別紙様式８

研　究　主　論　文　抄　録

論文題目

The Effect of Seismic Retrofitting and Risk Curve on Estimating Value of Statistical Life, A Case Study of Kabul, Afghanistan

（アフガニスタンのカブール市の統計的生命の価値の推定に対する耐震補強とリスク曲線の影響)

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主論文要旨

Occurrence of natural hazards such as earthquakes leads to widespread damages and human losses in Afghan cities every year. Existence of active faults near to Kabul city, the capital, which have the capacity of generating heavy ground motion of 0.8g with 2 percent probability of exceedance in 50 years threatens the live of more than 4 million people living in the city in the situation that majority of building constructions are not within the acceptable norms. Although in the recent years many projects with the concept of disaster risk reduction run across the country but due to lack of a comprehensive benefit-cost analysis at policy level, Afghan government is still challenging to manage the disaster risks properly in the absence of an important context which is the value of statistical life (VSL) for Afghanistan. This research was conducted to fill this gap by estimating VSL for Afghanistan based on stated preference method using seismic risk curve and risk of human loss due to building collapse in the event of earthquake. We first elaborated on different methods of seismic retrofitting of non-engineered houses which was conducted by 'Project for City Resilience', under the supervision of United Nation Human Settlements Program (UN-Habitat) for 48 retrofitted sun-dried clay brick masonry buildings in Kabul. The project was implemented by local masons and welders who were trained by the project, and the main tasks included installation of an additional steel frame, additional reinforced concrete foundation ring, ceiling replacement, and wall strengthening (via mesh and plaster). After a visual assessment of retrofitted buildings considering the original retrofitting design and actual work done, a vulnerability index for retrofitted buildings

was developed based on behaviour modifier factor, which was assigned to each retrofitting activity using a combination of values and a proportion of scores for each retrofitting activity. The results indicate that training of local masons and welders to undertake retrofitting activities could decrease the damage ratio by 15% to 20% for peak ground acceleration values of 0.3 g and higher. The next step was to calculate the risk in terms of human loss by using seismic risk curve for generally 3 building typologies including adobe, masonry and concrete in Kabul city. The risk was calculated before and after retrofitting activities. Then the results of seismic risk calculation in terms of human loss were used in a format of risk grid to design a questionnaire survey based on contingent valuation method. The survey asked people's preferences based on a multiple bounded format to clarify the amount that they are willing to pay for retrofitting their houses for reducing risk of death. The survey was in-person interview and it was conducted for a sample of 340 respondents living in Kabul city. The survey also captured other variables across the sample including socio-economic and housing attribute. The data were analysed in software STATA 14 using probability density function. The results indicate that across the sample, annual income and housing typology have a positive correlation with people's WTP. With consideration to demographic characteristics and housing attributes the average annual WTP by respondents living in three building typologies of adobe, masonry and concrete are 21.44, 29.03 and 42.44 USD for retrofitting their houses annually for 10 years to decrease the risk of death 1 in 1000 for adobe and masonry and 1 in 10,000 for concrete buildings. The estimated average WTP for individuals living in three building typologies has been fitted with approximately 10% of their annual income. The VSL for respondents living in concrete buildings was estimated 3,630,813 USD which was greater than VSL for those living in masonry and adobe buildings which is 303,519 USD and 223,904 USD respectively. In order to validate the estimated VSL in this study, we also developed another model for estimating VSL in developing countries by using the data of related studies and conducting a meta-analysis. The VSL based on this model was estimated to be 149,390 USD for case of Afghanistan. This VSL was predicted by explanatory variables including annual income, annual working hours and age. Finally the VSLs estimated in this study were used to incorporate the human loss with the building damage loss for case of Kabul city and cost benefit analysis of a retrofitting project for different percentage of adobe houses were developed. The final results indicate that by retrofitting different percentage of adobe buildings in Kabul city for reducing risk of death, the sufficient amount of benefits to exceed the costs cannot be achieved at the current situation. This means that the Afghan government is suggested to stop self-construction of new adobe houses and to take the initial step to implement retrofitting activities with improvement in structural task for existing adobe building.

Gradually, this will lead to higher quality of the work and achieving higher vulnerability reduction which will make a trust for local people for investing more in such retrofitting activities. Greater WTP for reducing risk of death will be equivalent with larger VSL and more benefits for future which can be a solid base for disaster risk management in Afghanistan.

Key words: value of statistical life, retrofitting, seismic risk curve, contingent valuation method, Kabul, disaster risk management