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Learning from Habitat Reconstruction Initiatives—New Approach for Reducing Vulnerability of Rural Housing in India

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Abstract: Post-disaster reconstruction offers an opportunity to address some of the fundamental causes of vulnerability that are an inherent part of mainstream housing processes located at the intersectionality of sectoral interdependencies. Well-designed initiatives in the aftermath of a disaster can help displaced populations enter a positive cycle of resilience-building using new approaches. This paper draws from a recent field study to examine the reasons for the poor performance of existing housing stock in the face of disasters and presents a chain of graded causal factors that contribute to their vulnerability. Specifically, in the context of rural housing, the paper looks at three case studies of innovative habitat reconstruction initiatives undertaken in the aftermath of major disasters in India and analyses them for their impact on building the resilience of displaced communities. The study highlights that in order to address the various causes of vulnerability of rural housing, it is important to leverage the existing connections between different dimensions of habitat development, including access to finance, choice of appropriate materials, skill-building, and safe construction methods. This is at the core of the ethos of "building back better".

Keywords: build back better; habitat reconstruction; local capacities; post-disaster recovery; rural housing; resilience; vulnerability

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1. Introduction

Housing assumes great significance for the poor; it lays the foundation for a life of dignity and allows them a distinct, secure identity while giving them the foundation to pursue a better quality of life. Adequate housing facilitates the realisation of human potential of people, families and communities and catalyses social stability, productivity and the development of a nation [1]. The terms "house" and "home" are used interchangeably in common parlance. However, the literature distinguishes a house as a "shelter," a safe place to sleep, rest and enjoy privacy; a place where families can be raised. A home has a more qualitative connotation related to lifestyle and quality of life in the context of the local culture that varies from place to place [2–4]. While some researchers have interpreted the concept of home as one-dimensional [5–8], others argue that a home is a multi-layered phenomenon that integrates various facets of life of its occupants [9–13].

In the context of natural hazards, damage to shelter is perhaps the most significant structural impact of disasters possible in a community as a whole. In rural areas that are often characterised by shades of "underdevelopment", housing is a vital area of interest for governments to demonstrate development investment; destruction of houses in the aftermath of a disaster is therefore a major setback for people as well as for governments [14].

An analysis of a government response to a question at the upper house of the Indian parliament reveals that during 1 April 2018 to 31 March 2021, India lost a total of about 3.5 million houses only to floods across different states in the country [15–17]. This translates to an average of over 100,000 houses damaged per annum nationally with an annual estimate of INR 84,742 or approximately USD 120 million over a three-year period lost to floods alone. The numbers are expected to be far greater if other hazards such as landslides and earthquakes are also considered.

However, a significant extent of this damage can be prevented by incorporating risk awareness at each step of the process. This includes risk informed habitat planning, incorporating disaster resilient detailing in design, following techniques of safe construction and ensuring postconstruction maintenance of houses. However, this is a difficult proposition that requires fundamental changes in policy and practice, mostly overcome only in the context of a major disaster providing the opportunity for a "grand reset" of the system.

This paper is based on a field study of a small sample of houses constructed under the Prime Minister's Housing Programme (Rural), locally known as *Pradhan Mantri Awaas Yojana (Grameen)*, earlier implemented as India Awaas Yojana (IAY) in the four most disaster-prone states of India—Gujarat, Odisha, Tamil Nadu and Uttar Pradesh—to understand the causes of vulnerability of rural housing. The study further examines three postdisaster reconstruction and recovery initiatives to draw lessons for mainstream policy and programming so that existing issues of vulnerability of rural housing and habitat can be addressed for long-term resilience.

2. Literature Review

Disaster affected populations who have lost their houses need a private and secured place to live and start rebuilding their lives after a disaster [18]. Effects of disasters may also cause long term socio-economic impacts. For instance, the loss of housing can impact employment/income generation of the communities and increase poverty incidence and out migration. However, disaster is also a critical opportunity to promote disaster risk reduction as part of the recovery and reconstruction process and bridge the gaps between recovery and development [19]. Therefore, recovery is strategically important as it not only helps in restoring normalcy but also has the potential for reducing disaster risk and laying the foundation for long-term resilience.

Holistic recovery of disaster-affected communities requires a sound policy to guide reconstruction of homes [20]. A good policy can potentially help in empowering the communities to rebuild their housing, lives and livelihoods. Resilient recovery needs to be based on (i) a postdisaster assessment of damage and losses for the prioritisation of recovery and reconstruction needs; (ii) the policy framework to guide the recovery and reconstruction approach; (iii) identification of agencies or institutions responsible for implementation; (iv) mobilisation of funds to finance recovery; (v) articulation of exit strategies with linkages to sustainable development and (vi) development of monitoring and evaluation systems of recovery and reconstruction programmes [19–22].

The World Bank advocates that as part of the recovery framework [19], the principle of "build back better" (BBB) must be included in order to address existing vulnerability and improve overall well-being while focussing on reconstruction. Disaster recovery can serve as a great opportunity to reset practices and redesign systems to provide support for livelihood restoration and income generation opportunities during the recovery and reconstruction process. Equitable and inclusive recovery can be promoted through participation and prioritisation of the needs of the most vulnerable. Reconstruction of houses, infrastructure and services should equally focus on enabling economic activities to foster swift recovery and restore the livelihoods and income of the disaster-affected populations. The reconstruction of housing and infrastructure should take into consideration the location of new settlements and structural designs of individual units to promote resilience against local hazards and prevent environmental degradation, while incorporating local knowledge. Although every recovery effort is unique, the institutional context of the country, its

socio-economic profile, local culture and prevalent systems of construction have a bearing on the overall design of the recovery process as such [20,22].

For the above principles to manifest as tangible improvement in the lives of the disaster-affected people, reconstruction needs to ensure that community members partner in policy making, lead the local implementation and are involved in the monitoring and evaluation process. This is commonly known as "owner-driven approach (ODA)", where house owners themselves are facilitated to drive decisions on materials and design typology and execution in compliance with government regulations [23]. Owners may carry out rebuilding or repairing themselves with help from their own family members or local labourers. The government/any other support agency provides financial support within the limits of a clearly spelt out regulation for ensuring that houses are built back better. On the other end of the spectrum is a product-driven approach that is focused only on the delivery of a house designed and implemented in a manner that may be totally divorced from the local context and the real needs of the people with regard to their family size, local resources, climate comfort, livelihoods, etc. [23].

ODA has gained currency over the last two decades for its opportunity to empower disaster-affected communities to participate in decision making in relation to recovery and reconstruction [23,24]. This not only enables better long-term outcomes with regard to community acceptance but also provides immediate co-benefits, such as enhancing local building skills and revitalizing the local economy. However, ODA has challenges as well. A robust techno-legal regime and a corresponding mechanism for quality assurance, backed by easy availability of adequately trained quality of construction are essential for an owner-driven process. Moreover, education of homeowners on the dos and don'ts of good construction is critical for them to truly lead the process of construction. In the absence of this effort, pre-disaster vulnerabilities may be perpetrated further [24].

3. Materials and Methods

3.1. Data Collection and Analysis

The study followed a 3-phase approach. Phase 1 was limited to understanding the problem using the existing literature on the subject. Phase 2 included a primary survey to understand gaps in the existing policy framework for rural housing based on a structured questionnaire. The survey was complemented by key informant interviews (KII) and focus group discussions (FGDs) with local stakeholders. Phase 3 of the study examined a set of three innovative examples of post disaster recovery/reconstruction initiatives after major disasters.

3.1.1. Understanding Resilient Housing Problematics (Phase I)

To understand the problems of resilient housing, an extensive study of the existing literature on IAY was carried out. The literature study pointed to the trends of disaster-induced loss of houses across India and the current systems of housing construction as part of government-supported programmes. This exercise was useful in designing the primary survey, identifying locations for the survey and enlisting local stakeholders to be consulted.

As an outcome of this phase, the most vulnerable states representing different predominant hazard exposure were identified for the study. Selected via random sampling of houses constructed through government support during 2000 to 2015, a notional representative figure of 100 houses each were identified given the massive number of houses constructed in the following states of India:

- Gujarat—earthquakes and cyclones;
- Odisha—cyclones and floods;
- Tamil Nadu—tsunami and high-speed winds;
- Uttar Pradesh—floods;
- Uttarakhand—landslides, flash floods and earthquakes.

3.1.2. Primary Survey of the Rural Housing (Phase II)

The household survey was conducted using a structured questionnaire to understand homeowners' perception on the following parameters:

(1) Whether the house was perceived by the homeowners to be disaster resilient, e.g., safe or unsafe to their local hazards. This assessment was documented based on indicators such as the evidence of settlement in foundations, structural cracks, tilting of the building, frequent need for repairs, etc.
(2) Whether houses that were assessed to be safe/unsafe were sited in locations that inherently exposed them to hazards, e.g., whether the location of the house was safe/unsafe.
(3) Whether houses that were assessed to be safe/unsafe were constructed by the homeowners themselves (self-built) or by masons who were experienced/inexperienced in disaster-resilient construction.
(4) Whether houses that were assessed to be safe/unsafe were so on account of the funds invested in construction.

This data was analysed to develop layers of causality that were captured using causal loop diagrams (CLD) to illustrate interlinkages between different factors influencing the quality of housing and show how a change in one causes either a decrease or increase in another [25]. CLD is widely used as a tool to understand systems and present relationships among the variables in the system that are not linear cause-and-effect chains. The diagrams also help to understand loops that are reinforcing or balancing when the system is viewed as a whole [26].

3.1.3. Cases Selection (Phase 3)

Classified as a part of qualitative research methodology, case studies, in general, are widely used for conducting exploratory research, especially where the field of enquiry is under-researched or has a strong qualitative dimension. In these circumstances, case studies can be used to explore and describe the issues within a given context. Case studies are also lauded for their effectiveness in complex and dynamic contexts with multiple, influencing variables [27].

Disasters are "exemplary cases" since each disaster can possibly provide greater understanding of why things go wrong and how they can be corrected for mitigating future risks. Case studies are a widely adopted methodological tool for disaster research given their potential to allow deep enquiry into the hazard, elements at risk and their causes of vulnerability, consequences of the combination of vulnerability factors and how these may be addressed in the future for influencing mitigation strategies [28].

The aim of the study is to propose an approach to resilient rural housing based on three case studies of housing reconstruction after a major disaster. Using the existing literature as well as key informant interviews, each case study includes successes and challenges associated with their unique approach.

For the purpose of the study, case studies were selected based on the following reasoning:

(1) All the initiatives were implemented after a large-scale event declared as a disaster by the government.
(2) All the initiatives set out with the aim of rebuilding communities rather than reconstruction of houses alone. Hence, this approach allowed them to engage with various other processes such as livelihood restoration, exploring contextually relevant construction, etc., as inputs into the reconstruction effort.
(3) All the initiatives have survived for more than 10 years after their inception, demonstrating the sustainability and scalability of the idea.

Each case study selected for the research offered unique learning as follows:

SEWA Nirman, Gujarat:	Collective of construction artisans trained in disaster-resilient construction started in the aftermath of the Gujarat earthquake in 2001. The initiative continues to promote safe construction in rural areas of Gujarat.
Sustainable Reconstruction Initiative in Tsunami-Affected Villages of Karaikal, Puducherry, India:	End-to-end community rebuilding initiative taken up for the 2004 Indian Ocean Tsunami. The initiative demonstrates various steps to be followed for developing an integrated system for resilient housing reconstruction.
ASHRAYA Building Materials and Services Bank:	A private enterprise started in the aftermath of the Orissa Super Cyclone in 1999 that demonstrates a business case for green building materials enterprises that may outlive immediate reconstruction needs.

4. Analysis and Results

4.1. Analysis and Key Findings of the Primary Survey

The Primary Survey revealed the following trends:

a. As indicated in Figure 1, a majority of houses surveyed in Gujarat and Tamil Nadu were perceived to be in unsafe locations that exposed the house to hazards. Surprisingly, houses in the Bahraich district of Uttar Pradesh were perceived to be in safe locations despite the annual onslaught of floods in the area. Focus group discussion with the participating households revealed that this trend was reported as floods were perceived and accepted as a necessary determinant of the local geography.
b. A large majority of houses that were perceived to be "unsafe" were constructed by masons experienced in disaster-resilient construction as illustrated in Figure 2.
c. Homeowners' perception of whether a house is safe or unsafe has no direct connection with the amount of funds spent on construction as illustrated in Figure 3.

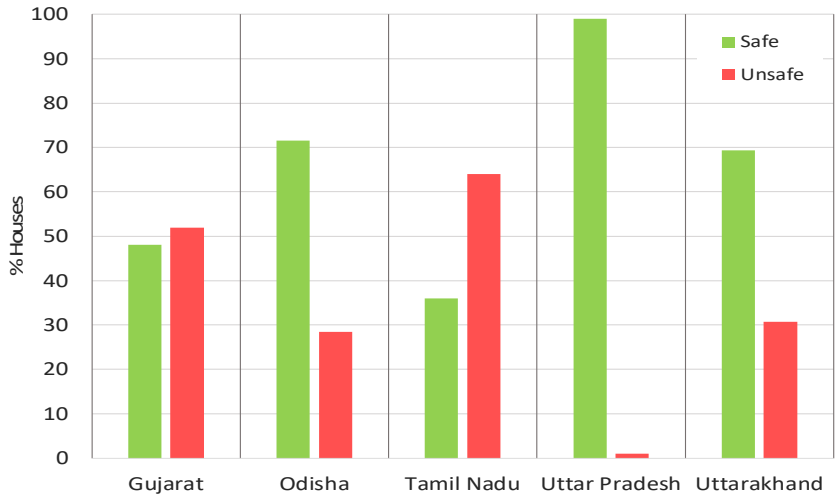

Figure 1. State wise distribution of safe/unsafe houses.

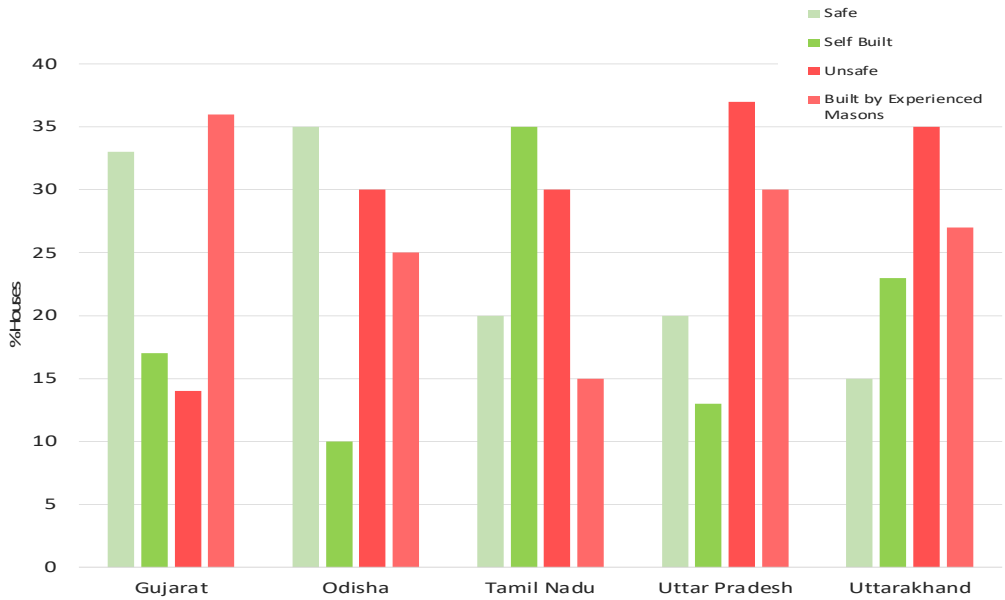

Figure 2. Stagewise distribution of safe/unsafe houses built by self-experienced masons.

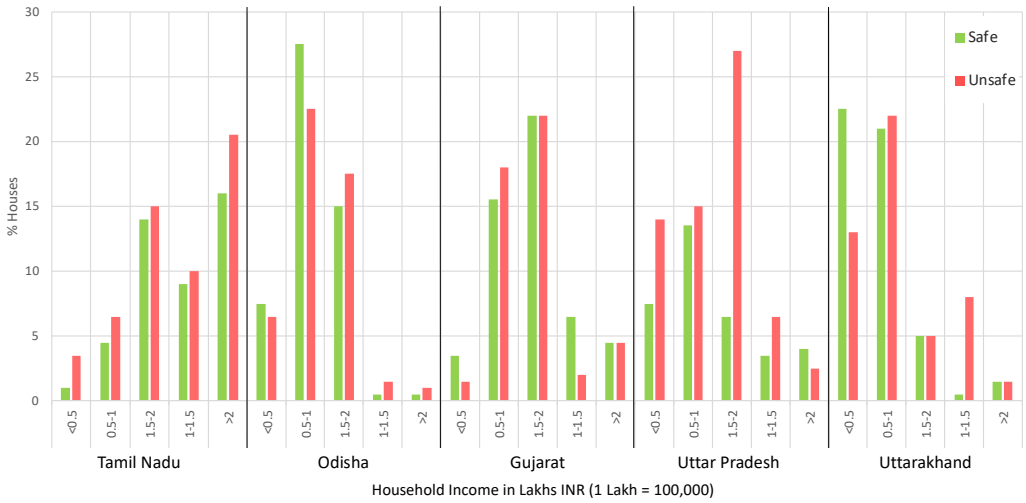

Figure 3. Distribution of safe/unsafe houses by expenditure on construction.

Qualitative inferences from the primary survey undertaken during the study, focus group discussions and interviews highlighted the causes of vulnerability of houses. These are summarised in the following paragraphs within the framework of the Crunch model proposed by Blaikie et al. [29]. The model articulates a progression of vulnerability as a multi-layered concept starting from unsafe conditions to dynamic pressures and underlying causes that ultimately result in the vulnerability of a house.

4.1.1. Layer 1: Unsafe Conditions

Unsafe conditions or physical, economic and social circumstances expose populations to natural hazards. Analysis of data and field interviews reveal that on the surface, poor performance of houses in the face of a hazard is a cumulative result of four critical conditions. The poorest often live in fragile locations. Additionally, a large number of houses perform poorly during crises on account of poor quality of construction, which is a result of multifarious reasons. Closely linked, yet independent, is the quality of materials used, and post occupancy maintenance of these houses as presented. These are the factors that predominantly cause the poor performance of houses during a calamity, as depicted in Figure 4.

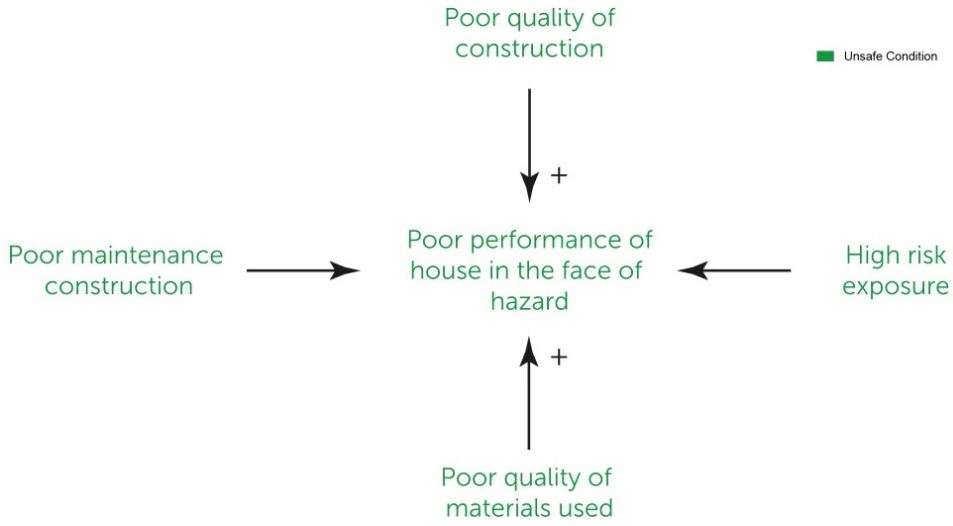

Figure 4. Layer 1—Unsafe conditions.

4.1.2. Layer 2: Underlying Causes

Vulnerability is rooted in underlying causes or established behaviours on which society is built. Each of the factors that appear to have a direct bearing on the performance of a house during hazardous conditions has few predominant underlying causes. These include poor habitat planning that enables hazard exposure: inadequate supervision that leads to poor quality of materials being used as well as poor quality of construction. Furthermore, the poor quality of construction as well as limited technical ability of construction artisans in the first place, necessitates the need for frequent maintenance of houses. Poor quality of materials is also a result of the limited menu of construction materials in small rural markets. This second layer of causality of vulnerability or underlying causes is depicted in Figure 5.

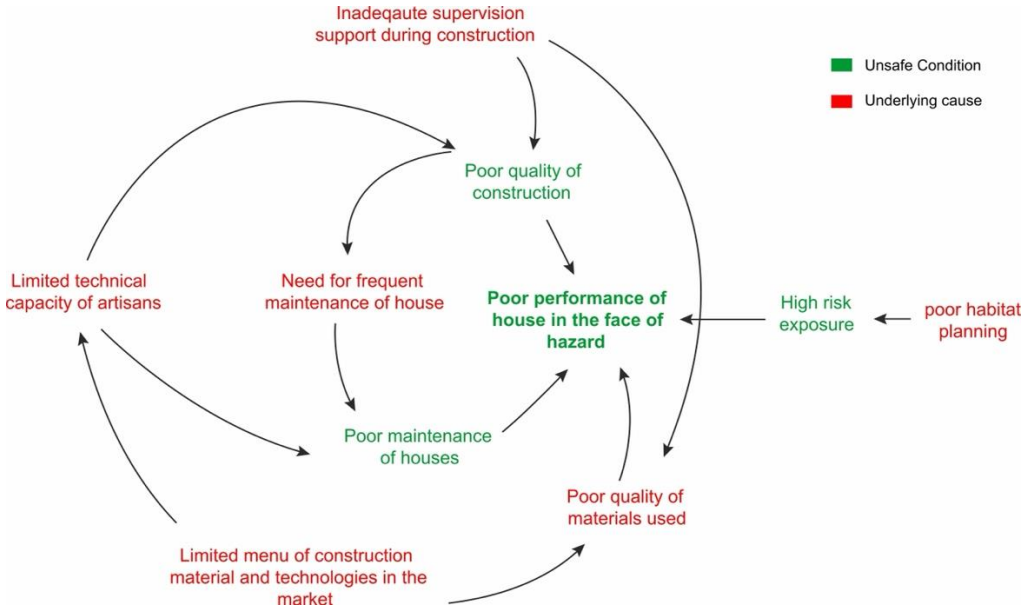

Figure 5. Layer 2—Underlying causes.

Until 2016, IAY did not have any funds for ground-level advice or supervision during construction. Thus, IAY construction was left to the beneficiaries and building artisans; the responsibility of taking decisions as well as their consequences was the sole responsibility of the people and the artisans.

Limited technical capacity of artisans is recognised as a key bottleneck in quality construction [30]. As per the Working Group on Construction set up by Government of India during the formulation of the 11th Five Year Plan (2007–2012), India had a workforce of around 31 million involved in construction. About 82% of these are unskilled [30]. Upward movement of construction workers within the value chain is mostly via on-the-job learning with their "skilled" seniors. However, the understanding and technical competence of the "skilled" workers who provide apprenticeship to the less skilled. This trend has a significant adverse impact and is at cross-purposes with the whole ethos of "skilling" per se.

Similarly, poor location of houses is often a result of poor habitat planning at the village and regional level. Moreover, as indicated by the primary survey, lack of understanding on settlement-level disaster mitigation measures such as bio shields for cyclone risk mitigation, plinth raising at hamlet level, etc., were undertaken to a very limited extent in most locations. As a result, the risk exposure of socially supported houses is much higher, and their vulnerability enhanced.

4.1.3. Layer 3: Root Causes

In a deeper analysis, each of these factors have other casualties that are perhaps outside the direct control and command of most of the stakeholders involved in rural housing. Lack of funding and human resources for guidance and supervision of construction is clearly a result of limited priority in government-sponsored housing. As a result, not only are houses constructed with glaring omissions in disaster resilient features, but construction itself is also poorly planned and managed.

Another factor connected to poor affordability is the use of substandard materials in construction by BPL families undertaking construction. This affects the nature of the local-level market of building materials that, consequently, does not remain conducive to supply of better-quality materials. Moreover, the policy environment for housing has so far also not supported the consolidation of markets, even for beneficiaries who may benefit tremendously as a consolidated whole. These factors have been illustrated in Figure 6.

Thus, the overall outcome of lack of structural performance in rural houses is on account of a combination of complex factors and conditions, many of which are not directly under the influence or control of homeowners.

4.2. Analysis and Key Findings of Case Studies of Select Recovery and Reconstruction Initiatives

Case studies examined as part of this study lend unique insights on practical implications of specific dimensions of recovery efforts undertaken after a major disaster. These are presented in the following sections:

4.2.1. Case Study of SEWA Nirman, Gujarat

a. Reason for Selection

SEWA Nirman has its genesis in the post earthquake recovery and reconstruction initiative in Gujarat in 2001. It offers a unique solution in terms of the aggregation of trained artisans who have systematically organised themselves.

b. Overview

SEWA Nirman Construction Workers Company Ltd. was set up in April 2008 by members of the Self-Employed Women's Association (SEWA) in Gujarat as a private/public limited company, owned and managed by construction workers.

The 2001 earthquake in Gujarat demolished thousands of houses creating the urgent need for trained masons, carpenters and other artisans to aid reconstruction. With fewer than 5% of masons in Gujarat having undergone any systematic training, demand for skilled masons to be deployed in reconstruction efforts by the government and civil society was evident. Sewa Nirman was thus set up to fill this critical gap that also sought to promote livelihood recovery through this process. Over the years, masons trained by

SEWA have formed a group that is well recognised for its quality of work and is therefore registered with the state government as a supplier of prefabricated toilets [31].

c. Evolution and Growth

SEWA organised "on the job" training for construction workers to facilitate their absorption into the reconstruction process. Training needs assessments highlighted the need to include skills on improved construction practices as part of this effort. a "Basic Construction Training Manual" for trainers was developed as a collaborative effort between Swiss Red Cross, SKAT Consulting, Swiss Solidarity and field-based SEWA construction engineers to support the training efforts for the desired purpose.

Additionally, trainings were also carried out for production of low energy and locally appropriate building materials such as earth blocks. This strategy helped promote local livelihoods as well as minimise cost for transportation of materials for reconstruction.

SEWA currently has a trained workforce of nearly 1400 masons engaged in quality construction across various parts of Gujarat. In its initial years, the company provided work to the masons. Over the years, however, masons were also able to secure work independently. Joining the company has provided them the platform to negotiate larger contracts as a collective. Besides construction contracts, the company also undertakes capacity building of construction workers, as well as production, distribution and sale of low-cost building materials.

The library of tools and equipment run by SEWA Nirman also lends essential but expensive tools and equipment, such as shuttering plates, etc., that are required for quality construction. This also generates additional revenue for the company and has further enhanced the capacity of its members [31].

d. Successes

(1) Gender-sensitive approach

SEWA Nirman has a mix of men and women members, although the latter comprises the dominant majority. This has brought a gender-sensitive approach to construction services provided by the company. Availability of trained women masons within their own neighbourhood has helped the village economy by minimising the need for male workers who were earlier invited from other villages.

In addition, given the interest of women to work close to home, especially with increases in their family responsibilities, production of building materials has gained popularity as an income-generating option within the construction trade. Other locally useful items such as kothis or grain storage bins, pitcher stands, tree guards, etc., are also produced for the local market.

(2) Trainee-sensitive methodology

In a typical batch, about 50% of the trainees, mainly women, are generally reported to be illiterate. Thus, the role of practical training is vital in transferring the necessary knowledge and skills to the trainees. Increasingly, trainings are now being conducted by SEWA Nirman alumni who understand the challenges of both learning as well as teaching in their local context. Pictorial modules with minimal writing are used to overcome the literacy barrier.

e. Challenges

The biggest challenge lies in the business prospects of the trainee workforce available for construction of rural homes. Many of the trained workers have to compromise on the high-quality standards of construction learnt during the training as the end client in the village is unable to afford the expense when following the correct specifications.

Hiring trained workers for the construction of houses is not a binding condition for state-supported housing which affects the employability of trained workers

SEWA Nirman is also registered as a vendor with the state government for the construction of toilets. There are severe constraints posed by this situation. The group is

informally recognised as people who are specialists in "toilet construction", and therefore construction of houses is not an easy market for them.

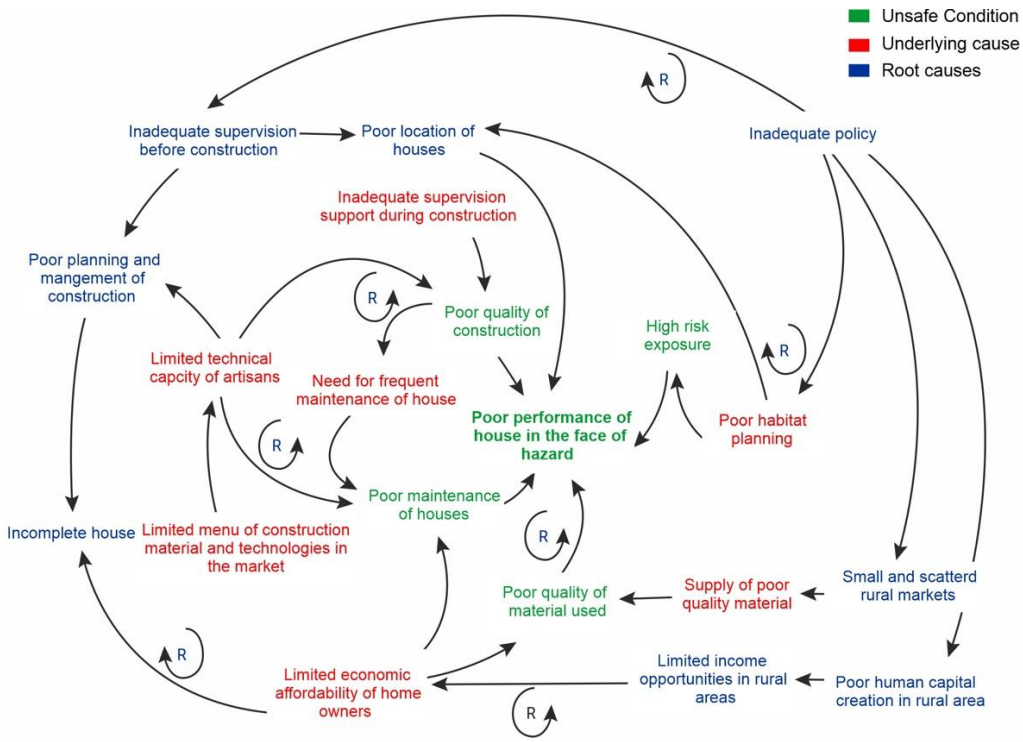

Figure 6. Layer 3—Root causes.

4.2.2. Case Study of Sustainable Reconstruction Initiative in Tsunami-Affected Villages of Karaikal, Puducherry, India

a. Reason for Selection

The project was designed in response to the need for relocation, reconstruction and rehabilitation of the 2004 tsunami-affected villages of Karaikalmedu, Kilinjalmedu and Kottucherrymedu, in the Karaikal district of the state of Puducherry (formerly Pondicherry). The project included contextualised planning and design, introduction of environment-friendly construction systems, local capacity building and institutional strengthening measures. The redevelopment and reconstruction were based on a feasibility study that highlighted the post disaster needs of the communities in relation to reconstructed houses with basic amenities, community infrastructure, economic opportunities and skill building for safe and sustainable building construction.

b. Overview

The tsunami of 26 December 2004 in the Indian Ocean caused extensive damage across several districts of Tamil Nadu and Pondicherry in India. In the villages of Karaikalmedu, Kilinjalmedu and Kottucherrymedu, in the Karaikal district of Pondicherry, 68 lives were lost, while all families lost their homes, schools and other common infrastructure. Since they were within 500 m from the coast, the villages required to be relocated inland as per the Coastal Regulation Zone requirements of the Government [32].

With support from Swiss Red Cross and Swiss Solidarity, Development Alternatives, an NGO based in New Delhi, designed and executed the project. In total, 909 houses with basic amenities were constructed across three new village settlements. Each house was designed for a plot of 800 sq. ft. with a plinth area of 407 sq. ft. including staircases. The local government took the responsibility of providing land for the reconstruction of housing along with the provision of basic infrastructure such as roads, drains, street lighting and water supply. The project also supported 70 artisans, 25 local engineers and 7 local civil

contractors by building their capacity in safe construction practices. Additionally, 18 youth were trained as electricians and plumbers and were deployed with local contractors engaged in the project. For long-term knowledge and skill transfer, the project involved the local building centre as a critical stakeholder [33].

Rather than limiting itself to the reconstruction of houses damaged by the tsunami, the project sought to substantially reduce the long-term vulnerability of the affected families by "building back better" and improving the overall quality of life of the people.

c. Evolution and Growth

Strong emphasis was laid on a participatory approach. To represent the families in the process of habitat planning, development of type-design of houses and selection of technology for construction, a village reconstruction committee (VRC) was constituted in each location. The committee helped incorporate the needs of women, men and children with regard to the design of the house.

d. Successes

With the central idea of rebuilding safer houses and settlements, the project took up a holistic approach to foster longer-term sustainable development, as illustrated below [32,33]:

(1) Risk reduction through contextual response to planning and design

Given the allotment of relocation sites in low-lying areas by the government, professionals were engaged to seek community inputs for designing the settlement layout and developing type designs for houses. This was performed to integrate local cultural practices along with disaster resilience and climatic comfort features. As a result, settlements included wind breaks, adequate drainage as well as public and private greens. Community facilities such as childcare centres, community halls, village markets, bus stops, etc. to be developed later by the government were earmarked in the settlement plan. To manage low-lying sites, landfilling was undertaken; retaining walls and locally suitable plantations were included for edge protection of the sites. House designs were developed in discussion with the families based on local cultural and religious beliefs in keeping with thermal comfort requirements. The designs were subjected to detailed structural analysis for cyclone and seismic performance prior to execution.

(2) Livelihood creation through construction

The project initiated building material production enterprises for over 40 people within the villages. Skill enhancement of local masons along with training of eligible youth in construction-related trades facilitated their deployment with contractors hired for the project. In addition, village nurseries were set up by women's groups from the three villages to provide saplings for the new settlements on a commercial basis.

(3) Post-occupancy support

In keeping with the government directive, families were allotted houses only after the completion of the project. This prevented the project from providing the needed customisation for each family as per their size, composition and livelihood requirements. Left on their own, it was suspected that families may inadvertently end up making structural alterations affecting the performance of the houses. Hence a "maintenance cell" was set up for assisting families for alterations and expansions in their new houses with professional help. Individual choice of colour of the paint for each house, orientation of families to maintenance regimes, toilet orientation for first time users, applications for electricity and water meter connections and insurance was facilitated through the cell over a period of six months per village after hand over.

(4) Anchoring knowledge of safe and sustainable construction technologies

The reconstruction process was designed such that safe and sustainable construction practices were integrated with the local knowledge systems. Orientation of VRCs, Panchayats and women's groups, as well as government engineers on technical aspects

of design and construction, was regularly undertaken to ensure that the new materials, such as fly-ash bricks and technologies such as rat-trap method of masonry, were well understood and accepted. Training of local masons and contractors was undertaken for construction under the project as well as to leave behind a pool of competent workers for future construction and maintenance needs in the region. Engineers of the local building centre were trained to provide guidance on fly-ash block production in the future.

e. Challenges

(1) Economies of scale for new solutions

The project introduced several new initiatives in the context. These included building materials and technologies, mainly fly-ash blocks and rat-trap masonry, to promote ecological construction. However, the solutions could not be mainstreamed for two main reasons—one, their demand was rather limited and two, promotion of these solutions by other stakeholders was not evident.

(2) Navigating the existing relationships between stakeholders

The biggest challenge for the project was with regard to navigating the existing relationships between different stakeholders. Women members of the community were initially not even allowed to speak in meetings with the community. The project negotiated for their role and voice in the design of houses and settlement planning. Such factors that define the relationships between various actors in the ecosystem were critical in determining the project design as it evolved and its outcomes. Besides, the onboarding of the local building centres at Poovam, as well as government permissions to use such nonconventional solutions, posed challenges that affected the pace of the project.

4.2.3. Case Study of Ashraya Building Materials and Services Bank, Choudwar, Odisha

a. Reason for Selection

Ashraya was born out of a need for quality building materials and skills for reconstruction in the aftermath of the Odisha super cyclone in 1999. It is the only surviving enterprise of its nature in Odisha.

b. Overview

The genesis of Ashraya Building Materials and Services Bank (BMSB) lies in the "Ashraya Project", a large rehabilitation programme initiated by CARE India and Development Alternatives in the aftermath of the Odisha super cyclone in 1999. The project included investment in setting up a supply chain for locally produced building materials for use in construction of houses destroyed by the super cyclone. Ashraya BMSB was set up in Choudwar as an independent entity after the completion of the Ashraya project, continuing to produce nonconventional building materials and supply of skilled manpower. The initial focus of Ashraya was essentially on:

i. Ensuring availability of quality products for construction and construction services for reconstruction.
ii. Long-term availability of sustainable building materials and skills.
iii. Livelihood creation for local unemployed youth.

c. Evolution and Growth

The Odisha super cyclone in 1999 left thousands of people in the coastal districts of Odisha homeless. In response, the Ashraya Project took up the development of cyclone-resistant reconstruction of the core houses. The project included training of masons in building materials production, construction techniques and construction management, thus providing livelihood opportunities for local people during the reconstruction process. The BMSB became a centre where NGOs and community groups building core houses for the project could obtain building materials and components and also hire skilled construction workers. Outreach was later extended by setting up mobile building centres that offered in situ training at construction sites.

In the year 2000, Ashraya became an independent legal entity by registering under the Societies Registration Act 1860. It is now a section 25 company owned as a partnership by 25 women entrepreneurs [31].

Ashraya is linked with the Orissa Housing Finance Corporation and provides employment to local masons and building materials producers. It also provides access to habitat finance through 200 self-help groups (SHGs) and a women's housing co-operative [34].

d. Successes

During the years 2000–2001, Ashraya was recognised by UN Habitat as one of the ten best habitat projects from India. Its key successes are:

- Ashraya continues to produce materials for construction of houses for different programmes and projects of the government.
- It is involved in undertaking sanitation programmes in Orissa by constructing toilets.
- It continues to provide training and employment opportunities to rural women, artisans, masons and rural youth.

Ashraya has also demonstrated that BMSBs can be financially viable as enterprises in the long run.

e. Challenges

From a simple building material production and supply enterprise, Ashraya has evolved to taking up new roles such as providing loans and linking poor families to government schemes. While this may have led to some small successes, the challenge of developing expertise in these roles has its own failings. It is interesting to note that despite being a centre promoting disaster-resilient and green construction, the bulk of the business of Ashraya comes from the construction of toilets in the villages. Building material production was also pruned to a bare minimum and toilet construction contracts dominate the balance sheet of the organisation.

The case studies covered in this section illustrate that well-crafted, multisectoral approaches to design of reconstruction efforts can help correct the causal chain of vulnerability in the pre-disaster context. They serve as a strong base for not only the reconstruction of houses but also bring about overall improvement in the well-being of the disaster-affected communities by enhancing their capacities and rebuilding their livelihoods.

4.3. Results

The key results of the study are summarised below:

4.3.1. Addressing Locational Vulnerability of Houses and Homesteads

Suitable land of appropriate size that is in a safe location, accessible and affordable for housing the poor has been a challenging proposition for housing development as well as post-disaster reconstruction. This results in new houses being located in rather unsafe locations such as the hillslopes and flood plains. As also observed in the primary survey, such houses are most vulnerable to local hazards. However, as evident in the Karaikal reconstruction project, hazard mitigation measures for reducing locational vulnerability of houses are possible. This requires funds which are often not available in mainstream housing programmes, nor with homeowners who are mostly families with meagre earnings. This issue may be resolved by linking housing programmes with other government programmes for land development/employment generation. Such convergence would help secure new houses by reducing their locational vulnerabilities.

4.3.2. Promoting Appropriate Choice of Materials and Technologies to Promote Resilient and Sustainable Construction

The study revealed that the most common materials used for construction of houses are brick/stone and reinforced cement concrete (RCC). The reasons for this shift away from more environmentally appropriate options that may also be contextually relevant is due to

a variety of reasons, such as aspirations of the homeowner for more "permanent" solutions that require less maintenance.

It is evident from the experience of the Karaikal reconstruction project, SEWA Nirman as well as Ashraya BMSB that substantial time, energy and resources are required to convince new homeowners to move away from industrial materials that are often detrimental to the local environment. In a mainstream housing programme, this is often not a part of the plan, where the focus is mostly on disbursement of funds and tracking the progress of completion over quality monitoring.

4.3.3. Inclusion of Standard Disaster Risk Reducing Details in Construction

Even in states such as Tamil Nadu and Gujarat that provide detailed guidance to poor families, the study revealed that safe construction details are not implemented in practice. This is mainly on account of limited affordability of the homeowners as well as their limited understanding of risk and vulnerability. Limited access to trained manpower for disaster-resilient construction also affects construction quality.

The experience of the Karaikal reconstruction project highlights that quality monitoring systems, especially with regard to the correct use of disaster-resilient features is critical for meaningfully utilising public investment.

4.3.4. Limited Capacity of the Delivery Agents at the State, District and Ground Level

As agents of delivery of housing, masons have played a prime role in influencing the selection of building materials, design typology, as well as the ultimate quality of construction on the ground [30]. Even though not perfectly implemented on the ground, risk-resilient features in construction were evident in states such as Odisha that have invested heavily in training of masons on safe construction in the aftermath of large-scale disasters. However, in places where such investment has been missing and construction is left to the mason regardless of his/her understanding of safety issues, fundamental mistakes such as the use of mud mortar in the foundation in flood-prone areas were evident [31].

5. Discussion

Impacts of disaster events are a cumulative outcome of the existing vulnerability conditions of housing assets in the context of prevailing hazard exposure. The notion of disasters as effects of natural events, rather than acts of omission or commission by human beings, is increasingly being challenged globally by researchers based on a deeper exploration into the causality of disaster events [35–37].

Rural habitat development is a classic example of what Sterman calls a "wicked problem". These are situations that are in effect characterised by the creation of unanticipated side effects of well-intentioned efforts to solve pressing problems. The result is that such interventions are defeated by the response of the larger context to the intervention itself [38]. The "larger context" thus plays an important role in the success and failure of any given strategy [39].

Solutions to such wicked problems are explored in systems thinking. A system is defined in the literature as "a complex aggregation of the interactions of all its parts" [40]. Neglect of any of these individual parts could disrupt the functioning of the entire system in general. A systems approach enables diverse stakeholders to represent their mandates/interests and collaborate such that multiple solutions can be explored in a collaborative mode. Authors such as Ackoff argue that many social problems can be resolved by using a systems approach, "A system is never the sum of its part, but the product of the interaction of its parts" [41].

With its modest sample of houses, the study identified critical gaps in the delivery of social housing. All the states covered in the study had a system for monitoring the progress of construction synchronised with the disbursement of funds. However, structured systems for tracking and supporting quality in construction were deficient. Reconstruction projects

included in this study demonstrated that inclusion of a system for monitoring quality helps to ensure inclusion of safety features. Furthermore, in places such as Gujarat and Odisha that have suffered major disasters, a significant pool of masons trained in safe construction was created. As a result, the use of risk-resilient features was more common in such places. This was also reinforced by the presence of initiatives such as SEWA Nirman and ASHRAYA, which have continued to promote safe construction practices even after the recovery initiative ended. Furthermore, the perception of the homeowner as a "beneficiary" of financial aid is propagated in the way different actors deal with homeowners. Policy actors need to move beyond the traditional focus on numbers and establish performance standards for monitoring as well as find ways of meaningfully involving other stakeholders in the task of resilient rural housing.

A systems approach spells the essence of how the disaster-resilient rural housing problem can be addressed by ensuring access to risk-informed settlement planning, safe design and construction techniques, skilled construction artisans adept at resilient construction and institutional processes for quality monitoring and technical supervision [42].

6. Conclusions

Post-disaster reconstruction of housing for the poor has been a political priority for all the governments since the independence of India. However, given the multi-hazard profile of the country, concerted and systematic action on strengthening disaster performance of the housing stock created through government support is conspicuous by its absence. There is plenty of evidence to illustrate the dire impact of natural hazards and even manmade ones, such as fire on rural houses that are many a time the only shelter the poor have. This was also established by the study despite being limited by a small sample of houses in the primary survey due to paucity of time. Consequently, rural housing targets of the government continue to be high despite the investment of a range of resources for rural housing construction. Structured interventions at post-disaster reconstruction of housing have substantial lessons for realigning the efforts of the government, private sectors and people themselves for creating a more disaster-resilient built environment. There is a need to delve deeper into the "systems" approach to rural housing development to build upon the existing strengths of each stakeholder involved in rural housing development.

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References

1. Asiedu, A.B. The Potential of Systems Dynamic Modelling in the Sustainable Planning and Management of Essential Environmental Facilities in an Urban Area of Sub-Saharan Africa. In Proceedings of the International Conference on Spatial Information for Sustainable Development, Nairobi, Kenya, 2–5 October 2001.
2. Perkins, H.C.; Thorns, D.C. *The Study of 'Home' from a Social Scientific Perspective*; Human Sciences Division, Lincoln University: Canterbury, New Zealand, 2001.
3. Chapman, T.; Hockey, J. *Ideal Homes*; Routledge: London, UK; New York, NY, USA, 1999.

4. Wright, G. Prescribing the Model of Home. *Soc. Res.* **1991**, *58*, 213–225.
5. Douglas, M. The Idea of a Home: A Kind of Space. *Soc. Res.* **1991**, *58*, 287–307.
6. Rapport, N.; Dawson, A. *Migrants of Identity: Perceptions of Home in a World of Movement*; Berg: Oxford, UK, 1998.
7. Porteous, J.D. Home: The Territorial Core. *Geogr. Rev.* **1976**, *66*, 383–390. [CrossRef]
8. Anand, M.C.; Niazi, Z. *Framework for National Rural Habitat Policy for India*; Basin South Asia: New Delhi, India, 2005.
9. Bowlby, S.; Gregory, S.; McKie, L. Doing home: Patriarchy, caring, and space. *Womens Stud. Int. Forum* **1997**, *20*, 343–350. [CrossRef]
10. Wardhaugh, J. The Unaccommodated Woman: Home, Homelessness and Identity. *Sociol. Rev.* **1999**, *47*, 91–109. [CrossRef]
11. Somerville, P. Homelessness and the Meaning of Home: Rooflessness and Rootlessness? *Int. J. Urban Reg. Res.* **1992**, *16*, 529–539. [CrossRef]
12. Dam, H.; Eyles, J. "Home Tonight?" What? Where? An Exploratory Study of the Meanings of House, Home and Family. *Forum* **2012**, *2*, 13–19. [CrossRef]
13. Mallett, S. Understanding Home: A Critical Review of the Literature. *Sociol. Rev.* **2004**, *52*, 62–89. [CrossRef]
14. National Housing Bank. *Report on Trend and Progress of Housing in India*; National Housing Bank: New Delhi, India, 2012.
15. BMTPC. *Vulnerability Atlas of India*; BMTPC: New Delhi, India, 2016.
16. The Hindu Business Line. Available online: http://www.thehindubusinessline.com/industry-and-economy/real-estate/urban-housing-shortage-to-touch-34-cr-units-by-2022-report/article6901847.ece (accessed on 10 March 2021).
17. Government of India. *Ministry of Home Affairs, Rajya Sabha Unstarred Question No. 2587 of 11 August 2021*; Government of India: New Delhi, India, 2021.
18. Johnson, C. *Impacts of Prefabricated Temporary Housing after Disasters: 1999 Earthquakes in Turkey*; Habitat International, Elsevier: Amsterdam, The Netherlands, 2007.
19. The World Bank Group; UNDP; European Union. *Guide to Developing Disaster Recovery Frameworks*; The World Bank: Washington, DC, USA, 2015.
20. The World Bank. *Safer Homes, Stronger Communities: A Handbook for Reconstruction after Natural Disaster*; The World Bank: Washington, DC, USA, 2010.
21. Asian Disaster Preparedness Center. *Handbook for Disaster Recovery Practitioners*; Asian Disaster Preparedness Center: Phaya Thai, Thailand, 2015.
22. Federal Emergency Management Agency, USA. *Planning Considerations: Disaster Housing. Guidance for State, Local, Tribal and Territorial Partners*; US Department of Homeland Security: Washington, DC, USA, 2020.
23. Government of Nepal. *Nepal Earthquake 2015: Post-Disaster Recovery Framework*; Government of Nepal: Kathmandu, Nepal, 2016.
24. Jha, A.K.; Barenstein, J.D.; Phelps, P.M.; Pittet, D.; Sena, S. *Safer Homes, Stronger Communities*; The World Bank: Washington, DC, USA, 2010.
25. Richardson, G.; Pugh, A. *Introduction to System Dynamics Modeling with DYNAMO*; Productivity Press: Cambridge, MA, USA, 1981.
26. North, K. An Introduction to Systems Thinking. 2005. Available online: http://courses.umass.edu/plnt597s/KarlsArticle.pdf (accessed on 25 November 2015).
27. Eisenhardt, K.M. Building theories from case study research. *Acad. Manag. Rev.* **1989**, *14*, 532–550. [CrossRef]
28. Yin, R.K. *Case Study Research: Design and Methods*, 5th ed.; Sage Publications, Inc.: Thousand Oaks, CA, USA, 2014.
29. Blaikie, P. *At Risk: Natural Hazard, People's Vulnerability and Disasters*; Routledge: London, UK, 2003.
30. Seeds Technical Services Pvt Ltd. *Evolving Strategy for Capacity Building of Masons, Carpenters and Wire Benders at Panchayat Level for Safe Construction*; HP State Disaster Management Authority: Shimla, India, 2012.
31. Anand, M.; Niazi, Z. *Understanding Rural Habitat—Lessons in Sustainability*; Rural Housing Knowledge Network: New Delhi, India, 2013.
32. Skat Consulting. *Sustainable Reconstruction Initiative in Tsunami-Affected Villages of Karaikal Pondicherry, India*; Skat Consulting: St. Gallen, Switzerland, 2008.
33. Niazi, Z.; Roy, A. *Sustsinable Recconstruction Inidtaive in Karaikal*; Development Alternatives: New Delhi, India, 2008.
34. Ashraya Building Materials and Services Bank. *Annual Report*; Ashraya: Chowdwar, Odisha, India, 2014.
35. Kelman, I. *Disaster by Choice: How Our Actions Turn Natural Hazards into Catastrophes*; Oxford University Press: Oxford, UK, 2020.
36. Anthony Oliver-Smith, A. Disaster Risk Reduction and Applied Anthropology. *Ann. Anthropol. Pract.* **2016**, *40*, 73–85. [CrossRef]
37. Bernstein, P.L. *Against the Gods*; John Wiley & Sons: New York, NY, USA, 1996.
38. Sterman, J.D. System Dynamics Modelling: Tools for Learning in a Complex World. *Calif. Manag. Rev.* **2001**, *43*, 8–25. [CrossRef]
39. Williams, L. *Getting to Know the Built Environment as a Complex System*; Wellesley Institute: Toronto, ON, Canada, 2013.
40. Cao, L. *Metasynthetic Computing and Engineering of Complex Systems*; Springer: Berlin/Heidelberg, Germany, 2015; p. 162.
41. Ackoff, R. The systems revolution. *Long Range Plan.* **1974**, *7*, 6. [CrossRef]
42. Lewis, J.; Kelman, I.; Lewis, S.A. Is "Fear Itself" the only thing we have to Fear? Explorations of Psychology in Perceptions of the Vulnerability of Others. *Aust. J. Disaster Trauma Stud.* **2011**, *3*, 89–104.