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Impact and Analysis of Training Programs Focused on Shelter Reconstruction for Post-Disaster Communities

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IMPACT AND ANALYSIS OF TRAINING PROGRAMS FOCUSED ON SHELTER
RECONSTRUCTION FOR POST-DISASTER COMMUNITIES

by

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Faculty of the Graduate School of the

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This thesis entitled:
Impact and Analysis of Training Programs Focused on Shelter Reconstruction for Post-Disaster
Communities
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The final copy of this thesis has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above-mentioned discipline.

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Impact and Analysis of Training Programs Focused on Shelter Reconstruction for Post-Disaster Communities

Thesis directed by Associate Professor Amy Javernick-Will

ABSTRACT

Benjamin Franklin, in an essay titled *The Way to Wealth*, said, “An investment in knowledge always pays the best interest.” This adage remains relevant when applied to addressing the impact and risks of natural disasters on the built environment, particularly in developing communities. However, we currently lack an understanding of the post-disaster training programs implemented within communities affected by disaster events. This research examines shelter reconstruction programs within nineteen communities that were struck by Typhoon Haiyan in 2013 in the Philippines. Specifically, I first characterized training programs and the learning styles of community members through the lens of Experiential Learning Theory. Then, I explored potential factors that influence the retention and reapplication of trained material. The results of this thesis can apply to future implementation of training programs, while also identifying avenues for expanded study into the impact of training on post-disaster communities.

For Rachelle
My loving and supportive wife

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CHAPTER I: INTRODUCTION

Observed Problem

Disasters are becoming increasingly problematic on a worldwide scale. They are not only increasing in impact on populations and the built environment, but also frequency (Guha-Sapir et al. 2015; UNISDR 2015b). Many times, communities affected by disasters barely enter the recovery phase of shelter reconstruction operations before experiencing another disaster event, forced to abandon current timelines and thrust into another disaster cycle. As a result, aid organizations have begun to incorporate training programs aimed at developing disaster-resilient infrastructure and communities that are better prepared for the future disaster events (Ahmed 2011; Pelling 2007). These training programs extoll better building, maintenance and preparation practices that are easily understood by the common homeowner and increase the resiliency of the housing stock within a community. Yet, the focus for these programs has been to build capacity within the community itself so as the community may become more self-reliant. This research explored shelter training programs within the context of the Philippines, post-Typhoon Haiyan, focusing on the development of resiliency through the training of construction principles that reduce the impact of disasters.

Many aid organizations today are recognizing the importance of training communities to construct and maintain disaster resilient housing (Schilderman and Lyons 2011). By doing so, they aim to transfer relevant engineering knowledge and increase a community's capacity to rebuild themselves. During my graduate studies, I was particularly interested in the training programs implemented by these aid organizations and their effectiveness at improving a community's understanding of proper construction processes. Yet, is unclear how aid

organizations are approaching training and if they are accounting for the specific learning needs of the community in which they are training.

One training goal was set forth in the 2005 Hyogo Framework for Action: to ‘use knowledge, innovation and education to build a culture of safety and resilience at all levels’ (ISDR 2007 p. 9). In doing so, this transfer of knowledge helps develop disaster-resilient communities that become self-reliant in terms of shelter construction and maintenance. Academic institutions often recognize the importance of learning styles and learning theory for transferring knowledge, with previous studies finding that methods of instruction affect knowledge retention in students (Gradl-Dietsch et al. 2016; Halili et al. 2015). However, there was a dearth of literature that addressed learning styles and learning theory in training programs implemented by aid organizations. We must therefore better understand training programs and their alignment with community members’ learning styles. Thus, I identified the need **(Gap #1) to analyze training programs implemented and communities’ preferred learning styles.**

To address this gap, I asked the following research questions, using Kolb’s Experiential Learning Theory:

- ❖ *What learning modes are accommodated by post-disaster construction training programs?*
- ❖ *What are the learning styles of community members trained in post-disaster construction?*

Next, given the importance of ensuring uptake of training messages in the disaster context, we must better understand how learning styles and other factors may influence the effectiveness of knowledge retention from training in post-disaster contexts. Previous research has examined factors tied to enhanced retention of material, yet many of these studies are conducted within a

formal academic setting (Van Doorn and Van Doorn 2014). The situational variables of a post-disaster environment, particularly within vulnerable or developing communities, would most certainly come to influence the findings of similar knowledge retention research. Furthermore, studies in this body of knowledge did not consider specifically the implications of instructing laypeople on disaster resilient construction principles. Therefore, I noted the need **(Gap #2): to identify potential factors that influence retention and recollection of knowledge related to risk-reducing construction techniques.**

To address this gap, I asked the following research questions, using the multivariate statistical methods, notably cluster and factor analysis:

- ❖ *What are the characteristics of communities that had similar performances when recalling construction knowledge?*
- ❖ *How are the individual themes within the 8 Key Messages connected in terms of performance?*

Figure I-1 depicts the connection between research gaps and their associated questions.

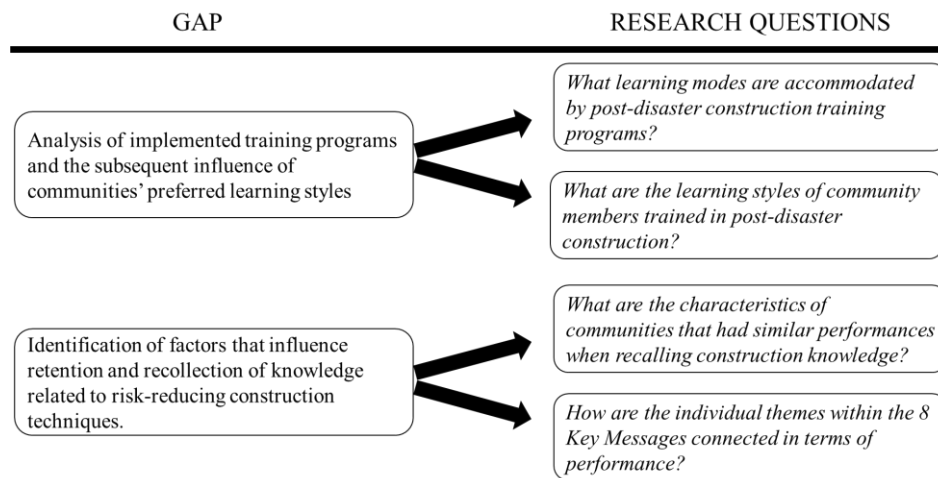


Figure I-1: Gaps & Research Questions

Research Method Overview

I employed multiple research methods to address these two sets of research questions. The research method in Chapter 2 was a mixed methods research design that combined qualitative and quantitative techniques. Using NVivo® software, interview transcripts of shelter beneficiaries and aid organization personnel were coded to properly characterize the training programs implemented after Typhoon Haiyan. Separately, I used a questionnaire distributed in the communities to collect quantitative data regarding the learning styles of its members.

To address the research questions found within Chapter 3, I employed statistical data analysis that included univariate and multivariate methods. The same survey distributed for the learning style inventory from Chapter 2 also collected respondents' demographic information and administered a construction knowledge test derived from the risk-reducing construction techniques found in the '8 Build Back Safer Key Messages'. The resulting test scores, in combination with the descriptive demographic variables, were then analyzed under two separate statistical techniques: agglomerative hierarchical cluster (AHC) and factor analysis.

Thesis Format

The thesis is formatted in a manner that is conducive to journal articles. As such, the two main chapters (Chapters 2 and 3) are written as stand-alone chapters for publication. Chapter 2 has already been submitted and accepted into a peer-reviewed journal and Chapter 3 is under development for a conference proceedings or journal article. Chapter 2 presents a characterization of construction training programs implemented in post-disaster communities, followed by a comparison of each community's preferred learning style. Chapter 3 identifies key factors involved with knowledge retention, specifically of risk-reducing construction principles

disseminated post-disaster. Each paper has similar sections, including an abstract, introduction, background, research method, key findings, discussion, conclusion and references. The conclusion summarizes the key points from each paper, how they contribute to both theoretical and practical areas, as well as suggestions for future research. While each chapter of this thesis includes the applicable references, they are also consolidated into a full list at the end. Lastly, appendices complete the thesis and contain additional information used through the research process relevant to its methodology and analysis.

References

- Ahmed, I. (2011). "An overview of post-disaster permanent housing reconstruction in developing countries." *International Journal of Disaster Resilience in the Built Environment*, 2(2), 148–164.
- Gradl-Dietsch, G., Korden, T., Modabber, A., Sönmez, T. T., Stromps, J.-P., Ganse, B., Pape, H.-C., and Knobe, M. (2016). "Multidimensional approach to teaching anatomy—Do gender and learning style matter?" *Annals of Anatomy - Anatomischer Anzeiger*, 208, 158–164.
- Guha-Sapir, D., Hoyois, P., and Below, R. (2015). *Annual Disaster Statistical Review: Numbers and Trends 2014*. Centre for Research on the Epidemiology of Disasters, Brussels, Belgium, 54.
- Halili, S. H., Naimie, Z., Sira, S., AhmedAbuzaid, R., and Leng, C. H. (2015). "Exploring the Link Between Learning Styles and Gender Among Distance Learners." *Procedia - Social and Behavioral Sciences*, 191, 1082–1086.
- ISDR. (2007). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*. Geneva, Switzerland.
- Pelling, M. (2007). "Learning from others: the scope and challenges for participatory disaster risk assessment." *Disasters*, 31(4), 373–385.
- Schilderman, T., and Lyons, M. (2011). "Resilient dwellings or resilient people? Towards people-centred reconstruction." *Environmental Hazards*, 10(3–4), 218–231.
- UNISDR. (2015). "The Economic and Human Impact of Disasters in the Last 10 Years." <<https://www.unisdr.org/we/inform/disaster-statistics>> (Apr. 9, 2017).

Van Doorn, J. R., and Van Doorn, J. D. (2014). "The quest for knowledge transfer efficacy: blended teaching, online and in-class, with consideration of learning typologies for non-traditional and traditional students." *Frontiers in Psychology*, 5.

CHAPTER II: CHARACTERIZING POST-DISASTER RECONSTRUCTION TRAINING METHODS AND LEARNING STYLES

Abstract

Large disasters damage or destroy infrastructure that is then reconstructed through programs that train community members in construction techniques that reduce future risks. Despite the number of post-disaster reconstruction programs implemented, there is a dearth of research on education and training in post-disaster contexts. To address this gap, we applied a mixed methods approach based upon experiential learning theory (ELT) to three shelter programs administered in Eastern Samar, Philippines following Typhoon Haiyan. First, we characterize post-disaster training programs based on learning modes and then, compared this to the learning styles of community members. To assess learning modes of training programs, we analyzed qualitative data from interview accounts of community members and aid organizations; and, to delineate community member's learning style preferences, we analyzed quantitative data from survey questionnaires. Findings show that aid organizations administered training largely in lecture format, aligning with the reflective observation mode of ELT, but lacked diversity in formats represented in other poles of ELT. Moreover, analysis revealed that community members tended to grasp new information in accordance with the concrete experimentation mode, then preferred transforming newly acquired knowledge via the reflective observation mode. The lecture-based training predominately administered by aid organizations partially aligned with community learning preferences, but fell short in cultivating other forms of knowledge acquisition known to enhance long-term learning.

KEYWORDS: Training, Disasters, Experiential Learning Theory

Introduction

Communities, recovering from a disaster event, tend to rebuild using the same risk-prone designs, leading to new construction that is only marginally safer than pre-disaster conditions (Olshansky 2009). While many factors contribute to reconstruction, including financing, time, and skill; this research focuses on one component of recovery—skill development through training. A focus on measuring the impact of involving the communities in recovery versus measuring the output of recovery activities (e.g., number of structures built) has gained increased importance for aid organizations (Lawther 2009). Consequently, to use training as a means of community involvement not only empowers locals (Davidson et al. 2007), but adds additional benefits, such as psychosocial recovery (Sullivan 2003). Further studies (e.g. Barakat 2003; Barenstein 2006; Fallahi 2007; Thwala 2005) demonstrate multiple advantages of community participation in post-disaster recovery, such as cost savings, quality control, increasing construction capacity, and preserving the cultural heritage of affected communities. However, there is a lack of studies that unpack and analyze training programs administered in post-disaster environments. Yet, better understanding and characterization of these programs is critical, as training has the potential to improve recovery outcomes and reduce future risks within communities impacted by disasters.

As disasters and their corresponding effects continue to escalate (Guha-Sapir et al. 2015), the United Nations (UN) has championed efforts to reduce disaster impacts by improving the resilience of both the built environment and social systems. This charge crystalized with the declaration that the 1990s were to be the International Decade for Natural Disaster Reduction. The work derived from this program manifested with the UN adoption of the International Strategy for Disaster Reduction (UNISDR). One of its earliest priorities, set forth in the 2005 Hyogo

Framework for Action, was to ‘use knowledge, innovation and education to build a culture of safety and resilience at all levels’ (ISDR 2007 p. 9). UNISDR’s newest guiding document, the Sendai Framework for Disaster Risk Reduction, also includes a priority that ‘enhances disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction’ (UNISDR 2015a p. 21).

The charge to build back safer, widely adopted by international aid organizations requires the global populous to be trained in order to achieve these goals. And, derivatively, as disasters continue to increase, it becomes even more critical to improve recovery practices by training local community members in construction skillsets. There is no single technique or methodology currently used to train a diverse community comprehensively. However, within educational theories on learning styles, we know that learners must receive information in a variety of ways to enhance not only the acquisition and retention of knowledge, but also its understanding and application (Prince and Felder 2006). Knowing this, we assessed and categorized three construction training programs employed in the wake of Typhoon Haiyan through the lens of experiential learning theory (ELT). This theory defines learning as ‘the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience’ (Kolb 1984 p. 38). When grasping new information, ELT postulates learning occurs on a continuum with two learning modes or poles: concrete experience and abstract conceptualization. Once grasped, learners transform this experience on a separate continuum with two additional modes: active experimentation and reflective observation.

In order to improve training, we must first understand and unpack the types of post-disaster construction training programs employed and determine the learning modes that they

accommodate. Therefore, we seek to better understand post-disaster construction training programs by collecting and analyzing the learning modes employed within training programs implemented by aid organizations following Typhoon Haiyan. We ask:

RQ1: What learning modes are accommodated by post-disaster construction training programs?

The application of learning styles outside of traditional classroom education, such as post-disaster training sites, is sparse. However, a study of learning styles of community members receiving training in post-disaster programs, compared to the learning modes implemented in training programs in these settings, has the opportunity to improve the theoretical application of education research and the practical implementation of post-disaster training programs. Further, based on educational research in learning styles, we know that individuals develop preferences for how they receive information and knowledge. A better understanding of community member preferences, and the alignment of these preferences with the training methods, may enhance post-disaster reconstruction programs in resource limited contexts. Doing so requires assessing both the learning modes used by aid organizations to administer training programs and the learning styles of community members. Therefore, our second research question asks:

RQ2: What are the learning styles of community members trained in post-disaster construction?

Background

The UN doctrine over the last three decades has expressed the desire to reduce disaster effects on the built environment. One manner in which to achieve this goal is by educating communities to ‘Build Back Safer.’ Many post-disaster shelter reconstruction programs have a training element to educate builders and community members on design and construction

techniques that enable safer shelter. In 2010, the World Bank published a holistic reference guide on the process of reconstruction after natural disasters and dedicated an entire chapter on the requirements for reconstruction training programs (Jha 2010). This chapter included recommendations regarding staffing, governance, structure, policy considerations, and content. It advocates for varied training methods comprising of lecture format, model building, and practical demonstrations.

However, much of the shelter reconstruction literature (e.g., Asharose et al. 2015; Thayaparan et al. 2015; Tuladhar et al. 2015) focuses on training deficiencies, but does not further unpack training programs to understand the specified goals of the programs, analyze the intended target audience, and categorize the training methods. To address this, our research employs experiential learning theory (ELT) and Kolb's Learning Style Inventory (LSI) to assess training programs conducted by aid organizations to Filipino community members after Typhoon Haiyan.

Experiential Learning Theory

As Dewey (1938 p. 7) noted, '...there is an intimate and necessary relation between the process of actual experience and education.' Grounded in work by Dewey (1938), Lewin (1951), and Piaget (1973), Kolb (1984) developed experiential learning theory, which is an approach to education and learning based in philosophy, social psychology, and cognitive psychology. Kolb envisioned a 'framework for examining and strengthening the critical linkages among education, work, and personal development' (Kolb 1984 p. 4). The links he describes attempt to bridge the gap between the 'abstract ideas of academia into the concrete practical realities' of everyday life (Kolb 1984 p. 4). Experiential Learning Theory (1984) is based upon six distinct propositions:

1. Learning is best conceived as a process, not in terms of outcomes (p. 26).
2. Learning is a continuous process grounded in experience (p. 27).

3. The process of learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world (p. 29).
4. Learning is a holistic process of adaptation (p. 29).
5. Learning involves transactions between the person and the environment (p. 35).
6. Learning is the process of creating knowledge (p. 35).

In Kolb's theory for experiential learning, he submits that learning occurs within a 'four-stage cycle involving four adaptive learning modes—concrete experience, reflective observation, abstract conceptualization, and active experimentation' (Kolb 1984 p. 40). These four modes, or stages, are defined below:

- ❖ The *Concrete Experience* (CE) mode characterizes a person's emphasis on feeling and analysis of the present reality, as opposed to thinking and a concern over the theories and concepts that apply.
- ❖ The *Abstract Conceptualization* (AC) mode, opposite of CE, centers on thinking rather than feeling. This mode focuses on logic and concepts that downplay artistic influences.
- ❖ The *Reflective Observation* (RO) mode concentrates on understanding a situation's meaning through observation. This mode is less concerned with the pragmatic application of ideas, but rather understanding the true underlying concepts that govern.
- ❖ The *Active Experimentation* (AE) mode, opposite of RO, places practical application of ideas over the need to understand their meaning. Therefore, this mode cares about what works at the present moment and not necessarily the fundamental concept behind it.

The first of Kolb's major assumptions is that a learner progresses through the four modes in a clockwise manner that accentuates the adaptive and integrative process of learning by experience. While learners may prefer a particular mode, they transform learning into knowing by navigating through all four modes.

Learning Styles

Kolb indicates that the relationship between abstract conceptualization vs. concrete experience (AC-CE) and active experimentation vs. reflective observation (AE-RO) are ‘two distinct dimensions, each representing two dialectically opposed adaptive orientations’ (Kolb 1984 p. 41). This is Kolb’s second major assumption, effectively stating that learners must choose a greater partiality towards one mode or the other. To explain further and depicted in Figure II-1 below, the AC-CE dimension consists of *prehension* while the AE-RO dimension is that of *transformation*. Prehension is the process of either grasping experience by tangible qualities, called *apprehension* (CE) or conceptual interpretation, named *comprehension* (AC). Transformation is then the processing of this grasped experience, focused on contrary methods of internal reflection, called *intention* (RO) or through active handling, called *extension* (AE).

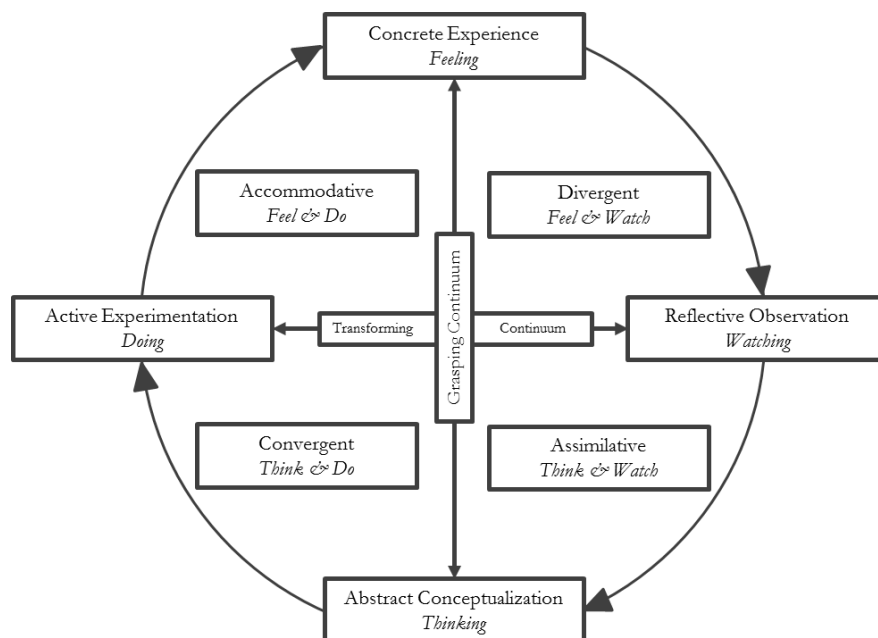


Figure II-1: Kolb’s Cycle of Experiential Learning

Although Kolb describes that learning best occurs when the student travels through all four stages of the learning styles, he accepts the basic human tenant of gravitating to programmed

tendencies that are influenced by five different levels: personality, educational specialization, professional career, current job role, and adaptive competencies (Kolb and Kolb 2005). Based on the observational research of Hudson (1966), Torrealba (1972), and Grochow (1973), Kolb thus characterizes four learning styles—convergent, assimilative, divergent, and accommodative—as shown in the quadrants in Figure II-1.

The *convergent* learner is dominant between the abstract conceptualization and active experimentation modes. The convergent knowledge seeker's prehensive tendency is toward comprehension (AC) and transforms it through extension (AE). He or she performs well when solving problems with only one answer and prefers to address technical tasks while avoiding social concerns. Oppositely, the *divergent* learning style relies on concrete experimentation and reflective observation. The divergent style grasps knowledge through apprehension (CE) and transforms it through intention (RO). This group tends to be problem solvers due to their imaginative nature and reliance on generating alternative perspectives to a problem. They thrive in interpersonal brainstorming sessions. Those that *assimilate* knowledge do so through abstract conceptualism and reflective observation. The assimilative style grasps knowledge through comprehension (AC) and transforms it with intention (RO). These individuals excel at development of theoretical models by integrating seemingly disconnected pieces of information into a single thought. Lastly, and opposite to assimilators, are the *accommodative* learners who use concrete experience and active experimentation. The accommodative style uses apprehension to take in experience and transforms it via extension (AE). They are prone to the 'trial-and-error' method, are action based, and heavily reliant on personal interaction. When the presented facts do not fit the proposed theory, they disregard the theory and adapt to the facts.

Learning Style Inventory

While ELT professes a varied exposure to the four modes and styles, Kolb observed that individuals would gradually condition themselves to *prefer* a particular learning style. Thus, he developed the Learning Style Inventory (LSI) to determine this preference. Kolb constructed LSI to adhere to a few basic tenets. The first is that LSI should resemble an actual learning experience for the user, thereby forcing the survey respondent to address their partiality between concrete vs abstract prehension and reflective vs active transformation. Secondly, Kolb made LSI a self-assessment, convinced that people's description of themselves would better represent their true self than a performance test would show. Lastly, he wanted a valid, simple, yet candid assessment that could provide virtually instant feedback.

The LSI has undergone several revisions since its creation in 1969, but we employed Version 3.1, published in 2005, for our research. This version has undergone a multitude of different studies (e.g., Kayes 2005; Ruble and Stout 1991; Veres et al. 1991) confirming internal consistency reliability, which is a robust indication of validity. On top of which, its mainstream use in measuring learning styles (Kolb and Kolb 2005) and for its applicability across national and cultural context (Joy and Kolb 2009; Yamazaki 2005) offer further justification for its selection. For each of the 12 questions within the LSI, the respondent ranks four statements that complete a sentence stem (e.g., 'I learn best when') on an ipsative scale of 1 to 4 in a manner reflecting their preferences. The results include scores that highlight the emphasis that respondents place on each of the four modes (CE, RO, AC, and AE), and a derivative score that indicates their preference on the dimensional scales (AC-CE, AE-RO).

One component from the body of education theory seeks to understand the impact that an individual's learning style imparts on knowledge prehension and transformation. The study of

learning styles is typically confined to academic contexts, such as curriculum development and cross-cultural learning. We apply the same theory of learning style to a post-disaster reconstruction setting. Using Kolb's experiential learning theory as a lens, this paper identifies communities' preferred learning styles and analyzes training programs according to ELT's learning modes.

Research Method

This research aimed to characterize residential post-disaster construction training programs and identify community members' preferred learning styles. To accomplish this, we selected a mixed method research design. Mixed methods research is defined as 'the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration' (Johnson et al. 2007 p. 123). The narrative data adds context and meaning to the numerical data derived from the Kolb LSI survey. Conversely, the LSI data corroborate and add precision to the interview accounts. In the end, the two sets of data become mutually beneficial. We conducted this research within three communities in Eastern Samar, Philippines following Typhoon Haiyan.

Research Context

In November 2013, Typhoon Haiyan decimated a large swath of the central Philippines. All told, the storm killed over 6,000 people, injured almost 29,000, destroyed or damaged 1.1 million homes and cost over \$12.9 billion in economic impacts (Del Rosario 2014; NEDA 2013). By February 2014, over 65 nations and private donors contributed close to \$663 million (USD) in relief aid in areas ranging from logistics, shelter, water, sanitation, and economic recovery (Lum and Margesson 2014). Numerous international organizations assisted the Philippines throughout early post-disaster response and recovery, with many of these aid organizations helping with

shelter reconstruction projects. To provide context on the national culture of the Philippines, we turn to Hofstede (2001), who states that there are cultural dimensions that distinguish countries from one another. Examining the Philippines through Hofstede’s cultural dimension scores, we find that the Philippines scored relatively high on ‘Power Distance’, thus revealing a hierarchical society and low on ‘Individualism’, suggesting the Philippines’ affinity toward collectivism, notably centered around the family unit; and low on ‘Long-Term Orientation’, suggesting they are normative in their thinking, closely adhering to established traditions, taking a cautious view of any proposed social change, and focus on achieving quick results.

Community Selection

We collected and analyzed data within three communities from Eastern Samar – Cantahay, Cogon, and Sulangan. We selected these communities because they had similar damage levels from the typhoon and were comparable in size and socio-economic demographics, but they had different implementing organizations, which resulted in the implementation of different post-disaster recovery training strategies. Additionally, the population size and shelter reconstruction plan, summarized in Table II-1 below, are notably similar as to draw comparisons across communities.

Barangay	Population (2010)	Shelters	
		Planned	Completed
Cantahay	1,118	169	105
Cogon	1,146	132	133
Sulangan	3,597	300	100

Table II-1: Number of Shelters

We selected a community (or barangay—the lowest political level within the Philippines) as the unit of analysis for our research since a regional breakdown was too broad and individual households too specific. A community includes the active participation of aid organizations’

leadership and members, along with local stakeholders categorized as government officials, shelter beneficiaries or skilled laborers.

Data Collection

Within the three communities identified for analysis, data collection occurred in two distinct phases. In the first phase, the research team's second author conducted semi-structured interviews with project stakeholders (e.g. community members and aid organizations) that focused on identifying training methods employed at different recovery stages. We employed a snowball sampling technique that incorporated consultation from aid organizations working on the ground to achieve diversity in opinions and involvement. Respondents were selected from the communities who both actively participated in a construction training program and those that did not participate. Interviews were conducted in the native language of Waray with the help of a translator. These interviews were then translated and transcribed into English. Within the three communities, 42 interviews were conducted—six with respondents from three separate aid organizations and 38 with local stakeholders.

In the second phase of research, we collected additional quantitative data from within the selected communities. A local research assistant, familiar with the region and a native Waray speaker, administered a written survey to community members that collected basic demographic information along with administering Kolb's LSI. The research assistant translated the survey responses, conveyed in the native Waray dialect, into English for our analysis. We wanted to ensure a representative sample of participants, including both males and females, and obtain responses from individuals who had participated in a structured training program. Of the 118 total responses, 47% (56 respondents) were male, 53% (62) were female, and 34% (40) noted they had participated in a structured training program.

Data Analysis

Qualitative Analysis

We imported the interview transcripts into NVivo coding software to conduct content analysis. We blended our approach by including deductive and inductive coding that generated relevant themes for further analysis. Our initial coding structure used ‘top-down’ or deductive information derived from experiential learning theory and were revised through ‘bottom-up’ or inductive refinement that incorporated any emergent categories (Fereday and Muir-Cochrane 2006). Overall, our analysis initially unpacked the training methods employed by aid organizations, then subsequently categorized these methods according to ELT’s learning modes. In order to ascertain accuracy, we continually reviewed the data for coding and categorized various aspects according to the established themes (Creswell 2013). An undergraduate researcher assisted by coding the data independently. The research team met on an iterative basis to verify the coding dictionary and discuss emergent themes. Using NVivo software, we ran a coding comparison across pertinent nodes (e.g. ELT mode) and sources (e.g. community members). The inter-rater reliability score, in the form of Cohen’s Kappa coefficient, averaged across interviews was 0.68, suggesting sufficient agreement. Kappa scores in excess of 0.4 are considered acceptable, whereas scores over 0.8 are considered excellent (Munoz and Bangdiwala 1997).

The final codebook contained several categories (See Appendix A), but for the scope of this paper, we will focus on the following major themes: **Training Methods; Training Objectives; and Community Perception**. Training methods stemmed from our deductive coding, which categorizes the employed training methods to the learning modes of ELT. For example, when an interviewee said ‘*Yes, there were lectures done, like on the measurements, and they were taught how to use the carpenter’s meter. That was important, how to use the meter,*’ we coded it

as lecture format, which in turn deductively relates in ELT terms to reflective observation. Training objectives and community perception emerged through the process as prominent themes. As an example for one these themes, one shelter beneficiary stated, '*I have learned some new things in this construction, like making the rings [rebar stirrups] on the steel bars. They are using a different way from what we used to do here.*' This statement fits into the Community Perception theme, which we then coded inductively as a positive sentiment.

Quantitative Analysis

To understand the learning style preferences of community members, we analyzed and recorded each respondent's answers to Kolb's LSI. To review, the LSI is a 12-question survey that provided statements of learning methods where respondents rate their agreement or disagreement according to their preferences. The completed LSI produces a measurement of six ELT variables that includes four primary scores that are tied to the learning modes (CE, RO, AC, AE) and two combination scores that measure the preference on the two continuums (AE-RO, AC-CE). For example, when a respondent ranked a statement that was *most* preferred, it translated into a score of 4 and conversely a score of 1 meant it was the respondent's *least* preferred statement. Each of the 12 questions correlate to a learning mode and the resulting summation of statement rankings produced its score. With the four primary scores calculated, we derived the combination score by subtracting the two dialectic modes on the two separate continuums (AE – RO; AC – CE). The combination scores for an individual were then plotted.

The next step was to aggregate the individual plots into our unit of analysis: the community. This aggregation incorporated two measures: the mean plot based on the two continuums (AE-RO, AC-CE) and the standard deviation from the mean for the community at-large. We derived the mean by plotting the average AE-RO score on the *x*-axis and the AC-CE average on the *y*-axis.

We visually represented the variation of a community's scores by calculating the standard deviation along each continuum, scaled it to the Learning Style Type Grid, and then assigned these values to the dimension of an oval, whose center was the mean plot. The oval's height represented the scaled standard deviation for the AC-CE axis, while the width represents the same for the AE-RO axis.

Key Findings

The key findings of our analysis split according to our two research questions. The first categorizes, in accordance with ELT, the types of training programs employed by aid organizations in the aftermath of Typhoon Haiyan. We analyzed training programs based upon their objectives and methods employed within the community from the qualitative analysis of the interviews with aid organizations and community members, triangulating the results with training materials collected on the ground. These findings first explore the similarities of overall objectives for training programs and then account for the frequency of applied training methods, coded against Kolb's learning modes. Secondly, we present the individual and aggregated community learning style preferences resulting from administering Kolb's LSI within the selected communities.

Training Objectives

It is widely noted in literature that setting training objectives aid significantly in effective knowledge transfer (Kontoghiorghes 2001; Kraiger et al. 1995; Lee and Pucel 1998; McCrudden and Schraw 2007). Optimally, a training program's design should start with needs assessment to determine: organizational goals, where training is needed, and a robust analysis of the training audience in order to determine their learning needs and preferences (Arthur et al. 2003). This process establishes the evaluation criteria needed to conduct an evaluation of how the training program performed on its intended function. The effectiveness of the training program conveys

itself through a specific measure of the intended changes to an individual's skill or behavior. Through the coding process, we found specific references to stated objectives of the three organizations leading shelter projects in the selected communities. Our findings discuss the training objective similarities that all of the organizations emphasized and shared in their interviews. All three organizations studied discussed two distinct training programs within each community—one geared towards the builders of post-disaster shelters and the second centered on training the individual homeowners.

Builder-Centric

For the builder-centric training program, the method of training relied heavily on certification standards from the Filipino government agency known as the Technical Education and Skill Development Authority (TESDA). Enacted in 1994, TESDA's overall purpose is to 'promote and strengthen the quality of technical education and skills development programs to attain international competitiveness' (de Venecia and Angara 1994 p. 2). Within this program, middle-level skilled workers, including carpenters and masons, undergo a structured program that concludes with a certification if trainees meet certain prescribed competency standards. While TESDA's training program does not specifically target post-disaster shelter construction, the certification process remained a highly coveted asset to both aid organizations and shelter beneficiaries who sought to employ builders in disaster-affected areas. All references, no matter the source, spoke positively of having TESDA trained and certified builders. One of the organization's team leaders instructed shelter beneficiaries, '*It's more practical to hire the builders that were trained by TESDA*' and that '*before we started the construction of houses, we have this training with TESDA. The builders and those who were interested attended the training.*' Although certification was not a requirement to work on building shelters, organizations encouraged

community members to hire a trained and certified builder. The Director of Education for an organization described complementary characteristics for builders in that *‘they are the people with the construction experience, they are the builders, they are the people from inside the community, the people that we have worked with before, very familiar with our systems, the best people to train.’*

On top of their TESDA training and prior work experience, skilled builders received additional training from aid organizations on specific construction plans for designed structures. In terms of ELT, an initial lecture-based review of blueprints and technical documents allowed builders to grasp the new design through the lens of the abstract conceptualization mode. The Education Director reinforced the reliance on the document review, by saying, *‘We use the construction documents as the main point of reference for everything. So for all training, there is always the relationship to the construction documents.’* Experienced builders progressed through the ELT cycle by moving out of the classroom, typically to the construction of a ‘pilot’ house that transformed the grasped construction concepts via active experimentation. When asking an organization’s shelter consultant if this step helped assess the builder’s knowledge, he responded, *‘Yeah, by doing rather than having all these theoretical ways to do it.’*

Homeowner-Centric

Whereas the builder received technical instruction on specific construction methods from TESDA, aid organizations indicated that homeowners needed broader and less technical training. A shelter cluster coordinator stated, *‘We train all the beneficiaries at recovery but the expectation isn’t that they will be able to build a house for themselves after this training but rather that they are aware of the key messages.’* The key messages he mentions refer to the ‘Build Back Safer’ initiative found with the UN’s Sendai Framework. In essence, the UN’s success criterion was to

raise awareness of these key messages within communities so that they could better understand the intent of better building practices. Building on this objective theme, the shelter consultant conveyed the importance that raising homeowner awareness of sustainable construction methods is paramount to resiliency by saying, *‘we developed the methodology, we don’t do anything, people will have to do it, [and] we can facilitate and train them to do it.’* He continues by saying a key aspect of their training program is that *‘people can do it [learn] so they can train each other, others can’t do it but they can help each other...and that is resilience.’*

A second stated objective for homeowners was to train them on how to effectively screen and hire competent builders for their homes. An organization’s area team leader described that once they identified a beneficiary for a new shelter, *‘before you [beneficiary] will be given this project, you have to go through first with the homeowners training, to ensure that you can find a builder who will pass the builder’s screening.’* The team leader continued that once a homeowner hires a builder, any subsequent decisions and agreements made (e.g. material purchases) are between them and do not involve the aid organizations. Therefore, the aid organizations deemed builder screening a particularly essential skill to train.

A last collective objective for homeowner training found among the aid organizations was that homeowners needed to know how to procure good, quality materials for building their homes. It is an important aspect as noted by the Director of Education when he said, *‘material quality is included in this training, for [the] homeowner is responsible for that.’* An architect from one of the aid organizations reiterates this point when he said, *‘We explain to them that you will be living in this house so you must know how to choose materials. We usually had training with our consultant engineer and we trained homeowners...how to choose materials that are safe to use in the construction.’*

To summarize, the training objectives set forth by the aid organizations were different for builders and homeowners. The builders, preferably TESDA certified, received technical instruction on how to build the designed shelter by focusing on the provided plans and practical experience on a pilothouse. For homeowners, aid organizations wanted to raise their awareness of resilient building practices, how to screen capable builders properly for hire, and how to procure safe and reliable building materials.

Training Methods

The coding process revealed two distinct attributes of the employed training programs. The first attribute relates to the interviewees' occupation. This ranged from fishermen or unemployed beneficiaries (titled 'homeowner') to individuals that had construction experience who also participated in the shelter building process (titled 'builder'). There were a few cases where these overlapped, such as a fisherman who also actively participated in construction, so they coded as 'mix.' The second attribute classified the training program's delivery method into the four Kolb learning modes. For instance, when a community member spoke of attending a seminar presentation regarding construction methods and processes, but it lacked any participatory activities, this interaction coded as solely within the reflective observation mode. Table II-2 lists the percentage of community members, separated by the aforementioned occupation type, which received training in a manner tied to one of the ELT modes. It is worth noting that 27 of the 28 interviewees received training that classify as reflective observation and members from Cantahay experienced the widest variety of ELT modes.

		Total Respondents	AC (Thinking)		AE (Doing)		CE (Experiencing)		RO (Reflecting)	
Cantahay	Homeowner	5	0%	(0)	20%	(1)	40%	(2)	100%	(5)
	Builder	0	0%	(0)	0%	(0)	0%	(0)	0%	(0)
	Mix	3	33%	(1)	67%	(2)	67%	(2)	100%	(3)
Cogon	Homeowner	6	0%	(0)	0%	(0)	17%	(1)	100%	(6)
	Builder	1	0%	(0)	100%	(1)	0%	(0)	100%	(1)
	Mix	0	0%	(0)	0%	(0)	0%	(0)	0%	(0)
Sulangang	Homeowner	10	0%	(0)	20%	(2)	40%	(4)	100%	(10)
	Builder	1	100%	(1)	0%	(0)	0%	(0)	0%	(0)
	Mix	2	0%	(0)	0%	(0)	50%	(1)	100%	(2)

Table II-2: Relative Frequency by ELT Mode

Further analysis linked these training methods with the training objectives and intended audience. For example, a builder from Cantahay first received an extensive plan overview (AC) and a lecture that included ‘*how to do the construction work, like how to do the flooring, the footing, the posts, and the like*’ (RO). When asked to elaborate, the builder stated the lecture was *just for half a day only, and it was done one morning; in the afternoon we proceeded with the actual house construction.*’ Therefore, aid organizations rounded out a builder’s skill set through additional training on a ‘pilot’ house with the aid of a supervising engineer (AE, CE). The Director of Education explained, ‘*You can look at a construction plan, but you can’t visualize in your mind what it looks like. So, being able to have these completed structures, and being able to do this training in that kind of environment really helps them to build.*’ The combination of all the ELT modes sufficiently provided these builders with the necessary skills to build a reliable structure according to the design drawings.

In contrast, the homeowners experienced vastly different methods of training. The first exposure that homeowners faced occurred during an early coordination meeting hosted by the aid organizations. As a part of this meeting, they presented technical blueprints and photographs of shelters in various stages of construction to future homeowners as a technique, aligning with

reflective observation. A Sulangan beneficiary, when asked if they received an explanation regarding the new shelter design specifications, responded that, *'They just asked us to give it to the carpenters for them to follow.'*

Additionally, the aid organizations across the three communities used these communal lectures to present information that included topics on construction, material purchasing, and preparation tactics. However, there remained a significant absence to any subsequent organizational training that would have satisfied the other ELT modes. Although, it emerged that beneficiaries often sought learning opportunities from within the AE and CE modes through informally observing the builders constructing their house. One respondent, with no construction experience, noted, *'Since they were already skilled carpenters and had undergone training, I got to learn from them.'* These impromptu lessons covered complex topics such as blueprint interpretation to practical construction skills like measurements, nailing, bracing, joints, and foundations.

Community Preferred Learning Style

Using the aggregation method described in the quantitative analysis subsection, Figure II-2 displays the three communities, consisting of mean averages for each continuum, plotted on the respective axis, along with standard deviations, shown as heights and widths of ovals. For further clarification, Table II-3 contains the raw data for the respective community plots. Of note, the Learning Style Type Grid does not follow the standard coordinate plane format. In contrast, the values are reversed in terms of position on each axis. Additionally, the axes do not converge at zero, but instead the AE-RO dimension crosses at +6, while the AC-CE axis crosses at +7.

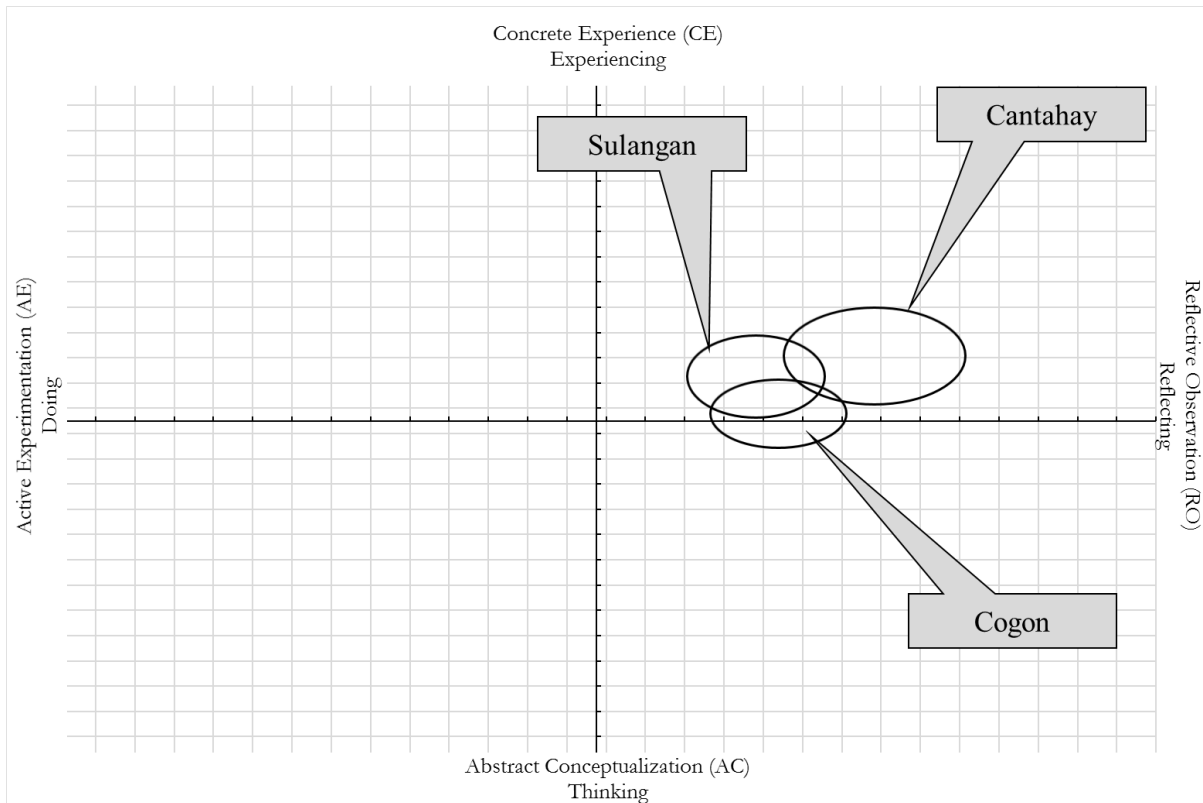


Figure II-2: Aggregated Community Learning Style Inventory

Barangay	Avg AE-RO	Avg AC-CE	Std Dev AC-CE (H)	Std Dev AE-RO (W)
Cantahay	-7.7	1.9	8.1	5.9
Cogon	-2.8	6.4	5.7	4.5
Sulangan	-1.7	3.5	6.8	3.8
OVERALL	-4	3.9	6.9	4.7

Table II-3: Learning Style Inventory Means & Standard Deviations

As Figure II-2 depicts, along the prehension continuum (AC-CE), there remains a varied preference on how communities prefer to grasp new experience. While a majority of community respondents prefer concrete experience, there is a slight partiality for using abstract conceptualization to think about new concepts. The respondents, on the transformation continuum (AE-RO), gravitate toward the reflective observation mode over active experimentation, which speaks to how respondents prefer to transform these grasped experiences. Across all three

communities, therefore, the preferred learning style is primarily diverging, but teeters close to the assimilating style.

Kolb submits the greatest strength of the divergent learning style lies in using ‘imaginative ability’ to gather ‘many perspectives’ in a manner that is best suited for the ‘generation of alternative ideas and implications’ (Kolb 1984 pp. 77–78). Alternatively, the assimilator relies on ‘inductive reasoning’ to incorporate ‘disparate observations into an integrated explanation’ (Kolb 1984 p. 78). While the choice for a lecture-based format suited the emphasis on reflection rather than active experimentation, aid organizations fell short when addressing the need to process newly acquired information. These two descriptions are apt in explaining the importance of alignment in terms of a community’s preferred learning style and that of an aid organization’s approach to teaching sound construction principles.

Discussion

Kolb’s ELT is rooted deeply in the learning process, wherein a learner progresses through the cycle of learning modes (CE, RO, AC, AE) to gain true knowledge of a given subject. The relative emphasis of how a learner grasps (abstract versus concrete) then transforms (active versus reflective) experience into knowledge is defined by Kolb into four learning styles (*convergent, divergent, assimilate, accommodate*). While Kolb highlights the importance of progressing through the learning modes and by default, the learning styles, he accounts for the human tendency to form habits and preferences that stem from experience, skill, and attitude. It should be concluded, therefore, that an effective learning program first acknowledges a learner’s preference, but then purposefully addresses the remaining gaps to complete the cycle of experiential learning. Through analysis of training programs and learning modes, we noted two distinct findings regarding the types of post-disaster training administered: (1) those that actively participated in the

construction of new shelters (skilled workers or those with construction experience) received a wider exposure to each of the learning modes; (2) unskilled homeowners received formal training predominately through lecture (RO), but actively sought out informal experience through observing the construction process (CE).

Builders, therefore, had greater coverage of the ELT cycle, through detailed plan reviews, demonstrations on pilot shelters, and active construction work. The broad exposure of multiple modes, coupled with relying on the process of experiential learning, pushes these builders into a more complex form of development. Kolb calls this a ‘shift in the frame of reference used to experience life, evaluate activities, and make choices’ that results in an ‘increasing experience of self as *process*’ (Kolb 1984 p. 210). In other words, skilled builders trained in this manner gain control of their interactions with the environment by better integrating the techniques of the four modes in increasingly complex scenarios. Instead of merely giving the answer, they are equipped with the process to finding their own answer.

Conversely, aid organizations had a tendency to employ fewer of the learning modes for homeowners, mainly providing lecture-based seminars. By only providing one mode of learning, this form of training did not accommodate all learning styles, nor did it emphasize various aspects of the learning cycle as prescribed by ELT. While lectures accurately aligned with the community preference toward grasping new experiences, aid organizations fell short when providing learning opportunities for processing the presented concepts. Active demonstration or practical exercises that incorporate construction work would have adequately addressed this gap in the learning process.

The practicality of administering a construction training program to entire communities that also adheres to the entire process expounded by ELT has its restrictions. Limited resources in

the form of finances, materials, time, and participation hamper the ability of aid organizations to teach in a comprehensive way. Yet, our exploratory research suggests that focusing the resources on the builders, and training the builders to educate the community members, may offer the best opportunity to offer post-disaster training to the community. With this, we suggest that aid organizations could maintain the processional learning (lecture, model house demonstrations, actual construction work), but add a ‘train-the-trainer’ program to the curriculum that empowers builders to teach relevant construction knowledge to housing beneficiaries during construction. This will concentrate scarce resources to targeted audiences (builders) who can then multiply the impact of the training without burdening already taxed aid organizations.

Limitations and Future Work

We acknowledge several limitations in the LSI. For instance, there is little empirical evidence that shows the predicative ability of the LSI results towards an individual’s performance in knowledge transfer, understanding, and application (Koob and Funk 2002; Manolis et al. 2013). Furthermore, Kolb claims that learners need to learn immersed within all four learning styles, yet his LSI ipsative rating scale forces respondents to narrowly choose between the four statements (Henson and Hwang 2002; Kayes 2005). There is also no room for flexibility or comparative analysis (i.e., it is impossible to score as strong or weak in all four styles), and, by identifying a single preferred style, it makes it impossible to identify relevant substyles (Manolis et al. 2013). However, we believe that analyzing the predominant learning style within a community, and comparing this to the learning modes that existing training programs accommodate, offers new insights that will help improve post-disaster training programs. Specifically, we hypothesize that if an aid organization, set to teach a community better construction practice, customizes their teaching methods to accurately fit the dominate learning styles of the target audience, the retention

and application of the new knowledge will improve. This may result in stronger civil infrastructure construction, thus increasing resiliency within the community.

This leads us to recommendations for future work. Specifically, we encourage work that will administer construction knowledge examinations that test respondent's understanding and retention of the UN's 'Build Back Safer' themes. Administering this test, and comparing test results to the learning modes of training programs, will help future work determine the effectiveness of training programs. Furthermore, additional research could conduct a longitudinal study to determine if achieving learning objectives changes behaviors in regards to construction and maintenance of resilient and sustainable infrastructure systems. Moreover, future work could analyze the root causes for differences in knowledge retention and application by community members, be it the impact of learning style within different cultures and contexts, specific demographic variables, or a multitude of overlapping characteristics that emerge.

Conclusion

We analyzed the learning modes provided in post-disaster construction training programs, bridging the disconnect in literature between disaster, educational and organizational theories. Much of existing knowledge in the project organization community that crosses these boundaries stems from studies at the national level (e.g., Chinowsky et al. 2011; Tsai and Chi 2011). Our findings provide new insights that connect program and individual attributes. Further, while educational research has traditionally focused on formal academic institutions (e.g., Skipper and Brandenburg 2013), our analysis investigates technical skills development in field construction. Through the application of Kolb's experiential learning theory, we applied one educational theory into a previously under-represented domain (disasters). In this light, we have categorized the

training programs administered by organizations recovery efforts following Typhoon Haiyan according to Kolb's ELT.

Our analysis shows that builders had greater exposure to the full cycle of ELT modes, not only from organizational training programs, but also through past construction work and the TESDA formalized certification program. For the case of homeowners, this group predominately received structured training in the form of seminars and lectures that we solely linked to the RO mode. However, as the LSI results convey, the three communities tend to gravitate toward RO instructional methods when grasping new experiences. Yet, as Kolb describes, 'more powerful and adaptive forms of learning emerge when these strategies [learning styles] are used in combination' (Kolb 1984 p. 65). Intuitively, homeowners sought out additional learning opportunities outside the organized classroom that crossed the AE and CE modes by observing the construction of their new shelter. By watching, or even participating in the construction process, they transformed their conceptual knowledge into applicable skills.

Practically, aid organizations should promote the additional role of skilled builders as educators for unskilled homeowners during actual construction. This inclusion of builders as trainers promotes efficient use of scarce funding while maximizing inclusion of homeowner oversight in construction. By focusing on a select audience of experienced skilled builders and establishing training objectives grounded in ELT, training programs can increase the resilience of communities and infrastructure.

References

Arthur, W., Jr., Bennett, W., Jr., Edens, P. S., and Bell, S. T. (2003). "Effectiveness of training in organizations: A meta-analysis of design and evaluation features." *Journal of Applied Psychology*, 88(2), 234–245.

- Asharose, Saizen, I., and Sasi, P. (2015). "Awareness Workshop as an Effective Tool and Approach for Education in Disaster Risk Reduction: A Case Study from Tamil Nadu, India." *Sustainability*, 7(7), 8965–8984.
- Barakat, S. (2003). *Housing reconstruction after conflict and disaster*. Overseas Development Institute, London, England.
- Barenstein, J. D. (2006). *Housing reconstruction in post-earthquake Gujarat: a comparative analysis*. Humanitarian Practice Network, Overseas Development Institute, London, England.
- Chinowsky, P., Hayles, C., Schweikert, A., Strzepek, N., Strzepek, K., and Schlosser, C. A. (2011). "Climate change: comparative impact on developing and developed countries." *Engineering Project Organization Journal*, 1(1), 67–80.
- Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed-method approaches*. Sage Publications, Los Angeles.
- Davidson, C. H., Johnson, C., Lizarralde, G., Dikmen, N., and Sliwinski, A. (2007). "Truths and myths about community participation in post-disaster housing projects." *Habitat International*, 31(1), 100–115.
- Del Rosario, E. (2014). "Effects of Typhoon Haiyan." Nation Disaster Risk Reduction and Management Council.
- Dewey, J. (1938). *Experience and Education*. Kappa Delta Pi, West Lafayette.
- Fallahi, A. (2007). "Lessons learned from the housing reconstruction following the Bam earthquake in Iran." *The Australian Journal of Emergency Management*, 22(1), 26–35.
- Fereday, J., and Muir-Cochrane, E. (2006). "Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development." *International Journal of Qualitative Methods*, 5(1), 80–92.
- Grochow, J. (1973). "Cognitive Style as a Factor in the Design of Interactive Decision-Support Systems." Ph.D dissertation, Massachusetts Institute of Technology, Sloan School of Management.
- Guha-Sapir, D., Hoyois, P., and Below, R. (2015). *Annual Disaster Statistical Review: Numbers and Trends 2014*. Centre for Research on the Epidemiology of Disasters, Brussels, Belgium, 54.
- Henson, R. K., and Hwang, D.-Y. (2002). "Variability and prediction of measurement error in Kolb's learning style inventory scores a reliability generalization study." *Educational and Psychological Measurement*, 62(4), 712–727.

- Hofstede, G. (2001). *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations*. Sage Publications, Inc., Thousand Oaks, CA.
- Hudson, L. (1966). *Contrary Imaginations*. Penguin Books, Ltd, Middlesex, England.
- ISDR. (2007). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*. Geneva, Switzerland.
- Jha, A. K. (2010). *Safer Homes, Stronger Communities: A Handbook for Reconstructing After Natural Disasters*. The World Bank.
- Johnson, R. B., Onwuegbuzie, A. J., and Turner, L. A. (2007). "Toward a Definition of Mixed Methods Research." *Journal of Mixed Methods Research*, 1(2), 112–133.
- Joy, S., and Kolb, D. A. (2009). "Are there cultural differences in learning style?" *International Journal of Intercultural Relations*, 33(1), 69–85.
- Kayes, D. C. (2005). "Internal validity and reliability of Kolb's learning style inventory version 3 (1999)." *Journal of Business and Psychology*, 20(2), 249–257.
- Kolb, A. Y., and Kolb, D. A. (2005). *The Kolb Learning Style Inventory—Version 3.1 2005 Technical Specifications*. HayGroup, Boston, MA, 1–72.
- Kolb, D. A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. Prentice-Hall, Englewood Cliffs.
- Kontoghiorghes, C. (2001). "Factors affecting training effectiveness in the context of the introduction of new technology - A US case study." *International Journal of Training and Development*, 5(4), 248:60.
- Koob, J. J., and Funk, J. (2002). "Kolb's learning style inventory: Issues of reliability and validity." *Research on social work practice*, 12(2), 293–308.
- Kraiger, K., Salas, E., and Cannon-Bowers, J. A. (1995). "Measuring knowledge organization as a method for assessing learning during training." *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 37(4), 804–816.
- Lawther, P. M. (2009). "Community involvement in post disaster re-construction - case study of the British red cross Maldives recovery program." *International Journal of Strategic Property Management*, 13(2), 153–169.
- Lee, K., and Pucel, D. J. (1998). "The perceived impacts of supervisor reinforcement and learning objective importance on transfer of training." *Performance Improvement Quarterly*, 11(4), 51–61.
- Lewin, K. (1951). *Field Theory in Social Sciences*. Harper & Row, New York.

- Lum, T., and Margesson, R. (2014). "Typhoon Haiyan (Yolanda): US and International Response to Philippines Disaster*." *Current Politics and Economics of South, Southeastern, and Central Asia*, 23(2), 209.
- Manolis, C., Burns, D. J., Assudani, R., and Chinta, R. (2013). "Assessing experiential learning styles: A methodological reconstruction and validation of the Kolb Learning Style Inventory." *Learning and Individual Differences*, 23, 44–52.
- McCrudden, M. T., and Schraw, G. (2007). "Relevance and Goal-Focusing in Text Processing." *Educational Psychology Review*, 19(2), 113–139.
- Munoz, S. R., and Bangdiwala, S. I. (1997). "Interpretation of Kappa and B statistics measures of agreement." *Journal of Applied Statistics*, 24(1), 105–112.
- NEDA. (2013). "Reconstruction Assistance on Yolanda." National Economic and Development Authority.
- Olshansky, R. B. (2009). "The Challenges of Planning for Post-Disaster Recovery." *Building Safer Communities: Risk Governance, Spatial Planning and Responses to Natural Hazards*, 58, 175.
- Piaget, J. (1973). *To Understand is to Invent: the Future of Education*. Grossman Publishers, New York.
- Prince, M. J., and Felder, R. M. (2006). "Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases." *Journal of Engineering Education*, 95(2), 16.
- Ruble, T. L., and Stout, D. E. (1990). "Reliability, construct validity, and response set bias of the revised learning style inventory (LSI-1985)." *Educational and Psychological Measurement*, (50), 619–629.
- Ruble, T. L., and Stout, D. E. (1991). "Reliability and classification stability, and response set bias of alternative forms of the learning style inventory (LSI-1985)." *Educational and Psychological Measurement*, 51(2), 481–489.
- Skipper, C. O., and Brandenburg, S. (2013). "Emotional intelligence and academic performance of engineering students." *Engineering Project Organization Journal*, 3(1), 13–21.
- Sullivan, M. (2003). "Integrated recovery management: A new way of looking at a delicate process." *Australian Journal of Emergency Management, The*, 18(2), 4–27.
- Thayaparan, M., Siriwardena, M., Malalgoda, C. I., Amaratunga, D., Lill, I., and Kaklauskas, A. (2015). "Enhancing post-disaster reconstruction capacity through lifelong learning in higher education." *Disaster Prevention and Management: An International Journal*, 24(3), 338–354.

- Thwala, W. D. (2005). "Employment creation through the provision of low cost housing in South Africa." *Proceedings of the XXXIII IAHS World Congress on Housing: Transforming Housing Environments through Design, Pretoria, South Africa*, 27–30.
- Torrealba, D. (1972). "Convergent and Divergent Learning Styles." Master's Thesis, Massachusetts Institute of Technology, Sloan School of Management.
- Tsai, J.-S., and Chi, C. S. F. (2011). "Dysfunction of governmental emergency management system for natural disaster: a case study of Taiwan Xiaolin village." *Engineering Project Organization Journal*, 1(2), 107–119.
- Tuladhar, G., Yatabe, R., Dahal, R. K., and Bhandary, N. P. (2015). "Disaster risk reduction knowledge of local people in Nepal." *Geoenvironmental Disasters*, 2(1).
- UNISDR. (2015). *Sendai Framework for Disaster Risk Reduction 2015-2030*. Geneva, Switzerland, 37.
- de Venecia, J., and Angara, E. (1994). *Technical Educational and Skills Development Act of 1994*. 22.
- Veres, J. G., Sims, R. R., and Locklear, T. S. (1991). "Improving the reliability of Kolb's revised learning style inventory." *Educational and Psychological Measurement*, 51, 143–150.
- Yamazaki, Y. (2005). "Learning styles and typologies of cultural differences: A theoretical and empirical comparison." *International Journal of Intercultural Relations*, 29(5), 521–548.

CHAPTER III: EXPLORATORY ANALYSIS OF FACTORS THAT INFLUENCE RETENTION OF CONSTRUCTION KNOWLEDGE IN POST-DISASTER COMMUNITIES

Abstract

Disasters are an ever-present reality throughout the world, but their effects are particularly felt in vulnerable areas that are unequipped and unprepared to face the challenges disasters entail. Often, international aid organizations provide needed support and assistance particularly in terms of shelter reconstruction. Yet these organizations have begun to include training programs among their shelter assistance efforts aimed at developing disaster resilient communities through construction education. However, it is unclear what factors influence the ability of communities to retain and recall this training for future application. To address this gap in knowledge, a survey of 19 communities in the Philippines affected by the 2013 Typhoon Haiyan collected demographic information as well as administered a construction knowledge test. This test examined respondents' understanding of risk-reducing construction principles outlined in the Global Shelter Cluster's 8 Key Messages. Multivariate data analysis that included cluster and factor analysis simplified the large data set to better interpret the results and determine relevant conclusions. One major finding from cluster analysis indicated that higher performing communities also had higher rates of participation in formalized training programs. Factor analysis uncovered three relationships between the 8 individual key messages, categorized by how disaster effects are mitigated through structural resilience, site selection and roof performance. In combination, the two analyses showcase the need to understand the inherent contextual traits, be it of the community or curriculum, as it applies to influencing retention of knowledge.

KEYWORDS: Training, Disasters, Multivariate Data Analysis

Introduction

Disasters are on the rise, not only in frequency, but also in their effect on people and their built environment. Data from 2005 to 2014, compiled by the U.N. Office for Disaster Risk Reduction, shows that disasters account for approximately \$1.7 trillion in damage, while affecting 1.7 billion people (UNISDR 2015b). While it is impractical to engineer the world against all disasters, organizations assisting communities in post-disaster setting can help train communities to build safer structures that can better withstand disaster effects. Standing committees, such as the Global Shelter Cluster, help to coordinate country-level shelter clusters with the aim of “strengthening the shelter response of humanitarian actors through leadership, coordination and accountability” (Shelter Cluster 2012). In an effort to serve the communities effectively and avoid reliance on aid organizations, the shelter has begun establishing key messages to train community members on disaster risk reduction construction techniques.

However, there is a dearth of literature that determines if this knowledge is retained within communities and the factors that affect retention of the key messages. Thus, I conducted an exploratory analysis of factors that affect the retention and recollection of knowledge learned through post-disaster training within the context of the Philippines after a massive and destructive typhoon landed in 2013. I first analyzed the characteristics shared between communities based upon their performance on a post-disaster questionnaire:

RQ₁: What are the characteristics of communities that had similar performances when recalling construction knowledge?

A separate analysis was then performed to examine the inherent relationships between themes in the 8 Key Messages based upon performance on the questionnaire. I ask:

RQ2: How are the individual themes within the 8 Key Messages connected in terms of performance?

Ultimately, the combination of these two analyses can provide practitioners valuable insight that will aid in the development of further training programs for a variety of contexts.

Point of Departure

This research focused on the context of the Philippines following Typhoon Haiyan and the retention of the 8 Key Messages the Global Shelter Cluster developed for communities to construct improved shelters. Below, I discuss the disaster and the 8 Key Messages developed to assist in building back safer.

In November 2013, Typhoon Haiyan decimated a large swath of the central Philippines (See Figure III-1). All told, the storm killed over 6,000 people, injured almost 29,000, destroyed or damaged 1.1 million homes and cost over \$12.9 billion in economic impacts (Del Rosario 2014; NEDA 2013). By February 2014, over 65 nations and private donors contributed close to \$663 million



Figure III-1: Typhoon Haiyan Pathway

(USD) in relief aid in areas ranging from logistics, shelter, water, sanitation, and economic recovery (Lum and Margesson 2014). Numerous international organizations assisted the Philippines throughout early post-disaster response and recovery, with many of these aid organizations helping with shelter reconstruction projects.

Global Shelter Cluster & Build Back Safer Messages

Born from the Humanitarian Reform of 2005, the United Nations adopted the cluster system to address the myriad of global humanitarian requirements. The established 11 clusters each have a dedicated focus (e.g., health and food security), the sum of which addresses the main sectors of humanitarian actions. Each cluster consists of humanitarian organizations, both UN and non-UN, that form partnerships and act upon needs within a given focus.

One of these clusters, the Global Shelter Cluster (GSC), has a mandate to support people displaced by natural disasters or conflict. The cluster is co-chaired by the International Federation of Red Cross and Red Crescent Societies (IFRC) and the United Nations High Commissioner for Refugees (UNHCR). The IFRC convenes the GSC during natural disasters, as was the case for Typhoon Haiyan, and coordinates shelter support, housing construction, and settlement planning. With typhoons as the leading hazard identified within the greater Pacific region, the GSC sought to establish a common understanding of appropriate shelter construction practices. As a result, they developed ‘8 Build Back Safer Key Messages’. These messages (See Appendix B) include:

- (1) Foundations,
- (2) Tie-downs
- (3) Bracing
- (4) Joints
- (5) Roofing
- (6) Site selection
- (7) Building shape
- (8) Preparedness

This collection of simplified construction principles aimed to provide simple, agreed upon tips of how to improve housing being constructed by communities. A primary aim of which was

to have government and non-governmental agencies providing same messages, and to have community members directly use and learn from the messages. The messages were translated into 8 languages within the country and have been translated and used in a range of other similar disasters contexts (Humanitarian Benchmark 2015).

Research Method

I analyzed retention of the 8 Key Messages for shelter reconstruction by collecting and analyzing data within 19 barangays, the lowest political level, within three provinces of the Philippines – Leyte, Cebu, and Eastern Samar. Below, I provide a summary of the barangays, followed by the development of the survey used to assess retention of the eight key messages. I then describe data collection methods and the initial analysis of the survey. Following this, I break the analysis and discussion of the results into two sub-questions: what demographic characteristics are shared between high and low performing communities and how do the individual themes within the 8 Key Messages relate to one another? Based upon these results, I conclude with the implications for practitioners.

Barangay Summary

I selected a barangay as the unit of analysis for our research since a provincial breakdown was too broad and individual households too specific. I selected these communities because they had similar damage levels from Haiyan and were comparable in size and socio-economic demographics (See Table III-1: Community Selection). As much as they shared, they differed in terms of disaster recovery processes. While all received assistance through formal organizational efforts, the way recovery unfolded varied, ranging from self-recovery to housing provided by an NGO or government agency. Overall, the demographic similarities along with the comparable

damage assessments assisted with isolating the varied recovery experiences across the cases. This aided in explaining a portion of the variability within the construction knowledge test.

Province	Case	Barangays	Respondents	Population (2010)	Shelters Complete	Aid Duration (Months)
Cebu	1	Okoy, Santa Fe	71	3,532	230	12
	2	Maricaban, Santa Fe	61	2,999	118	36+
	3	Poblacion, Santa Fe	48	2,345	40	12
	4	Sungko, Bantayan	67	3,296	183	11
	5	Sillon, Bantayan	80	4,064	75	11
	6	Kankaibe, Bantayan	52	2,635	348	18
Leyte	7	Tagpuro, Tacloban	20	677	86	4
	8	Pago, Tanauan	20	917	365	36
	9	New Kawayan, Tacloban	20	543	148	7
	10	Bagacay (93), Tacloban	80	3,936	150	7
	11	San Agustin, Jaro	20	824	363	36
	12	San Jose (83C), Tacloban	51	2,548	42	11
	13	Magallanes (52), Tacloban	28	1,304	199	18
	14	San Jose (85), Tacloban	31	1,572	234	5
	15	Hiabangan, Dagami	20	958	165	12
	16	Saghakan (62), Tacloban	94	1,434	484	19
Eastern Samar	17	Sulangan, Guiuan	73	3,597	63	36
	18	Cogon, Guiuan	23	1,146	133	12
	19	Cantahay, Guiuan	22	1,118	105	12

Table III-1: Community Selection

Development of the Questionnaire

8 Key Messages

To assess construction knowledge, the research team developed a 15-question survey (See Appendix C), based on GSC's technical guidance published within the 8 Key Messages. Questions included a combination of true/false, multiple choice (select one and select all that apply) and rank-order. Table III-2 includes the theme, type, and description of each question:

Question #	Theme	Type	Description
1	Foundation	Rank-Order	Strongest (1) to Weakest (7)
2	Bracing	Rank-Order	Strongest (1) to Weakest (4)
3	Tie-Downs	Rank-Order	Strongest (1) to Weakest (4)
4	Joints	Rank-Order	Strongest (1) to Weakest (6)
5	Roofs	Rank-Order	Best (1) to Worst (3)
6	Roofs	Rank-Order	Strongest (1) to Weakest (3)
7	Shape	Multiple Choice	Select One (4 Pairs)
8	Foundation	Multiple Choice	Select All that Apply (1 Negative)
9	Location	Multiple Choice	Select One
10	Joints	True/False	
11	Bracing	Multiple Choice	Select One
12	Roofs	Multiple Choice	Select One
13	Roofs	True/False	
14	Roofs	True/False	
15	Preparation	Multiple Choice	Select All that Apply (2 Negative)

Table III-2: Question Descriptions

Standards were taken verbatim from Shelter Cluster documentation. For example, when asking about bracing within Question 2, four alternatives were listed with a picture and description. The respondent was then asked to rank the four configurations in order from strongest to weakest (See Figure III-2). According to information presented in the 8 Key Messages, the Nail Timber and Steel Strap option is deemed the ‘strongest’, therefore response is ranked 1. Similarly, the option labeled Nail Timber is listed as ‘stronger’, therefore, this is ranked 2 among the options provided on the survey. Lastly, the two alternatives titled Thick Steel Wire and Rebar are both considered equals, with a description of ‘strong’ according to the 8 Key Messages, but not as strong as the previous two alternatives. Therefore, each of these are ranked 3.

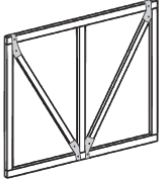
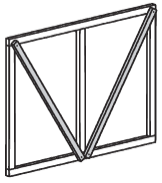
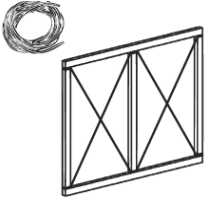
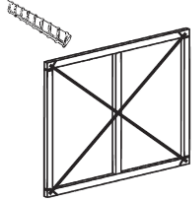
				
Alternative	Nail Timber & Steel Straps	Nail Timber	Thick Steel Wire	Rebar
GSC Ranking	Strongest	Stronger	Strong	Strong
Rank Order	1	2	3	3

Figure III-2: Question 2 Example

Scoring Questionnaire Responses

To score a respondent’s answer to Question 2, I determined the distance away from the correct rank order, which was the ‘score’. The lower the score, the closer the response was to the correct order and vice versa. For example, if a respondent placed the Rebar option as the strongest, they would be two (2) rank order spots from the correct position. Each position was compared in the same manner and the summation of the individual distances determined the overall score.

Within this example for Question 2, the possible scores included 0, 2, 4, and 6 (See Table III-3).

Question #	Theme	Type	Theoretical Scoring Space
1	Foundation	Rank-Order	0 2 4 6 8 10 12
2	Bracing	Rank-Order	0 2 4 6
3	Tie-Downs	Rank-Order	0 2
4	Joints	Rank-Order	0 2 4 6 8 10
5	Roofs	Rank-Order	0 2 4
6	Roofs	Rank-Order	0 2 4
7	Shape	Multiple Choice	0 1 2 3 4
8	Foundation	Multiple Choice	-1 0 1 2 3 4 5 6
9	Location	Multiple Choice	0 1
10	Joints	True/False	0 1
11	Bracing	Multiple Choice	0 1
12	Roofs	Multiple Choice	0 1
13	Roofs	True/False	0 1
14	Roofs	True/False	0 1
15	Preparation	Multiple Choice	-2 -1 0 1 2 3 4 5 6
			Minimum -3
			Maximum 60

Table III-3: Scoring Possibilities per Question

In a similar manner, true/false and multiple-choice questions had possible scores of 0 or 1, where 0 was a correct response and 1 was incorrect. The difference between them being that true/false had only one correct choice, whereas the multiple-choice questions had several correct choices depending on the nature of the question. Additionally, two multiple-choice questions (#8 and #15) had incorrect answers among the possible options. To account for these, if a respondent correctly chose *not* to select them, they were rewarded with a score of -1, thus lowering their overall score. The scoring format for the 15-question test netted a possible range of scores from -3 to 60. As stated earlier, a lower score not only within each score, but also aggregated across the 15 questions, signified that the responses reflected the 8 Key Messages more accurately.

Other Questionnaire items

In addition to the construction knowledge test, the survey collected information on the respondent's demographics and information on their learning style. These were included to stratify the test scores beyond merely using location and to determine which, if any, traits could explain test performance. Standard demographic information (age, gender, etc.) was aimed at further describing a community's make-up, while also supplementing with questions revolving around the collective experience (training participation and construction work history) of the community members. The justification for inclusion of Kolb's Learning Style Inventory into the survey derived from an early hypothesis that a respondent's preferred learning style would thereby influence the ability to retain and recall construction knowledge.

Demographics

Standard variables, such as gender and age, were meant to stratify the respondents beyond their community's location. The inclusion of the remaining demographics stemmed from early hypotheses centered on what influences a person's ability to retain and recall information,

especially construction knowledge. As such, I collected respondents' construction experience both before and after Typhoon Haiyan, along with their history with formal education, and participation in any organized training program post-disaster. I also asked respondents to rate their proficiency level with English, as it might influence their ability to understand the material presented by NGOs. By asking if respondents were native to the community, I expected to examine the influence on test scores derived from a local understanding of the environment, culture, building materials, hazard threats, and construction practices.

Kolb's Learning Style Inventory

I also administered Kolb's Learning Style Inventory (LSI) in conjunction with the construction knowledge test (Zerio et al. 2016). To understand the learning style preferences of community members, I analyzed and recorded each respondent's answers to Kolb's LSI. Kolb's LSI is a 12-question survey that provided statements of learning methods where respondents rate their agreement or disagreement according to their preferences. The completed LSI produces a measurement of six ELT variables that includes scores for each of the four learning modes (CE, RO, AC, AE) and two combination scores that measure the respondent's preference on the two continuums (AE-RO, AC-CE). For example, when a respondent ranked a statement that was *most* preferred, it translated into a score of 4; conversely, a score of 1 meant it was the respondent's *least* preferred statement. Each of the 12 questions correlate to a learning mode and the resulting summation of statement rankings produced its score. With the four primary scores calculated, I calculated the combination score by subtracting the two dialectic modes on the two separate continuums (AE – RO; AC – CE). A respondent's position on the two continuums signals an affinity to one of Kolb's four learning styles: convergent, assimilative, divergent, and accommodative.

Data Collection

In total, this research surveyed 881 respondents from across the 19 studied communities (see Table III-1 for a breakdown of responses by community). Surveys were provided in written format and provided in the native language of the household, either Bisaya or Waray. Households were selected using a stratified random selection, using puroks (neighborhoods) as the strata. This geographic approach to sampling was selected in the absence of any database to perform true random selection methods. Minimum sample sizes were determined for each community using populations and expected variance in test score data. A minimum threshold of 20 questionnaires per community was set above the minimum thresholds for sample size calculations.

A local research assistant, familiar with the region and a native Waray speaker, administered the written survey to community members that began with selected demographic information, Kolb's LSI, and the construction knowledge test. The research assistant translated the survey responses, conveyed in the native Waray dialect, into English for our analysis. I wanted to ensure a representative sample of participants, including both males and females, and obtain responses from individuals who had participated in a structured training program. Of the 881 total responses, 46% (417 respondents) were male, 54% (464) were female, and 22% (193) noted they had participated in a structured training program.

Initial Data Analysis

Due to the large volume of data, this exploratory analysis began with a cursory examination of the test results. To do this, the raw data was organized based upon two distinct characteristics. The first grouped test results by location. Considering that each locale received a varied experience in terms of training and exposure to the 8 Key Messages, an early hypothesis assumed this would produce significant variability in the results. The second compiled results within each of the 8 Key

Message themes. This entailed combining scores from individual questions derived from similar themes into an average score per theme (See Table III-4). This first phase of analysis produced visual representations of the test results that aided in the detection of patterns across the two types of characteristics studied.

Theme	Questions
1: Foundations	Q1 Q8
2: Tie-Downs	Q3
3: Bracing	Q2 Q11
4: Joints	Q4 Q10
5: Roofs	Q5 Q6 Q12 Q13 Q14
6: Location	Q9
7: Shape	Q7
8: Preparation	Q15

Table III-4: Questions by Theme

Test Performance

Our initial analysis analyzed individual scores without reference to location or any other demographic variable. The distribution of total scores (See Figure III-3) appeared to follow a normal distribution with a skewness to the left, but failed normality tests for both skewness and kurtosis ($p < 0.05$). Of note, close to two-thirds (63.8%) of the respondents' scores fell between 61% and 80%, while less than half (45.9%) scored a passing grade ($>70%$).

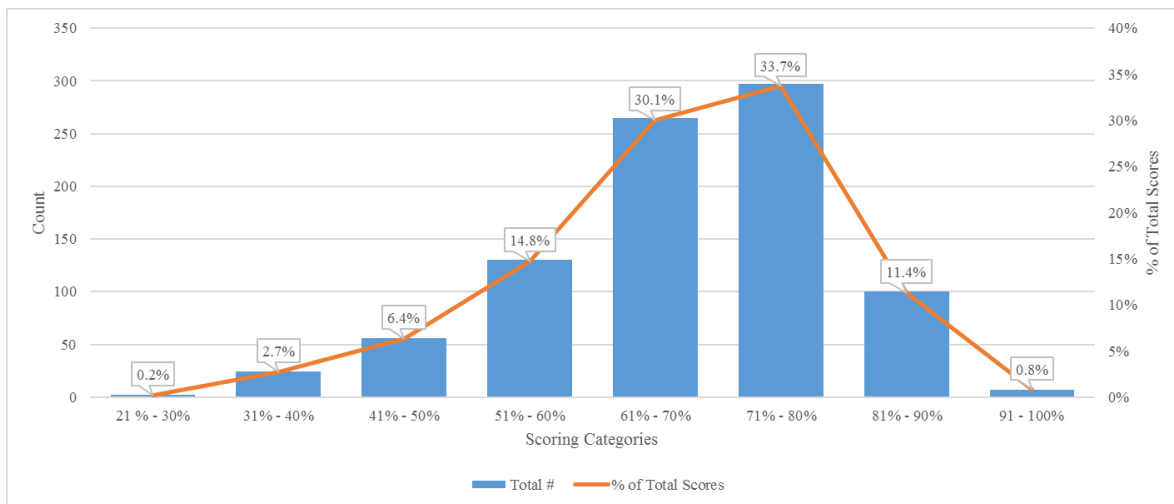


Figure III-3: Overall Score Distribution

I next analyzed the scores by community. To do this, I averaged individual scores (See Table D-1). The average overall score for the entire data set (See Figure III-4) was 62.4%. with 9 communities performing better than average and 10 below average. The top three communities for the overall average score, from one (1) to three (3), are Sungko, Kankaibe, and Hiabangan. The bottom three performers, from seventeen (17) to nineteen (19), are Sillon, New Kawayan, and Poblacion.

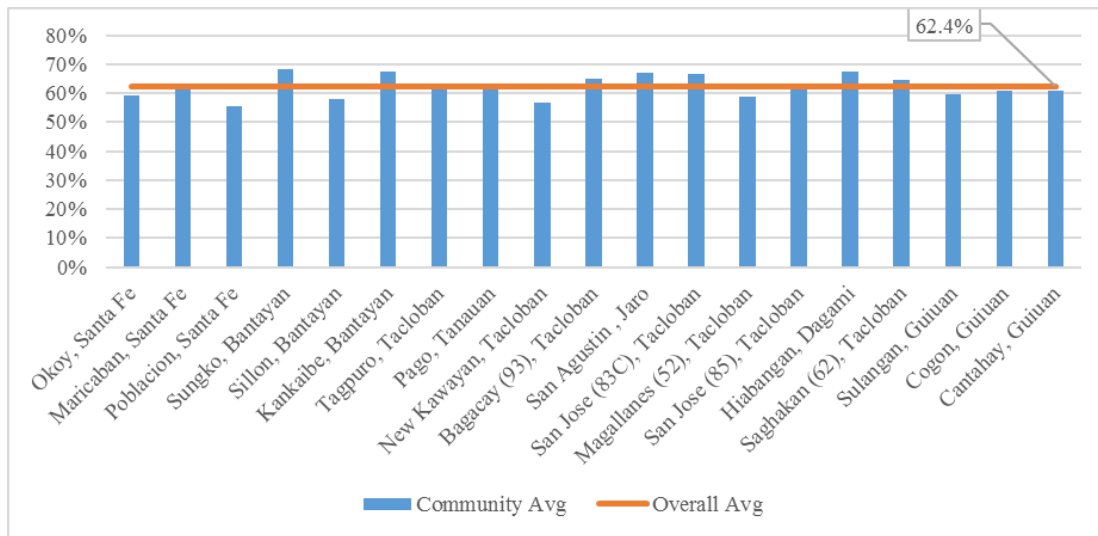


Figure III-4: Community Averages

I expanded the review to include average scores by theme and converted the average scores into a rank order table (See Table III-5) with conditional formatting to better visualize any patterns. While this table denotes the relative rank order of the communities, it does not relay the significance between ranks. Hypothetically, a community ranked 1st may only be a percentage point in front of number 2, but 10 percentage points in front of the 3rd ranked. However, the rank order of communities within each of the themes generally follow the results shown by the overall community averages with some exceptions. For instance, Sungko ranked first in overall community average and in the top 5 for 5 other categories, but had the worst score out of the 19

communities within Theme 7 (Shape). These assertions, however, are not backed by mathematical or statistical evidence, merely deduced from visual interpretation of the table.

Barangay	1: Foundations	2: Tie-Downs	3: Bracing	4: Joints	5: Roofs	6: Location	7: Shape	8: Preparation	Community Avg
Sungko, Bantayan	1	1	3	6	4	13	19	3	1
Kankaibe, Bantayan	2	2	14	12	5	5	17	2	2
Hiabangan, Dagami	6	9	1	3	3	11	10	10	3
San Agustin, Jaro	7	10	16	14	1	6	1	1	4
San Jose (83C), Tacloban	3	6	15	2	12	1	9	9	5
Bagacay (93), Tacloban	10	5	8	9	10	4	13	12	6
Saghakan (62), Tacloban	13	8	11	7	9	9	2	16	7
Maricaban, Santa Fe	4	3	5	13	6	15	18	5	8
Pago, Tanauan	12	11	19	5	8	2	5	8	9
Tagpuro, Tacloban	14	12	7	15	14	7	4	15	10
San Jose (85), Tacloban	8	14	17	16	7	8	6	13	11
Cantahay, Guiuan	5	19	4	1	2	16	15	7	12
Cogon, Guiuan	15	18	13	8	11	3	8	17	13
Sulangan, Guiuan	11	15	12	4	15	12	12	14	14
Okoy, Santa Fe	9	4	10	17	17	18	16	6	15
Magallanes (52), Tacloban	18	17	6	10	16	10	11	19	16
Sillon, Bantayan	16	7	9	19	19	17	7	4	17
New Kawayan, Tacloban	19	16	18	11	13	14	3	18	18
Poblacion, Santa Fe	17	13	2	18	18	19	14	11	19

Table III-5: Rank Order of Communities by Theme & Overall Score

I performed the same rank order analysis as stated previously, but switched the focus to the performance of themes within individual communities (See Table III-6). A cursory examination of this table showcases that *all* communities scored well within Theme 8 (Preparation), and worse on Theme 3 (Bracing), Theme 7 (Shape), and Theme 2 (Tie Downs).

Barangay	1: Foundations	2: Tie-Downs	3: Bracing	4: Joints	5: Roofs	6: Location	7: Shape	8: Preparation
Okoy, Santa Fe	2	3	6	5	4	8	7	1
Maricaban, Santa Fe	3	4	6	5	2	7	8	1
Poblacion, Santa Fe	3	7	5	4	2	8	6	1
Sungko, Bantayan	2	3	6	5	4	7	8	1
Sillon, Bantayan	2	3	7	6	4	8	5	1
Kankaibe, Bantayan	2	4	7	5	3	6	8	1
Tagpuro, Tacloban	3	7	8	5	2	4	6	1
Pago, Tanauan	5	7	8	3	2	4	6	1
New Kawayan, Tacloban	4	7	8	3	2	6	5	1
Bagacay (93), Tacloban	3	6	7	5	2	4	8	1
San Agustin, Jaro	3	7	8	5	2	4	6	1
San Jose (83C), Tacloban	2	6	8	3	4	5	7	1
Magallanes (52), Tacloban	4	8	6	3	2	5	7	1
San Jose (85), Tacloban	3	7	8	5	2	4	6	1
Hiabangan, Dagami	3	5	6	4	2	7	8	1
Saghakan (62), Tacloban	4	6	8	3	2	5	7	1
Sulangan, Guiuan	3	8	7	2	4	5	6	1
Cogon, Guiuan	5	8	7	4	2	3	6	1
Cantahay, Guiuan	4	8	5	3	2	6	7	1
Average Rank	3.2	6.0	6.9	4.1	2.6	5.6	6.7	1.0

Table III-6: Rank Order of Themes within a Community

Visualized differently, a box plot (See Figure III-5) of the average scores within themes depicts the same findings as above. However, this representation showcases how the variance of scores was the largest within Theme 2 (Tie-Downs) and Theme 6 (Location).

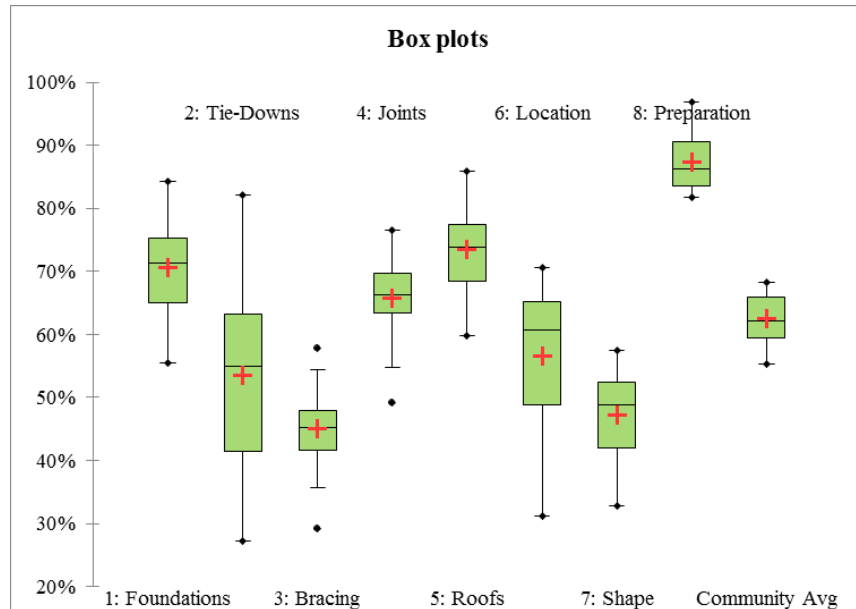


Figure III-5: Box Plot of Theme Scores

Significant Differences in Scores

Lastly, I conducted tests of significance across a variety of variables to determine which categories of data are significantly different from another. While these calculations signify little on their own, it aides with interpretation within further analysis and will be referenced in subsequent sections. Moreover, variables without significant differences in scores are also meaningful.

In this initial phase of data analysis, statistical tests verified if there were significant differences in test scores based upon demographic groupings. I analyzed the research question: Are there significant differences between test scores for different demographic groups? Thus, the null hypothesis stated that test scores grouped according to varied demographics are equal and the alternate is that test scores are unequal. The data set did not pass tests for a normal distribution

and is also continuous, thus necessitating the use of the Kruskal-Wallis test. If the null hypothesis is rejected when multiple groups are tested, the Kruskal-Wallis test does not distinguish which individual group is considered different from one another. Therefore, I used multiple comparison procedures outlined by Dunn (1964) to determine which specific groups were different.

In Table III-7, a summary of p-values from this test depicts the comparisons between themes using the Friedman test for non-normal data with paired samples. Those cells highlighted in green denote when the p-value < α (0.05), thus a statistically significant difference between scores. Of note, Theme 8 (Preparation) had the most differences between themes with five, while comparably, Theme 6 (Location) had the least amount of differences (2).

Significant Diff	1: Foundations	2: Tie-Downs	3: Bracing	4: Joints	5: Roofs	6: Location	7: Shape	8: Preparation
1: Foundations		0.010	0.000	0.934	0.996	0.052	0.000	0.123
2: Tie-Downs	0.010		0.951	0.254	0.001	0.999	0.989	< 0.0001
3: Bracing	0.000	0.951		0.012	< 0.0001	0.716	1.000	< 0.0001
4: Joints	0.934	0.254	0.012		0.538	0.584	0.029	0.003
5: Roofs	0.996	0.001	< 0.0001	0.538		0.005	< 0.0001	0.493
6: Location	0.052	0.999	0.716	0.584	0.005		0.861	< 0.0001
7: Shape	0.000	0.989	1.000	0.029	< 0.0001	0.861		< 0.0001
8: Preparation	0.123	< 0.0001	< 0.0001	0.003	0.493	< 0.0001	< 0.0001	

$\alpha=5\%$

Table III-7: Theme Test of Significance (Friedman)

Furthermore, I tested for significant differences within the collected demographic variables. To do so, I used the Kruskal-Wallis test of significance since the assumption of normality is not accepted and I had multiple variables to test (overall and theme scores). In summary (See Table III-8), differences showed within location, participation in a training program, age, native born, education levels, and construction experience. No difference in scores presented within gender, English proficiency and Kolb’s learning styles. While looking at Location, Theme 3 (Bracing) was the sole category that showed no statistical difference of scores across the 19 communities.

Significant Diff	Location	Participation	Age Group	Native	Education	Construction Experience	Gender	English Proficiency	Learning Style
Overall Avg	< 0.0001	0.016	0.007	0.462	0.014	0.925	0.475	0.163	0.181
1: Foundations	< 0.0001	< 0.0001	0.316	0.063	0.076	0.005	0.099	0.152	0.212
2: Tie-Downs	< 0.0001	0.026	0.022	0.000	0.927	0.163	0.279	0.065	0.243
3: Bracing	0.053	0.351	0.269	0.015	0.014	0.050	0.184	0.515	0.424
4: Joints	< 0.0001	0.446	0.379	0.681	0.069	0.638	0.455	0.195	0.151
5: Roofs	< 0.0001	0.822	0.141	0.138	0.003	0.361	0.155	0.421	0.261
6: Location	< 0.0001	0.620	0.091	0.008	0.585	0.208	0.693	0.643	0.091
7: Shape	< 0.0001	0.167	0.008	0.015	0.238	0.414	0.803	0.115	0.859
8: Preparation	< 0.0001	< 0.0001	0.014	0.250	0.766	0.002	0.084	0.106	0.472

$\alpha=5\%$

Table III-8: Demographic Tests of Significance (Kruskal-Wallis)

Multivariate Data Analysis

Using the visual results found in the initial phase of analysis alone could not definitively answer either research question. However, it provided valuable background information that aided in decisions for additional analysis. To address the research questions, multivariate techniques provided specific tools that either simplified the data or repackaged it, thus making interpretations and discovery of relevant findings easier and more apparent.

The subsequent analyses first called upon exploratory hierarchical clustering to determine the natural groupings of barangays based upon their overall test score and their performance within individual themes. The process entails an iterative clustering of data based on their proximal distance from each other using squared Euclidean distances. A smaller distance between two groups signifies a similarity between cases, just as a large distance denotes dissimilarity. In order to distinguish if any two cases are close enough to become a cluster (or if two clusters can join), I used a forward-thinking linkage method called Ward's method. This method calculates an individual case's (or cluster) squared Euclidean distance from the center of the formed cluster. Using statistical software, I repeat that process until the smallest distance is achieved. This produced a visual representation of the clustering in the form of a dendrogram. This pictorial hierarchy is useful when interpreting partitioned groups to explore further. With clusters in place,

I explore summary statistics (i.e., demographic variables) in order to determine any latent patterns that emerged.

The last phase sought to explore concepts that are not directly measurable using factor analysis. As IQ is an indirect measure of intelligence and occupation is tied to social class, factor analysis measures indicators of an unmeasurable quality to explain the observed phenomena. Within this research, I use the construction knowledge test (indicator) to examine the 8 Key Messages (unmeasurable quality). Yet factor analysis is predicated on the discovery of latent factors that are derived from the correlation between variables, in this case, performance across the 8 Key Message themes. When extracting factors, I used Principal Components Analysis (PCA) to reduce multivariate data variables into manageable components. These components comprise meaningful combinations of the original data variables, so the information is not lost, but greater order is established. Through eigenanalysis, the whole data set reduces into 2 or 3 relevant factors while still capturing as much of the data as possible. Interpreting 2 or 3 factors is far easier and translatable compared to the entirety of the dataset. Eigenanalysis calculates eigenvectors, or loadings, that depict how the individual variables (i.e., theme score) relate to a factor. This is an important tool for understanding the internal characteristics of the factor and aides in summary interpretations.

Agglomerative Hierarchical Clustering

Research Question

To increase the understanding, retention and recollection of construction knowledge, I must first understand the characteristics of communities that performed well and poorly on the test. In that same light, I ask:

RQ1: What are the characteristics of communities that had similar performances when recalling construction knowledge?

Method

Cluster analysis is a statistical tool aimed at reducing whole data sets into natural groupings for further analysis. Based upon Euclidean distance measurements, grouping is an iterative mathematical process that seeks to find the smallest distance that best fits the data. The first step involves grouping cases (i.e., barangays) into clusters, then followed by partitioning clusters using Ward’s method for deciding how close clusters are to each other. At the right delineation level, clusters share similar characteristics that, when exploited, provide manageable data sets for interpretation.

Results

In our case, Agglomerative Hierarchical Clustering (AHC) manipulates the average overall and theme scores per barangay to produce four clusters for further analysis. Inputting this data into statistical analysis software produces Table III-9 and a dendrogram (See Figure III-6). The vertical dendrogram is a pictorial representation of the four clusters with the scale on the left axis showing the distance between nodes.

Cluster	1	2	3	4
Barangays	5	8	4	2
Within-class variance	0.032	0.026	0.034	0.032
Average distance to centroid	0.149	0.147	0.151	0.127
	Magallanes (52), Tacloban	Saghakan (62), Tacloban	Kankaibe, Bantayan	Poblacion, Santa Fe
	Cantahay, Guiuan	San Jose (85), Tacloban	Maricaban, Santa Fe	Sillon, Bantayan
	Cogon, Guiuan	Bagacay (93), Tacloban	Okoy, Santa Fe	
	New Kawayan, Tacloban	San Jose (83C), Tacloban	Sungko, Bantayan	
	Sulangan, Guiuan	Hiabangan, Dagami		
		Pago, Tanauan		
		San Agustin , Jaro		
		Tagpuro, Tacloban		

Table III-9: AHC Results

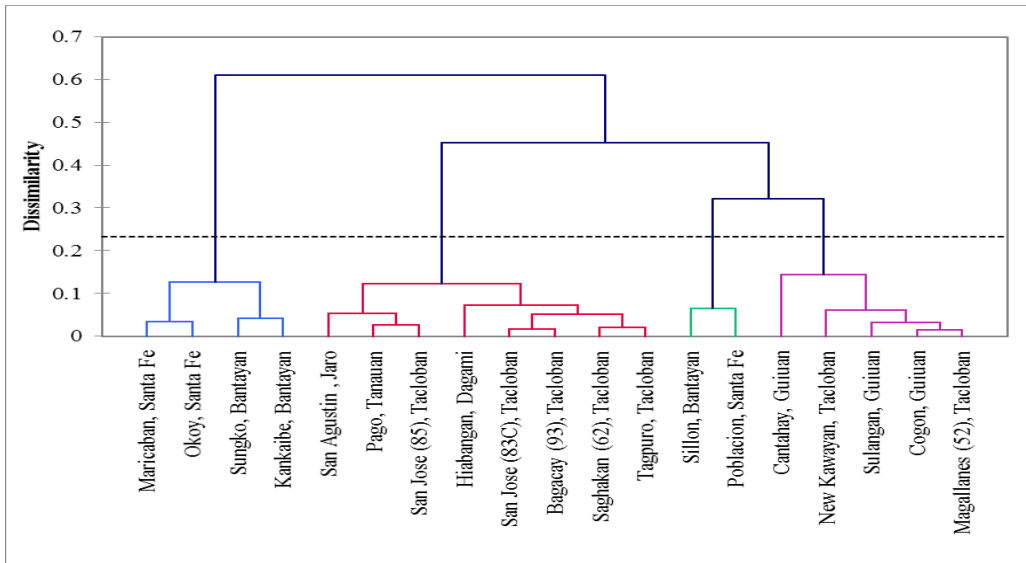


Figure III-6: AHC Dendrogram

Profile Plot

A benefit of cluster analysis is that it converts a complicated profile plot containing all the barangays, as seen below in Figure III-7:

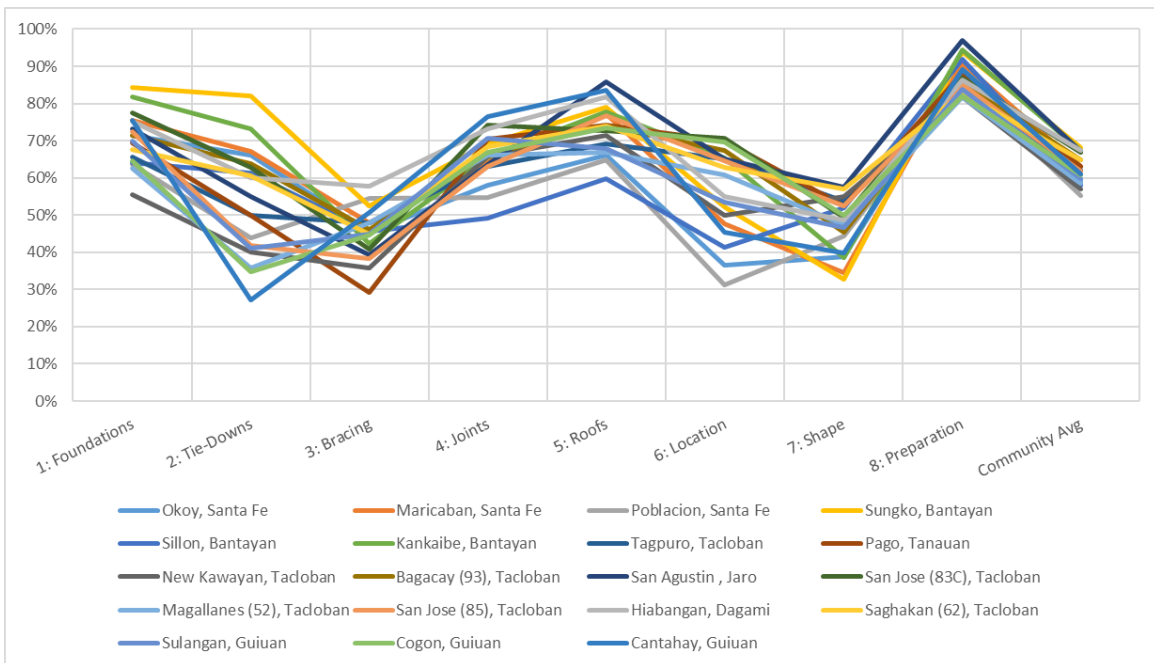


Figure III-7: Profile Plot of Barangay Averages by Theme

...into a manageable plot (See Figure III-8) with the same distinct shape across the themes. From this plot, Theme 2 (Tie-Downs) shows wide variation across the cluster's scores as compared to Theme 3 (Bracing) which scored poorly, but relatively close in proximity across all four clusters. This can also be seen within the box plot in Figure III-5.

Additionally, the first three clusters performed relatively similar within Themes 4 (Joints), 5 (Roofs), and 6 (Location). Yet, Cluster 4 (Poblacion & Sillon) trailed behind in all three themes, which is a revelation that was hidden in the profile plot of all 19 communities.

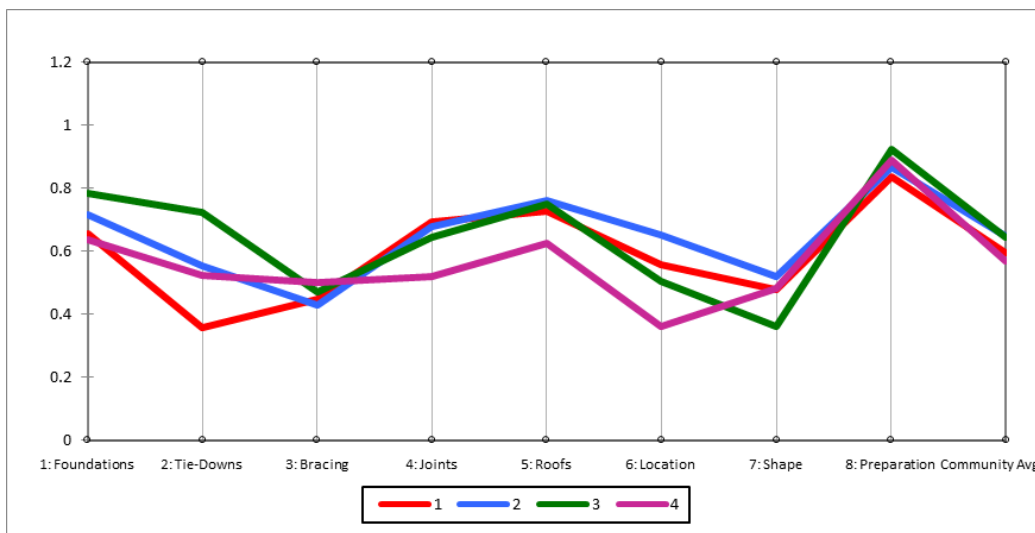


Figure III-8: AHC Profile Plot

Standardized Cluster Scores

With the clusters in place, the next analysis step standardizes scores from each of the barangays and then averages them into a cluster score. Using standardized scores allows for equal comparison across the variables by considering the mean and standard deviation. Therefore, standard scores are simply the raw data minus the category's mean divided by the standard deviation. This ensures a unit change is uniform across the categories and aides when interpreting the cluster's characteristics. A positive standardized score represents a score above the mean and vice versa for a negative score.

The resulting table (See Table III-10) with conditional column formatting produces a visual method of determining relative performance within themes across the clusters. For example, within Theme 1 (Foundations), Cluster 3 contains 4 barangays with a higher than average score (1.09; mean is positive). Contrast that to Cluster 4 with its 2 barangays and exceptionally lower than average score (-0.96; mean is negative). Moreover, just as the cluster profile plot (See Figure III-8) showed Cluster 4’s poor performance within Themes 4, 5, and 6, the standard scores within Table III-10 for the same themes further solidify their poor performance relative to the other clusters.

Cluster	n=	1: Foundations	2: Tie-Downs	3: Bracing	4: Joints	5: Roofs	6: Location	7: Shape	8: Preparation	Community Avg
1	5	-0.71	-1.21	-0.05	0.52	-0.13	-0.06	0.08	-0.79	-0.78
2	8	0.14	0.14	-0.30	0.31	0.38	0.72	0.67	-0.12	0.59
3	4	1.09	1.28	0.29	-0.21	0.23	-0.51	-1.49	1.08	0.52
4	2	-0.96	-0.07	0.74	-2.10	-1.65	-1.70	0.12	0.30	-1.47
Mean		70.6%	53.5%	45.1%	65.8%	73.5%	56.5%	47.2%	87.4%	62.4%

Table III-10: Standard Cluster Scores by Theme

Upon further examination, Cluster 2 performed the highest above the mean (+0.59) within the Community Average category, coincidentally with the highest number of communities within the cluster (n=8). Additionally, Cluster 2 performed above the average mean in six out the 8 Key Message themes. In particular, Cluster 2 communities scored the highest above the average in Themes 6 (Location) and 7 (Shape), two themes that communities overall performed poorly on, shown by the mean score of 56.5% and 47.2% respectively. Contrast that to Cluster 4, which not only had the fewest number of communities within its cluster, but also a well below average Community Average score (-1.47). Cluster 4 displays a poor performance within individual theme scores as well, having the worst scores compared to the mean in four separate themes (Foundations, Joints, Roofs, Location).

Refer to Table III-8 and the tests of significance that determined which demographic variables displayed statistically difference within scores. In no particular order, they were a respondent’s participation in a training program, their age, if they were a native to the barangay, their education level and if he or she had any experience with construction work. Using these same demographics, but now within the clusters, I standardize the scores in the same manner as above (See Table III-11).

Cluster	n=	Participated in Training		Age	Born in barangay		Education				Construction Jobs BEFORE Typhoon Yolanda		Construction Jobs AFTER Typhoon Yolanda	
		Yes	No	Average	Yes	No	College Graduate	High School Graduate	Elementary Graduate	No Formal Education	Yes	No	Yes	No
1	5	0.05	-0.57	-0.11	-0.49	-0.32	-0.26	-0.57	-0.25	0.38	-0.84	-0.40	-0.77	-0.43
2	8	0.63	-0.43	-0.19	-0.36	0.21	0.08	0.09	-0.47	-0.42	-0.02	-0.19	0.01	-0.20
3	4	-0.89	1.04	0.40	0.80	0.09	-0.16	0.28	0.88	0.25	0.64	0.59	0.17	0.69
4	2	-0.86	1.08	0.24	1.07	-0.24	0.65	0.48	0.74	0.25	0.92	0.58	1.53	0.47
Mean		10.2	36.2	37.7	26.9	19.4	4.0	10.9	7.5	0.3	6.6	39.7	5.9	40.4
Std Dev		9.4	23.8	2.8	19.1	12.1	3.1	6.5	5.4	0.7	5.3	22.1	4.6	22.5

Table III-11: Standard Cluster Scores by Demographics

Of note, the high performing Cluster 2 had more than average number of training program participation (0.63), while also a higher than average number of non-native respondents within its communities (0.21). Interestingly enough, Cluster 4, which displayed a rather poor performance as a cluster in both overall and theme questions, had positive standardized scores across the three levels of education (College, High School and Elementary Graduates).

In terms of construction experience, Cluster 4 had the highest above the average scores for work before and after Typhoon Haiyan struck the Philippines. This revelation is coupled with the fact that this cluster also had above average number of respondents that had no construction work before and after the disaster. Cluster 1, also a poor performer in the test, had a mirror image in terms of construction experience. They had the lowest number of respondents with construction experience, yet also a below average score for respondents that did not have construction work either before or after. These numbers within Clusters 1 and 4 demonstrate that construction

experience does not guarantee an understanding of the 8 Key Messages. What the data lacks is an understanding of the type, duration, or skill involved with the construction work these respondents performed and how that might influence their understanding of construction principles laid forth in the 8 Key Messages.

Findings

Based upon the standardized Community Average score (See Table III-10), the highest performing group was Cluster 2. Knowing this, I analyzed this cluster according to their demographic scores (See Table III-11). The eight communities that make up this cluster are all located within the province of Leyte and share the following demographic traits: (1) they participated in an NGO-sponsored training well above any other cluster; (2) they are the youngest in age; and (3) they had the most number of respondents that were transplants.

The worst performing group according to the standard Community Average score was Cluster 4. When reviewing their demographic scores, the two communities (both located in Cebu province) within this cluster had the following traits of substance: (1) they had the least amount of training participants; (2) they were, on average, older; (3) they had the most native-born respondents, (4) they had the highest amount of formal education graduates ranging from elementary to college level; (5) they had the most amount of respondents with construction experience both before and after Typhoon Haiyan.

Discussion

On the surface, it would seem that Cluster 4 would perform much better than they did. Their education levels and high amount of construction work, coupled with an older sample size and a familiarity with their community, would intuitively predict a better performance in recollecting risk-reducing construction practices. Yet, they performed the worst out of the four

clusters. While most would see their education and experience level as an advantage, it could possibly show that this cluster had established construction habits contrary to the 8 Key Messages. This is cemented in their poor rates of training program participation. This assertion, however, is limited without a more thorough analysis of the training programs offered within these communities. Perhaps the aid organizations within these communities placed less of an emphasis on community participation during the recovery phases and hired outside workers to complete the shelter reconstruction.

On the opposite side, the highest performing group, Cluster 2, was also the youngest and participated in the most amount of training programs. As stated earlier, further detailed analysis of the training programs offered within these communities is required. However, the fact that the younger respondents attended a training program at all increased their exposure to the 8 Key Messages, the construction principles within them, and perhaps a greater understanding of the test material.

Overall, by understanding the characteristics of the barangay within these limited terms, NGOs can identify potential obstacles or opportunities inherent within a community. Specifically, one obstacle may be a reliance on the populations' education levels and any resulting assumptions regarding their current knowledge base. Whereas, an opportunity may arise if a community is part of a resettlement project and therefore, unfamiliar with their new site. The fear of the new unknowns may influence their desire to educate themselves on proper construction techniques that are best matched against prevalent hazards. Armed with this knowledge, aid organizations can better tailor a recovery program that builds upon a community's strengths and mitigate its weaknesses.

Factor Analysis

Research Question

Consider that architects, engineers, and construction workers undergo arduous training on both theoretical and practical topics in a wide array of subjects. The GSC understood that much of the population they aimed to assist did not have the drive and/or opportunity to complete such training. Therefore, they developed the 8 Key Messages to share with common homeowners that live within disaster prone areas. The purpose was not to make them professional engineers, but rather present useful material that, if applied properly, can reduce the effects felt during disaster events.

The strict adherence to the Shelter Cluster document in terms of scoring placed the focus of the analysis on the respondents' understanding of the 8 Key Messages as they stand. Therefore, the researchers did not examine the legitimacy of the construction principles set forth by the Shelter Cluster, but rather, tested the ability of the respondents to recall any knowledge of the 8 Key Messages.

Yet, the 8 themes do not stand independently of each other, nor do the barangays' scores for each theme. Just as a structure contains a foundation, joints, bracing, and a roof, these themes are connected in a much less obvious way. Therefore, I ask:

RQ₂: How are the individual themes within the 8 Key Messages connected in terms of performance?

Method

As cluster analysis looked at communities, our factor analysis examines the relationships between the 8 Key Message themes themselves. This analysis aides in the study and visualization of variable correlations otherwise difficult to interpret. It reduces the information contained in

variables (theme scores) seen across recorded observations (barangays). The resulting mathematical reductions are founded upon geometric projections and eigenanalysis. The overall goal is to reduce the most information into 2 or 3 factors as to produce 2-dimensional plots of the data. The data used in this analysis comes from the heat map with rank ordered barangays (See Table III-5). Therefore, Spearman's correlation technique is used to determine the resulting eigenvalue. To extract the appropriate number of factors, those with an eigenvalue over 1 are kept for further analysis. Lastly, with geometric projections, the matter of perspective plays an important role. To overcome this, a technique called Promax with Kaiser normalization involves orthogonal and oblique rotations of variables and aides in producing an interpretable representation of the data.

Factor Extraction with Principal Component Analysis

The first step of factor analysis is the conversion of variables into components. This is executed first because it is physically impossible to model the data set as it stands initially. Graphs are limited to 2 or 3 dimensions, therefore making it impossible to properly represent how 19 different communities perform on 8 themes. However, using factor analysis can reduce the dimensionality of the data by making linear combinations of variables into components. Within these combinations, components can be characterized by two traits. First, all the information in the original variables (e.g., test scores by theme by community) are contained in the components, which remain independent from one another. Secondly, the components are ordered when calculated. This means that the first component contains within it the most amount of information from the original variables, while the second components maintains the second most, and so forth. When determining the number of components to use for further analysis, I employed Kaiser-

Guttman rule (Kaiser 1991) that suggests keeping all components with an eigenvalue greater than 1.

Rotation

When watching a sporting event on television, multiple cameras provide different views of the same game. If I were to see everything at once, say from a blimp camera, I would lose the details. However, closer cameras in different positions provide better detail, but cannot capture everything. To overcome this, multiple camera angles are used in succession to build an adequate model of the game’s action. In essence, this principle is applied in factor analysis in the form of rotation. Instead of different camera angles, factor loadings are rotated to form a comprehensive view of the data. The information does not change, only the perspective of the researcher, which allows for the solution to become more interpretable. Variables that are not correlated can be rotated orthogonally, whereas those variables that are correlated, can be transformed obliquely. When variables are a mixture of types of correlations, the Promax technique is a rotation method that handles both as is the case with the data observed.

Results

When analyzing the rank order of communities by average theme scores, factor analysis produces 3 factors with eigenvalues greater than 1 that in combination, account for 80.3% of the variability of the data.

Extraction	F1	F2	F3	F4	F5	F6	F7	F8
Eigenvalue	3.008	2.113	1.307	0.643	0.388	0.274	0.178	0.089
Variability (%)	37.598	26.407	16.332	8.041	4.856	3.426	2.229	1.110
Cumulative %	37.598	64.005	80.337	88.378	93.235	96.661	98.890	100.000

Table III-12: Factor Extraction with PCA

The factor loadings (See Table III-13) after rotation are used to interpret the meaning of the rotated factors. To be included in further discussion, each loading should explain at least half

of the original variable's variance. Therefore, only loadings with value greater than 0.50 (highlighted in bold) are associated with subsequent interpretations of factors.

Promax Rotation	D1	D2	D3
1: Foundations	0.676	-0.070	0.490
2: Tie-Downs	0.919	0.022	-0.226
3: Bracing	-0.127	-0.924	0.136
4: Joints	-0.396	-0.113	0.986
5: Roofs	0.309	0.117	0.695
6: Location	0.022	0.734	0.417
7: Shape	-0.313	0.735	-0.136
8: Preparation	0.940	-0.003	-0.114

Table III-13: Factor Loadings with Promax Rotation

Findings

Table III-13 depicts that Themes 1 (Foundations), 2 (Tie-Downs) and 8 (Preparation) are highly loaded on the first factor (far from zero and positive). Because factor analysis orders the components, the positive loadings within the first factor also signify that these themes account for the greatest amount of variability in the test scores. When interpreting the relationship between the three themes, consider that Preparation had an 87.4% average score and was the highest scored category across all 19 communities. These high scores explain its influence, but add nothing further. The remaining two themes, Foundations and Tie-Downs are related through their ability to withstand high winds, which is a major cause of damage during a typhoon.

Factor 2 is positively loaded by Theme 6 (Location) and Theme 7 (Shape), while conversely negatively loaded for Theme 3 (Bracing). In other words, the better a respondent does in Theme 6 (Location) and 7 (Shape), the worse they will do in Theme 3 (Bracing) or vice versa. Considering that respondents across all communities performed the worst on Theme 3 (Bracing) is a finding on its own. However, this uncovers that it is also coupled with a greater understanding of how location and shape influence structural resilience. To explain this observation, it seems that

Location and Shape are superficially intuitive on how they influence structural performance during a typhoon. Choosing a location near to a coastline increases the risk of flooding, while a structures shape will affect its resilience toward high winds during a storm. Bracing, on the other hand, is difficult for untrained non-engineers to understand why it helps or hurts during a typhoon, hence the poor performance seen throughout all the communities tested.

One could argue that the three themes in this factor are tied to site selection and the subsequent hazard identification process. Depending on if the site is nearer to the coast or more inland will ultimately drive construction and design considerations for all three of these themes. Another explanation is that location and shape are influenced by a respondent's personal preference, such as choosing a site close to their livelihood or a shape conducive to their family size. Conversely, bracing is a core structural concept that is crucial when dealing with the intense push and pull loads seen during torrential typhoon effects, but is less influential on a homeowner's preference. If I am to assume that respondents are generally not trained engineers, they have a greater understanding of how location and shape affect their shelter's resilience during a storm event and fail to grasp why bracing is an important aspect.

The last factor is loaded heavily on Theme 4 (Joints) and 5 (Roofs). While this factor accounts for the least variability of test scores, it does signify that a respondent's knowledge within these two subjects influences their score to a degree. While joints can be found throughout a building, they are most readily seen in trussed roofing designs and could be the explanation for their appearance together in this third factor. Additionally, the destruction of the roof at the hand of high winds would be a powerful visual to community members that experienced the typhoon's effects. If this was a majority occurrence, it could explain the appearance within this last factor.

Discussion

Factor analysis is useful in measuring a seemingly unmeasurable quality of the dataset. On their own, the theme scores portray the communities understanding of the themes independent of each other. As stated earlier, the goal is to determine how the themes relate to each other in terms of performance. The reason for using factor analysis was to determine, out of the 8 different themes, the relevant groupings that were likely to influence performance outcomes. The relationship of themes uncovered by this factor analysis can be an important consideration when aid organizations develop their training programs.

Limitations and Future Work

Despite the plethora of data from the construction knowledge test and survey, this research is not without its limitations. Multivariate data analysis is inherently interpretive in nature and subsequent conclusions are based solely on the data collected. For instance, the demographic information that was collected compiled into the standardized scores that aided in characterizing the clusters into high and low performers. These variables were included in the survey based upon early hypotheses into what influences knowledge retention and recollection in disaster victims. While it was expected that gender, English proficiency, and learning style were to produce variance in performance scores, this was disproved in the early analysis stages (See Table III-8). I recommend that future work include a robust literature review prior to collection of data. The content analysis of education research could extract established and tested factors that influence knowledge retention that could then be applied to disaster-prone communities.

Moreover, I assumed that participation in training was a positive trait that would produce higher scores within themes independently and for the overall score. This was loosely proven to be true when Cluster 2 had the highest participation rate while subsequently scoring the highest

community average. However, future research could work on isolating how formalized, structured training programs directly impacts performance outcomes. First, a definition of training and participation would have to be formalized to ensure observations are accurately categorized. Following this, training methods and procedures would need to be characterized according to a single pedagogy so as to isolate the causes of variability in performance measures. Future work could hone in these steps to determine how training influences understanding of the 8 Key Messages or a whole host of other Build Back Safer initiatives.

Conclusion

There were several cursory findings through the initial analysis of the test scores. Through the bar chart of community averages (See Figure III-4), communities showed minor variance across average overall score. The data, represented in rank-order form across communities (See Table III-6) and themes (See Table III-7) provide visual indicators of performance that contradict the finding within overall scores, but do not have the robustness to validate them. Significant differences in scores arise not only between theme scores (See Table III-8), but demographic variables (See Table III-9). Upon this discovery, additional analysis was used to further explore any existence of data groupings using cluster analysis and using factor analysis to further the understanding of any statistical relevancy between themes.

Cluster analysis categorized the 19 communities into four different groups based upon each barangay's performance across the themes as well as their average overall score. When determining the characteristics of these clusters, standardized scores derived from the collection of demographic information helped determine the common characteristics of the barangays within each cluster. Tying this information together with the test performance revealed an interesting conclusion. The cluster that performed the best on the test also participated in the most training,

was generally younger, and only had average rates of construction experience and education levels. The worst performing group had essentially the opposite in all these categories. The conclusion, therefore, is that worst performing cluster had established methods of construction, learned through the experience of multiple disaster recovery cycles. Quite oppositely, the better performing grouping of barangays approached training possibly with a willingness and openness that promoted greater exposure to the 8 Key Messages.

Factor analysis explored the performance on each of the 8 Key Messages with the goal of uncovering how the themes possibly interconnected. As a result, three latent factors emerged that signified relationships exist between themes. The first factor can be tied to structural resistance as it was heavily loaded by scores from Foundations and Tie-Downs. The second factor consisted of themes related to site selection as a product of hazard identification. Depending on the hazards most commonly seen at a certain site (i.e., flooding at the coast or high winds at altitude), this influenced the chosen location, shape of the building, and type of bracing required to resist these hazards. Consequently, bracing showed to be a particularly difficult concept for community members and respondents to grasp. Joints and roofs rounded out the last factor, connected perhaps by the common truss design or the visual impact of observing a collapsed roof and associating that with poor joints.

While executed separately, the two analyses of the construction knowledge test share a singular commonality. Reverting back, the overall objective is to develop disaster resilient communities capable of withstanding hazard events and able to return to normalcy as quickly as possible. In the past, this was accomplished through directly providing shelter reconstruction, livelihood assistance and a wide array of needed resources. However, to affect the long-term recovery capability of disaster-prone communities, education and training community members to

Build Back Safer are proven tools. What these two separate analyses showcase is the importance of understanding the internal traits and properties of the affected community so as to leverage potential opportunities and mitigate against inherent weaknesses. By identifying if a barangay has developed construction habits based on experience, aid organizations can tailor training programs that first discredit outdated construction techniques that have become routine practice. Armed with this knowledge of the community, NGOs can coordinate for an active demonstration for disaster victims and future homeowners that explains the ramifications of improper bracing. Adding a step into the recovery process that canvases the audience before administering aid may seem to delay results, but in the end, the programs are tailored to the unique scenario, thus providing better solutions.

References

- Del Rosario, E. (2014). "Effects of Typhoon Haiyan." Nation Disaster Risk Reduction and Management Council.
- Dunn, O. J. (1964). "Multiple Comparisons Using Rank Sums." *Technometrics*, 6(3), 241.
- Humanitarian Benchmark. (2015). "8 Key Messages for Safer Reconstruction in Philippines." <https://www.facebook.com/pg/HumanitarianBenchmark/photos/?tab=album&album_id=496413727179800> (Apr. 6, 2017).
- Kaiser, H. F. (1991). "Coefficient Alpha for a Principal Component and the Kaiser-Guttman Rule." *Psychological Reports*, 68(3), 855–858.
- Lum, T., and Margesson, R. (2014). *Typhoon Haiyan (Yolanda): US and International Response to Philippines Disaster*. Congressional Research Service, 37.
- NEDA. (2013). "Reconstruction Assistance on Yolanda." National Economic and Development Authority.
- Shelter Cluster. (2012). "GSC Strategy 2013-2017."
- UNISDR. (2015). "The Economic and Human Impact of Disasters in the Last 10 Years." <<https://www.unisdr.org/we/inform/disaster-statistics>> (Apr. 9, 2017).

Zerio, A., Opdyke, A., and Javernick-Will, A. (2016). "Characterizing post-disaster reconstruction training methods and learning styles." *Engineering Project Organization Journal*, 6(2-4), 142-154.

CHAPTER IV: CONCLUSION

Summary of Findings

The body of this thesis examines the potential benefit of using training to advance construction and maintenance of shelter within disaster-resilient communities. The first paper (Chapter 2) discovered that organization varied their training based upon the type of audience. Experienced and skilled builders experienced a more robust and thorough training, while homeowners received broader and less technical instruction. This finding was reinforced when we analyzed the training programs through qualitative coding and then categorized them in terms of learning modes found in Kolb's Experiential Learning Theory. Builders, we discovered, had greater exposure to a variety of learning modes ranging from detailed plan overviews to active demonstrations on a model house. Homeowners, on the other hand, received much of their formalized instruction through lectures. Yet, they usually took it upon themselves to interact with the builders during construction, thus indirectly receiving additional training in an informal manner. Among all three communities examined in this study, we discovered that the preferred learning style was divergent. This style prefers to collectively generate ideas and solutions to a problem and thus aligned with the multiple training methods administered to builders received. However, aid organizations fell short in addressing the entirety of needs for the common homeowner.

The multivariate statistical analysis performed in Chapter 3 sought to investigate latent factors that influenced retention and recollection of construction knowledge. Through an exam, I tested communities' understanding of the 8 Key Messages extolled by the Shelter Cluster. I found

that high performing barangays shared key demographic traits, namely higher participation rates in training programs, younger in age, and relatively average rates of education and construction work. This could possibly indicate that these communities had not established a set of construction practices, and were, perhaps, more inclined to learn about the principles derived from the 8 Key Messages.

In the second part of this chapter, factor analysis explored the interconnectivity between the eight themes and produced three key relationships. The reason for using factor analysis was to determine, out of the 8 different themes, the relevant groupings that were likely to influence performance outcomes. The first factor can be tied to structural resistance as it was heavily loaded by scores from Foundations and Tie-Downs. The second factor consisted of themes related to site selection as a product of hazard identification, shown by high loadings for Location, Shape, and Bracing. The third factor displayed a link between Joints and Roofs, possibly connected by design standards or that roof collapse was associated as a common consequence of typhoon winds. In combination, the two separate analyses showcase that an understanding of internal traits of a community or curriculum material are important factors that affect how communities retain and apply the presented material over the long-term.

The summary of gaps, research questions and corresponding findings are seen in Figure IV-1.

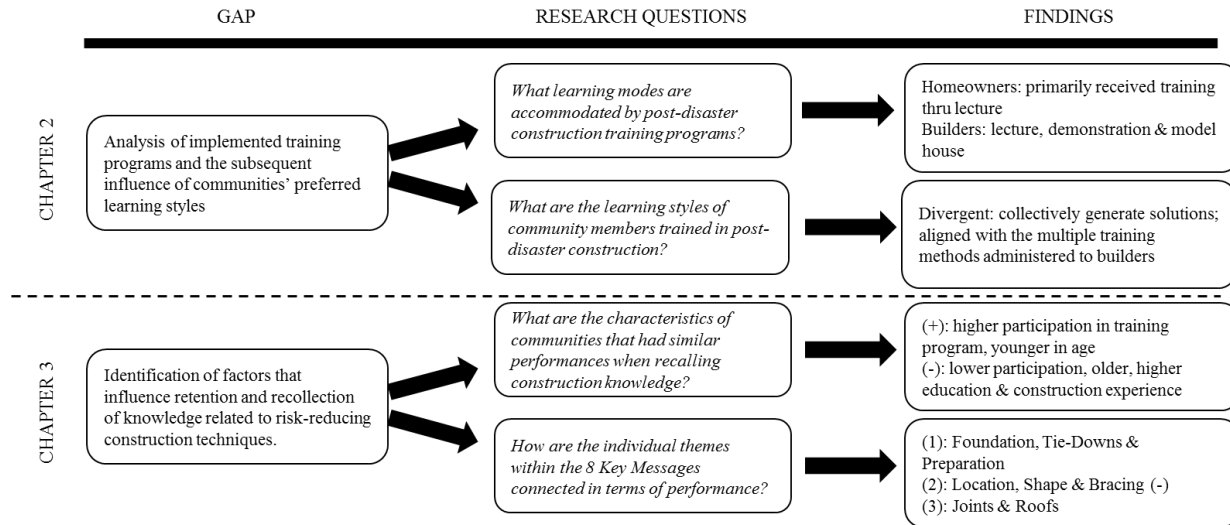


Figure IV-1: Summary of Thesis

Suggestions for Future Research

The research had its limitations, mainly due to the devotion of learning multivariate statistical methods. Therefore, this thesis lacked any inclusion of analysis of training methods and its subsequent impact on test results. I have included a summary within Appendix E of my suggested research method to examine this important factor. This is an important aspect to consider for future research for its potential in both practical and theoretical applications. Practically, any research into the positive and negative outcomes related to training methodology can only improve future training program development. Theoretically, the knowledge research is mainly focused in formal settings found in academia, but the results of this study could show the applicability or any modification required when the context is found within a post-disaster environment.

Despite the plethora of interview and quantitative data collected, this research could benefit from replication within another national context or disaster setting to determine the findings replicability. Internally, the learning style research in Chapter 2 only included three of the nineteen communities, thus an inclusion of the remaining locations could denote any significant variability

between locations within the Philippines itself. Through the analysis of training methods in combination with learning styles, additional research could identify its impact on knowledge retention and recollection outcomes.

Moreover, the definition of training was a fluid and subjective term that showed tremendous variability across communities and organizations. Future research would first have to arrive at a consensus for what defined training methods and outcomes, then standardize the means for collecting training data. This would ensure commonality across contexts that would afford for better comparisons in terms of performance measures.

COMPLETE THESIS REFERENCES

- Ahmed, I. (2011). "An overview of post-disaster permanent housing reconstruction in developing countries." *International Journal of Disaster Resilience in the Built Environment*, 2(2), 148–164.
- Arthur, W., Jr., Bennett, W., Jr., Edens, P. S., and Bell, S. T. (2003). "Effectiveness of training in organizations: A meta-analysis of design and evaluation features." *Journal of Applied Psychology*, 88(2), 234–245.
- Asharose, Saizen, I., and Sasi, P. (2015). "Awareness Workshop as an Effective Tool and Approach for Education in Disaster Risk Reduction: A Case Study from Tamil Nadu, India." *Sustainability*, 7(7), 8965–8984.
- Barakat, S. (2003). *Housing reconstruction after conflict and disaster*. Overseas Development Institute, London, England.
- Barenstein, J. D. (2006). *Housing reconstruction in post-earthquake Gujarat: a comparative analysis*. Humanitarian Practice Network, Overseas Development Institute, London, England.
- Chinowsky, P., Hayles, C., Schweikert, A., Strzepek, N., Strzepek, K., and Schlosser, C. A. (2011). "Climate change: comparative impact on developing and developed countries." *Engineering Project Organization Journal*, 1(1), 67–80.
- Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed-method approaches*. Sage Publications, Los Angeles.
- Davidson, C. H., Johnson, C., Lizarralde, G., Dikmen, N., and Sliwinski, A. (2007). "Truths and myths about community participation in post-disaster housing projects." *Habitat International*, 31(1), 100–115.
- Del Rosario, E. (2014). "Effects of Typhoon Haiyan." Nation Disaster Risk Reduction and Management Council.
- Dewey, J. (1938). *Experience and Education*. Kappa Delta Pi, West Lafayette.
- Dunn, O. J. (1964). "Multiple Comparisons Using Rank Sums." *Technometrics*, 6(3), 241.
- Fallahi, A. (2007). "Lessons learned from the housing reconstruction following the Bam earthquake in Iran." *The Australian Journal of Emergency Management*, 22(1), 26–35.
- Fereday, J., and Muir-Cochrane, E. (2006). "Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development." *International Journal of Qualitative Methods*, 5(1), 80–92.

- Gradl-Dietsch, G., Korden, T., Modabber, A., Sönmez, T. T., Stromps, J.-P., Ganse, B., Pape, H.-C., and Knobe, M. (2016). “Multidimensional approach to teaching anatomy—Do gender and learning style matter?” *Annals of Anatomy - Anatomischer Anzeiger*, 208, 158–164.
- Grochow, J. (1973). “Cognitive Style as a Factor in the Design of Interactive Decision-Support Systems.” Ph.D dissertation, Massachusetts Institute of Technology, Sloan School of Management.
- Guha-Sapir, D., Hoyois, P., and Below, R. (2015). *Annual Disaster Statistical Review: Numbers and Trends 2014*. Centre for Research on the Epidemiology of Disasters, Brussels, Belgium, 54.
- Halili, S. H., Naimie, Z., Sira, S., AhmedAbuzaid, R., and Leng, C. H. (2015). “Exploring the Link Between Learning Styles and Gender Among Distance Learners.” *Procedia - Social and Behavioral Sciences*, 191, 1082–1086.
- Henson, R. K., and Hwang, D.-Y. (2002). “Variability and prediction of measurement error in Kolb’s learning style inventory scores a reliability generalization study.” *Educational and Psychological Measurement*, 62(4), 712–727.
- Hofstede, G. (2001). *Culture’s Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations*. Sage Publications, Inc., Thousand Oaks, CA.
- Hudson, L. (1966). *Contrary Imaginations*. Penguin Books, Ltd, Middlesex, England.
- Humanitarian Benchmark. (2015). “8 Key Messages for Safer Reconstruction in Philippines.” <https://www.facebook.com/pg/HumanitarianBenchmark/photos/?tab=album&album_id=496413727179800> (Apr. 6, 2017).
- ISDR. (2007). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*. Geneva, Switzerland.
- Jha, A. K. (2010). *Safer Homes, Stronger Communities: A Handbook for Reconstructing After Natural Disasters*. The World Bank.
- Johnson, R. B., Onwuegbuzie, A. J., and Turner, L. A. (2007). “Toward a Definition of Mixed Methods Research.” *Journal of Mixed Methods Research*, 1(2), 112–133.
- Joy, S., and Kolb, D. A. (2009). “Are there cultural differences in learning style?” *International Journal of Intercultural Relations*, 33(1), 69–85.
- Kaiser, H. F. (1991). “Coefficient Alpha for a Principal Component and the Kaiser-Guttman Rule.” *Psychological Reports*, 68(3), 855–858.

- Kayes, D. C. (2005). "Internal validity and reliability of Kolb's learning style inventory version 3 (1999)." *Journal of Business and Psychology*, 20(2), 249–257.
- Kolb, A. Y., and Kolb, D. A. (2005). *The Kolb Learning Style Inventory—Version 3.1 2005 Technical Specifications*. HayGroup, Boston, MA, 1–72.
- Kolb, D. A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. Prentice-Hall, Englewood Cliffs.
- Kontoghiorghes, C. (2001). "Factors affecting training effectiveness in the context of the introduction of new technology - A US case study." *International Journal of Training and Development*, 5(4), 248:60.
- Koob, J. J., and Funk, J. (2002). "Kolb's learning style inventory: Issues of reliability and validity." *Research on social work practice*, 12(2), 293–308.
- Kraiger, K., Salas, E., and Cannon-Bowers, J. A. (1995). "Measuring knowledge organization as a method for assessing learning during training." *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 37(4), 804–816.
- Lawther, P. M. (2009). "Community involvement in post disaster re-construction - case study of the British red cross Maldives recovery program." *International Journal of Strategic Property Management*, 13(2), 153–169.
- Lee, K., and Pucel, D. J. (1998). "The perceived impacts of supervisor reinforcement and learning objective importance on transfer of training." *Performance Improvement Quarterly*, 11(4), 51–61.
- Lewin, K. (1951). *Field Theory in Social Sciences*. Harper & Row, New York.
- Lum, T., and Margesson, R. (2014). *Typhoon Haiyan (Yolanda): US and International Response to Philippines Disaster*. Congressional Research Service, 37.
- Manolis, C., Burns, D. J., Assudani, R., and Chinta, R. (2013). "Assessing experiential learning styles: A methodological reconstruction and validation of the Kolb Learning Style Inventory." *Learning and Individual Differences*, 23, 44–52.
- McCrudden, M. T., and Schraw, G. (2007). "Relevance and Goal-Focusing in Text Processing." *Educational Psychology Review*, 19(2), 113–139.
- Munoz, S. R., and Bangdiwala, S. I. (1997). "Interpretation of Kappa and B statistics measures of agreement." *Journal of Applied Statistics*, 24(1), 105–112.

- NEDA. (2013). "Reconstruction Assistance on Yolanda." National Economic and Development Authority.
- Olshansky, R. B. (2009). "The Challenges of Planning for Post-Disaster Recovery." *Building Safer Communities: Risk Governance, Spatial Planning and Responses to Natural Hazards*, 58, 175–181.
- Pelling, M. (2007). "Learning from others: the scope and challenges for participatory disaster risk assessment." *Disasters*, 31(4), 373–385.
- Piaget, J. (1973). *To Understand is to Invent: the Future of Education*. Grossman Publishers, New York.
- Prince, M. J., and Felder, R. M. (2006). "Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases." *Journal of Engineering Education*, 95(2), 123–138.
- Ruble, T. L., and Stout, D. E. (1991). "Reliability and classification stability, and response set bias of alternative forms of the learning style inventory (LSI-1985)." *Educational and Psychological Measurement*, 51(2), 481–489.
- Schilderman, T., and Lyons, M. (2011). "Resilient dwellings or resilient people? Towards people-centred reconstruction." *Environmental Hazards*, 10(3–4), 218–231.
- Shelter Cluster. (2012). "GSC Strategy 2013-2017."
- Skipper, C. O., and Brandenburg, S. (2013). "Emotional intelligence and academic performance of engineering students." *Engineering Project Organization Journal*, 3(1), 13–21.
- Sullivan, M. (2003). "Integrated recovery management: A new way of looking at a delicate process." *Australian Journal of Emergency Management*, 18(2), 4–27.
- Thayaparan, M., Siriwardena, M., Malalgoda, C. I., Amaratunga, D., Lill, I., and Kaklauskas, A. (2015). "Enhancing post-disaster reconstruction capacity through lifelong learning in higher education." *Disaster Prevention and Management: An International Journal*, 24(3), 338–354.
- Thwala, W. D. (2005). "Employment creation through the provision of low cost housing in South Africa." *Proceedings of the XXXIII IAHS World Congress on Housing: Transforming Housing Environments through Design, Pretoria, South Africa*, 27–30.
- Torrealba, D. (1972). "Convergent and Divergent Learning Styles." Master's Thesis, Massachusetts Institute of Technology, Sloan School of Management.

- Tsai, J.-S., and Chi, C. S. F. (2011). “Dysfunction of governmental emergency management system for natural disaster: a case study of Taiwan Xiaolin village.” *Engineering Project Organization Journal*, 1(2), 107–119.
- Tuladhar, G., Yatabe, R., Dahal, R. K., and Bhandary, N. P. (2015). “Disaster risk reduction knowledge of local people in Nepal.” *Geoenvironmental Disasters*, 2(1).
- UNISDR. (2015a). *Sendai Framework for Disaster Risk Reduction 2015-2030*. Geneva, Switzerland, 37.
- UNISDR. (2015b). “The Economic and Human Impact of Disasters in the Last 10 Years.” <<https://www.unisdr.org/we/inform/disaster-statistics>> (Apr. 9, 2017).
- Van Doorn, J. R., and Van Doorn, J. D. (2014). “The quest for knowledge transfer efficacy: blended teaching, online and in-class, with consideration of learning typologies for non-traditional and traditional students.” *Frontiers in Psychology*, 5.
- de Venecia, J., and Angara, E. (1994). *Technical Educational and Skills Development Act of 1994*. 22.
- Veres, J. G., Sims, R. R., and Locklear, T. S. (1991). “Improving the reliability of Kolb’s revised learning style inventory.” *Educational and Psychological Measurement*, 51, 143–150.
- Yamazaki, Y. (2005). “Learning styles and typologies of cultural differences: A theoretical and empirical comparison.” *International Journal of Intercultural Relations*, 29(5), 521–548.
- Zerio, A., Opdyke, A., and Javernick-Will, A. (2016). “Characterizing post-disaster reconstruction training methods and learning styles.” *Engineering Project Organization Journal*, 6(2–4), 142–154.

APPENDIX A: CODING DICTIONARY

We imported 36 interview transcripts into NVivo coding software to conduct content analysis. Overall, our analysis initially unpacked the training methods employed by aid organizations, then subsequently categorized these methods according to ELT's learning modes. An undergraduate researcher assisted by coding the data independently. The research team met on an iterative basis to verify the coding dictionary (see below) and discuss emergent themes. Using NVivo software, we ran a coding comparison across pertinent nodes (e.g. ELT mode) and sources (e.g. community members). The inter-rater reliability score, in the form of Cohen's Kappa coefficient, averaged across interviews was 0.68, suggesting sufficient agreement. The final coding dictionary is listed below:

1. **Community Perspectives:** General comments on how training was received by the community (don't relegate into positive or negative yet)
2. **Content-Specific Relevancy:** did the organization customize the objectives to meet the community's needs; community buy-in
 - a. **Date:** how recent (up-to-date) is the information provided
3. **Comprehension:** did the audience have a clear understanding of the material presented upon leaving
 - a. **Certification:** documentation that signified completion of training; proficiency-level
4. **Objectives:** what did the organization want to teach them; concrete; feeder for more strategic objectives
5. **Incentives:** did the organization offer anything for those that completed training job-site; financial (stipend); why did or didn't the community members attend training; competing interests (day laborers, missing work)
6. **Training Organization:** how is the training organized, roles of trainers, audience members; who manages content, delivery functions; ownership of the construction (training the household versus hiring labor)
 - a. **Audience:** homeowner versus skilled worker (occupation); gender biases; age, education level
 - b. **Content:** text/picture based, topics covered in training
 - c. **Format**
 - i. **Active Demonstration**
 - ii. **Blueprints_Diagrams**
 - iii. **Handout Materials**
 - iv. **Lecture**
 - v. **Maps**
 - vi. **Photographs**
 - vii. **Posters**
 - viii. **Storytelling**

ix. **Video**

- d. **Language:** English, Filipino, dialect
- e. **Length:** duration of training, session length, multiple days
- f. **Location:** community center, outdoors, centralized location, outside the community, classroom
- g. **Size:** teacher to student ratio; number of attendees to training

APPENDIX B: 8 BUILD BACK SAFER KEY MESSAGES

With typhoons as the leading hazard identified within the greater Pacific region, the Global Shelter Cluster sought to establish a common understanding of appropriate shelter construction practices. As a result, they developed ‘8 Build Back Safer Key Messages’. These messages include: (1) foundations, (2) tie-downs, (3) bracing, (4) joints, (5) roofing, (6) site selection, (7) building shape, and (8) preparedness. This collection of simplified construction principles aimed to provide simple, agreed upon tips of how to improve housing being constructed by communities. A primary aim of which was to have government and non-governmental agencies providing same messages, and to have community members directly use and learn from the messages. The messages were translated into 8 languages within the country and have been translated and used in a range of other similar disasters contexts.

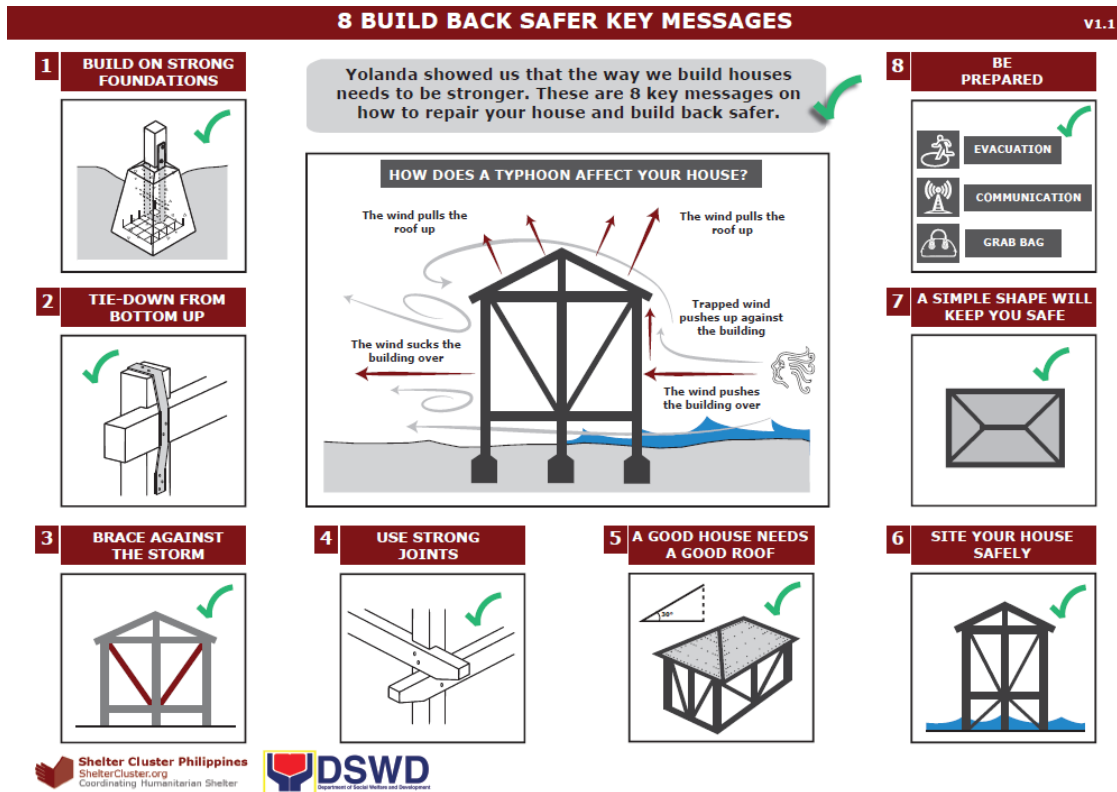


Figure B-1: 8 Build Back Safer Key Messages

APPENDIX C: CONSTRUCTION KNOWLEDGE QUESTIONNAIRE

Demographic Information

Please complete the following information about yourself:

Gender (Select one):

- Male Female

Age: _____

English Proficiency (Select one):

- Beginner
 Intermediate
 Advanced
 Fluent

Highest Educational Attainment (Select one):

- College Graduate
 College Level (Year Level: _____)
 High School Graduate
 High School Level (Year Level: _____)
 Elementary Graduate
 Elementary Level (Grade: _____)
 No Formal Education

Were you born in this barangay?

- Yes No

Please select the training methods that you prefer when learning about *disasters, risk or construction*?

Select all that apply.

- Lecture – Instructor talks to large audience
 Posters – Informational diagram with photos and text posted in your barangay
 Active Demonstration – Building or testing a concept, such as hammering nails
 Hand-out Materials – Booklet or brochure that you can take home to read
 Video – Recording showing images
 Storytelling – Use stories from past experience
 Photographs – Pictures of materials, joints, houses or other construction items
 Maps – Visual representation of your barangay, such as a hazard map
 Blueprints/Diagrams – Technical drawings of houses or other infrastructure

Pre-Yolanda Construction Jobs

Please provide a list of construction jobs you held **before** Typhoon Yolanda. Please leave blank if your work did not involve construction.

<u>Job Description</u>	<u>Duration (Years, Months)</u>


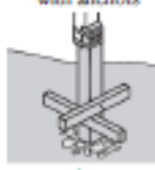
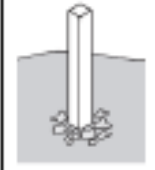
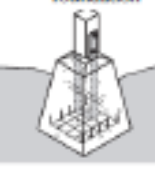
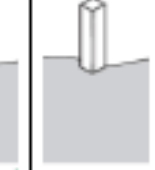
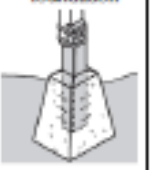
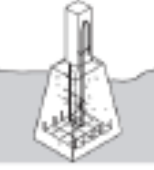
Post-Yolanda Construction Jobs

Please provide a list of construction jobs you held **after** Typhoon Yolanda. Please leave blank if your work did not involve construction.


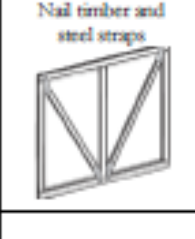

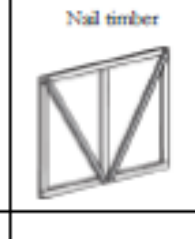
<u>Job Description</u>	<u>Duration (Years, Months)</u>	<u>Currently Employed? (Yes/No)</u>

Construction Knowledge

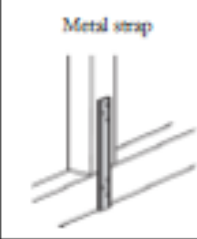
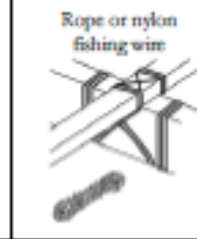
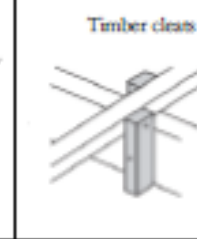
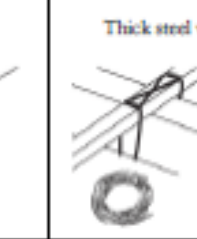
Q1. Please rank the following types of foundations from strongest (1) to weakest (7).

Below ground anchors	Treated hardwood post below ground with anchors	Below ground timber post	Steel strap bolted to post on concrete foundation	Above ground timber post	Hardwood post set in concrete foundation	Rebar set into concrete foundation
						

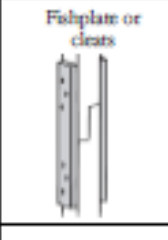
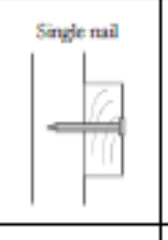
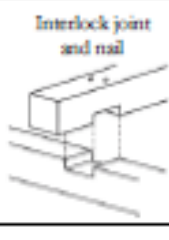
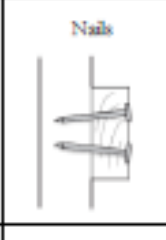
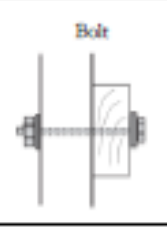

Q2. Please rank the following types of bracing from strongest (1) to weakest (4).

Rebar	Nail timber and steel straps	Thick steel wire	Nail timber
			


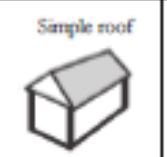

Q3. Please rank the following tie-downs from strongest (1) to weakest (4).

Metal strap	Rope or nylon fishing wire	Timber cleats	Thick steel wire
			



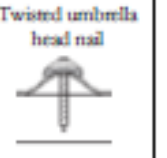
Q4. Please rank the following joints from strongest (1) to weakest (6).

Fishplate or cleats	Single nail	Interlock joint and nail	Nails	Bolt	Screw
					

Q5. Rank the roof types from best (1) to worst (3) when protecting against strong winds.

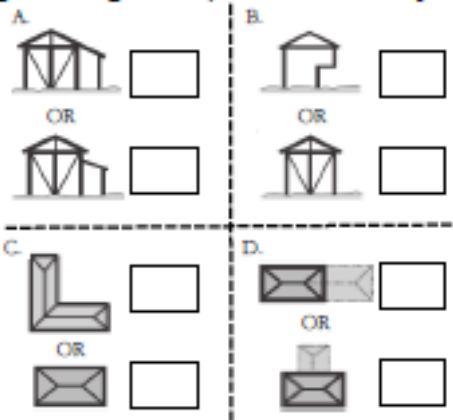
Single slope roof	Simple roof	Quatro Aquas
		

Q6. Rank the roof connectors (to secure roof) from strongest (1) to weakest (3).

German wire	Regular nail	Twisted umbrella head nail
		

Construction Knowledge

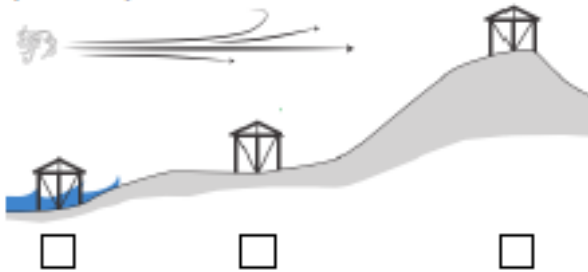
Q7. Choose the better building shape that will reduce damage in strong winds. (Select one for each pair)



Q8. Foundations serve the following purpose (Select all that apply):

- Protects the building from pests - like termites
- Keeps the timber away from water so it does not rot
- Protects the building from fire
- Stops the building from being pushed over
- Weights the building down so it can't be sucked up
- Stops the building sinking into the ground

Q9. Choose the best location to build your house. (Select one)



Q16. Did you participate in a construction training provided by an NGO or the government after Typhoon Yolanda? (Select one)

- Yes No

If yes, please list:

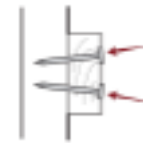
Training

NGO or Government Agency

Date (Approx.)

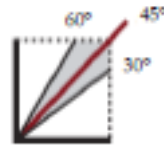
Q10. Nailing at an angle will make a joint harder to pull apart.

- True
 False



Q11. Wall bracing should ideally be placed at what angle?

- 60° 45° 30°



Q12. Roof pitch should ideally be what angle?

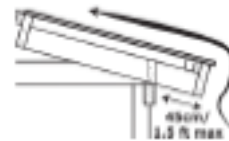


Q13. Roof edges should have more nails.

- True
 False

Q14. The eaves on a roof should not be longer than 45cm (1.5ft).

- True
 False



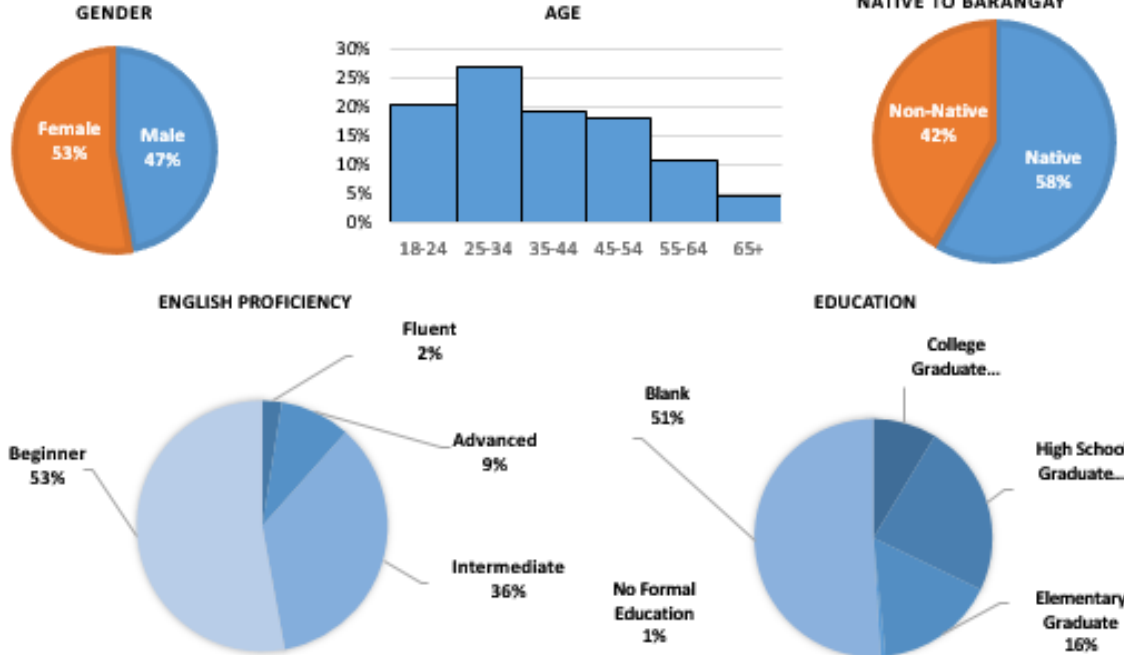
Q15. When a typhoon is approaching, what actions can you take to prepare? (Select all that apply)

- Evacuate to a safe location
- Disregard early warning information
- Create a 'grab bag' with medicines, basic food and important records
- Inform relatives/friends where you will evacuate
- Wait until the last minute to decide to evacuate
- Tie-down your roof with rope or fishing wire

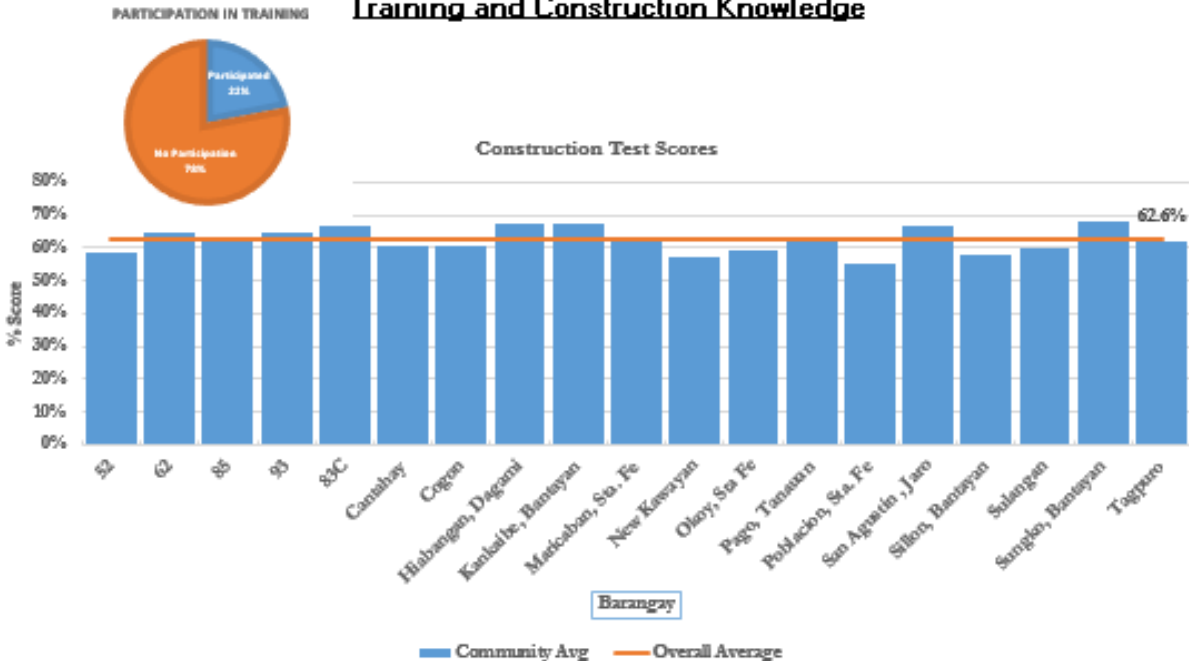
APPENDIX D: SUMMARY STATISTICS

Barangay: Overall
 Sample Size (n): 881

Demographics



Training and Construction Knowledge



Case	Province	Barangay	<i>n</i>	1: Foundations	2: Tie-Downs	3: Bracing	4: Joints	5: Roofs	6: Location	7: Shape	8: Preparation	Community Avg
1	Cebu	Okoy, Santa Fe	71	71.5%	66.2%	45.3%	58.1%	66.1%	36.6%	38.7%	90.3%	59.1%
2		Maricaban, Santa Fe	61	75.5%	67.2%	48.0%	64.7%	77.2%	47.5%	34.4%	90.8%	63.2%
3		Poblacion, Santa Fe	48	63.5%	43.8%	54.5%	54.7%	65.0%	31.3%	44.3%	85.7%	55.3%
4		Sungko, Bantayan	67	84.2%	82.1%	52.5%	69.1%	79.0%	52.2%	32.8%	94.0%	68.2%
5		Sillon, Bantayan	80	64.1%	61.3%	45.5%	49.2%	59.9%	41.3%	51.9%	91.9%	58.1%
6		Kankaibe, Bantayan	52	81.9%	73.1%	42.3%	65.7%	77.8%	65.4%	38.5%	94.5%	67.4%
7	Leyte	Tagpuro, Tacloban	20	65.5%	50.0%	47.9%	63.2%	69.1%	65.0%	53.8%	83.1%	62.2%
8		Pago, Tanauan	20	69.5%	50.0%	29.3%	70.5%	74.1%	70.0%	52.5%	88.1%	63.0%
9		New Kawayan, Tacloban	20	55.5%	40.0%	35.7%	65.9%	71.4%	50.0%	55.0%	81.9%	56.9%
10		Bagacay (93), Tacloban	80	71.4%	63.8%	46.1%	66.3%	73.9%	67.5%	45.3%	85.5%	64.9%
11		San Agustin , Jaro	20	73.2%	55.0%	39.3%	63.6%	85.9%	65.0%	57.5%	96.9%	67.0%
12		San Jose (83C), Tacloban	51	77.4%	62.7%	40.9%	74.2%	72.7%	70.6%	49.5%	86.8%	66.8%
13		Magallanes (52), Tacloban	28	62.6%	35.7%	48.0%	66.2%	66.9%	60.7%	47.3%	81.7%	58.6%
14		San Jose (85), Tacloban	31	72.3%	41.9%	38.2%	63.0%	76.8%	64.5%	52.4%	85.1%	61.8%
15		Hiabangan, Dagami	20	75.3%	60.0%	57.9%	73.2%	81.8%	55.0%	48.8%	86.3%	67.3%
16		Saghakan (62), Tacloban	94	67.6%	60.6%	45.0%	68.5%	73.9%	62.8%	56.9%	82.8%	64.8%
17	Eastern Samar	Sulangan, Guiuan	73	69.8%	41.1%	44.8%	70.6%	67.9%	53.4%	46.6%	83.9%	59.8%
18		Cogon, Guiuan	23	64.5%	34.8%	44.7%	66.8%	73.5%	69.6%	50.0%	82.1%	60.7%
19		Cantahay, Guiuan	22	75.4%	27.3%	50.6%	76.4%	83.5%	45.5%	39.8%	89.2%	61.0%
Theme Average				70.6%	53.5%	45.1%	65.8%	73.5%	56.5%	47.2%	87.4%	62.4%

Table D-1: Average Community Scores

APPENDIX E: FUTURE WORK

Introduction

In its entirety, this thesis examines what are the impacts of training a community in disaster resilient construction, to include analyzing what inherent demographic traits influence how training is retained and recalled for future use. The thought being that improving fundamental knowledge within the community will increase these communities' capacity to become less reliant on outside agencies to rebuild shelters post-disaster. Yet, this thesis lacked a comprehensive causal analysis that linked the training methods employed by aid organizations to the ability of community members to understand the principles found in the 8 Key Messages. This appendix suggests an outline for future work that would examine this gap. To address this gap, the research question would ask:

RQ: How does post-disaster construction training interventions impact knowledge retention?

Suggested Research Method

Define Training Activities

The first step required is a definitive understanding of what constitutes training. The importance of setting this definition is to set the boundaries of the study before further analysis. For example, deciding beforehand if this study aims includes only formalized, corporate training or if impromptu or informal training, perhaps on the construction site, is also worthy of inclusion. Additionally, this step standardizes what constitutes a training activity across the different organizations, thereby allowing for comparisons of training methods across different contexts.

Characterize Training Methods

Chapter 2 investigated 3 of the 19 selected communities and how the formal training programs of aid organizations could be characterized according to Kolb's experiential learning theory. Coupled with the pre-defined training methods discussed in the previous section, this next step expands the same process to all 19 communities. Coding software would aid in analyzing the collected interviews of community members and aid organization personnel in the pursuit of unpacking the training methods employed in terms of Kolb's learning modes. For instance, when a community member spoke of attending a seminar presentation regarding construction methods and processes, but it lacked any participatory activities, this interaction coded as solely within the reflective observation mode. Coding of these interviews would yield a comprehensive understanding of how the training unfolded at each location and how these methods aligned to modes described by Kolb.

Yet, this would require going beyond a frequency table of learning modes employed that was seen in Chapter 2. This step must also yield an assessment of a training program's commitment to each of the four modes. As such, it is not merely a confirmation that a program included activities aligned with one of the four modes, but also how intense or effective were said training. For example, if a demonstration was included, did it include resources used in the real construction and what, if any, was the impact of audience participation? The answers to these would have to be scored according to a defined and developed rubric, thus providing a final quantitative score for training activities within each of the four learning modes. The rubric should contain a mixture of analytical measurements as scoring the effectiveness or intensity of training is a highly subjective endeavor. To wit, I would suggest the following inclusions. A voluntary survey given to the participants would measure pre-training expectations or motivations, while a

post-training survey would measure satisfaction. Administering a short construction test, like the one developed in Chapter 3, would capture their level of understanding following the instruction. Alternatively, interviews of the aid organizations themselves would reveal their comprehensive plan for training, any internal performance metrics, along with any strategic objectives for their training programs. In concert with each other, the rubric's scoring system would have to accommodate these data collection methods in a way that allows for comparable scores across varying contexts.

Including a quantifying measure of the training programs as seen through Kolb, which was not included in Chapter 2, unpacks it further, thus allowing for better understanding of its impact on knowledge retention. Additionally, a quantitative assessment of training programs, derived from qualitative data, would standardize the observed data across the varying aid organizations. Lastly, as these assessments would be subjective to the individual researcher, multiple coders would be required to verify and gain consensus on training program assessments, thus minimizing biases.

The end result at this stage would be a clear narrative of how training was executed at each of the 19 reconstruction sites. This narrative will produce not only the frequency of training events that match a learning mode, but also a quantitative assessment of a training programs' effectiveness within each mode.

Cluster Analysis

The final stage of analysis would employ the same technique of cluster analysis and standardized scores seen in Chapter 3. Cluster analysis depicted that homogenous groups form in accordance with their performance on the construction knowledge test. Chapter 3 then applied various demographic traits in order to determine if performance groups shared certain traits.

However, this analysis did not include the impact potentially seen by the training methods employed by organizations. Therefore, expanding the analysis would include the results gleaned from characterizing the training methods of all 19 communities. The training method assessment from the previous section would first be standardized in the same manner as seen in Chapter 3. Next, these scores would be compared across the statistically determined grouping to detect any emergent patterns within higher or lower performing clusters.

One consideration overlooked in the thesis was the inclusion of a control group to better determine how impactful training methods were on knowledge retention. To accomplish this, a statistically determined sample size, who also had no training experience, would partake in the test and provided a valued comparison sample to the analysis. This comparison would allow for meaningful measurements in terms of training impacts.

Conclusion

The method suggested here is possible to execute given the data collected. The interviews, triangulated with field notes and documentation, were collected in all 19 communities and can provided the needed narrative to describe how training unfolded. By expanding now only the number of communities analyzed, but also including a quantitative analysis measurement could then be fed into cluster analysis. The result is an answer to the question: How does post-disaster construction training interventions impact knowledge retention?