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Effectiveness of Socio-Technical Assistance (STA) Program for Vulnerable Beneficiaries: Evidence from Nepal's Post-Earthquake Reconstruction

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Abstract: This research study assesses the effectiveness of the Socio-Technical Assistance (STA) program when combined with owner-driven housing reconstruction on rural private housing recovery after Nepal's 2015 earthquake, particularly regarding vulnerable households. Through a quantitative, 304-question survey, the study reveals that 96% of households credited STA activities for accelerating reconstruction, with 95% acknowledging its significance and 78% emphasizing its necessity. Notably, 89% expressed dependency on STA for reconstruction, and 85% believed it heightened disaster risk reduction awareness. In conclusion, the study establishes that STA activities significantly contributed to the successful reconstruction of houses for vulnerable households, addressing such critical aspects as financial support, technical assistance, housing accessibility, earthquake-resilient construction, improved livelihoods, and safety enhancements. The field study presents crucial recommendations for enhancing the effectiveness of Socio-Technical Assistance (STA) activities in post-earthquake, rural private housing reconstruction. Emphasizing the need for tailored, demand-driven interventions, the study cautions against relying solely on an owner-driven reconstruction model, challenging the one-size-fits-all strategy. The study proposes integrating tailored interventions into overarching recovery strategies, advocating for coordinated efforts to enhance disaster risk reduction (DRR) awareness and to cultivate resilient communities in particularly vulnerable households as aligned with United Nations Sustainable Development Goal 11, which focuses on sustainable cities and communities. This research aims to enhance the literature on post-disaster humanitarian shelter and settlement by emphasizing the significance of inclusive and comprehensive approaches to recovery and reconstruction.

Keywords: effectiveness; Gorkha earthquake 2015; owner-driven reconstruction; private housing reconstruction; vulnerable earthquake beneficiaries; socio-technical assistance

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1. Introduction

Disasters disproportionately affect developing countries, with poor and marginalized people bearing the brunt of the effects [1]. The capacity of individuals to cope or recover following a disaster is contingent upon an intricate interplay of factors, including abilities, class, gender, social networks, income, land and other assets, information access, legal entitlements, government policies, and mechanisms, among other considerations. Disparities in physical and financial capabilities, along with uneven access to resources, can render specific groups more susceptible than others, potentially intensifying social divisions and conflicts [2–4]. Disasters exacerbate coping and recovery capacities, leading to heightened vulnerabilities [4–6]. To assist vulnerable beneficiaries overlooked in the post-earthquake period, governmental and non-governmental organisations introduced the Socio-Technical Assistance (STA) program in conjunction with owner-driven reconstruction (ODR) in Nepal.

Nepal is ranked as the 20th most disaster-prone country globally, and holds the 4th, 11th, and 20th positions in various climate change vulnerability categories [7,8]. The 7.8 magnitude earthquake of 25 April 2015 led to more than 8790 fatalities and over 22,300 injuries, and incurred approximately USD 7 billion in damages, with housing (755,000 houses destroyed or damaged) contributing to nearly half of the total damages [9]. Nepal's post-earthquake reconstruction is considered the world's largest owner-driven housing reconstruction (ODR) effort, with over 753,104 beneficiaries (93%) rebuilding their houses [10]. In response, the Government of Nepal (GoN) embraced the owner-driven reconstruction (ODR) approach in accordance with the 'Build Back Better' approach outlined in the Sendai Framework [11]; based on its successful international implementation, it is considered a 'global default reconstruction strategy' in low-income countries [12,13]. ODR emphasizes a process-driven housing reconstruction, fostering beneficiary involvement, promoting self-reliance and livelihood exploration, and improving quality of life, resilience, and connectivity. In contrast, a product-driven approach focusing solely on housing delivery results in a passive dependency [14]. There is a growing need for empirical evidence on the subject, as shelter and settlement interventions remain an inadequately explored facet of the humanitarian response [15–17], and a need to explore its impacts [18].

Against this backdrop, the paper examines the effectiveness of the Socio-Technical Assistance (STA) program when combined with owner-driven reconstruction, especially for vulnerable households, also referred to in this paper as 'beneficiaries', who were left behind in the large-scale private housing reconstruction. The study highlights the positive impact of well-implemented STA activities on the providing of crucial relief to vulnerable earthquake beneficiaries and on the leading of their recovery efforts in rural housing reconstruction. It stresses the necessity of socio-technical facilitation mechanisms at different levels. Conducting an analysis of recovery programs some years after they have occurred is valuable because most assessments are short-term, but the effects of recovery, both good and bad, can last for years. The analysis of the effectiveness of ODR in this paper can prove valuable in the processes of the design and the implementation of such post-disaster programs in coming years.

2. Literature Review and Research Gaps

Numerous studies focus on the successful international implementation of guidelines and models for the owner-driven reconstruction (ODR) approach [14,19–24], as well as on its framework [19,25–31], its resulting satisfaction [32], its evaluation [12], on comparative studies of donor vs owner-driven reconstruction approaches [13,33], and on its limitations [34]; there is a notable dearth of research specifically assessing the effectiveness of STA interventions on vulnerable beneficiaries. Existing studies primarily explore specific programs, and few address the effectiveness of STA targeting vulnerable beneficiaries eight years after the earthquake. In our earlier study, we observed the heterogeneity of households with respect to several background factors, including gender, age, education, religion, ethnicity, and vulnerability; whether satisfaction rates differed across these factors was tested in our previous study [32].

Previous research highlights challenges in Nepal's reconstruction, such as not being able to build houses even after receiving grants due to the government's inefficiency in delivering funding and services to affected beneficiaries, the lack of coordination among NGOs [35], geographical challenges [36,37], vulnerability and social inequality [38–40], the issue of INGO's top-down policy implementation [41], and corruption [42]. Despite implementing the ODR model, vulnerable beneficiaries were proven in this study to be '*left behind*' by the large-scale private housing reconstruction.

Limited studies have assessed the effectiveness of STA interventions on project-specific program interventions in Nepal's post-earthquake context, evaluating specific projects outcomes [20,43–48], the inclusion of the poor and vulnerable [40], approaches to build back better [49–51], community mobilization programs [49], Socio-Technical Assistance [52], and Socio-Technical Facilitation [53,54]. Therefore, there is a need for an independent research

study to assess the effectiveness of targeting vulnerable beneficiaries even eight years after the earthquake.

The lessons from the 2004 South Asian tsunami underscore the importance of aligning aid with actual needs and ensuring long-term sustainability [55]. However, research is scarce on the perspectives of 'bottom-up' or aid recipients, hindering a comprehensive understanding and enhancement of aid quality [56,57]. Marginalized individuals often struggle to advocate for themselves, posing challenges for humanitarian organizations in addressing their needs effectively [55] and ensuring aid reaches the intended target group. Consequently, there is a need for renewed guidelines and criteria, particularly for the most vulnerable [58].

An in-depth examination of specific cases is essential to illustrate how interventions provide distinct evidence for assessing the prompt delivery of aid and its effectiveness in bringing about intended improvements in recipients' lives [59]. Moreover, it is crucial to generate reliable evidence to assess the prompt delivery of aid, its effectiveness in bringing about intended improvements in recipient's lives [60,61], and its alignment with the humanitarian assistance context.

3. Critical Evaluation of Owner-Driven Reconstruction (ODR)

Table 1 presents an overview on the magnitudes of six major earthquakes and the size of post-earthquake ODR budgets for implementing post-disaster reconstructions in India (Gujarat, Tamil Nadu, and Bihar), Sri Lanka, Indonesia, Pakistan and Haiti.

Table 1. Summary of six major earthquakes with ODR programs.

1. Gujarat Earthquake 2001 (6.1 magnitude):			
Number of Deaths	**No. of Destroyed houses**	**Housing Grants**	**Rebuild Progress**
20,000	880,000	INR 40,000–90,000 (USD 570 to 1300) in 2 tranches	2 years completed
2. Sri Lanka Tsunami 2004 (9.1 magnitude):			
Number of Deaths	**No. of Destroyed houses**	**Housing Grants**	**Rebuild Progress**
35,000	100,000–120,858	Sri Lankan Rupees 250,000 (USD 21000) in 4 tranches	3 years completed (77%)
3. Indonesia's Earthquake of 2004 (8.9 magnitude):			
Number of Deaths	**No. of Destroyed houses**	**Housing Grants**	**Rebuild Progress**
220,000	139,000	US$ 3000 (Full reconstruction) US$ 1000 (renovation of damaged house)	8 years
4. Pakistan Earthquake 2005 (7.6 magnitude):			
Number of Deaths	**No. of Destroyed houses**	**Housing Grants**	**Rebuild Progress**
73,000	463,000	Pakistani Rupees 175,000 (USD 2916) in 3 tranches	3.5 years (74.4%)
5. Bihar Flooding 2008:			
Number of Deaths	**No. of Destroyed houses**	**Housing Grants**	**Rebuild Progress**
239	340,742	Indian Rupees 55,000 (USD 1200), Plus Rs 2300 (USD 50) & Rs 5000 (USD 100) in 3 tranches for solar	Slow 7 years (48%)
6. Haiti Earthquake of 2010: (7.0 magnitude)			
Number of Deaths	**No. of Destroyed houses**	**Housing Grants**	**Rebuild Progress**
316,000	300,000	US$ 500 Yearly Rental Cost transferred to landlord. US$ 2000–2800 for Transitional Shelter US$ 3500–4500 for permanent house × varied per agencies support	10 years plus ongoing

Notes: Details of strengths and weakness of each of these are in Table A4 in Appendix A. It presents an overview of the merits and drawbacks of the ODR model, recognised as a 'default strategy' in low-income countries and implemented in various post-disaster contexts as described above.

Further analysis of Table A4 sheds light on the limitations of the ODR model. While ODR evaluations often report positive outcomes, experiences of recoveries from disas-

ters like the Gujarat earthquake, Tamil Nadu, and Haiti's highlight the limited universal effectiveness of informally applied ODR [19,25]. Adapting program approaches to be 'demand-driven', while considering regional variations, is crucial, recognising that ODR cannot provide a 'one-size-fits-all' solution for post-disaster housing challenges. Concerns arise about the evolving nature of ODR—aiming to 'build back better' with high building standards and social-technical community support—potentially proving insufficient in extensive reconstruction projects [62].

Existing research underscores the benefits of the ODR model based on labour availability and straightforward housing designs [63]. Challenges extend beyond housing investment, encompassing housing governance and the procurement process [64]. However, this study indicates that vulnerable beneficiaries need assistance in leading the reconstruction process independently. Furthermore, the analysis of other information in A1 reveals limitations to the ODR approach, with scant evidence from a vulnerable household perspective. Studies emphasize unsuccessful reconstruction, citing ***insufficient social mobilization*** [65] and lack of evidence for support and program effectiveness from the 'user-end'. These studies underscore the necessity for a distinct, targeted approach for the most vulnerable, drawing lessons from Nepal's ODR-STA intervention [40,44–46,48,49,52,66–68].

4. Conceptual Framework of This Study

This study aims to assess the effectiveness of the 'demand-driven' STA program in rural private housing reconstruction settings through a quantitative survey of 304 vulnerable beneficiaries. The conceptual framework given below illustrates the causal relations between independent variables (STA Activities: seven activities) and dependent variables in program outcomes, focusing on the user-end perspectives of vulnerable beneficiaries.

Dependent Variables

The study examined the outcomes of Social Technical Assistance (STA) interventions on supporting vulnerable beneficiaries in private housing reconstruction, as depicted in the above conceptual framework (Figures 1 and 2 and Table 2). Participants were surveyed on various aspects, including their ability to construct houses with or without STA support, the satisfaction of needs in newly reconstructed houses, the effectiveness of financial and technical assistance, access to financial grants from banks and financial institutions (BFIs), the acceleration of reconstruction facilitated by STA, awareness of disaster risk reduction (DRR), and the perceived need for STA among vulnerable categories. The study analysed the findings of both constructs—STA activities (Independent Variable) and outcomes as (Dependent Variable)—in measuring the effectiveness of STA activities.

Table 2. Socio-Technical Assistance (Independent Variables).

	Socio-Technical Assistance (Seven Activities)
I	**Door-to-door technical assistance:** Field mobile teams, including social mobilizers and mobile masons, provided on-site support, assisting vulnerable beneficiaries in accessing financial and technical aid, documentation, and overall reconstruction guidelines.
II	**Demo-Reconstruction:** Practical initiative clarifying construction information, customizing for local practices, and complementing existing materials.
III	**Helpdesk & Technical Resource Centre:** Provides reconstruction support and advice and facilitates access to information/resources through social mobilization staff.
IV	**Community Reconstruction Committees:** Enhance community participation, ownership, and coordination in the reconstruction process.
V	**Short Training for Masons:** a 7-day program to enhance mason skills, prioritizing earthquake-affected individuals, women, and the untrained.
VI	**VI. On-the-Job Training for Masons:** a 50-day program to expand the skilled labour force with expertise in earthquake-resistant structures.
VII	**Community/Household Orientation:** Enhance communication, create awareness of policies and standards, and coordinate with community committees and officials through the helpdesk/technical resource centre.

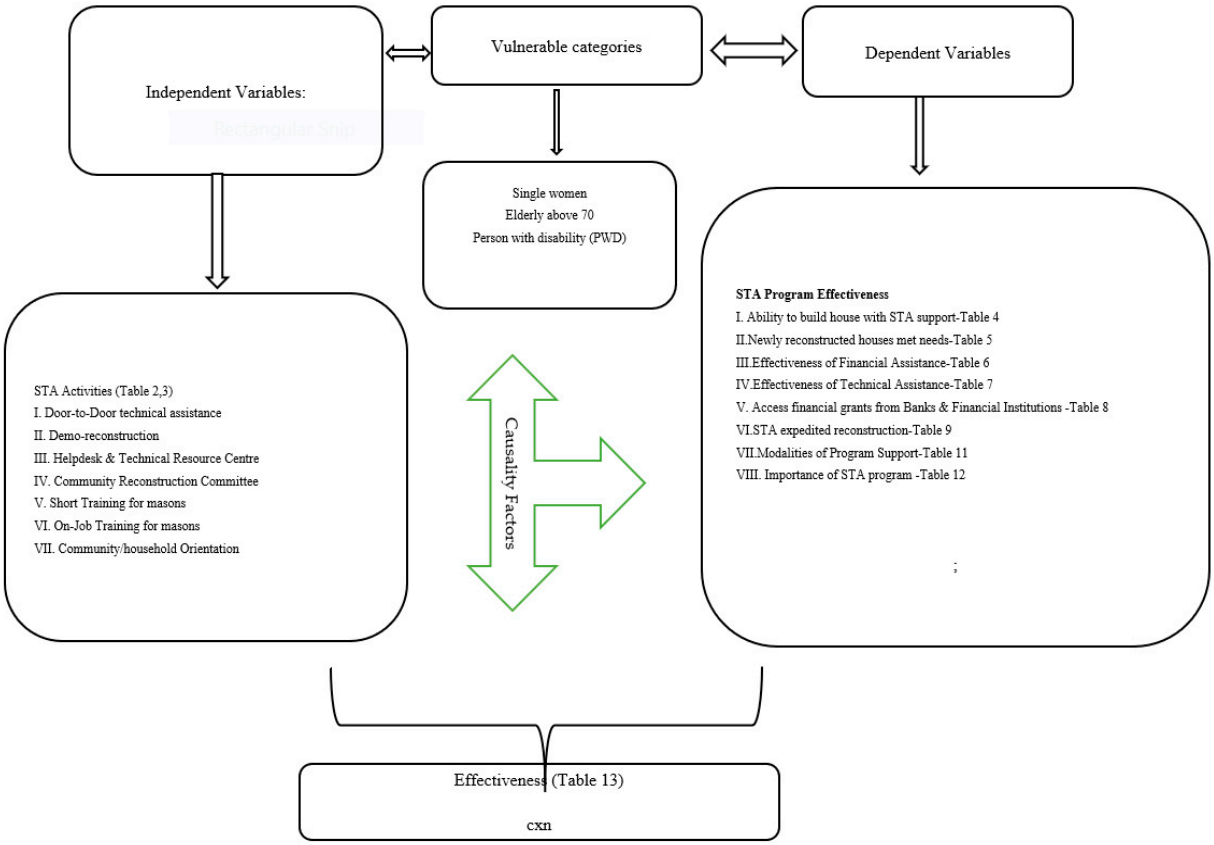

Figure 1. Conceptual framework of this study.

Figure 2. Core Socio-Technical Package; Source: [69].

The study challenges the assumption that owner-driven reconstruction (ODR) or 'self-recovery' is universally applicable, particularly in vulnerable contexts, as suggested in the previous literature [12,13,25,27,33,61,62,70,71].

There is a significant gap between project implementation and completion, often due to terminated projects or achievement-focused outcomes, which neglect future program dynamics and sustainability. Assistance for disaster-affected individuals often needs more timelines, adequacy, fairness, and predictability. The above conceptual framework, summarized in Figure 2, delineates the logical sequence of the seven Independent Variable STA activities that culminate in the Dependent Variable for desired effectiveness in the lives of vulnerable beneficiaries. The detailed operational definition of these measurement variables is as illustrated in Figure 2.

5. Description of the Study Area and Methodology

5.1. Nepal's Post-Earthquake Owner-Driven Housing Reconstruction

The recovery concept involves rebuilding, restoring, rehabilitating, and redeveloping, centred on "putting the community back together again" [72]. The ODR approach prioritizes recipient "choice" and diverse household coping strategies for alleviating disaster impacts. Involvement in the design and building process significantly impacts the psychological recovery of households, empowering them and providing control over uncontrollable circumstances [63]. ODR was initially adopted as a 'default strategy for post-disaster housing reconstruction after the 2001 Gujarat earthquake (2001), the South Asian tsunami (2004), and the Kashmir earthquake (2005) [40,73–75].

Nepal's post-earthquake housing reconstruction is considered one of the largest owner-driven housing reconstruction programs globally, reconstructing more than 700,000 houses through a dedicated new entity known as the 'National Reconstruction Authority'. The GoN provided uniform cash grants of NPR 300,000 (about USD 3000) to affected beneficiaries, disbursed in tranches tied to construction compliance. Partially damaged homes received NPR 100,000 (about USD 1000) in two tranches, with an additional NPR 50,000 (about USD 500) top-up for vulnerable beneficiaries [69].

5.2. Socio-Technical Assistance Component

Despite the success of Owner-Driven Reconstruction (ODR) in constructing nearly 741,031 [76] houses in Nepal, post-earthquake challenges persist for vulnerable populations. To address inclusivity, a Socio-Technical Assistance (STA) module was introduced in a collaboration between the government and partner agencies to ensure that '*No one is left behind*'. Recognizing the distinct needs of vulnerable beneficiaries, the implementation of the STA module was deemed necessary [69,77]. The GoN identified 18,505 beneficiaries (2.4%) as vulnerable from the 782,695 beneficiaries of the top-up housing assistance program [40]. The STA program entails seven core activities (refer to Figure 2), outlined by the NRA and HRRP, and complements financial and technical assistance by guiding beneficiaries to meet reconstruction standards within a specified timeframe [69,78]. It aims for transformative change, requiring behavioural shifts and empowering communities through capacity-building training and income-generating activities.

The ODR model proved ineffective for vulnerable beneficiaries, which led to the recognition of the STA modality in the post-disaster needs assessment, aligned also with the "Leave No One Behind" approach [79,80]. Non-governmental agencies, avoiding a blanket approach, implemented the STA module, prompting the NRA to reintroduce the STA model due to its proven effectiveness in expediting reconstruction for the most vulnerable beneficiaries [44,49,53,66,81].

The key criteria for Socio-Technical Assistance are for it to accomplish the following:

- Engage all families and communities in timely and relevant guidance for safer and sustainable house construction, providing support throughout the inspection process.
- Enhance the availability and proficiency of skilled construction workers to facilitate reconstruction.
- Foster community resilience and long-term benefits.

5.3. Research Motivation, Geographical Locations, and Participants

First-hand experience of the first author as a survivor of the 2015 Nepal Earthquake inspired a research focus on assessing the perspectives of 'end-users' regarding the effectiveness of post-disaster reconstruction activities, specifically of the STA program combined with ODR. This study is part of a broader initiative examining post-disaster recovery among government-identified vulnerable beneficiaries, extending even into the eighth year after the earthquake in the context of rural private housing reconstruction.

5.4. Data Collection Methods

The research employed a quantitative approach, using a questionnaire survey gathered through a pen-and-paper survey administered to 304 vulnerable beneficiaries, later manually entered into JISC-V2 online software to ensure data quality. The field data collection occurred between May and July of 2022 in Gorkha districts, covering three municipalities (Palungtar, Gorkha, and Sulikot/Barpak). Cluster random sampling was used to select respondents. The questionnaire, designed by the author and translated into Nepali, ensured clarity and respondent anonymity via pseudonyms. Ethical approval and clearance were obtained from the relevant authorities to conduct the study.

5.5. Sampling Size Calculation and Data Analysis

The survey targeted vulnerable beneficiaries identified by the Government of Nepal's National Reconstruction Authority (NRA), with a total of 18,505 individuals identified in 32 earthquake-affected regions as vulnerable under criteria which included senior citizens above 70 years of age, single women above 65 years of age and people with disabilities (red or blue cardholders), excluding minors under 16 years old due to ethical issues. The Gorkha district was the centre of the earthquake and classed as a 'highly affected' region; the total identified as a vulnerable population was (N) = 1431, with a 95% confidence level (Z value), 5% margin of error (e value), and 50% prevalence (p-value). From the calculation, the sample size becomes 304 for the questionnaire survey. Quantitative data analysis, including descriptive and Chi-square tests, were conducted using the statistical software SPSS-27.

5.6. Research Questions and Hypotheses

This research aims to assess the effectiveness of socio-technical assistance on vulnerable earthquake beneficiaries in Nepal, focusing on its effectiveness in private housing reconstruction, particularly on those involved in private housing reconstruction. We quantitatively tested the following research hypothesis by using our database constructed from the primary survey:

- To what extent is the Socio-Technical Assistance program effective for earthquake-affected beneficiaries?

H1. *There is no significant association between vulnerable categories and the likelihood of building a house with STA support.*

H2. *There is no significant association between vulnerable categories and the level of agreement on whether newly reconstructed houses met their needs in the STA program.*

H3. *There is no significant association between vulnerable categories and the perceived effectiveness of financial grants in the STA program.*

H4. *There is no significant association between vulnerable categories and the perceived effectiveness of technical assistance in the STA program.*

H5. *There is no significant association between vulnerable categories and the level of agreement on STA support in receiving tranches from banks and financial institutions (BFIs).*

H6. *There is no significant association between vulnerable categories and the level of agreement on STA activities expediting reconstruction.*

H7. *There is no significant association between vulnerable categories and the perceived importance of the STA program activities.*

H8. *There is no significant association between vulnerable categories and the perceived DRR (disaster risk reduction) awareness of the STA Program.*

6. Results and Discussion

The primary results are showcased in Tables 3–12, providing insights into the effective assessment of ODR-STA program interventions among vulnerable earthquake beneficiaries in the study area.

I. Socio-Technical Assistance Activities

The study assessed the participation and effectiveness of the seven STA Activities, aligning with the overarching goal of ensuring that vulnerable beneficiaries reconstruct their homes and communities within specified standards and timeframes. Table 3 summarizes the engagement in STA activities among vulnerable beneficiaries, with the overall participation percentages as follows: (i) Community/Household Orientation: 66.45%, (ii) Door-to-door technical assistance: 39.80%, (iii) Short Training for masons: 60.86%, (iv) Helpdesk & communication centre: 29.28%, (v) Demo-construction: 34.21%, (vi) Reconstruction committee support: 9.87%, (vii) On-job training for masons: 3.29%.

Table 3. Socio-Technical Assistance Seven Activities (STA).

STA Activities			Vulnerable Categories			Total
			Single Women above 65 Years	Elderly above 70 Years	Persons with Disabilities (PWD)	
	Community/household Orientation	Count	62	124	16	202
		%	68.1%	63.9%	84.2%	66.45%
	Door-to-door technical assistance	Count	36	80	5	121
		%	39.6%	41.2%	26.3%	39.80%
	Short Training for masons	Count	51	122	12	185
		%	56.0%	62.9%	63.2%	60.86%
	Helpdesk & communication center	Count	25	59	5	89
		%	27.5%	30.4%	26.3%	29.28%
	Demo-Construction	Count	31	66	7	104
		%	34.1%	34.0%	36.8%	34.21%
	Reconstruction committee support	Count	7	22	1	30
		%	7.7%	11.3%	5.3%	9.87%
	On-job training for masons	Count	4	6	0	10
		%	4.4%	3.1%	0.0%	3.29%
Total		Count	91	194	19	304
Percentages and totals are based on respondents.						

Notes: Single women above 65, elderly people above 70, and people with disabilities were identified as vulnerable categories and their views were assessed in determining effectiveness of the seven STA Activities in the 2022 Field Survey.

Surveyed participants identified the most effective STA activities based on their engagement in supporting their reconstruction efforts as follows: (i) Orientation: 84.2% of PWD, (ii) Door-to-door technical support: 41.2% of elderly above 70, (iii) Short training: 63.2% of PWD, (iv) Helpdesk information centre: 30.4% of elderly above 70, (v) Demo reconstruction: 36.8% of PWD, (vi) Reconstruction committee support: 11.3% of elderly above 70 and (vii) Vocational training: 4.4% of single women; many responded regarding expediting the reconstruction through complementing the ODR housing reconstruction model with tailored STA activities.

II. Ability to Build a House with STA Program Intervention

This outcome demonstrates the impact of STA program activities on the capacity of vulnerable beneficiaries to construct houses. Table 4 presents responses from these beneficiaries, probing whether they could have independently built their houses without STA support. *Nearly 89% of surveyed participants indicated they would have needed help to construct a house independently*.

Table 4. Could you have built your house without STA Support?

			Vulnerable Categories			Total
			Single Women above 65 Years	**Elderly above 70 Years**	**Person with Disability (PWD)**	
Could you have built your house without STA support?	No, I could not	Count	83	169	18	270
		%	91.2%	87.1%	94.7%	88.8%
	Yes, I could	Count	8	25	1	34
		%	8.8%	12.9%	5.3%	11.2%
Total		Count	91	194	19	304
		%	100.0%	100.0%	100.0%	100.0%
Chi-Square Tests						
		Value		df	Asymp. Sig. (2-sided)	
Pearson Chi-Square		1.761 [a]		2	0.415	

Notes: Participants stated that they would not have been able to build on their own without STA support in the 2022 Field Survey. [a]. Dichotomy group tabulated at value 1.

Additionally, 91.2% of single women above 65 years of age, 87.1% of elderly citizens above 70 years of age, and 94.7% of persons with disabilities (PWD) stated that they would not have been able to build on their own without STA support. The lack of a significant difference among the three vulnerable categories is indicated by a *p*-value of 0.415 (Accepted H1), suggesting a similar situation for all vulnerable groups.

III. Newly Reconstructed House Met Needs

The results in Table 5 show that surveyed respondents responded to the statement "***Newly reconstructed house met needs***" as follows; on average, 22.2% strongly agree, 58.6% agree, 3.3% neither agree nor disagree, 10.9% disagree, and 5.0% strongly disagree, with an average mean of 2.18, which is close to the 'Agree' response overall.

Table 5 indicates an overall positive response of 81%, with 22% strongly agreeing and 59% agreeing that the newly reconstructed houses met their needs. There is no significant association among all vulnerable categories regarding the "New Reconstruction House met needs" program support, as the *p*-value is 0.652 (Accepted H2), suggesting unanimous agreement across all beneficiary groups.

Table 5. Newly reconstructed house met needs.

			Vulnerable Categories			Total
			Single Women above 65 Years	Senior Citizen above 70 Years	PWD	
New reconstruction house met needs	Strongly Agree	Count	18	46	3	67
		%	19.8%	24.0%	15.8%	22.2%
	Agree	Count	59	107	11	177
		%	64.8%	55.7%	57.9%	58.6%
	Neither agree or disagree	Count	4	5	1	10
		%	4.4%	2.6%	5.3%	3.3%
	Disagree	Count	8	23	2	33
		%	8.8%	12.0%	10.5%	10.9%
	Strongly Disagree	Count	2	11	2	15
		%	2.2%	5.7%	10.5%	5.0%
Total		Count	91	192	19	302
		%	100.0%	100.0%	100.0%	100.0%
Average Mean			**2.18**			
Chi-Square Tests						
		Value	Df	Asymp. Sig. (2-sided)		
Pearson Chi-Square		5.956 [a]	8	0.652		

Notes: Participants stated that the newly reconstructed houses met their needs in the 2022 Field Survey. [a]. Dichotomy group tabulated at value 1.

IV. Effectiveness of Financial Grant

The below depicts the effectiveness of financial grants by the respondents, which was measured through the Likert scale (Highly effective = 3, Effective = 2, Less effective = 1, Not effective = 0). The average mean is 2.84 with a minimum of 1 and a maximum of 3, close to the 'highly effective' response. So, it is found that STA's role in supporting the obtaining of financial grants is highly effective for vulnerable beneficiaries.

The results in Table 6 show that 84% of beneficiaries highly rated the government's financial grant program, with 15.1% considering it effective and none perceiving it as ineffective. Only 0.7% found it less effective. The findings indicate a unanimous positive impact of financial grants, with no significant difference among vulnerable categories, as indicated by a *p*-value of 0.874 (Accepting H3).

V. Effectiveness of Technical Assistance

For surveyed respondents, the effectiveness of technical assistance is illustrated below, measured on a Likert scale (Highly effective = 3, Effective = 2, Less effective = 1, Not effective = 0). The average mean is 2.32, with a minimum mean of 1 and a maximum of 3, indicating close effectiveness. Therefore, it is concluded that STA effectively supports vulnerable beneficiaries in obtaining technical assistance.

The results in Table 7 reveal that a minimal 2.3% of beneficiaries perceived technical assistance as less effective, while the vast majority (98%) found it effective. The findings affirm the equal distribution of the STA program among all vulnerable categories, including women, seniors, and persons with disabilities, with a *p*-value of 0.731 (Accepting H4), indicating unbiased support based on the humanitarian aid principle.

Table 6. Effectiveness of financial grants.

Effectiveness of Financial Grant			Vulnerable Categories			Total
			Single Women above 65 Years	Senior Citizen above 70 Years	PWD	
Financial Grant	Less effective	Count	1	1	0	2
		%	1.1%	0.5%	0.0%	0.7%
	Effective	Count	12	30	4	46
		%	13.2%	15.5%	21.1%	15.1%
	Highly effective	Count	78	163	15	256
		%	85.7%	84.0%	78.9%	84.2%
Total		Count	91	194	19	304
		%	100.0%	100.0%	100.0%	100.0%
Average Mean			**2.84**			
Chi-Square Tests						
		Value	df	Asymp. Sig. (2-sided)		
Pearson Chi-Square		1.223 [a]	4	0.874		

Notes: Participants highly rated the government's financial grant program in the 2022 Field Survey. [a]. Dichotomy group tabulated at value 1.

Table 7. Effectiveness of technical assistance.

Effectiveness of Technical Assistance			Vulnerable Categories			Total
			Single Women above 65 Years	Senior Citizen above 70 Years	PWD	
Technical Assistance	Less effective	Count	1	5	1	7
		%	1.1%	2.6%	5.3%	2.3%
	Effective	Count	61	119	11	191
		%	67.0%	61.7%	57.9%	63.0%
	Highly effective	Count	29	69	7	105
		%	31.9%	35.8%	36.8%	34.7%
Total		Count	91	193	19	303
		%	100.0%	100.0%	100.0%	100.0%
Average Mean			**2.32**			
Chi-Square Tests						
		Value	Df	Asymp. Sig. (2-sided)		
Pearson Chi-Square		2.026 [a]	4	0.731		

Notes: The vast majority found technical assistance very effective in the 2022 Field Survey. [a]. Dichotomy group tabulated at value 1.

VI. STA Support in Accessing Financial Grants from Banks and Financial Institutions (BFIs)

Table 8 presents survey results evaluating the contribution of STA activities to accessing financial grants from banks and financial Institutions (BFIs). Overall, the responses based on the Likert scale (Strongly Agree = 1, Agree = 2, Neither Agree nor Disagree = 3, Disagree = 4, Strongly Disagree = 5) show that 33.3% strongly agreed, 45.9%, agreed, 3.6% neither agreed nor disagreed, 13.2% disagreed, and 4% strongly disagreed, with an average mean of 2.09, which is close to the 'Agree' response overall.

Table 8. STA support in receiving tranches from Banks & Financial Institutions (BFIs).

			Vulnerable Categories			Total
			Single Women above 65 Years	Senior Citizen above 70 Years	PWD	
STA support in receiving trances form BFIs.	Strongly Agree	Count	33	61	7	101
		%	36.7%	31.4%	36.8%	33.3%
	Agree	Count	39	92	8	139
		%	43.3%	47.4%	42.1%	45.9%
	Neither agree or disagree	Count	6	4	1	11
		%	6.7%	2.1%	5.3%	3.6%
	Disagree	Count	8	29	3	40
		%	8.9%	14.9%	15.8%	13.2%
	Strongly Disagree	Count	4	8	0	12
		%	4.4%	4.1%	0.0%	4.0%
Total		Count	90	194	19	303
		%	100.0%	100.0%	100.0%	100.0%
Average mean			**2.09**			
Chi-Square Test						
		Value	Df	Asymp. Sig. (2-sided)		
Pearson Chi-Square		7.236 [a]	8	0.511		

Notes: Participants were equally happy in receiving grants from banks and financial institutions (BFIs) in the 2022 Field Survey. [a]. Dichotomy group tabulated at value 1.

There is no significant correlation among vulnerable categories regarding program support for receiving tranches from BFIs, with a p value of 0.511, surpassing the 0.05 significance level. The result accepted H5; overall, 79.2% of all vulnerable categories responded positively, with 33.3% strongly agreeing and 45.9% agreeing.

VII. STA Activities Expedited Reconstruction

The following results illustrate the surveyed respondents' views on how STA activities facilitated reconstruction, assessed on a Likert scale (Strongly Agree = 1, Agree = 2, Neither Agree nor Disagree = 3, Disagree = 4, Strongly Disagree = 5). The overall average responses showed that 25.8 strongly agreed, 70.5% agreed, 2.3% disagreed, and 1.3% strongly disagreed, with an average mean of 1.83, close to the 'Agree' response overall.

There is no significant difference among vulnerable categories regarding STA intervention support for house reconstruction, with an overall positive response of 96.3%. The Chi-square test accepted H6, suggesting that the program benefited all vulnerable beneficiaries equally. The p value (0.228) exceeded the 0.05 significance level.

VIII. Modalities of STA Program Support Reception

Results from Table 10 show that 77.6% of respondents—especially single women above 65 years of age (78.0%) and elderly above 70 years of age (77.3%)—self-approached for STA program activities. Organizations approached a smaller percentage of participants (9.8%), 29.28% were recommended or referred, and 65.79% received support through the local community. Moreover, 4.93% were assisted by social mobilizers.

Table 9. STA expedited reconstruction.

			Vulnerable Categories			Total
			Single Women above 65 Years	Senior Citizen above 70 Years	PWD	
STA Activities Expedited Reconstruction	Strongly Agree	Count	18	53	7	78
		%	20.0%	27.5%	36.8%	25.8%
	Agree	Count	70	133	10	213
		%	77.8%	68.9%	52.6%	70.5%
	Disagree	Count	2	4	1	7
		%	2.2%	2.1%	5.3%	2.3%
	Strongly Disagree	Count	0	3	1	4
		%	0.0%	1.6%	5.3%	1.3%
Total		Count	90	193	19	302
		%	100.0%	100.0%	100.0%	100.0%
Average mean			**1.83**			

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.139 [a]	6	0.228

Notes: The reconstruction program benefited all vulnerable participants equally in the 2022 Field Survey. [a]. Dichotomy group tabulated at value 1.

Table 10. Modalities of STA program support reception.

How Did You Receive the Program Support?			Vulnerable Categories			Total
			Single Women above 65 Years	Senior Citizen above 70 Years	PWD	
Total	Self-approached for the need of the program activities	Count	71	150	15	236
		%	78.0%	77.3%	78.9%	77.6%
	Approached by organization	Count	6	13	1	20
		%	6.6%	6.7%	5.3%	9.80%
	Recommended or referred	Count	21	61	7	89
		%	23.1%	31.4%	36.8%	29.28%
	Local community	Count	61	124	15	200
		%	67.0%	63.9%	78.9%	65.79%
	Social mobilizer	Count	5	9	1	15
		%	5.5%	4.6%	5.3%	4.93%
Total		Count	91	194	19	304
Percentages and totals are based on respondents.						

Notes: Varied pathways existed for receiving program support, with a notable trend of self-initiation by vulnerable participants in the 2022 Field Survey.

Results from Table 10 show that approximately 78% of single women and around 77–79% of vulnerable individuals needed urgent support from the STA program intervention, leading them to self-approach in order to expedite reconstruction efforts. The findings suggest varied pathways for receiving program support, with a notable trend of self-initiation by vulnerable beneficiaries.

IX. Importance of STA Program Activities

Table 11 gauges the perceived importance of the STA program activities among different vulnerable categories measured on the Likert scale (Strongly Agree 1, Agree = 2, Neither Agree Nor Disagree = 3, Disagree = 4, Strongly Disagree = 5). Many respondents across all vulnerable categories agreed that the STA support program was crucial for their reconstruction efforts.

Table 11. Importance of STA program activities.

			Vulnerable Categories			Total
			Single Women above 65 Years	Senior Citizen above 70 Years	PWD	
STA support program was very important for me	Strongly Agree	Count	31	60	4	95
		%	34.1%	30.9%	21.1%	31.2%
	Agree	Count	55	126	14	195
		%	60.4%	64.9%	73.7%	64.1%
	Disagree	Count	1	7	1	9
		%	1.1%	3.6%	5.3%	3.0%
	Strongly Disagree	Count	4	1	0	5
		%	4.4%	0.5%	0.0%	1.6%
Total		Count	91	194	19	304
		%	100.0%	100.0%	100.0%	100.0%
Average Mean			**1.80**			
Chi-Square Tests						
		Value	df	Asymp. Sig. (2-sided)		
Pearson Chi-Square		9.037 [a]	6	0.171		

Notes: Participants' scores indicate equal importance of this program across all vulnerable groups in the 2022 Field Survey. [a]. Dichotomy group tabulated at value 1.

The results reveal no significant difference in the perceived importance of the STA program among various vulnerable categories for house building. With a *p*-value of 0.171, surpassing the 0.05 significance level, the collective response of 95, with 31.2% strongly agreeing and 64.1% agreeing, suggests an overall positive sentiment with an average mean of 1.80, close to 'Agree' overall. The chi-square test value accepted H7, indicating equal importance of this program across all groups. Persons with disabilities consistently rated the support higher than the other two categories across all table categories.

X. Disaster Risk Reduction (DRR) Awareness via STA Program

Table 12 provides insights into disaster risk reduction (DRR) awareness among vulnerable categories in the STA program, across single women above 65 years of age, senior citizens above 70 years of age, and persons with disabilities (PWD).

The results indicate no significant difference in disaster risk reduction (DRR) awareness among vulnerable categories through the STA program. A majority (87.8%) of respondents express positive DRR awareness, with 27.8% strongly agreeing and 60.0% agreeing. Dissenting opinions are minimal at 9.0%. The Chi-square test result (5.648, *p*-value = 0.687) surpassed the 0.05 significance level, suggesting a consistent DRR awareness across all vulnerable categories. Therefore, H8 is accepted, indicating a positive and uniform understanding of DRR among the target groups.

Table 12. DRR awareness via the STA program.

			Vulnerable Categories			Total
			Single Women above 65 Years	Senior Citizen above 70 Years	PWD	
DRR Awareness	Strongly Agree	Count	25	71	6	102
		%	27.8%	36.8%	31.6%	33.8%
	Agree	Count	54	94	10	158
		%	60.0%	48.7%	52.6%	52.3%
	Neither agree or disagree	Count	3	8	0	11
		%	3.3%	4.1%	0.0%	3.6%
	Disagree	Count	3	11	2	16
		%	3.3%	5.7%	10.5%	5.3%
	Strongly Disagree	Count	5	9	1	15
		%	5.6%	4.7%	5.3%	5.0%
Total		Count	90	193	19	302
		%	100.0%	100.0%	100.0%	100.0%
Average mean			**1.95**			
Chi-Square Tests						
		Value	Df	Asymp. Sig. (2-sided)		
Pearson Chi-Square		5.648 [a]	8	0.687		

Notes: Participants had positive and uniform understanding of DRR among the target groups in the 2022 Field Survey. [a]. Dichotomy group tabulated at value 1.

XI. Effectiveness of the STA Program Activities

The Table 13 presents the effectiveness of the Socio-Technical Assistance (STA) program activities, focusing on vulnerable categories such as single women above 65, senior citizens above 70, and persons with disabilities (PWD).

- Financial Support: All three vulnerable categories show high percentages (99% to 100%) in acknowledging the effectiveness of financial support in their reconstruction.
- Technical Support: Over 90% of each vulnerable category perceive technical support as effective in aiding recovery.
- Accessible House: While there is a variation across categories, ranging from 70.3% to 78.9%, a substantial majority acknowledges housing accessibility as beneficial.
- Build Earthquake Resilient (EQ) House: A high percentage (94.7% to 96%) across vulnerable categories acknowledges the effectiveness of building earthquake-resilient houses.
- Improved Livelihood: The majority in each category (79.1% to 94.7%) recognise the program's impact on enhancing their livelihoods.
- Training & Orientations: Strong positive perceptions (82.4% to 84.5%) indicate the importance of training and orientation in recovery efforts.
- Sufficient Place to Live-In: Most respondents (73.6% to 89.5%) express satisfaction with being provided sufficient living space.
- Enhanced Safety: Across all vulnerable categories, a significant proportion (84.6% to 89.5%) perceive the program as contributing to enhanced safety.

The survey reports unanimously demonstrate the remarkable success of program implementation in meeting the fundamental needs of vulnerable beneficiaries, significantly aiding their recovery efforts. The consistently high percentages across the different program components underscore the program's effectiveness in comprehensively addressing the diverse needs of the identified vulnerable categories.

Table 13. Effectiveness of the STA program activities.

How Did the STA Support Program Benefit You in Your Reconstruction and Recovery Endeavors?		Vulnerable Categories			Total
		Single Women above 65 Years	Senior Citizen above 70 Years	PWD	
Financial support	Count	91	192	19	302
	%	100.0%	99.0%	100.0%	99%
Technical support	Count	86	180	18	284
	%	94.5%	92.8%	94.7%	93%
Accessible House	Count	64	137	15	216
	%	70.3%	70.6%	78.9%	71%
Build Earthquake resilient (EQ) House	Count	87	186	18	291
	%	95.6%	95.9%	94.7%	96%
Improved livelihood	Count	72	155	18	245
	%	79.1%	79.9%	94.7%	81%
Training & Orientations	Count	75	164	16	255
	%	82.4%	84.5%	84.2%	84%
Sufficient place to live-in	Count	67	159	17	243
	%	73.6%	82.0%	89.5%	80%
Enhanced safety	Count	77	168	17	262
	%	84.6%	86.6%	89.5%	86%
Total	Count	91	194	19	304
Percentages and totals are based on respondents.					

Notes: Participants felt that financial and technical support was helpful in reconstructing their houses, that it improved their livelihood provided, brought peace of mind, and enhanced their safely in the 2022 Field Survey.

Result of Hypothesis Testing

S. N	Hypothesis	*p*-Value Chi-Square Test	Results
H1	There is no significant association between vulnerable categories and the likelihood of building a house with STA support	0.415 (Table 4)	Accepted
H2	There is no significant association between vulnerable categories and the level of agreement on whether newly reconstructed houses met their needs in the STA program.	0.652 (Table 5)	Accepted
H3	There is no significant association between vulnerable categories and the perceived effectiveness of Financial Grants in the STA program.	0.874 (Table 6)	Accepted
H4	There is no significant association between vulnerable categories and the perceived effectiveness of Technical Assistance in the STA program.	0.731 (Table 7)	Accepted
H5	There is no significant association between vulnerable categories and the level of agreement on STA support in receiving tranches from Banks and Financial Institutions (BFIs)	0.511 (Table 8)	Accepted
H6	There is no significant association between vulnerable categories and the level of agreement on STA activities expediting reconstruction.	0.228 (Table 9)	Accepted
H7	There is no significant association between the vulnerable categories and the perceived importance of the STA program activities.	0.171 (Table 11)	Accepted
H8	There is no significant association between the vulnerable categories and the perceived DRR Awareness by the STA program.	0.687 (Table 12)	Accepted

7. Discussion

The study reveals significant findings related to the effectiveness of Socio-Technical Assistance (STA) interventions in post-disaster reconstruction. The findings demonstrate a substantial income increase for builders and a noteworthy inclusion of women in the work-

force (Table 3). Orientation and training efforts accelerated reconstruction by 75% [22,47,48], with approximately 20% of the 755 recruited masons being women. This is consistent with other studies [52]. Furthermore, both governmental and non-governmental entities significantly expedited reconstruction efforts. This is similar to findings in various project-based studies [40,45,46,49,52,82].

The role of tailored STA support for vulnerable beneficiaries is crucial, as it significantly contributes to socio-economic recovery and livelihood reinstatement (Table 4), which is also revealed by other studies [14,40,45,46,49,83]. Field survey results indicate that 89% of beneficiaries could not build their houses without focused STA program intervention, with over 97.1% finding it both practical and necessary, reinforcing the effectiveness and importance of such interventions. Similar findings were reported by [44,48]. Similarly positive perceptions of reconstruction grants are highlighted, with over 90.59% of beneficiaries finding them easy and timely (Table 5). A substantial portion of beneficiaries initiated reconstruction promptly upon receiving the grant, aligning with the Forum for Women, Law and Development's (FWLD's (2017)) findings that more than 61% of beneficiaries initiated reconstruction promptly upon receiving the grant.

The importance of technical and financial assistance for knowledge transfer and skills development in post-disaster reconstruction is reported in Tables 6 and 7. A prior study by Manindra Malla [48] emphasized the importance of technical assistance to 92%, and another study by Hülssiep, et al. [84] also evidenced the need for financial and technical assistance and the need for access to finance to 94% in April 2016 and 97% in June 2016. These findings align with various project-based reports underscoring the role of these elements in building resilience as also revealed in other disaster contexts [85,86] and other project-based reports [43,49,83,87], including also [40,44,46]. Previous research also highlighted the importance of enhanced financial access for disadvantaged segments of the population thanks to post-earthquake housing reconstruction initiatives [22,88].

STA's contribution to creating disaster resilience skills and employment opportunities, and to supporting the owner-driven reconstruction (ODR) approach to reinstating livelihoods is notable (see Table 8). The initiative is found by project-based reports [86,89] to impart technical skills, creating employment opportunities for both men and women.

STA activities expedited reconstruction, with an overall average 'agreed' response of 96.30% (see Table 9). The implementation of STA resulted in a high construction compliance rate of 81%, validated in effectiveness by project-based studies [45]. The perceived need for the STA program by 77.6% of respondents is consistent with findings from other studies (see Table 10) [44–46].

Post-disaster reconstructed houses provide safe and dignified shelters, serving as valuable assets and enhancing disaster reslience for beneficiaries (see Table 12). Similarly, another study by FWLD [90] found that 80.32% of female-owner beneficiaries perceived the effectiveness of earthquake resilience.

The effectiveness of the STA program when combined with technical and financial assistance in accelerating reconstruction efforts is emphasized, aligning with the principle of 'No One Left Behind' (see Tables 11 and 13) [40,45,46,91,92]. Consistent positive responses from beneficiaries regarding satisfaction with and effectiveness of the STA program are found in previous research [32,44]. Additionally, 92% reported that STA activities supported building back better [48]. Vulnerable earthquake beneficiaries also provided positive responses regarding friendly house design in the study area of the Gorkha district (women: 80.49%; children: 61.46%; persons with disability: 43.90%; elderly: 52.20%) [90]. Therefore, this research study evidences the effectiveness of STA program intervention, as revealed by prior project-based studies and reports.

This study contributes substantially to the post-disaster humanitarian literature by addressing a critical knowledge gap regarding shelter and settlement responses. It specifically examines Nepal's private housing reconstruction from the earthquake epicentre region from the perspective of vulnerable households eight years after a disaster. Thus, there was very limited independent academic research on this topic. Our study empiri-

cally demonstrates the significant impact of the STA program when combined with the owner-driven reconstruction (ODR) model, particularly for individuals struggling with self-reconstruction. Thus this study offers groundbreaking insights from Nepal's world's largest ODR housing recovery initiative. It also highlights that the ODR model, though widely preferred as a 'global reconstruction strategy' in low-income countries, requires tailored approaches rather than a universal application. Furthermore, the research aligns with the United Nation's Sustainable Development Goal (UN SDG: Goal 11), offering valuable insights for fostering sustainable cities and communities in disaster-affected regions.

8. Limitations

This study faced several limitations. It had a small sample size with a confined number of collected variables, limited data scale values, and a focus on one district with rural housing reconstruction and three municipalities out of the fourteen highly affected districts. Additionally, participant responses were influenced by their understanding of the questionnaire, education level, and mood during completion of the survey. Future research could enhance generalizability by increasing the sample size to include 31 earthquake-affected regions, thereby capturing diverse perceptions of vulnerable beneficiaries. Further investigations into the 14 'highly affected' and the 17 'less affected' districts, focusing on vulnerable or non-recipients of STA interventions or on those solely relying on ODR, could be undertaken using qualitative methods to consider the specific needs of families, challenges, and detailed experiences with the reconstruction processes. These could provide a deeper understanding of these dynamics. While this study focused on a particular episode of the disaster, the broader issues, such as environmental degradation, climate change, and socio-economic vulnerability, could be incorporated into the next paper. In the long-term we aim to research the relationship between disaster and economic development. To address this, we will broaden the scope and diversify the sample size in future studies.

9. Conclusions

In conclusion, this research study examined the effectiveness of Socio-Technical Assistance (STA) in aiding vulnerable beneficiaries during post-disaster reconstruction programs. The study revealed that 302 out of 304 respondents surveyed in the field (99.3%) successfully completed their reconstruction efforts, highlighting positive outcomes in various aspects, such as financial support, technical assistance, accessible housing, earthquake-resilient construction, improved livelihoods, training, sufficient living spaces, and enhanced safety. The predominant trend of the self-help approach by beneficiaries highlighted their urgency in seeking assistance. The research underscores the vital role of STA interventions in accelerating reconstruction and addressing specific needs, as is evident via overwhelmingly positive participant responses. The perceived importance of STA and positive disaster risk reduction (DRR) awareness underscores its significance for immediate recovery and long-term resilience. Overall, the study highlights the effectiveness of the owner-driven reconstruction (ODR) approach alongside tailored STA activities.

The study highlights the weakness of relying solely on ODR by indicating challenges faced by vulnerable beneficiaries who were unable to independently drive the reconstruction of houses on their own (see Table 1). Moreover, it sheds light on the limited evidence available from the perspective of vulnerable recipients, stressing the need to customize STA modalities in future post-disaster, rural, private housing reconstruction endeavours. These insights provide valuable guidance for post-disaster humanitarian responses and advocate for strategic policy considerations, including promoting the integration of STA into comprehensive recovery strategies and fostering awareness around disaster risk reduction (DRR) for future sustainable recovery efforts to build resilient communities.

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and edited the manuscript, contributed to re-writing sections, and sourced additional information and images. All authors have read and agreed to the published version of the manuscript.

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Appendix A

Table A1. Completion of house reconstruction.

Q22.COMPLETED OR NOT		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Under reconstruction	2	0.7	0.7	0.7
	Completed	302	99.3	99.3	100.0
	Total	304	100.0	100.0	

Table A2. Opening of bank accounts.

Q18.BANK A/C		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	After Earthquake	196	64.5	64.5	64.5
	Before Earthquake	108	35.5	35.5	100.0
	Total	304	100.0	100.0	

Table A3. Living in the newly reconstructed house.

Q25.LIVE IN OR NOT		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	3	1.0	1.0	1.0
	Yes	300	98.7	99.0	100.0
	Total	303	99.7	100.0	
Missing	System	1	0.3		
Total		304	100.0		

Table A4. Summary of critical analysis of ODR cases.

1. Gujarat Earthquake 2001 (6.1 magnitude):			
Number of Deaths	**No. of Destroyed houses**	**Housing Grants**	**Rebuild Progress**
20,000	880,000	INR 40,000–90,000 (USD 570 to 1300) in 2 tranches	2 years completed

Strength

- Recognised most successful ODR practice, achieving reconstruction completion in two years (rebuilt 200,000 houses and repaired 900,000 houses), described as the world's largest and fastest housing reconstruction program [93]
- Acknowledged as good ODR practice attributed to the performance of the reconstruction authority, NGOs, mason training, and community participation. Received the 2003 UN Sasakawa Award for excellent reconstruction managements [23,71].
- Over 94.5% of household beneficiaries expressed satisfaction with the reconstruction, reporting no faults [25].
- ODR initiatives were identified as the most cost-effective, fastest, and satisfactory approach for beneficiaries [94].

Weakness

- Reconstruction programs often overlook the evolving needs and requirements of beneficiaries, rendering newly constructed facilities potentially obsolete from the completion day [94,95].
- ODR models tend to prioritize resilience reduction rather than ***addressing vulnerability and pre-existing vulnerability issues for incapable individuals*** (Barenstein & Iyengar,2010; GoI and NDMA,2011 [95,96]. The evolution of ODR from top-down government to decentralized governance leaves gaps in addressing grassroots issues (Rumbach,2016).

Table A4. *Cont.*

2. Sri Lanka Tsunami 2004 (9.1 magnitude):

Number of Deaths	No. of Destroyed houses	Housing Grants	Rebuild Progress
35,000	100,000–120,858	Sri Lankan Rupees 250,000 (USD 21,000) in 4 tranches	3 years completed (77%)

Strength

- Embraced after the 2001 Gujarat earthquake, ODR proved successful as compared to donor-driven programs in terms of construction time, reconstruction quality, and satisfaction levels [94,97].

Weakness

- The ODR housing reconstruction program yielded mixed outcomes. Key issues included centralized governance, lack of experience overseeing extensive reconstruction, poor capacity of the Sri Lankan government, objections to the proposed no-build buffer zone, and shortages of materials and labour contributing to inflation in the construction sector [98].
- Evidence suggests that a centralized reconstruction program could have been more efficient for implementing the ODR program. Therefore, decentralized governance is recommended for efficient housing reconstruction in resource-poor countries.

3. Indonesia's Earthquake of 2004 (8.9 magnitude):

220,000	139,000	USD 3000 (Full reconstruction) USD 1000 (renovation of damaged house)	8 years

Strength

- Both owner-driven and donor-driven housing reconstruction models were implemented [94,99].
- ODR demonstrated success over the donor-driven housing reconstruction model [94]

Weakness

- Challenges included a scarcity of human resources, bureaucratic and institutional issues, logistical concerns, and a lack of coordination among governmental and NGOs, all compounded by limited road accessibility Ophiyandri, et al. [100].
- Involvement of humanitarian organizations lacking relevant experience in housing reconstruction led to program failures, halts, drops or stops, with poor coordination among ***housing providers and target beneficiaries*** [100].
- Major issues identified encompassed construction quality, ***dissatisfaction among beneficiaries due to unmet needs***, limited community-level participation, and accountability concerns [100].

4. Pakistan Earthquake 2005 (7.6 magnitude):

Number of Deaths	No. of Destroyed houses	Housing Grants	Rebuild Progress
73,000	463,000	Pakistani Rupees 175,000 (USD 2916) in 3 tranches	3.5 years (74.4%)

Strength

- Acknowledged successful ODR, notable for effectively integrating traditional architectural techniques into modern earthquake-resistant house design. The program achieved socio-technical alignment by adopting construction technology that matched the needs and preferences of beneficiaries [23,70].
- Within a month of the earthquake, the Pakistan government established the Earthquake Reconstruction and Rehabilitation Authority (ERRA) [101,102].
- Decentralized authority involving local government units actively participated in community consultation workshops, overcoming challenges of over-centralized, large-scale reconstruction that slowed the reconstruction pace.

Weakness

- Highlighted reconstruction challenges in the context of Pakistan, including issues of inaccessibility, lack of preparedness, loss of faith, building construction processes, and scarcity of manpower [75].
- Challenges encompassed a knowledge gap among the workforce regarding earthquake-resilient technology, insufficient infrastructure for reconstruction, limited options for rural reconstruction, lack of awareness, techno-legal regime, and restricted access to information.
- A significant number of people were economically disadvantaged and unable to afford modern materials, contributing to socio-cultural issues [75].

5. Bihar Flooding 2008:

Number of Deaths	No. of Destroyed houses	Housing Grants	Rebuild Progress
239	340,742	Indian Rupees 55,000 (USD 1200), Plus Rs 2300 (USD 50) & Rs 5000 (USD 100) in 3 tranches for solar	Slow 7 years (48%)

Strength

- ODR implemented as the housing reconstruction strategy, providing extensive support for local masons and artisans. As a result, most residents expressed satisfaction with the participatory process, hazard-safety considerations, construction quality, and the low maintenance of their rebuilt houses [21,27,103].
- The Owner-Driven Reconstruction Collaborative (ODRC), a multi-stakeholder of 27 organizations—including the National Disaster Management Authority, UNDP, a network of Indian development agencies, and institutions with expertise in community-led post-disaster reconstruction—was formed [27].

Weakness

- The ODRC withdrew after project completion without an effective handover to the state government.
- Bihar's reconstruction program after 2011 was deemed unsuccessful, primarily attributed to insufficient ***social mobilization efforts*** to initiate reconstruction work [65].

Table A4. *Cont.*

6. Haiti Earthquake of 2010: (7.0 magnitude)			
Number of Deaths	**No. of Destroyed houses**	**Housing Grants**	**Rebuild Progress**
316,000	300,000	USD 500 Yearly Rental Cost transferred to landlord. USD 2000–2800 for Transitional Shelter USD 3500–4500 for permanent house × varied per agencies support	10 years plus ongoing

Strength

- A community-based owner-driven model was piloted, and the reconstruction project was found to be highly effective in reducing disaster vulnerability [104,105], and that ODR can introduce disadvantaged segments to the banking sector [22].

Weakness

- Only 5200 permanent houses were built within two years, and the provided funds of USD 3500 were observed to be insufficient to complete the owner-driven reconstruction process [106].
- The housing reconstruction process was not directly led by the government, with heavy reliance on external agencies and a lack of coordination among them [106].
- The transition from post-disaster reconstruction to long-term socio-economic sustainable development was identified as a weak area for humanitarian agencies [106].

Source: 1. [19,62,70,94,97], 2. [107], 3. [99,108], 4. [70,109], 5. [26–28,103], 6 [12,22,110–112].

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