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Data collection challenge in seismic risk-based assessment at Ranau Township

Izni Izzati Mohamad[1*], Mohd Zulkifli Mohd Yunus[1], and Noor Sheena Herayani Harith[2]

[1]*School of Civil Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, Malaysia*
[2]*Faculty of Engineering, Universiti Malaysia Sabah, 88400 Kota Kinabalu, Sabah, Malaysia*

Abstract Seismic is an energy in the form of wave that will cause ground shaking and resulting in earthquake. Earthquake is a natural disaster that can bring damage to property, environment, and life. The structure of the building will determine the level of resistance when the earthquake occurs. Rapid Visual Screening is conducted to assess the durability and risk of building upon the earthquake events. There are some challenges faced during data collection including the topography of the study area, cooperation of the residents, time constraint and ground data limitation. This paper aim to describe the challenges encounter during data collection. Limitation and recommendation for future research also discussed in this paper. Data collection is a very crucial stage as it will determine the accuracy of the results and affect the findings of the research. From this data collection, it will help stakeholders, town planner and town authorities to plan the town and take precautionary measures against high-risk buildings in case of earthquake.

1 Introduction

Seismic is a wave that caused the earthquake event. It is formed when the rock within the earth suddenly breaking and released the energy in the form of wave [1], [2]. This energy travels through earth and cause shaking to the ground. There are two types of seismic wave; body waves and surface waves. Both waves can cause earthquake where the body wave can travel through the earth's inner layer, but surface can only travel along the surface of earth. Earthquake happened when two plate collide each other. This usually happens when rocks underground suddenly breaks along the faults because of sudden release of energy which results in ground shaking. Seismic risk is a risk of the earthquake incidents toward it surrounding and can be calculated using Equation 1 below;

$$\text{Seismic Risk} = \text{Seismic Hazard} \times \text{Exposure} \quad (1)$$

This equation shows that high seismic hazard not necessarily means high seismic risk if exposure is low, and vice versa [3].

There are many published research on seismic risk assessment. However, far too little attention has been paid to the challenge during data collection to conduct the assessment. Logistical challenge related to conducting research in seismic risk assessment including with conducting fieldwork since fieldwork can be complex and frustating endeavour, characterised by long hours and exposure to unfavorable local conditions [4]. Munro et al.(2009)[5] mentioned that these challenges range from gaining entry to study sites, geographical constraints such as

*Corresponding author: ezne007@gmail.com

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travelling long distances to access participants, to incomplete interview or high non-response rate. Other challenge includes using fieldworkers who are not indigeneous to the research area as the survey-participants easily to answer questions and trust their community member [6]. Fieldworker plays an important role during the survey as they need the skills to interact with the participants and get their trust and cooperation. Four dimensions of interviewer characteristics were identified which will affect the participation and responses results including; i) fieldworkers' behaviour; ii) interviewer attitudes; iii) fieldworkers' experience and skills with measurement device; and iv) fieldworkers' expectatations [7]. Besides that, the challenge often face by the fieldworker is the survey-participant lack of trust towards the fielworker which makes the survey more harder. This can be due to previous research conducted in communities where no one benefited and no feedback on research was received [8] and the community fell unsecure of the fieldworkers; misunderstood as scammer.

In seismic risk based assessment, there are two types of data were needed; primary and secondary data. However, in this paper, only primary data collection will be discussed focusing on Rapid Visual Screening (RVS) method. The main objective of this paper is to discussed the experienced of the authors during this data collection process specifically on Rapid Visual Screening method.

2 Earthquake in Ranau

Malaysia is close to the most two seismically active plate boundaries, the inter-plate boundary between the Indo-Australian and Eurasian Plates on the west and the inter-plate boundary between the Eurasian and Philippines Sea Plates on the east. Major earthquakes originating from these plate boundaries have been felt in Malaysia. Several potential active faults have been delineated and local earthquakes in East Malaysia appear to be related to some of them [9]as shown in Figure 1 [10]. In addition to the local earthquakes, East Malaysia is also affected by tremors originating from large earthquakes located over Southern Philippines and Northern Sulawesi. Malaysia is located near the Pacific Ring of Fire, a belt of seismic activity running around the basin of the Pacific Ocean that includes neighbors Indonesia and the Philippines. The most quake-prone state of Sabah has three major quake zones, namely Central-North (Ranau) Zone, Labuk Bay-Sandakan Basin Zone and Dent-Semporna Peninsula Zone. Figure 2 shows number of local earthquake with magnitude greater than 2.0 reported from 1902-2016 around Sabah [11].

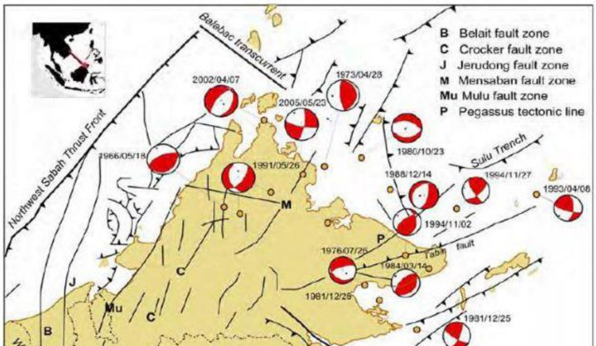


Figure 1. Seismic geometry of local earthquake around Sabah [10]

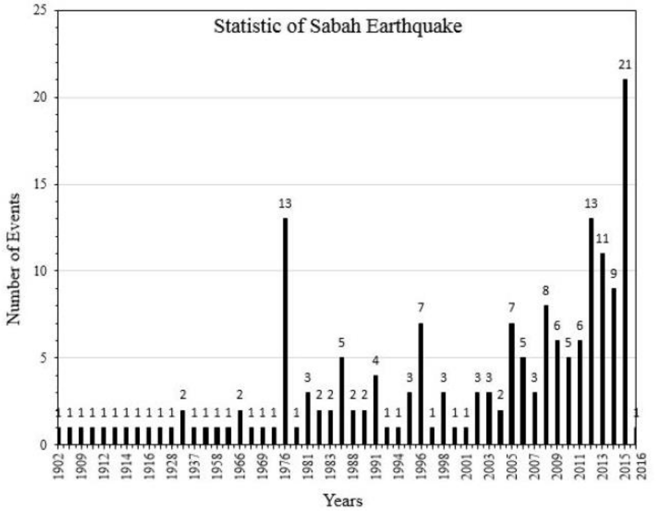


Figure 2. Number of local earthquake with magnitude greater than 2.0 reported from 1902-2016 around Sabah [11]

3 Method

3.1 Design

A post-study review of material generated was conducted as part of both the pilot and main study. These included (i) a review of notes taken during feedback sessions; (ii) minutes of regular project meeting among the research team members; and (iii) email correspondence with authorities.

3.2 Fielwork preparation activities

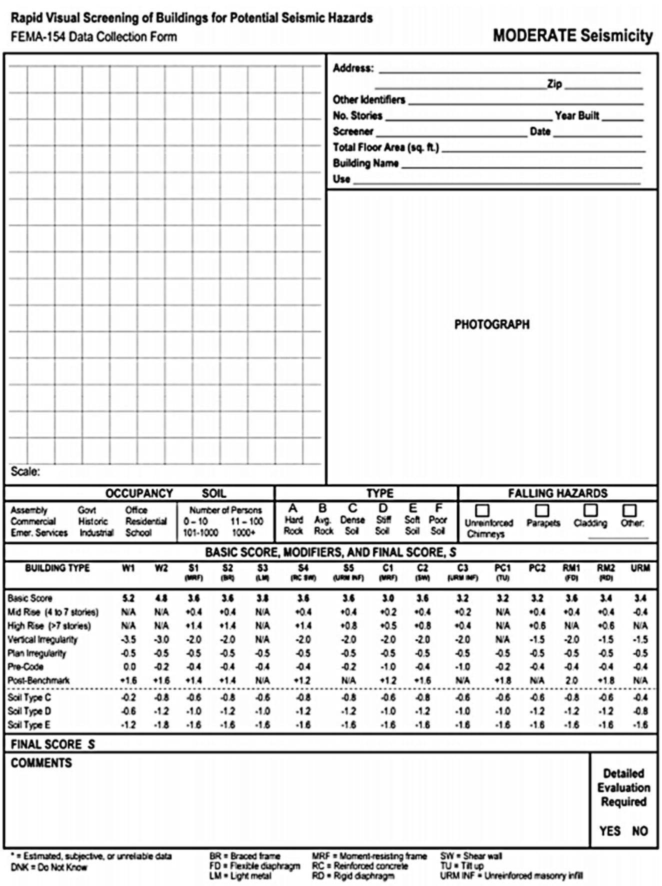
Prior to fieldwork, the community and the parties involved were informed about the study by various methods to avoid misunderstanding during survey. This includes meeting with village's chief, Head of Priciples of schools and District Officer. We also informed members of the police services and community policing in the study areas about the research. Four fieldworker were appointed. This fieldworkers were trained during a week training session on the collection of data, ethical principles, interviewing skills, reading of maps and completing other documentation as required. As far as possible, field staff were matched with anticipated study participants on gender, language and race. The native-speaker's fieldworker were selected to ease the communication with the communities.

In addition, site survey and preliminary data gathering were conducted before the fieldwork to ensure smoothness and time spent during the survey can be utilized efficiently. The preliminary data collected including the topography map, the type of soil and identification of usage of each building (this is important as we needs approval to access some buildings).

3.3 Questionnaire selection

To assess seismic risk, it requires evaluation of a large building population in a short period of time by a simple yet robust method, able to quantify the seismic performance of buildings and using vulnerability as an input parameter. Detailed analysis of vulnerability assessment are time consuming and these evaluations correspond to the methods of structural analysis and design. The main disadvantage is that they should be performed for every investigated building individually, so alternative methods like RVS have been developed to enable the rapid evaluation of large building stock [12]. Visual screening methods, based on systems calibrated by experts, allow for the quantification of structural vulnerabilities more easily than analytical approaches [13]. Detailed calculations and multiple scenarios are not needed in this method. Another method is score assignment which will determine seismically hazardous structures by structural deficiencies identification. To determine the level of damage according to the severity of a potential seismic event, quantitative information are gathered using parameters which includes; quality of materials, type of foundations, number of stories, state of conservation, and stiffness of the structure. From observed correlations between damage and structural characteristics, the potential structural deficiencies were identified. The main aim of this method is to determine if a particular building needs a more detailed investigation or not. Score assignment methods have been successfully applied recently to seven European cities in the RISK-UE European project [14].

In this survey, form from FEMA 154 were used as a data collection form because it is complete and simple to understand. There are three types of form in FEMA 154 that is divided according to the seismicity level of the surveyed area; high, moderate and low seismicity. In this study, moderate seismicity form were selected as the study area have reach 6.0 magnitude during earthquake. Figure 3 shows a sample of FEMA 154 form that were used during surveying. In this form, information needed including; i) general details of the building; ii) types of buildings; iii) type of soil; and iv) falling hazard from the building. In basic score, modifier and final score part, the marks will be given according to the building structure and parameter. Final score obtained will determine the building vulnerability.


Rapid Visual Screening of Buildings for Potential Seismic Hazards
FEMA-154 Data Collection Form

MODERATE Seismicity

Address: ____ **Zip** ____
Other Identifiers ____
No. Stories ____ **Year Built** ____
Screener ____ **Date** ____
Total Floor Area (sq. ft.) ____
Building Name ____
Use ____

PHOTOGRAPH

Scale:

OCCUPANCY	SOIL	TYPE	FALLING HAZARDS
Assembly, Govt, Office, Commercial, Historic, Residential, Emer. Services, Industrial, School; Number of Persons: 0 – 10, 11 – 100, 101-1000, 1000+	A Hard Rock, B Avg. Rock, C Dense Soil, D Stiff Soil, E Soft Soil, F Poor Soil		Unreinforced Chimneys, Parapets, Cladding, Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, *S*

BUILDING TYPE	W1	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (URM INF)	C1 (MRF)	C2 (SW)	C3 (URM INF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM
Basic Score	5.2	4.8	3.6	3.6	3.8	3.6	3.6	3.0	3.6	3.2	3.2	3.2	3.6	3.4	3.4
Mid Rise (4 to 7 stories)	N/A	N/A	+0.4	+0.4	N/A	+0.4	+0.4	+0.2	+0.4	+0.2	N/A	+0.4	+0.4	+0.4	-0.4
High Rise (>7 stories)	N/A	N/A	+1.4	+1.4	N/A	+1.4	+0.8	+0.5	+0.8	+0.4	N/A	+0.6	N/A	+0.6	N/A
Vertical Irregularity	-3.5	-3.0	-2.0	-2.0	N/A	-2.0	-2.0	-2.0	-2.0	-2.0	N/A	-1.5	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Pre-Code	0.0	-0.2	-0.4	-0.4	-0.4	-0.4	-0.2	-1.0	-0.4	-1.0	-0.2	-0.4	-0.4	-0.4	-0.4
Post-Benchmark	+1.6	+1.6	+1.4	+1.4	N/A	+1.2	N/A	+1.2	+1.6	N/A	+1.8	N/A	2.0	+1.8	N/A
Soil Type C	-0.2	-0.8	-0.6	-0.8	-0.6	-0.8	-0.8	-0.6	-0.8	-0.6	-0.6	-0.6	-0.8	-0.6	-0.4
Soil Type D	-0.6	-1.2	-1.0	-1.2	-1.0	-1.2	-1.2	-1.0	-1.2	-1.0	-1.0	-1.2	-1.2	-1.2	-0.8
Soil Type E	-1.2	-1.8	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6

FINAL SCORE *S*

COMMENTS

Detailed Evaluation Required
YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know
BR = Braced frame
FD = Flexible diaphragm
LM = Light metal
MRF = Moment-resisting frame
RC = Reinforced concrete
RD = Rigid diaphragm
SW = Shear wall
TU = Tilt up
URM INF = Unreinforced masonry infill

Figure 3. Sample of FEMA 154 data collection form

4 Results

Many challenges have been experienced during planning, preparation and conducting fieldwork (survey). These can be divided into two situation; identification of survey areas and conducting the survey.

4.1 Identification of survey area

Ranau is situated in Sabah, Malaysia. Topography map were collected from Department of Survey and Mapping Malaysia. To obtain more information, District Office have repeatedly been visited. This includes validating data that has been collected from the Google Maps that were used to assisst in planning the en-route of survey. This area was chosen as a study area because of the high population density and is experiencing rapid development in Ranau district compared to other area. The government agencies of Ranau and public facilities also located in this township area which makes this area have higher prioroties to checked it's building vulnerability, added with its long history of earthquake events. The survey area is limited to one kilometer square feet because of time limitation. Thus, the area with the highest number of buildings is selected including schools, hospital, residential, police station, fire department station and commercial buildings. Figure 4 shows the map of study area.

Figure 4. Study area located at Ranau Township

4.2 Conducting the survey

More challenges arise during the survey session. First, unavailability to gain access to houses because the residents refused to participate in the survey. Some of the residents were uninformed of the survey activities due to no communication system available in the community. On entering some residental, teams were told to inform the village communities during each visit despite the official letter had been made to the Village Chief to inform their presence. Failed to do so, the residental member would complain to the village communities the suspicious vehicle were driving around the area and then they either escorted out or will be questioned by the security officer of the area to validate the study purpose. The survey was conducted during the week and over weekend to enable fieldworkers to reach more targeted buildings. However, this was also a problem since majority of the residents in survey area self-employed and the house visited sometimes locked and the survey couldn't be made.

Privacy also was an issue during survey. The resident of the house refuse to open the gate and only allowed us to measure from outside. We prepared for such an eventuality by using laser measurement device to measure the distance to make floor plan for each of the buildings. The presence of aggressive dogs in some of properties especially in residential had prevented fieldworkers from gaining access to the properties. The high crime in the study area had negative influences on participation as people worried to allowed stranges into their properties.

As a result, 254 buildings were surveyed out of 271 buildings in the study area. Other 17 buildings weren't able to surveyed because of the stated limitation and challenges.

5 Discussion

This paper is intended to identify and describe the challenges faced during data collection for risk-based assessment for Ranau township and put forward recommendations for addressing some of these challenges. The main challenges experienced can be divided into 5 situation which are; i) pre-survey preparation; ii) identification of survey area; iii) informed the communities; iv) participation of communities; and v) contextual factors.

During survey, the planned study area had slightly change because of earthquake or the new development had been done in the area since the collected map is the older version and no latest version since then. In addition, new temporary buildings resulting in formation of informal roads making identification of survey area difficult and time consuming. Contextual factors such as high rate of crime in study area may influence negatively in the survey where there is limited access for the fieldworker to access the buildings since the residents untrusted the strangers to enter their buildings. In order to avoid this potential problem with communities, it is important all communities were well informed of any study planned to be conductd in their area by any means possible and reachable to all residents including the rural area. This include poster, bunting and flyers. The more aware the communities regarding the survey, the better cooperation they will be during the survey.

Despite the strength of the study, there are some limitation that were faced during the survey. Some of the challenges experienced by the fieldworker may have impacted the validity and reability of the survey results. These includes; i) misunderstanding types of construction or the building structures; ii) limited access to certain buildings; and iii) residents not participating. There are some buildings that the owner does not certain the types of stuctures used and different form what were surveyed. This had been a difficult for the fieldworker to do the survey and the process to determine the correct structure is time consuming. There were also some buildings that cannot be surveyed since it is not open for public and had limited access such as police station and police barrack.

As a recommendations, potential researcher planning to carryout survey on vulnerability assessment should avoid potential problem as outlined in this paper. Researchers should take more time in identifying types of buildings and determine the correct location of each buildings to be surveyed. It is better to get the updates floor map of each buildings before started the survey. Secondly, contextual factors should always be taken into account when planning the research. It is advisable to informed the police and district officer when the fieldworkers are in community to ensure their safety. To get the fieldworker who have some knowledge of the community is better as they can speak in native language and makes the communication easier with the communities. Finally, intensive training of fieldworker is important as they will know to use the survey tools and how to distinguish the types of buildings.

6 Conclusion

As a conclusion, this paper provides a contribution to the literature on challenge in data collection especially during conducting RVS. RVS is a reliable method to calculate building vulnerability. This experience will be useful for planning similar research in the future. Future work is needed to more measure the impact and nature of these challenges. By anticipating the challenges, researchers will be able to implement strategies to minimize the effect of the challenge.

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