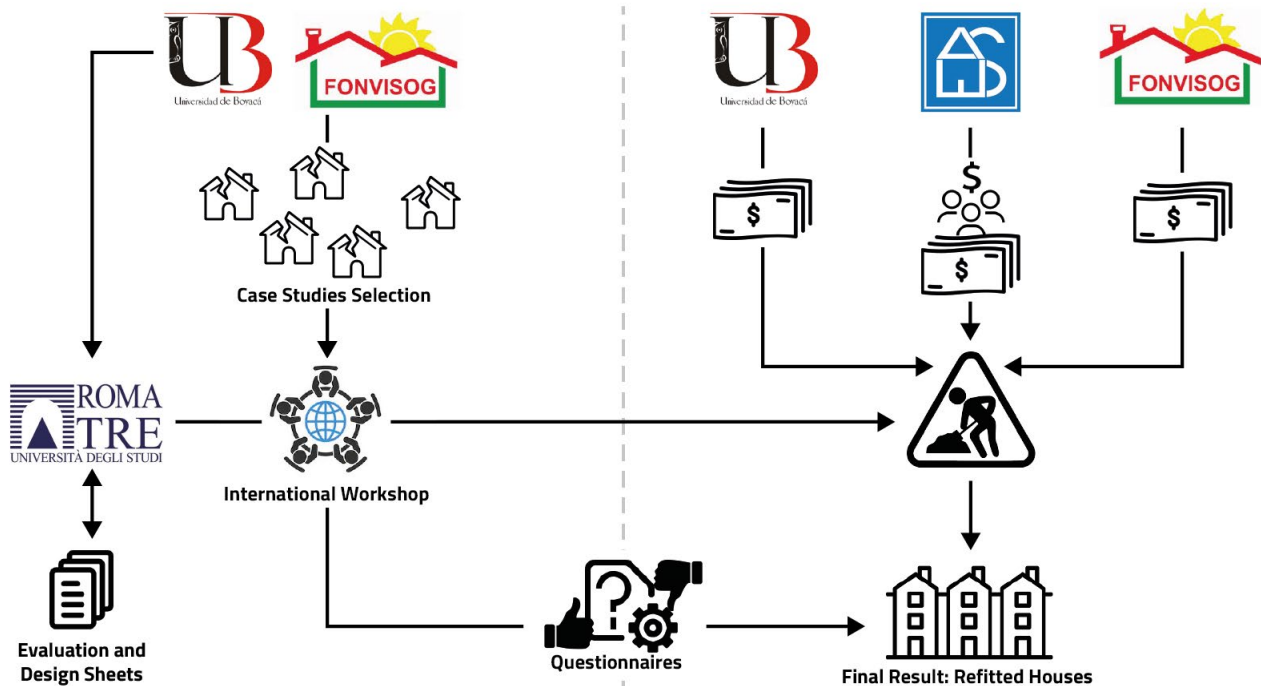


Figure 5. The research process scheme.

led the design process through the consultation, negotiation and deliberation phases between universities, associations involved and individual citizens. The research established a truly participatory process aimed at inclusiveness of citizenship within the main nodes of decision-making: from the preliminary formative-ideational one, to the evaluative one (in terms of value judgment and choice judgment) up to the actual choice act (24). This made it possible to strengthen and integrate the existing rules with a positive character, so as to confer quality, recognition and consensus on the complex system of interventions.

With reference to performance improvement actions, classes of requirements have been identified as codified by UNI standards. In particular, compliance with the requirements of safety, well-being, hygiene and health, appearance and usability (as classified by the UNI 8289: 1981 standard) was considered a priority, leaving out the management, integration and safeguarding of the environment and resources rational use. The latter, acquired in the regulatory integration of 2008, fulfill the typical needs of a building fabric made in formal conditions of construction and is typical of consolidated construction that has already fulfilled the other classes of requirements, therefore, a very different context from that of informal settlements.

To the evidence of analyzed case studies, the necessary safety requirements referred to the mechanical resistance of the structures, those on the well-being and health to aspects relating to environmental comfort, to those on the appearance and usability of the internal environments in the construction elements as well as the accessibility of the structures.

2.4. Description of improvement actions

Of the 40 houses intervened, with the objective of selecting the five buildings to be reinforced with reinforced plaster, the

research group visited about 20 houses, of which 15 were discarded due to difficulties for their formal integration to the improvement (figure 6).

At the end of the case study analysis process, improvement actions were classified in relation to the following.

1. Safety and structural behavior:

- integration of the foundations by inserting a system of steel chains, consisting of tie rods and staples for the fixing of orthogonal masonry;
- consolidation of the masonry by applying reinforced plaster, consisting of two reinforced layers, placed inside and outside, connected to each other by means of metal cross pins;
- integration of structural elements such as mahogany wood curbs, autochthonous species with good mechanical performance, to ensure the elevation of the structure with the floors and encourage box-like behavior also through the partial demolition and reconstruction of existing structures;
- restoration of the roofing elements.

2. Improvement of the conditions of environmental comfort, health and hygiene, natural lighting and building material quality:

- definition and construction of new windows in particular, in rooms that lacked them, and the expansion of existing windows surfaces deemed too small;
- realization or requalification of systems such as toilets and kitchen;

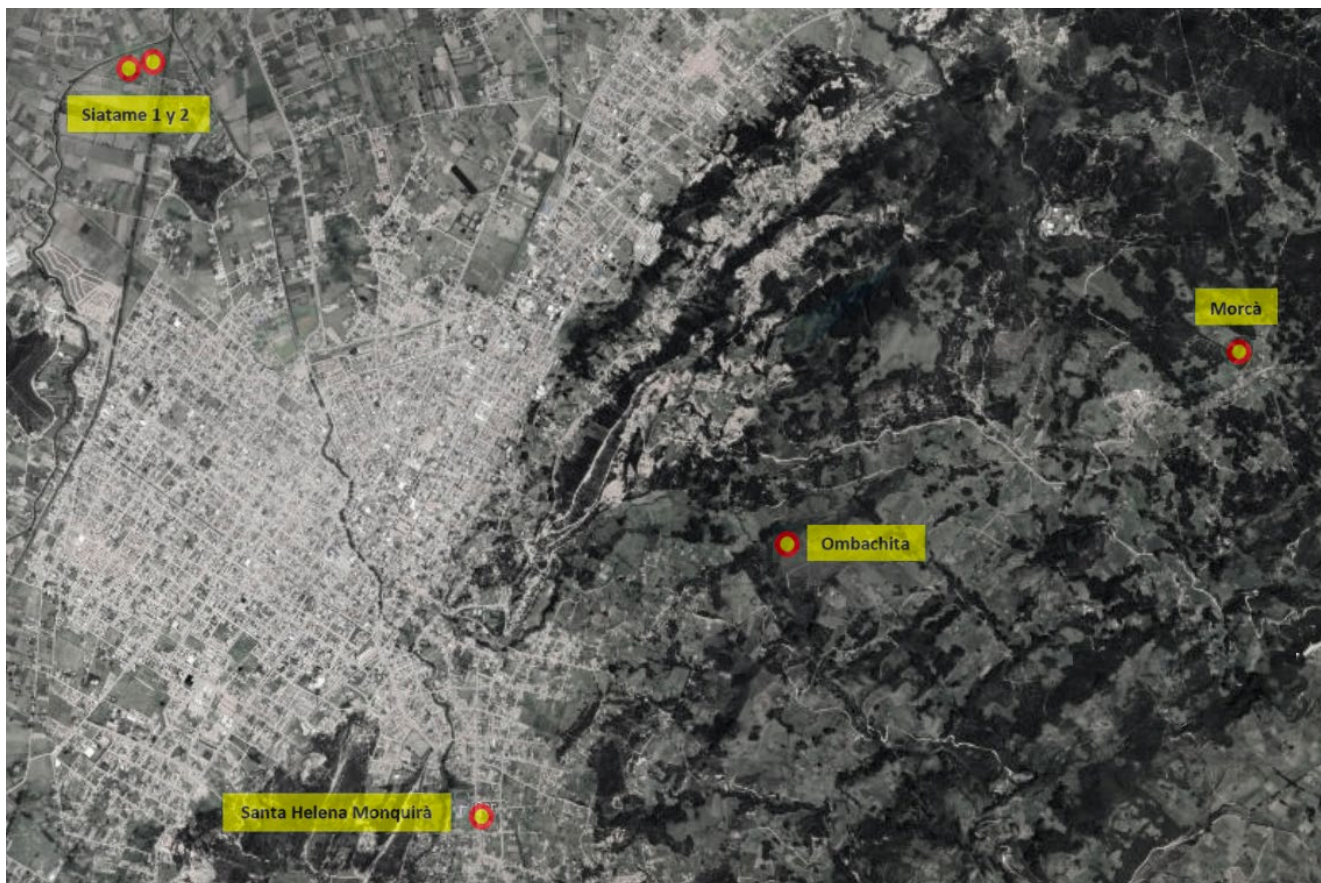


Figure 6. Localization of the interventions.

- integration into the building envelope of ventilation systems for the toilets;
 - acoustic and thermal insulation of the roofing with wood fiber panels.
3. Improvement of the usability of the internal environments in terms of accessibility and appearance:
- building of partition walls;
 - finishing by plastering or ceramic coating of the internal walls;
 - building or enlarging of the internal doors for the accessibility of the rooms.

Figure 7 shows one of the cases studies.

The process ended with the monitoring of the interventions. In this sense, the tools of the participatory process were also aimed at the ex-post evaluation of the interventions.

In the ex-ante phase, the participatory process was applied on site and on the basis of numerous meetings with the local community, while for the ex-post phase a questionnaire was prepared which was subsequently administered to housing users. The questionnaire was carried out to have feedback from users on the habitability conditions achieved, and with the specific objective to obtain a punctual qualitative feedback focused on aspects relating to safety only (specifically to seismic vulnerability, because of the greater evidence and sensitivity on the subject also by the inhabitants and for the possibility of applying, adapting it, the evaluation method of the Colombian Association of Seismic Engineering).

3. RESULTS AND DISCUSSION: EVALUATION OF RETROFIT ACTIONS

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The performance improvement of informal housing construction was the goal of all interventions, with greater attention being paid to those aimed at structural consolidation of the building (39%). However, the result highlights a general uniformity in the distribution of actions as showed by the intervention percentages for the improvement of environmental comfort (35%) and quality of construction (26%). This highlights two aspects: the first relating to the absence of a condition of prevalent building elements with lack of performance but with a widespread general state of lack of quality of the building; the second is that the prevalence of one intervention referred to another depended on user needs and built requirements of each individual building.

Therefore, prevalent, but not overwhelming, interventions where the ones for the improvement of the static behavior of the building and the consolidation of existing walls (22%), as well as, aimed at environmental comfort, the interventions for the construction of new external windows (13%) and, finally, the plastering of the internal surfaces (13%) for the general improvement of the quality and appearance of the internal environments (figure 8).

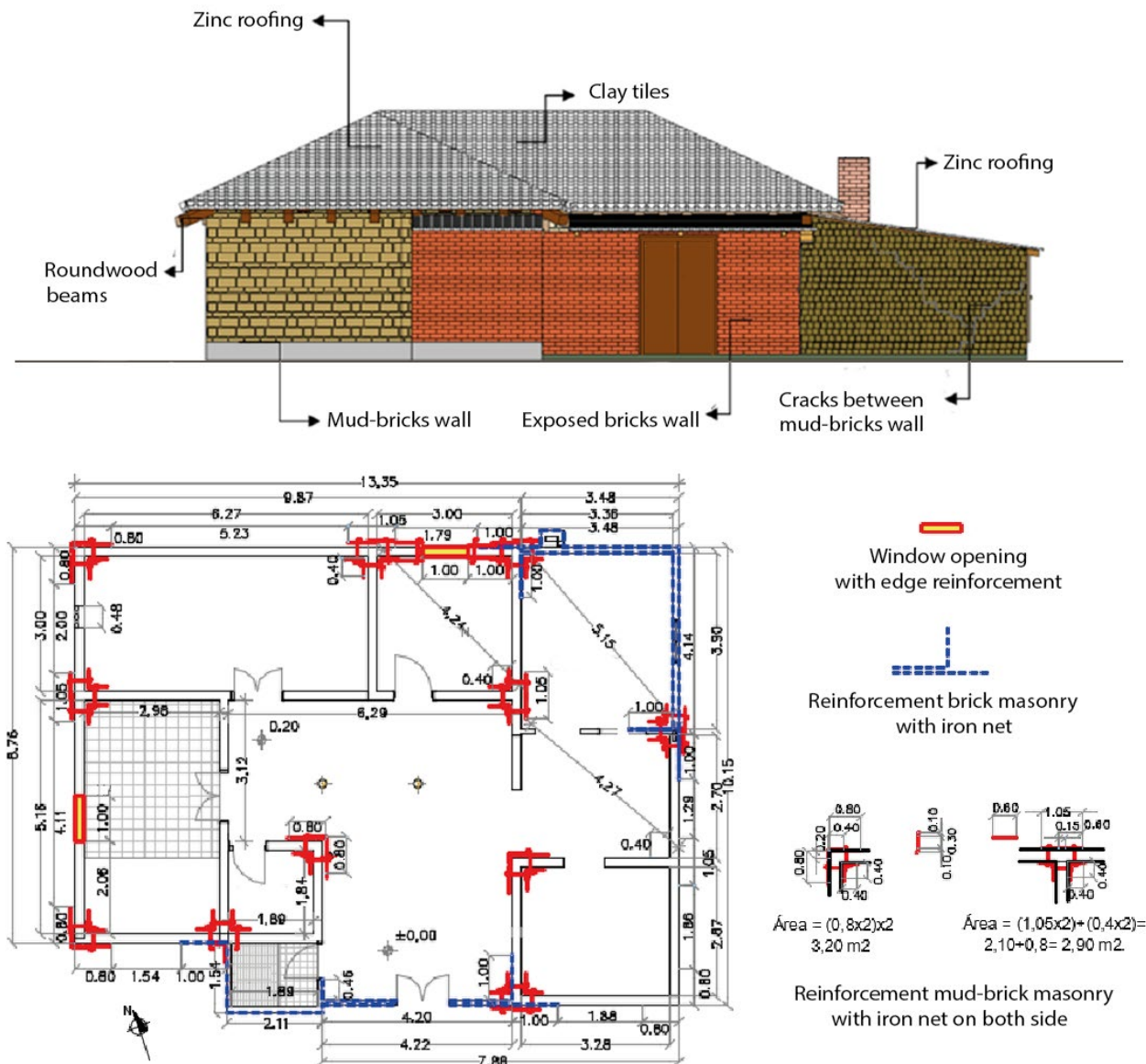


Figure 7. House in Morcà. Relief and interventions for static consolidation.

From an operational point of view, among the performance improvement interventions of the technical elements, 40 interventions were designed and built, thanks to the collaboration of AES and FONVIGOS which made available loans for 4.3 million Colombian pesos per intervention (approximately € 1.000) (25) (figure 9).

With particular reference to the improvement of the building's mechanical resistance, in some cases it was possible to propose a series of consolidation interventions whose theoretical models were assessed by testing (26, 27) through experimentation on low walls and clay block walls reinforced with reinforced plaster, the structural integrity was maintained when applying the reinforcement system, thus reducing the level of damage to the buildings.

The carried-out interventions have enabled to gain more than one class of building performance requirements, improving housing conditions and initiating a virtuous process of user involvement.

Recent studies evaluated the quality of these interventions: a first on the comparison of the quality of the applied technique, the reinforced plaster, vs confined masonry (28) and a second on the final quality of interventions (29). In the latter 5 of 40 houses are evaluated, the comparison is based on five parameters: permanent construction report, availability of basic services, number of the people living there, quality level of the finishes, adequate separation of the inner spaces of the house (29). This comparison shows the result of an average implemented quality of the 7% able to bring the quality of the house in the average level i.e., the houses are satisfying all the aspects required by the consolidation index (29).

The participatory mechanism had to deal with the limits of the social context, caused by the urban settlement typology made of isolated houses and, in the absence of a reference community, both the highly marginalized and excluded peoples.

For this reason, the participatory process had a twofold outcome: from a technical point of view, the interventions were more eas-

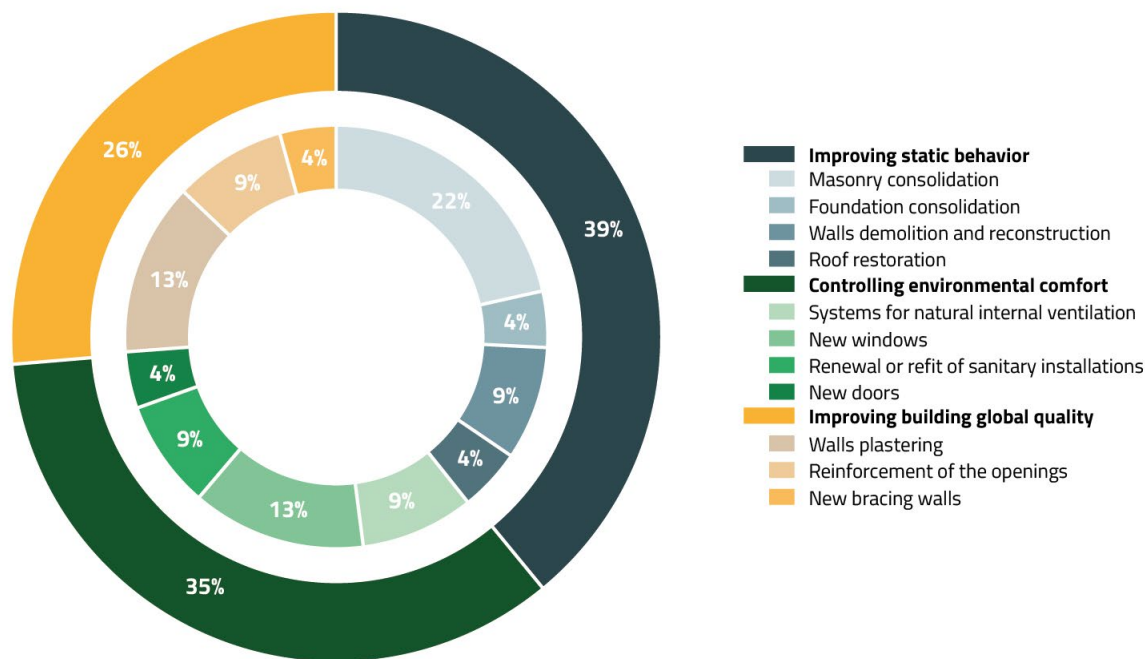


Figure 8. Distribution of interventions.

ily recalibrated according to the needs of the specific user, while, from a social point of view, the triggering of a propensity feeling was favored self-learning of techniques and solutions to improve homes, even in self-construction and in progressive form.

The main problems of this process were found in the taxonomizing of the interventions and therefore in the definition of structured and replicable guidelines. However, the replicability value of the research is determined by the participatory process, which has allowed the collaboration of various entities, the participation of users and the financing of interventions with valid social outcomes.

In fact, the participatory process and the tools implemented made it possible to carry out the interventions in a context of strong dependence on the responsiveness of the social context, although this required a long exploratory and cognitive phase of the reference context of the research, which was not always clear and referable to literature.

4. CONCLUSIONS

The fulfillment of the lines of intervention traced in the theoretical basis of the research is certainly due to an integrated approach, both trans-scalar and open, capable of contemplating the need to reconfigure the solutions proposed on the basis of contingency scenarios.

In addition, the research has taken the character of progressivity that characterizes the South American building processes in informal area. Informal progressivity leaves ample room for improvement, even losing something from the overall quality point of view.

In operational terms, the research reports, as positive results, achieved effective benefit of a small community in Sogamoso. In cultural terms, research has made it possible to:

- enhance the positive characteristics of the context, because the approach to the (positive) communities and users' practices involved was non-coercive;
- carry out a complete research path, starting from theoretical analysis to arrive at its application, involving urban, architectural, technical, technological, social, economic and financial aspects.
- define a process rich in cultural connections process, continuously evaluating and verifying the hypotheses, carrying out the repeated cultural exchanges between the partners.
- define a repeatable process, a virtuous path of cooperation and collaboration that can become a model of intervention in informal contexts.
- experiencing a social spin-off through the establishment of a non-profit organization which would continue to operate in other disadvantaged, developing or underdeveloped contexts.

In the constructive aspects, the group of master builders are able to replicate the implementation of the armed plaster. In management aspects, CAVIUR, the Center for Housing and Urban Development Advice of the University of Boyacá, the public officials of Fonvisog and the participating families, are also capable of replicating the activities carried out.

Aimed at improving spontaneous buildings, the research faced different complexity degrees, because it has meant moving between the theoretical issues of formal techniques and the practical ones of the informal. The research in its application has not been opposed to informal practices, but has established a dialogical relationship with them, making the houses more livable and safer, organically belonging to informal settlements. The community sense and the securi-

Houses	m ²	Improving static behaviour				Controlling environmental comfort				Improving building global quality			Pesos
		Masonry consolidation	Foundation consolidation	Walls demolition and reconstruction	Roof restoration	Systems for natural indoor ventilation	New windows	Renewal or refit of sanitary installations	New doors	Walls plastering	Reinforcement of the openings	New bracing walls	
Ombachita	77												\$ 4.732.079
El Portillo de Morcà	78												\$ 4.166.642
Siatame Tamarindo 1	63												\$ 3.374.598
Siatame Tamarindo 2	81												\$ 4.383.053
Santa Helena Monquirá	110												\$ 4.909.890

Figure 9. Interventions and costs.

ty perception of the inhabitants was improved. The research process has produced social well-being for the community, directly or indirectly, and has also made it possible to learn

how the informal city could be approached not as a condition to be corrected but as contagious phenomenon capable of reforming and humanizing itself.

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