CONSTRUCTION WITH BAMBOO AS A TOOL FOR RESEARCH-BASED SOCIAL DEVELOPMENT: A SUSTAINABLE LIVELIHOODS ANALYSIS

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ABSTRACT
Bamboo is a natural building material that grows widely across the tropics and subtropics. It has been used in traditional construction for millennia and is now used in a growing range of innovative bio-based building solutions. Citing bamboo's potential for carbon capture, promising physical properties and relative underdevelopment of the global bamboo industry, many projects and initiatives have been launched that aim to develop bamboo industries to support livelihood development. These projects use a wide range of implementation strategies. Using theory-based program evaluation based on the Sustainable Livelihoods Framework, this paper focuses on three case studies from Costa Rica, Nigeria, and Indonesia. Each case study employs different strategies for research for social development and utilized the harvest, processing and manufacture of bamboo construction materials and products. First, a low-cost self-help construction project in Costa Rica is described. Next, a bamboo architecture community development project in Indonesia using participatory action research is analyzed. The final strategy uses community-based action research to develop bamboo-based prototypes of vertical greening systems in Nigeria. In each case study, bamboo is selected as an affordable and locally available material. The projects are evaluated using logic models and the core principles of the Framework. This paper demonstrates applications of the Sustainable Livelihoods Framework and other theory-based evaluation frameworks to analyze research-for-development and social projects.

KEYWORDS
Theory-based evaluation; bamboo; construction; sustainable livelihoods

INTRODUCTION

Bamboo is often identified as an abundant, affordable, flexible material with a cultural, social and economic importance to local communities (Lin et al., 2019; Luo et al., 2020). Bamboo has been used in construction in many countries for thousands of years. A strong, flexible, naturally straight pole known as a culm and its material properties make it an ideal building material. Bamboo's abundance in many temperate and tropical areas is also an asset. Of bamboo's estimated 1600 species, only around 100, generally larger and thicker-walled species, can be used in structural applications (Kaminski et al., 2016). Smaller and less strong species can be used in decoration, in smaller non-load bearing structures such as fences, and in the manufacture of woven mats and furniture (Liu et al., 2016). Round bamboo culms can be used to make a dizzying number of different structures, from traditional housing to innovative and creative buildings tens of meters high (Habibi, 2019). Recent advances in engineered bamboo products have further widened the spectrum of products and structures available for use, and multi-story buildings using bamboo composite beams may soon be seen in modern cities across the world (Sharma et al., 2015).

An increasing number of studies have explored the environmental impact and investigated the material function of bamboo and its applications in construction. Several life cycle assessments have found bamboo buildings to compare favorably with other options in terms of environmental impact (Lugt & Vogtlander, 2015; Salzer et al., 2017; Zea Escamilla & Habert, 2014). However, the social

dimensions of bamboo building are less well understood. Promotion of bamboo-based construction, structures and building materials within communities has been identified as a promising tool for community development, livelihood generation and as a source of environmentally sustainable, functional, and affordable housing in bamboo-producing areas (Dwivedi et al., 2019; Habibi, 2019). Several countries, including Ecuador, have implemented pilot projects to build low-cost housing using bamboo (Ecuadorian Ministry of Agriculture and Livestock & International Bamboo and Rattan Organisation, 2018).

One strategy for understanding the potential of bamboo to address social issues is to implement pilot research projects that aim to achieve social objectives through research into bamboo building and making combined with community support, participation, and social development. Evaluation of these projects may provide insight into strategies for promoting bamboo as a building material in bamboo-producing countries, if indeed it proves valuable to do so.

In this paper, the social dimensions of bamboo building in livelihood development are placed front and center, and the material properties of bamboo structures are not prioritized. To rationalize and understand different strategies using bamboo construction as a tool for social development, a standardized methods of evaluation must be found. There is a well-recognized need for demonstrable, measurable, and evidence-based analysis of social impact, including of social development and research projects (Belcher et al., 2020). Due to the difficulty in inferring causality through large-scale, statistically sound experiments in this setting, theory-based evaluation can instead provide a framework for describing, testing, and evaluating cause, effect, and value. Theory-based evaluations often work by considering the "theory of change" of an intervention or approach, contextualizing inputs, outputs, actions, and decisions along a pathway towards change within a specific local context (Vogel, 2012). Among the most well-known theory-based evaluation frameworks using this method is the Sustainable Livelihoods Framework (SLF).

The SLF was developed in 1997 by British Department for International Development (DFID) as part of its Sustainable Livelihoods approach (DFID, 2008). Originally intended as a tool for project design, it has since become one of the most widely recognized and used evaluation frameworks in international development. The approach is flexible and applicable to many different contexts but underpinning the SLF are several key assumptions (Kollmair & Gamper, 2002). First, approaches for sustainable livelihoods must be **people-centered** since interventions involve human decision-making and wellbeing at their core. Then, the approach must be **holistic**, considering as many diverse perspectives as possible. Then, it must be **dynamic**, adapting to mitigate negative impacts and respond to feedback. It must build on and **identify strengths** rather than weaknesses as a starting point. It stresses **links between the macro and micro levels,** rather than working on one and ignoring the other. Finally, it must strive to be **sustainable**, both in terms of independence from external financial support and in terms of natural resource use.

A schematic showing the SLF is shown in Figure 1. Arrows do not represent causal links, but rather a connection of influence (UNDP, 2017). Central to the SLF are the five capital assets (natural, physical, social, financial, and human) that represent the existing or potential strengths of a community that can be impacted by different strategies. In in-progress projects, change can be measured using progress in advancing these five assets, but in retrospective analyses such as this one the five assets can be used to understand potential dimensions of change. Human capital refers to the strengths, knowledge and abilities required to participate in and contribute to livelihoods. Natural assets refer to the naturally occurring resources from which populations can draw to contribute to livelihoods. Physical assets refer to the physical infrastructure, machinery or materials needed. Social assets are the connections and relationships between stakeholders that can be utilized in livelihood generation. Finally, financial assets refer to financial resources or sources which can be employed in livelihood generation. In the sustainable livelihoods approach, strengthening and effectively utilizing these five capital assets to achieve livelihood outcomes becomes the primary goal of livelihood strategies. This is achieved by transforming structures and processes to alleviate the vulnerability context in which the intervention occurs. Livelihood outcomes may be financial (e.g., income

generation) but they may be social, cultural, or physical (e.g., health outcomes, community development).

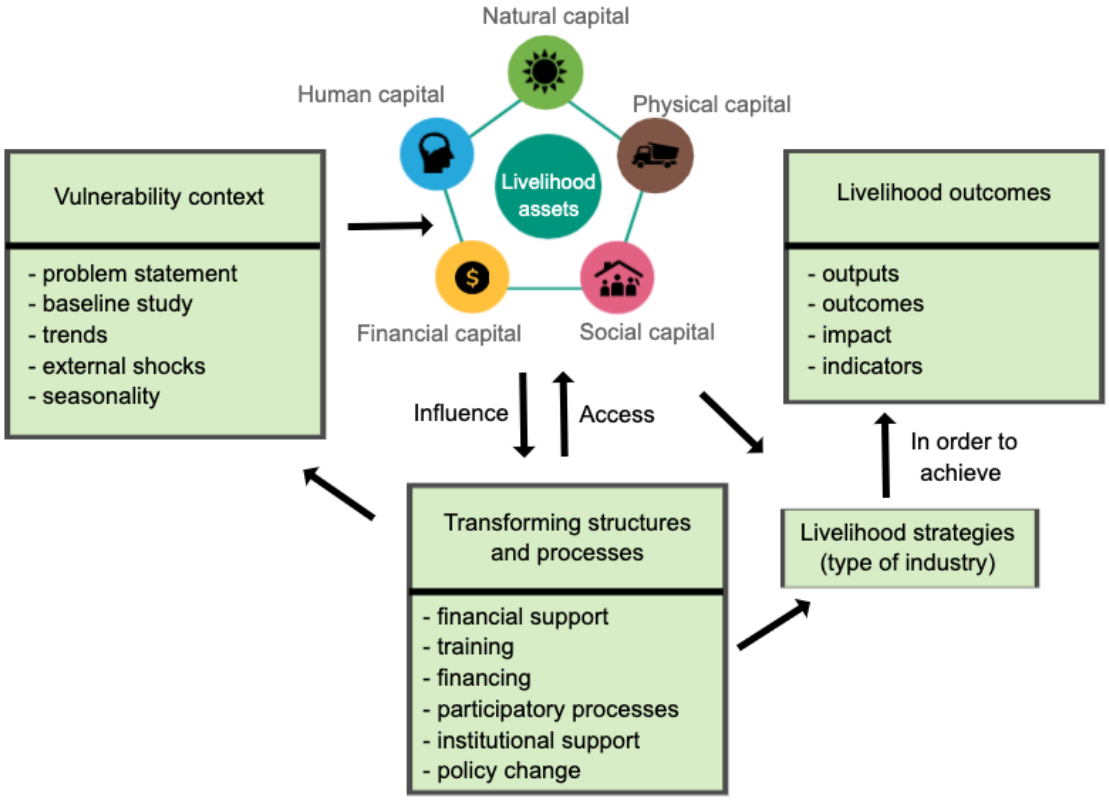

Figure 1: The Sustainable Livelihoods Framework with examples of key concepts, adapted from (DFID, 2008)

Using text analysis of existing literature, this paper presents a qualitative theory-based evaluation of three people-centered strategies for promoting bamboo as a sustainable construction material in communities. Focusing on the socio-economic dimensions of industry development, this paper uses the SLF as a framework for analysis and evaluation of social, environmental, and economic impact. The paper will explore the following questions:

- What strategies have been employed to facilitate the use of bamboo as a construction material via research for development?
- What can theory-based evaluations frameworks such as the SLF tell us about these strategies?

METHODS

Formulating search terms

To find appropriate case studies for this research, the PICO (Population, Intervention, Comparison/Control, Outcome) method was used to formulate appropriate search terms (Methley et al., 2014). Table 1 shows formulation of the final search string. Search strings were used in the Web of Science bibliometric database and in the Google web-based search engine (Bramer et al., 2018; Piasecki et al., 1948). Since selected case studies are to be compared with each other and not with a baseline or control group, no specific terms are included in the “comparison” column.

Table 1: PICO formulation of search terms

Population	Intervention	Comparison	Outcome
Livelihood OR Community	Bamboo AND Construction OR Housing OR Architecture AND Research	Evaluate OR Assess	Socio-economic impact OR Social impact OR Socioeconomic impact OR Case study

Lists of search terms in all four columns were combined using Boolean Operators to find papers containing at least one word from each column in "All Fields" (title, abstract, authors or keywords). An exception is column 2 in Table 1; it is necessary that search strings all contain the word "bamboo" in addition to the other terms used, so the Boolean Operator AND was used in place of OR. Results were scanned for appropriateness for inclusion. Three case studies were selected that revealed different strategies for promotion of the bamboo industry through people-centered research and development, and that contained enough information about project implementation and outcomes to evaluate the implementation using the SLF. Peer-reviewed sources and grey literature were both included in this search, which was not meant to be comprehensive, but rather to identify several appropriate case studies.

Analysis method

Texts were analyzed for elements corresponding to categories included in the SLF and presented in a qualitative narrative review. These elements were summarized in a representative schematic showing theory of change for each case study based on Figure 1 above. Using the core principles of the SLF, the three case studies are compared and thematically evaluated. Finally, a simple score system is applied to each case studies using the core principles to evaluate their adherence to the Sustainable Livelihoods approach.

Limitations of this study

The major limitation of this study is that it relies entirely on text-based sources, which may be incomplete, positively biased, contain inaccuracies, or reflect the author's priorities over any objective reality. Nevertheless, these sources provide an accessible way to apply a theory-based evaluation framework to a wide variety of case studies with similar aims.

RESULTS

Case studies (CS) selected for inclusion spanned the past several decades. CS were chosen from a range of geographical contexts including different countries and rural and urban settings and using very different building applications of bamboo: low-cost housing, an outdoor shelter and an indoor vertical greening and cooling system. The three strategies used in the selected CS in Table 3 can be summarized as a "self-help" construction project (Ham & Shroyer, 1993, p. 16); a "participatory action research" project (Nurdiah & Juniwati, 2020, p. 3) and a "Community Based Action Research" project (Akinwolemiwa et al., 2018, p. 278).

Table 2: Case studies selected for inclusion

CS number	Country	Region	Date	Project details	Project type	Source
CS1	Costa Rica	Indigenous communities of Boruca, Térraba, and Curré	1988 - 1990	Low-cost housing pilot project in Costa Rican Indigenous communities	"Self-help" housing project	(Ham & Shroyer, 1993)
CS2	Indonesia	Jarak Village, East Java	2019 - 2020	Bamboo architecture as a learning project for community development	Participatory action research	(Nurdiah & Juniwati, 2020)
CS3	Nigeria	Agege, Lagos	2014 - 2016	Building community-driven vertical greening systems in low-income neighborhoods	Community based action research	(Akinwolemiwa et al., 2018)

The three case studies selected for this analysis are described in the context of the SLF below.

CS1: Low-Cost Housing Project in Costa Rica (Ham & Shroyer, 1993)

Summary
Ham & Shroyer describe a pilot research and development project in Costa Rica led by the Costa Rica National Bamboo Project, in which 93 bamboo homes were designed by government-nominated architects and built by nominated representatives from Indigenous families in collaboration with trained technicians in the villages of Boruca, Terraba, and Curré. The pilot project was part of a collaboration between the United Nations Centre for Human Settlements (HABITAT), the Ministry of Housing of Costa Rica, and the Dutch government as a funding partner. The project demonstrated a "self-help" housing provision methodology, in which participants were given interest-free loans and training to help them build their own homes. A summary for CS1 using the SLF is shown in Figure 2 and expanded upon in detail below.

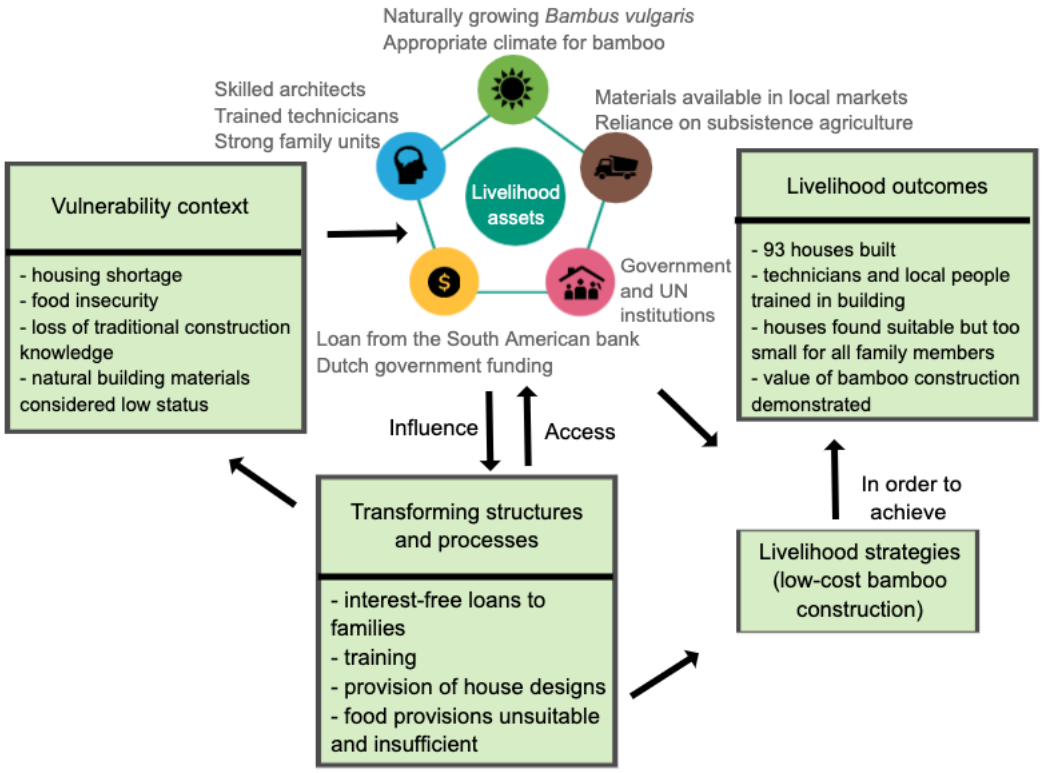

Figure 2: Sustainable Livelihood Framework analysis for CS1(Ham & Shroyer, 1993).

Livelihood Assets

Natural capital. The project site was within the Reserva Boruca-Térraba in a mountainous, forested area. Locally growing bamboo species include *Bambusa vulgaris*, and another locally growing bamboo-like species used in the project was *Gynerium sagittatum.* Although this was not a bamboo, it was used in the same function as local bamboo species in this project.

Human capital. The project benefited from a large amount of professional knowledge and skills from local technicians and architects, including well-known architects. HABITAT and international funding partners brought knowledge and skills in project management. There exists a wealth of local Indigenous knowledge of building materials and techniques dating from both pre- and post-colonial times. Although most of this knowledge has been left unused in the decades before the project, the project aimed to resurrect these skills, and a culture of community-driven construction, by combining traditional and new methods of construction with natural building materials. Participating community members were knowledgeable about bamboo harvesting techniques and local needs, but not generally about building with bamboo.

Physical capital. All necessary materials were easily obtained from local markets. Local people rely on subsistence agriculture for the entirety of their livelihoods.

Social capital. The project benefited from strong networks and connection between international NGOs, government institutions, and relationships between local technicians and families.

Financial capital. Funding for the project and construction was provided via a loan from South American bank, and funding from Dutch government. Houses were built via an interest free loan to participating families.

Vulnerability context

In the 1980's, lack of adequate and high-quality housing, particularly in remote areas and among recent migrants to urban areas, was a particular pressing issue in Costa Rica. Indigenous villages were found to be among the poorest and most in need of housing in the country. The government had

attempted several solid housing developments using quick build "modern" materials that had seen little success due to lack of material, high cost, lack of technical knowledge in construction, and low levels of satisfaction and uptake among rural communities. Transitioning to housing built by outsiders without specific and integrated reference to local needs, culture, and knowledge represents a loss of valuable traditional knowledge and way of life. Despite this, the trend at the time was for housing made from brick, concrete, and tile, rather than traditional materials such as adobe. Local communities consider houses made of bamboo to be low status and undesirable. A "modern" and clean look was important to the participating families. Families average six members and could be as high as 12 members, all of whom live together. Thus, the program aimed to provide an option that was affordable, suitable for the needs and wants of low-income families. The program prioritizes the use of a combination of Indigenous and modern construction techniques in a way that simultaneously developed construction and building skills in the target communities.

Transformation of structures and processes
The project was implemented in two phases. In the first, guadua bamboo (*Guadua angustifolia*, referred to in Ham & Shroyer, 1993 as *Bambusa guadua*) was planted to provide communities with a future source of raw material (bamboo) for structural use in construction. Since these bamboo plantations would take up to 12 years to mature, then locally available *Bambusa vulgaris*, timber, *Gynerium sagittatum*, and cement were used to build the houses in the pilot project (Phase 2). Houses were built by nominated family members over the course of one year using designs and plans given to them by the project and with the regular support of 15 trained live-in technicians**.** Since the people building the houses were those that would eventually live in them, then the plans and designs were able to be adapted to fit individual needs. For example, it became clear early on that local cooking habits would be unsuitable in an indoor kitchen. Most participants chose to not build an indoor kitchen and to construct an outdoor kitchen close to the house. To recompense the loss of income incurred by participation in the yearlong construction phase of the project, the project gave both food and money to participating families. However, the food was judged culturally unsuitable by many of the participants, and in any case was not given over a long enough time to make up for the food supply lost.

Livelihood Strategies
Develop raw material production and capacity for local families to be able to build suitable houses and other structures with locally available bamboo using a combination of traditional and modern methods.

Livelihood outcomes
Interest free loan for house available for repayment over a 15-year period are repaid into a community fund for local communities to use for home improvements and to fulfil other needs. Since no data was collected after the houses were built, then it is not clear whether these loans were repaid, and if loan repayment led to nay negative outcomes in the community. The project instilled a sense of pride and increased community pride in houses, with most houses being judged comfortable and beautiful by the participants. Participants adapted the houses, built upon them, and continued to use them after the project finished, showing a high degree of engagement with the project. The demonstration and realization that housing built using Indigenous and traditional methods and materials can be more functional, comfortable, and cheaper than alternatives. Several of the very poorest families had to withdraw from the project because they could not afford a year without work. Many other poor families in the regions did not own land upon which to build a house. These limitations may have led to an increase in inequality in the area, although no data confirms this.

CS2: Bamboo architecture as a learning project for community development (Nurdiah & Juniwati, 2020)

Summary
In this project, a group from the Department of Architecture at Petra Christian University were requested by the "headman" (p. 3) of Jarak village to co-create a construction project with the

villagers. The aim was to develop skills and knowledge among the villagers and provide a means of income and employment, especially for young people. The team worked with villagers to learn how to build with bamboo and built prototypes for useful structures to the community. The project is summarized using the SLF in Figure 3 and explored in detail below.

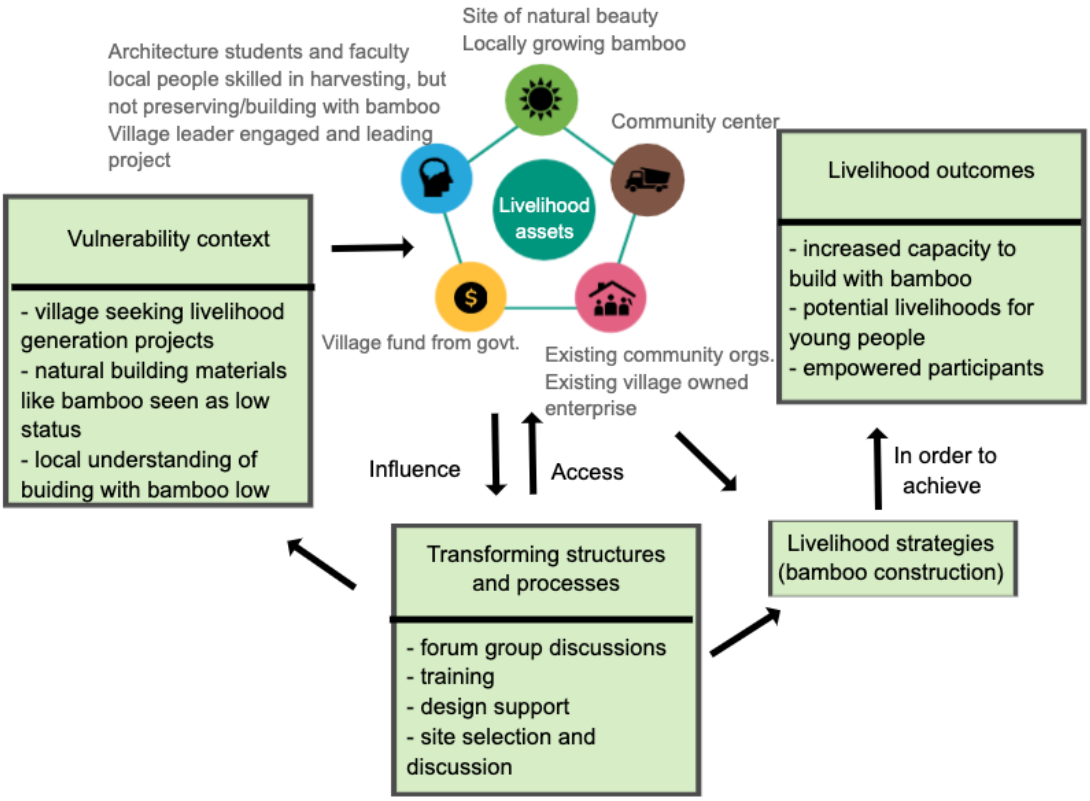

Figure 3: Sustainable Livelihoods Framework Analysis for CS2 (Nurdiah & Juniwati, 2020).

Livelihood Assets

Natural capital. Jarak village is located in a mountainous area with many waterways, known as a site of great natural beauty. Villagers and local government have identified this area as having a high potential for eco-tourism. Several bamboo species grow abundantly in the region.

Human capital. Local people are highly skilled and knowledgeable in harvesting good quality bamboo. Students and professors from the research university were knowledgeable in both modern and traditional architecture and Design Thinking. Local people were supported and empowered to build with bamboo.

Physical capital. A local community center provided a meeting place for discussions.

Social capital. University infrastructure supported researchers. Local community groups, including youth and women-only groups, local artisans and a "Village Owned Enterprise" (p. 7) made up of community members, provided the social and political infrastructure to engage with the community. Support of the local leader, or "headman" (p. 1), was essential.

Financial capital. Surrounding villages have successfully constructed ecotourism facilities using local government development funds, which will also be utilized in the future for this project.

Vulnerability Context

Local people were not amenable to building with bamboo, finding it to be a cheap and low-quality material only good for farm structures. Bricks and concrete have higher status, but they are scarce in the area and more environmentally costly. Architecture students are also taught more about high energy-consuming construction materials. Although bamboo has been used in Indonesia as a natural building product for thousands of years, technical knowledge in the area is currently low. The

community were actively looking for new sources of livelihood and community development but lacked resources to carry out such a project without external support.

Transformation Structures & Processes
The researchers employed several participatory action research methods to transform structures and processes in the village. The presented villagers with a shot inspirational video on the benefits and possibilities of bamboo building and then led participants in several forum group discussions, in which the group were trained in bamboo building and began to select and design the shelter that would be built as part of the project. Students supported the design process and implemented the desires of the villagers into potential designs.

Livelihood Strategies
Villagers were trained and learned more about bamboo building, with an eventual aim to generate income from ecotourism and bamboo construction, especially among the young people of the village.

Livelihood outcomes
The collaborative efforts led to the design of a shelter, and of several participants beginning to learn how to build with bamboo, including in their spare time after the project. Participants because convinced of the potential of bamboo as an attractive and interesting construction alternative, which differed from their opinions at the start of the project. Researchers reported that the community felt empowered by the collaborative decision-making process.

CS3: Building community-driven vertical greening systems in low-income neighborhoods (Akinwolemiwa et al., 2018)

Summary
Akinwolemiwa et al. describe a community-based action research project in which prototypes of vertical greening systems (VGS), including those made of bamboo, were built and tested in a low-income area of Lagos. The prototypes were co-created by a team of architecture students and with local community members, with support from community leaders known as Baales. The bamboo prototype was found to be significantly cheaper than the alternatives, and community acceptability was found to be high. The project demonstrated a high degree of community engagement. A theory of change for this project using the SLF is shown in Figure 3 and expanded upon below.

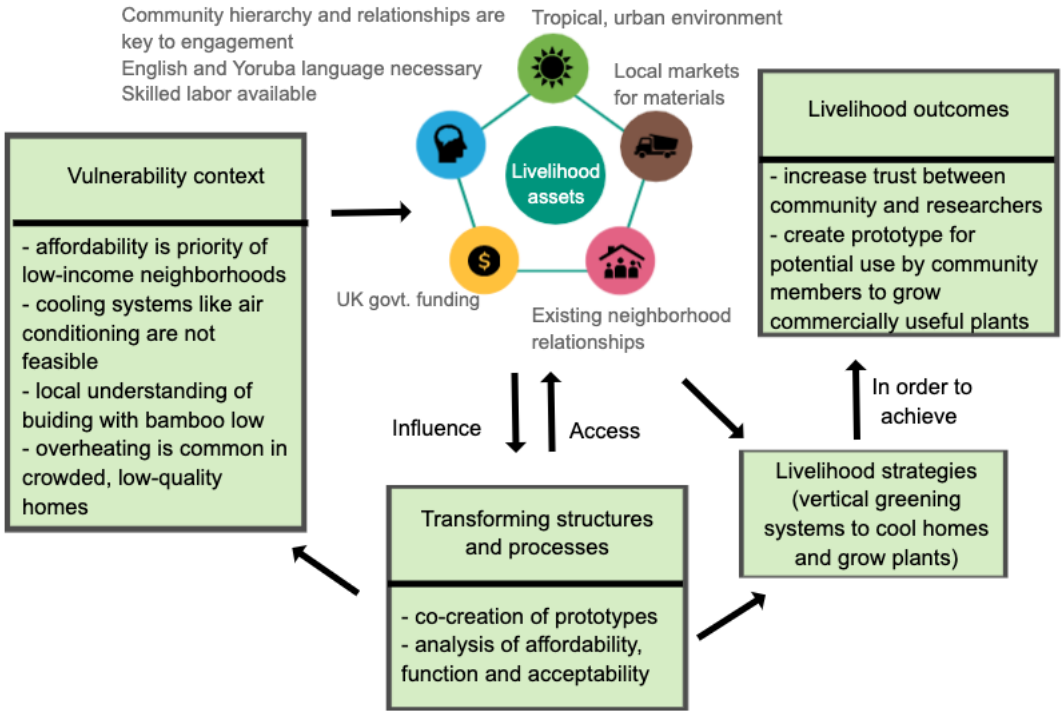

Figure 4: Sustainable Livelihoods Framework Analysis for CS3 (Akinwolemiwa et al., 2018).

Changes in Livelihood Assets

Natural capital. An urban environment in Nigeria, a tropical country, with a particularly suitable climate for the use of VGS to cool buildings.

Human capital. Researchers skilled in design and building fluent in both English and Yoruba implemented this project. They utilized valuable high-skilled labor in the community. Knowledge of local ways of life was invaluable, particularly when negotiating costs of goods and materials.

Physical capital. Many houses in the community have an appropriate "façade" (p. 278) for the construction of a VGS, and material could be purchased at local markets.

Social capital. Community leaders are traditional and informal but influential, known as the "Baale" (p. 278). Maintaining good relationship with the Baale and their deputies is key to achieving community engagement. Many neighborhoods declined to participate in project due to high mistrust in researchers or outsiders. University infrastructure supported researchers. The support of community members with relationships with vendors at the local market can better negotiate prices.

Financial capital. Researchers had funding from the United Kingdom government to carry out the research, but access to financial capital was a major limitation throughout for potential users of the prototype.

Vulnerability Context

Low-income communities living in urban environments in hot countries often cannot afford or install "active" (p. 277) cooling systems such as air conditioning. Electricity supply and access to running water may be intermittent or non-existent. Overcrowding, poor-quality housing and hot climate exacerbate a clear need for functional, affordable, and acceptable "passive" (p. 277) cooling systems. Landlords and not residents of area have the final say on additions to houses. Local communities have a high mistrust of researchers and outsiders.

Transformation Structures & Processes

Community-based participation research and co-creation of product prototypes**.** Four stages of community engagement by researchers engaged communities at all stages of product development.

Livelihood Strategies
Design and implementation of four prototypes for vertical greening systems made of 1) bamboo, 2) High density polyethylene and 3) timber. The prototypes were built on a clear façade in homes or community centers in the neighborhood. Plants considered useful for food, medicine or for commercial use by community members were planted in the prototypes. These plants could be used by community members or sold.

Livelihood outcomes
Increased trust between local community members and researchers was observed, with community members offering to work on the project for free and strong relationships built between researchers and community leaders and members. The researchers aimed to nurture a facilitating environment for innovation, product development and collaboration in the neighborhood, but this outcome is difficult to measure. All four vertical greening products remained at prototype stage but were able to cool houses and produce many varieties of medicinal and food plants. Community acceptability of the prototypes was very high, but affordability and landlord acceptability were recognized as the highest barriers to a market for the products.

DISCUSSION

As Figures 2-4 show, the SF was found to be compatible with all three selected projects. The core principles of the Sustainable Livelihoods Approach are used to compare the three interventions below (Table 3). The adherence of the project to the core principles is evaluated using a score out of five.

Table 3: Comparison and evaluation of selected case studies using the core principles of the SLF

Core principle of the SLF	CS1: Low-cost housing pilot project (Ham & Shroyer, 1993).	/5	CS2: Community-based participation research (Akinwolemiwa et al., 2018)	/5	CS3: Participatory action research (Nurdiah & Juniwati, 2020)	/5
People-centered	Original housing plans, designed by professional architects, did not take local cooking techniques and bathroom habits into account, but for the most part participants were able to adjust their houses to their specific needs during the construction process.	3	Community members were involved in co-creation at every stage of the project, and community acceptability and affordability were major parts of the evaluation process.	4	Community members requested that this project take place and were the central stakeholders and decisionmakers in the process.	5
Holistic	Project officials attempted to allay concerns over loss of income from	3	Researchers did not specifically address issues of landlord acceptability and	3	This project was based on the context and specific needs and	3

	agriculture during the construction of houses, but food provided to families was not enough and some of the poorest families dropped out of the project.		affordability in their prototype design, leaving potential for uptake of the innovation unclear.		wants of the community, so strictly profit-focused dimensions may have been ignored.	
Dynamic	Design of the houses was adjusted once technicians realized that the original designs were not feasible.	4	Community engagement strategy, design, function, and materials of the products were all tweaked according to community input between phase 1 and phase 2, showing dynamism and an ability to adapt. However, the second phase of products were found to be overall worse value for money than the first.	4	Plans for the type and design of structure to be built were deliberately open-ended, and plans changed with input from the community at several points.	4
Builds on strengths	Locally available *Bambusa vulgaris* and *Gynerium sagittatum* were used for the houses, and cement was sourced from local markets. Traditional building methods and bamboo harvesting techniques were utilized. However, most of the project involved participants learning new skills rather than building on existing ones	4	Community relationships and local knowledge was effectively utilized to negotiate prices for goods and to increase community engagement in the project. Highly skilled local workers were utilized and valued throughout.	5	Local natural resources were effectively utilized, but the bulk of the project involved teaching local people new skills and capacities rather than building on existing ones.	4
Macro-micro links	The project was a collaborative effort between large-scale and small-scale	5	Little attention was given to national and international scales during this	2	The project took place within the wider context of government and	3

	partners, utilizing networks on the local, national, and international scales.		project, which took place on a local neighborhood level without linking to wider networks or institutions.		neighboring village actions but remained focused on a hyper-local scale.	
Sustainability	According to online sources, the project was expanded and would eventually build over 2000 homes, but eventually could not survive without external support (Erickson, 2007). Participants in the pilot project received interest-free loans to build their houses, but no information is given on whether they were able to repay them. However, guadua bamboo has become a replenishing and sustainable resource in Costa Rica since this project.	3	Lack of financial sustainability was a major constraint for prospective users of the innovation, but the researcher hoped that their research would promote an enabling environment for entrepreneurs to adopt and adapt similar products for commercial use. In terms of environmental sustainability, bamboo was deemed to be the most environmentally friendly and affordable prototype developed.	2	This project was just the preliminary phase of a wider construction and livelihoods project, which the researchers hope will be self-sustaining after the project ends.	3
Total		22		20		22

Numerical values show approximate adherence to the core values of the Sustainable Livelihoods approach rather than an absolute measure of value. Nevertheless, they show the relative strengths and weaknesses of each approach in the context of the SLF and according to this analysis.

CONCLUSION

Research into building structures using bamboo, a natural, abundant, and environmentally sustainable building material, in areas where it grows, can achieve social objectives. This desk-based proof-of-concept paper demonstrates that SLF can be used to retrospectively evaluate and compare bamboo construction projects. This research highlights the need for the application of theory-based evaluation using such frameworks. Three strategies, including a “self-help” low-cost housing project, a community-based participation research project, and a participatory action research project, were evaluated according to the principles and elements of the SLF. A key benefit of this method is its flexibility; categories are specific enough to be comprehensive, but general enough to apply to a wide variety of interventions, scales, and contexts. The difference in scale and strategy between these three projects did not impede their suitability for comparison using the SLF. The SLF provided insights into their causal chain from livelihood assets to outcomes and impact. Using a simple logic model to describe key elements of the project aids in understanding the wider context, but much more detailed analysis is needed to fully understand a case study. Lessons learnt from this evaluation can be summarized thus: In CS1, the importance of building structures suitable for local community customs

and needs was highlighted, and the strategy scored very highly for micro-macro links. In CS2, a community engagement process that effectively centered local relationships and authority figures found some success. Finally, in CS3, providing community groups with inspiring and accurate information on bamboo building was the catalyst of motivation and action. Taken as a whole, the case studies demonstrate the need for a people-centered, dynamic, and localized approach when carrying out research using bamboo building for social development.

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CONFLICT OF INTEREST

The author declares that there are no conflicts of interest associated with the work presented in this paper.

DATA AVAILABILITY

1. No data was assembled for the production of this paper.