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# Knowledge Transfer to Builders in Post-disaster Housing Reconstruction in West-Sumatra of Indonesia

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**Abstract.** Housing is the most affected sector by disasters as can be observed after the 2009 earthquake in West Sumatra province in Indonesia. As in Indonesian construction industry, the housing post-disaster reconstruction is influenced by knowledge and skills of builders or laborers, or locally known as 'tukang'. After the earthquake there were trainings to transfer knowledge about earthquake-safe house structure for the builders in the post-disaster reconstruction. This study examined the effectiveness of the training in term of understanding of the builders and application of the new knowledge. Ten semi-structured interviews with the builders were conducted in this study. The results indicate that the builders with prior housing construction experience can absorb and understand the new knowledge about earthquake-safe house structure. Combination of lecturing and practice sessions also help the builders to understand the knowledge. However, findings of this research also suggest there is a problem in implementation of the new knowledge. Utilization of earthquake-safe house structure may leads to a rise in house cost. As a result, some house owners prefer to save money than to adopt the new knowledge.

## INTRODUCTION

Experience from various earthquakes show that the main factor contributing to losses and damages is the inadequate house design and construction [1, 2]. Particularly in Indonesia, most of the houses may be classified un-engineered buildings that constructed without a proper design from engineer. House is commonly built by hiring builders and rarely has a design by engineer.

Builders construct the house base on their experience, and they mainly do not have formal education in construction. In bigger scope, workers in Indonesian construction industry is around six million which constitutes 5.7% of the workforce [3]. The workers are traditionally evolved from farmers who looked for a temporary job after the crop harvest. The challenge in the construction industry is the low level of education of the workers. Soemardi et al. [4] show that more than half of the workers only had elementary education, and 1.5% of them are never received any formal education at all.

Builders, or known locally as 'tukang', like most of the Indonesian construction workers, learn their trade from the previous generation of workers. They usually have apprenticeship to build their knowledge and skills. As a rookie without any experience, they start with helping a senior worker in preparing jobs such as masonry, concrete and wood job. They asked to measure materials for the job then mix the material if needed. The senior worker will tell about his experience in a proper way to do the job. After some time, the rookie worker gets large work proportion, as his experience is developing, while the senior worker keeps conveying his experience. After the worker considered the worker have had adequate experience and skill then the worker start to work by himself.

Builders have an important role in post-disaster reconstruction especially in housing reconstruction. The quality of the constructed house will mainly depend on experience and skills of the builders. Builders become a vital link in mitigation and preparation for the next disaster. However, as previously discussed, the education of the workers is the main challenge where they have elementary education and inherited knowledge about house building from previous workers. Traditional house in most of Indonesia is wooden house and significant earthquakes only occur in the last decade, for that reason the knowledge about earthquake-safe concrete-structure house is relatively not present among

the builders. Suarjana and Sengara [5] shows that incorrect structural details have been widely used in Indonesia and become false standards that implemented from one project to another.

After 2009 West Sumatera earthquake many national and international organizations came to the province to give supports and donations. Training for the builders is one of the assistances and trainings are conducted by NGOs, local governments or universities. The trainings have a purpose to educate the builders about earthquake-safe house. However, the nature of the trainings is a project-like activity which temporary and in a limited time. Therefore, two questions have emerged about the effectiveness of the trainings for the builders: to what extent the builder understand about earthquake-safe house and how is the implementation of the knowledge?

Given the above backgrounds, this paper presents the effectiveness of the trainings of earthquake-safe house for builders. The effectiveness in this paper is constituted with the understanding of the builders as training participants and implementation of knowledge about earthquake-safe house.

## **LITERATURE REVIEW**

### **Indonesia and Disasters**

Indonesia is a very prone country to disasters. Data collected by CRED (Centre for Research on Epidemiology of Disasters) shows that floods, earthquakes and landslides are mayor disasters in Indonesia in the last twenty years. However, based on number of fatalities, earthquake is the deadliest disasters where six out of ten the most deadly disasters in Indonesia in the last twenty years are earthquakes [6]. Indonesia located on actives volcanoes and tectonic plates, often dubbed as 'ring of fire', so there is relatively high number of earthquake occurrence in Indonesia. Research finding from Irsyam et al. [7] shows that more than 14,000 occurrences of earthquake with magnitude of  $M > 5.0$  in Indonesia during duration 1987-2009. In the last decade, large earthquakes in Indonesia are 2004 Aceh earthquake and tsunami, 2005 Nias earthquake, 2006 Yogyakarta earthquake, 2009 Tasikmalaya earthquake and 2009 West-Sumatra earthquake. Those earthquakes were not only claiming lives, but also destroyed housings and infrastructures. Around 200,000 houses were destroyed in 2004 Aceh earthquake and tsunami. In 2006 Yogyakarta earthquake 306,234 houses were damaged. It is recorded 114,797 houses were collapsed in 2009 West-Sumatra earthquake.

In reconstruction after a disaster, there are five approaches that can be implemented [8]:

- Cash approach. Disaster victims are given financial (cash) to rebuild their houses.
- Owner driven reconstruction. In this approach beside receive financial aids, disaster victims also get technical assistance in building or repair their houses.
- Community driven reconstruction. Reconstruction is managed by disaster-affected community with support from agency.
- Agency-driven reconstruction in-situ and agency-driven reconstruction in the relocated site. In these approaches agency involvement in the reconstruction process are more dominant than disaster victims.

### **West Sumatra Reconstruction**

A 7.6 Richter scale earthquake struck off the western coast of Sumatra island Indonesia on 30th September 2009. The earthquake's epicenter was located at 45 kilometers from Padang, the capital city of West Sumatra province, in Indonesia. Two strong aftershocks succeeded a few minutes later after the earthquake. The earthquake claimed high fatalities, 739 lives were victims and 739 persons were missing. The damage from the earthquake also comprised 121,679 homes which were severely damaged, 52,206 which were moderately damaged, and 57,510 homes which were slightly damaged [9]. Moreover, infrastructures were also damaged, included 447 office buildings, 4,784 educational facilities, 153 health facilities, 285 religious buildings, 58 markets, and 68 bridges were damaged [10]. Although with this massive amount of damage, the West Sumatra earthquake was declared a provincial disaster, it was not a national level disaster as previously declared by the government earthquakes in the Aceh and Yogyakarta reconstruction.

The West Sumatra recovery process was managed by the Government of Indonesia (GoI). The recovery process is divided into several clusters: agriculture, early recovery, education, food and nutrition, health, logistics and telecommunications, protection, shelter, and water & sanitation. After the humanitarian response to the West Sumatra earthquake, the number of non-government organizations reduced from hundreds in 2009, after the earthquake, to a few in 2010 [11]. However, the role of local government increased.

## Knowledge Transfer

Knowledge may be defined as the mental state of ideas, facts, concepts, data and techniques which build on received information that is enriched by personal experience, belief, and values [12]. Another definition is from Davenport and Prusak [13] that state knowledge as a “fluid mix of framed experiences, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices and norms”. Knowledge is context specific, so that produced knowledge will be different from one individual to another if the context is different [14]. Bender and Fish [12] also note that even if different people receive the same information, formed knowledge will differ among the individuals.

Data, information, and knowledge are not the same thing, as suggested by Bender & Fish there is a hierarchy between data, information, knowledge, and expertise. Data are discrete objectives about facts or event, by adding meaning and understanding data will transformed into information, furthermore by adding personal experience, values, and belief a person can gain knowledge from the information [12]. In addition Bender & Fish also differentiate expertise and knowledge, where expertise is built from zero by a person and he/she develops it into far deeper knowledge that enhanced by long-time experience, education and training.

Liyanage et al. [15] proposed a knowledge transfer model which consists of five processes of transferring knowledge from the source to the receiver. The processes are (FIGURE 1):

- Knowledge awareness: the process of identification of valuable or appropriate knowledge.
- Knowledge acquisition: after needed knowledge has been identified then acquisition of knowledge by the receiver.
- Knowledge transformation: the process of adding and deleting knowledge to produce new useful knowledge to improve existing knowledge, skill and capacity.
- Knowledge association: relating transformed knowledge with internal needs and capabilities.
- Knowledge application: use of the acquired knowledge

However, among those processes, Liyanage et al. stressed out about the importance of knowledge application, all other processes of knowledge transfer will give no benefits except the transferred knowledge is implemented. Also in their model there are prerequisite factors in order the knowledge transfer taking place. Those factors are willingness to share knowledge from the source of knowledge’s side and absorptive capacity and willingness to acquire knowledge from receiver’s side.

In their model, Liyanage et al. is using SECI model from Nonaka and Takeuchi as modes of knowledge transfer, which inform that knowledge can be transferred with Socialisation, Externalisation, Combination, and Internalisation (SECI) modes. This implies there are many methods to transfers knowledge, depends on the type of knowledge.

There various knowledge in post-disaster reconstruction process, so that it is necessary to determine the most important knowledge, specifically in housing reconstruction context. As reconstruction in disaster management cycle is not only to rebuild after a disaster but also playing a part in mitigation stage toward the next disaster, it is arguable that quality of constructed houses is the main concern. Therefore earthquake-safe house is important knowledge which includes structure of house (beams, columns, and joints), construction materials, and construction methods.

## RESEARCH METHODOLOGY

A series of semi-structured interview was conducted in this research with respondents are the builders who have had training about earthquake-safe house after 2009 West-Sumatera earthquake. Questions in the interviews are question about syllabus of the training, methods of delivery in the training, barriers for the builders in understanding the training contents, and barriers in implementing knowledge from the training.

List of potential respondents for this research is obtained from various publications and reports. It was targeted in this research to interview builders who located in Padang City and Padang Pariaman district, because these two areas had the heaviest damage in the 2009 West-Sumatera earthquake. Candidates for the interview respondents were directly contacted in person or by phone to get their agreement and concern. Interviews were conducted in local language *Minangkabau* and *Bahasa Indonesia* during August and September 2014 and they were electronically recorded. There were 10 interviews conducted in this research and this number is considered adequate

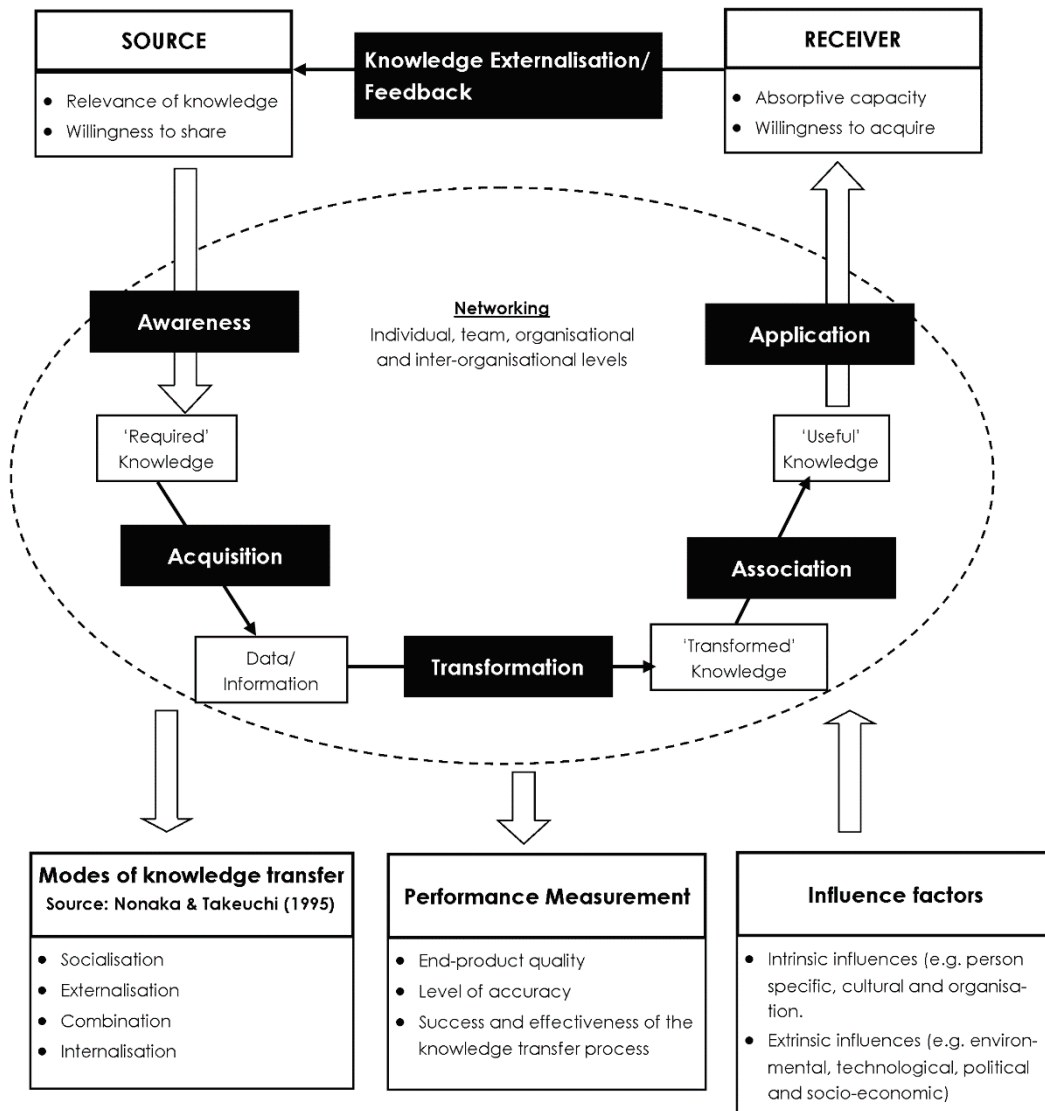


FIGURE 1. Knowledge transfer process (Liyanage et.al)

By the researchers as it has achieved data saturation, no new information has been emerged. This number of interviews is also considered adequate in qualitative research by other authors [16].

Interview recordings then converted into transcriptions in format of Ms-word document. To help to understand the knowledge transfer to builders from the interviews, NVivo version 9 software was utilised. Nvivo is a leading software in qualitative data analysis that help researchers to manage data, coding and to identify themes [17].

## RESULTS AND DISCUSSIONS

The interviews have identified some issues related to transfer of knowledge about earthquake-safe house to the builders, and those will be discussed in the following section.

### Experience

From the ten interviewees that attended the trainings, three of the builders were not have any experience as builders when joining the trainings. The rest has various experience, range from one year to twenty years that mostly has

experience in housing construction, irrigation and road construction. It seems that the trainings were held to accommodate not only builders but also residents who have interest in earthquake-safe housing.

## **Motivation**

When asked about motivation to attend the trainings, nine of ten builders revealed that the main motivation was to upgrade their knowledge on earthquake-safe house structure. They previously work to construct house based on their experience without knowing if they built the proper structure. The 2009 West Sumatra earthquake have collapsed residents' houses and also some of the builders' own houses. There were also curiosity rose among the builders how could the houses collapse, so that they understand the causes and improve their working methods. One of interviewee expressed "*I saw many houses were collapse due to the earthquake and its aftershocks. Most of people house were using inadequate number of steel bars, little proportion of cement [in concrete mix], and too many proportion of sand. With the training we understand the portion of the cement, number of steel bars used...there are rules, standard to follow (R02)*". Another interviewee added, "*I am as builder want to improve my knowledge, how is earthquake-safe house and how to do it (R04)*". Another interviewee added about improving work quality, "*...I want to improve my quality of work, so it will be better than previous [work] (R3)*".

Liyanage et. al.'s model of knowledge transfer (Fig.1) stated that, in order to transfer knowledge, one of aspects required from receiver of knowledge (the builders in the training) is willingness to acquire the knowledge, which is motivation from the builders. The interviews indicated there is motivation to seek knowledge about safe house structure and aware about benefits of the training for them. Research by Henry [18] shows that motivation and outcome expectancy of training's participants positively related to training effectiveness.

## **Method of Training and Curricula**

The next question in the interview was about the training: how long it was conducted, methods of its delivery, and contents of the trainings. The interviewees attended different session of trainings, but they had similar length of training and its delivery method, all the trainings were conducted in one week with two methods of delivery. Firstly, knowledge about earthquake-safe house structured was delivered by lecturing method that presented by instructors. Instructors were lecturers from university and different instructors may give different subject which based on their expertise. Secondly, practice sessions were conducted in the trainings where training participants after attended class or lecture then directly build some parts of house structure that the learn in the class. Interviewees revealed both in these two methods of delivery there were discussions with the instructors or among training participants.

Syllabus of the trainings consist of constructions tools, construction materials, foundation, beam, column, reinforce bar, joints, construction methods, brick and wall, roof structure, and house cost estimating. The participants were provided with books and manual about the syllabus. Then they were given bricks, steel reinforce bars, cements and construction tools to implement the syllabus in the practise session.

## **Barriers Faced by the Builders**

As mentioned earlier, most of the interviewees had have experience in housing construction prior to the training, so that they have basic knowledge about house construction and therefore can absorb knowledge from the training instructors. However, many interviews expressed about difficulties in understanding reinforce bars in joints between beam and column.

## **Barriers in Implementing the Knowledge**

As suggested by Liyanage [15] the important process of knowledge transfer is application of acquired knowledge. Thus the builders have got new knowledge or improved their knowledge of earthquake-safe house structure from the training and the knowledge need to be implemented when constructing new houses. In Indonesia, the common practice to build a house is the owner find a builder and negotiates about the cost and construction schedule.

The implementation of earthquake-safe house brings some consequences for the builders, mainly rise of cost of house and need extra time to do it. Meanwhile the builders get the job to build a house from house owner based on their compromise on cost and schedule. Builders in the interviews revealed that in order to have earthquake-safe house they need to add more portion of cement, more steel bars and at the end a rise of cost of the house. Some of the

interviewees stated that after the trainings they were offered to build house by the owner. They had informed the owner about the important of proper house structure with adequate reinforcements and good joints, but the cost is the main consideration for the owner. With limited fund, the house owner cannot fully implement earthquake-safe house structure design. As it was explained by one of interviews, “if we got a job to build a house, we offered (structural) suggestion from the trainings to the owner. But it was difficult because owner’s concern about the rise of construction cost. I predict ninety percent of the owners will refuse (to adopt earthquake-safe house structure). So, it depends on us as builders, we may not fully implement the knowledge from the trainings; If it was suggested in the training to have 30cm of overlapping reinforce bars in a joint between column and beam, we only did it 10cm in order to reduce cost, so the owner won’t complaint (R10)”.

The above conditions illustrate that house owners also play an important role to have earthquake-safe house, as decision to adopt it is on them. Therefore knowledge transfer about safe house should be conducted to both of the builders and house owners. This have been done in West Sumatra reconstruction where a various campaign about ‘Rumah Aman Gempa’ or earthquake-safe house had been launched [19] by Indonesian government and NGOs which included activities of advertisings, books and brochures, film, talks and trainings. In regards with builders and owners in earthquake-safe house there will be four combinations: knowledgeable builders and owners is the best result; knowledgeable builders with non-knowledge owners and vice-versa; and non-knowledgeable builders and owners is the difficult condition to have earthquake-safe house.

## CONCLUSION

Housing is the most affected sector after earthquake and also most needed in post-disaster reconstruction. In Indonesian context, the quality of housing construction is mostly influenced by knowledge and skills of the builders. However, the builders develop their knowledge based on experience, but sometimes on false standards. Earthquakes in various location show the collapse of the houses mainly caused by inadequate structure. Therefore, there is a need transfer of knowledge about earthquake-safe house structure to the builders.

Following 2009 West Sumatra earthquake there were some trainings about earthquake-safe house conducted to the builders. This research has identified that the builders had good motivation to attend the training and since they have building construction experience they can absorb and modify the new knowledge about earthquake-safe house structure. Combination of lecturing in class and practice session had helped the builder to understand the knowledge.

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