２．The Impact of Risk Perception, Disaster Schema, Resources, Intention, Attitude, and Norms upon Risk Aversive Behavior among Marikina City Residents: Structural Equation Modeling with Latent Variables

（リスク認知，災害スキーマ，対処資源，行動意図，態度，規範がマリキナ市住民のリスク回避行動に与える影響－潜在変数を含む構造方程式モデリングによる検証－）

和文要約

本論文では、マリキナ市住民１，０００名に対して実施した地震リスクに関する意識調査結果を用いて、将来発生が予想される地震災害に対する住民個人のリスク回避行動の決定員を予測する因果モデルの構築を試みた。モデル構築の出発点としてFishbain & Ajzen(1975)の認知・規範・態度・意図をてがかかりとして行動を予測する一般モデルに、Neisser(1978)の認知スキーマ概念を取り込み、地震リスク回避行動をモデル化した。モデルには９つの潜在変数が想定されている。a)個人が取りうる被害抑止・被害軽減行動、b)これらの行動意図、c)行動が起こしうる結果に対する個人の態度、d)主観的規範、e)コミュニティ内の規範的信念、f)地震をふくむ様々なハザードに関する主観的生起確率と被害の程度をもとにして測定したリスク認知量、g)ある特定の事象を「災害」と認知せしめる働きをする災害スキーマの形成度、h)個人が利用可能・アクセス可能と感じている対処資源、i)社会人口学的変数である。

上記９つの潜在変数間の因果構造をモデル化するために一連の構造方程式の当てはめをおこなった。その結果、リスク回避行動は行動意図、リスク認知、利用可能な対処資源によって直接に影響を受けていた。行動意図は、態度、主観的規範およびリスク認知によって規定されていた。主観的規範はコミュニティ内の規範的信念の影響を受けていた．リスク認知とコミュニティ内の規範的信念の双方は、スキーマの形成度により規定されていた．上記の結果がマリキナ市における地震防災対策にもつ政策的意味について最後に検討した。

なお、本研究の一部は、科学技術振興調整費「アジア・太平洋地域に適した地震・津波災害軽減化技術の開発とその体系化に関する研究（研究代表者：亀田弘行　地震防災フロンティア研究センター長)」、および、科学研究費補助金「災害情報の「情報到達度」向上のための戦略の開発（研究代表者：立木茂雄　関西学院大学教授)」によるものである。

The Impact of Risk Perception, Disaster Schema, Resources, Intention, Attitude, and Norms upon Risk Aversive Behavior among Marikina City Residents: Structural Equation Modeling with Latent Variables

Shigeo Tatsuki, Haruo Hayashi, Doracie B. Zoleta-Nantes, Michiko Banba, Koichi Hasegawa, and Keiko Tamura

ABSTRACT: **This paper builds and examines a model that predicts personal risk aversive behaviors against possible earthquake disasters using social survey data collected from 1,000 Marikina city residents. By incorporating Fishbein and Ajzen (1975) model of reasoned action and Neisser's (1978) model of cognitive schema, earthquake risk aversion specific behavior was modeled. Nine major components of the model consist of a) risk aversive behavior as measured by the degree of personal level earthquake disaster mitigation and preparedness practices, b) behavioral intention, c) attitude, d) subjective norm, e) normative belief, f) risk perception as measured by subjective probability and consequence estimates of major disasters including earthquakes, g) a disaster schema that guides individuals to construct certain phenomena as disasters, h) resources available to individuals, and i) socio-demographic variables. A series of structural equation modeling (SEM) with latent variables resulted in the following findings. Risk aversive behavior was directly predicted by intention, risk perception and resources. Intention was predicted by attitude, subjective norms and risk perception. Subjective norms were predicted by normative beliefs. Both perceived risk and normative belief were then predicted by the degree of disaster schema formation. The policy implications of these findings to the Marikina risk management policy were discussed.**

KEY WORDS: disaster schema; risk perception; risk aversive behavior; resource accessibility /constraints; structural equation modeling with latent variables

1. INTRODUCTION

In the study of hazard-related human behaviors, three different approaches have been employed in order to identify factors that determine the strength and scope of individual initiatives as well as that of public support for hazard-reduction measures. Those approaches are based on "adjustment/contextual" (Burton, Kates, & White, 1978; Mitchell, 1999;), "access/radical" (Blaikie, Cannon, Davis, & Wisner, 1994; Wisner & Fordham, 2001), and "rational choice" (Bernstein, 1996) paradigms.

Past US studies have for the most part, employed an adjustment/contextual paradigm. In such studies, hazard-related behaviors, risk perception, disaster preparedness, and willingness to pay for governmental mitigation were found to be associated with socio-economic-related demographic variables (e.g., income, education, home ownership, race), age/gender-related demographic variables (e.g., age, gender, presence of children in the home), and psycho-social-behavioral variables (e.g., risk experience and awareness, trust in social institutions)(Turner, Nigg & Heller-Paz, 1986; Lindell & Perry, 1992; Edwards, 1993; Palm & Carroll, 1998; Tierney, Lindell, & Perry, 2001; Tierney, 2001; Wachtendorf & Sheng, 2002).

The access/radical paradigm is most associated with disaster studies in developing countries. The main foci of such a paradigm have been the "root causes" of the disasters such as oppression of a minority group and uneven regional development coupled with a call for more accessibility to and less constraints of resources at the time of calamity. Zoleta-Nantes (2002), for example, illustrated that the concept of access along with that of contextual understanding and entitlement were effective in explaining differential flood risk perceptions among street children, the urban poor and residents of wealthy neighborhoods in Metro Manila, Philippines.

The rational choice paradigm uses a mathematical risk analysis of the relationship between perceived risk on one hand and individual risk-aversive/risk-seeking behaviors on the other (cf., Bernstein, 1996). Kahneman and Tversky (1979) illustrated widespread tendencies for humans to overweigh recent experience at the expense of long term average. In disaster mitigation field, this implies that people tend to be risk-aversive for gain but they tend to become risk-seeking when their choice involves losses. Okazaki (2002) urged more studies to identify the factors that lead people to make "rational" as opposed to "biased" investment choices in personal as well as societal disaster mitigation.

In an attempt to reassess natural hazard studies in the US, Dennis Mileti proposed a new paradigm that takes the above mentioned perspectives into one integrated framework, called the "sustainable hazards mitigation" paradigm (Mileti, 1999). More emphasis is placed on taking "a broader, more generous view of social forces and their role in hazards and disasters" (Mileti, 1999, p. 28) as one of the six most important shifts in this new paradigm. This emphasis directly corresponds with the principle of fostering "local resiliency to and responsibility for disasters"(Mileti, 1999, p.32). Assessing and identifying a way to increase public awareness of locally specific disasters and environmental sustainability are the first endeavors that should be taken toward local resiliency and responsibility.

In accordance with the sustainable hazards mitigation paradigm, this paper has developed and empirically tested a working model that explains impacts of demographic, psycho-social-behavioral, resource access, and rational choice variables upon risk aversive behaviors. In order to construct a working model of risk aversive behaviors, two general behavioral/cognitive science models are adopted. One is a general social psychological model of behavioral change developed by Fishbein and Ajzen (1975), who postulated that human reasoned actions can be predicted by such person-related variables as intention, attitude toward the behavior, behavioral belief and outcome evaluations, as well as by such environment-related variables as subjective norm, normative beliefs and motivation to comply (Ajzen & Fishbein, 1980). The other source for this working model is a general cognitive psychological model of perception proposed by Neiser (1978), who illustrates how people's perceptions of objects in the outside world are guided and oriented by a predisposing world view, called *schema* (Neisser, 1978). A schema provides a framework of understanding by which humans extract meanings. Thanks to schemas, humans can build knowledge with an array of outside world information, each of which is obtained by processing numerous data. Without a proper schema, one can neither process data nor obtain information from it, thus one cannot extract meanings from outside world. Figure 1 shows the current study's working framework for the prediction of risk aversive behavior that was employed in the current study.

This paper aims to examine the working model that predicts personal risk aversive behaviors against possible earthquake disasters using social survey data collected from 1,000 Marikina city residents in Metro Manila, Philippines.

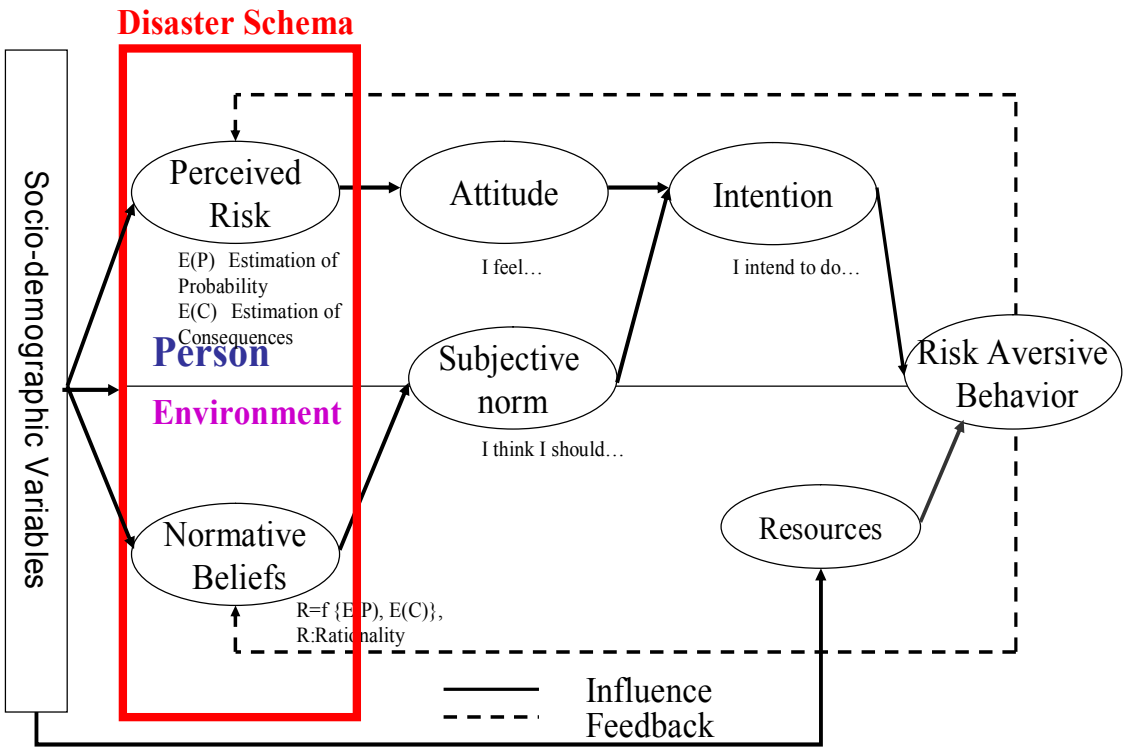

Figure 1. Working model for the prediction of risk aversive behavior

As figure 1 shows, nine major components among whose causal relations are to be tested are a) risk aversive behavior as measured by the degree of personal level earthquake disaster mitigation and preparedness practices, b) behavioral intention (e.g., I want to do…), c) attitude (e.g., I feel that earthquakes are scary), d) subjective norm scales included (I think I should do …), e) normative belief (wise people say …), f) risk perception as measured by subjective probability and consequence estimates of major disasters including earthquakes, g) disaster schema that guides individuals to construct certain phenomena as disasters, h) resources available to individuals, and i) socio-demographic variables.

STUDY METHODOLOGY

2.1 Study sample and survey strategy

Figure 2 shows the studied population areas and one hundred sampled grids (two hundred meters by two hundred meters) in Marikina city, Philippines with peak ground acceleration as predicted by PHIVOLCS. The studied one hundred grids were proportionally sampled in order to reflect population social class and earthquake hazard distribution. Ten households were evenly sampled in each grid and were visited by interviewers. Data were collected in a structured interview by means of a series of predetermined questions that were designed to measure each of the model's eight components as well as socio-demographic factors.

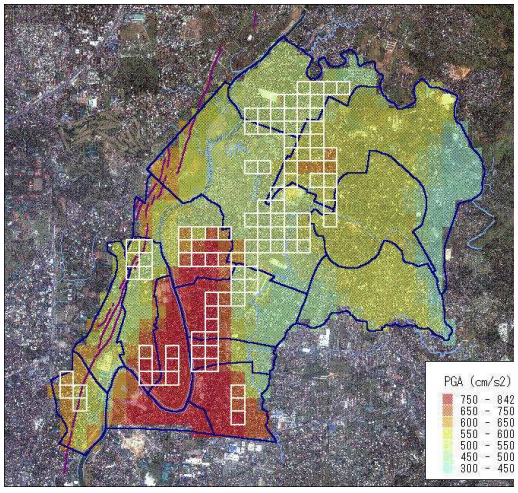

Figure 2. One hundred sampled grids with peak ground acceleration

2.2 Socio-demographic and latent variables included in the structured interview questionnaire

Respondents' socio-demographic characteristics surveyed in the interview include age, gender, education, ethnic affiliation, religion, house size, income, years residing in Marikina city, and whether respondents owned or rented their dwellings. In addition, the working model's constructs or latent variables were measured by means of a series of corresponding scales. a) Risk aversive behavior was measured by the degree of personal level earthquake disaster mitigation and preparedness practices. b) Behavioral intention at the time of disaster was asked from viewpoints of mitigation, preparedness and whether respondents would stay inside or go outside the house. c) Attitude was measured using a scale of earthquake-"scariness." d) Subjective norm was measured by Kahneman and Tversky (1979) type rational choice questions, trust in social institutions, and degree of community participation. e) Normative belief was measured by a civic-mindedness scale which consists of solidarity and self-governance sub-scales (Tatsuki & Hayashi, 2000). f) Risk perception was measured by subjective probability and consequence estimates of major disasters in general as well as those of earthquake-specific, both before and after the surveyor's brief lecture about the West Valley fault and its predicted seismic intensity with regard to the respondent's area if the fault raptures. g) Disaster schema that guides individuals to construct certain phenomena as disasters and orients them to prioritize what to be saved in such a time was measured by such scales as previous experiences of various disasters, earthquake risk awareness of the area, functional importance of critical facilities at the time of earthquake (Tierney, 2001), the degree of local community media reliance on earthquake risk information, and a sense of co-ownership of shared community resources or local commons (Tatsuki & Hayashi, 2002). Finally, h) Resources accessibility in the time of disasters was measured by a sense of accessibility to various resources and by a sense of constraints to use in both formal/governmental and informal/community resources. All the questionnaire questions were first composed in English and they were later translated into

Philippino version, which incorporated Philippino as well as some English technical terms.

3. STUDY FINDINGS

3.1 Results of socio-demographic/housing variables and their impacts upon risk aversive behavior and related variables

Surveyed Respondents consist of 390 (39%) males and 610 (61 %) females. Their average age was 40 (SD=16) years for males and 40 (SD=15) years for females. Total household income was asked about using twelve ordered categories and its median was category three (100,000 to 199,999 pesos). Similarly, respondents' levels of education were asked about using ten ordered categories. The results showed a two peaked distribution of education levels, one peaking at category four (high school diploma or G.E.D.) and the other peaking at category seven (Bachelor's degree), making the median for the entire sample to be category six (some college). With regard to house size, three ordered categories were used and its median was category two (fifty to seventy-five square meters).

Four variables were chosen in the present study for the purpose of structural equation modeling with latent variables in order to examine the impact of social class, and other demographic characteristics upon personal risk aversive behaviors and related variables. Structural equation modeling with latent variables (SEM) is a statistical technique that incorporates both confirmatory factor analysis and path analysis. A factor-analysis-like part is called a measurement model, where observed variables are considered to be indicators of a theoretically postulated factor or latent variable. A path-analysis-like part is called structural equation model, where causal relation or correlation among latent or observed variables are statistically estimated. One can test statistical significance of factor loadings, causal (i.e., regression) or correlation coefficients estimated by SEM technique. Furthermore, several indices concerning the goodness of fit of the postulated measurement as well as structural equation models are provided. With a sample size of one thousand and with about thirty observed variables in the equation, it is customary to support any SEM models if the GFI (goodness of fit index) exceeds a .90 level. The SEM results are usually presented by means of path diagrams (Bollen, 1989).

Figure 2 shows the results of SEM employing all the studied variables that are both latent (i.e., theoretically constructed) and observed (i.e., measure or scale scores). A latent variable called "social class" which is measured by house size, income and education was found to be a non-negligible predictor of risk aversive behavior (β=.05, p<.10) but a statistically significant predictor of post-lecture earthquake-specific risk perception (β=.16, p<.001). Meanwhile, age predicted intention negatively (β= -.10, p<.001) and risk aversive behavior in a positive direction (β=.06, p<.05). This suggests that the older one becomes, the less likely one is willing to take risk aversive behaviors at present, yet at the same time, the more likely one has conducted risk aversive behaviors in the past.

3.2 Impacts of latent explanatory variables upon risk aversive behavior

Risk aversive behavior is a target or dependent variable whose sources of influence this study aimed to identify. This latent variable was measured by the degree of personal level earthquake disaster mitigation and preparedness practices. Factor loading estimates of each measure was .52 (fixed) and .03 ($p<.001$), respectively. SEM provides researchers with R-squared estimate of any given dependent variables. R-squared for the risk aversive behavior was .57, suggesting that the current working model accounted for 57 % of the total variance.

Behavioral intention at the time of disaster turned out to be the strongest predictor ($\beta=.68$, $p<.001$) of actual risk aversive behavior as was expected from this paper's working model. Except for fixed variables (i.e., preparedness intention), the factor loadings were .78 ($p<.001$) for mitigation intention and .06 ($p<.10$) for whether respondents would stay inside or go outside the house. Behavioral intention is an intervening variable, which in turn is influenced by other predictors. The amount of variance accounted for by these preceding predictors was .54, meaning that the rest of working model components that influence intention explained 54 % of the total variance.

According to the Fishbein and Ajsen (1975) framework, attitude toward behavior was postulated as being one of the predictors of behavioral intention. Our working model supported this postulation and its path coefficient was one of the strongest ($\beta=.38$ ($p<.001$) among the other predictors.

Subjective norm was another predictor of behavioral intention in Fishbein and Ajsen (1975) model. The SEM result shows that it is the second best predictor ($\beta=.26$, $p<.001$) of the behavioral intention. It should be noted that three empirical measures designed to measure the subjective norm turned out to be all good indicators with relatively high factor loadings. Factor loadings for Kahneman and Tversky (1979) type rational choice questions was .15 ($p<.01$), trust in social institutions .38 ($p<.001$), and degree of community participation .52(fixed). This suggests that rational choice, trust in social institutions and community participation are correlated due to the fact that they all share the common latent trait of the subjective norm. In the working model, the subjective norm was influenced by two explanatory variables, normative belief and resource accessibility. Those two variables accounted for 31 % of total variance in the subjective norm.

As mentioned in the above, a normative belief that exists in an environment is one of the two predictors that influence the subjective norm. Again it turned out to be a significant predictor ($\beta=.47$, $p<.001$). Normative belief was measured by solidarity and self-governance variables. Their factor loadings were both high, .74 (fixed) and .70($p< .001$), respectively.

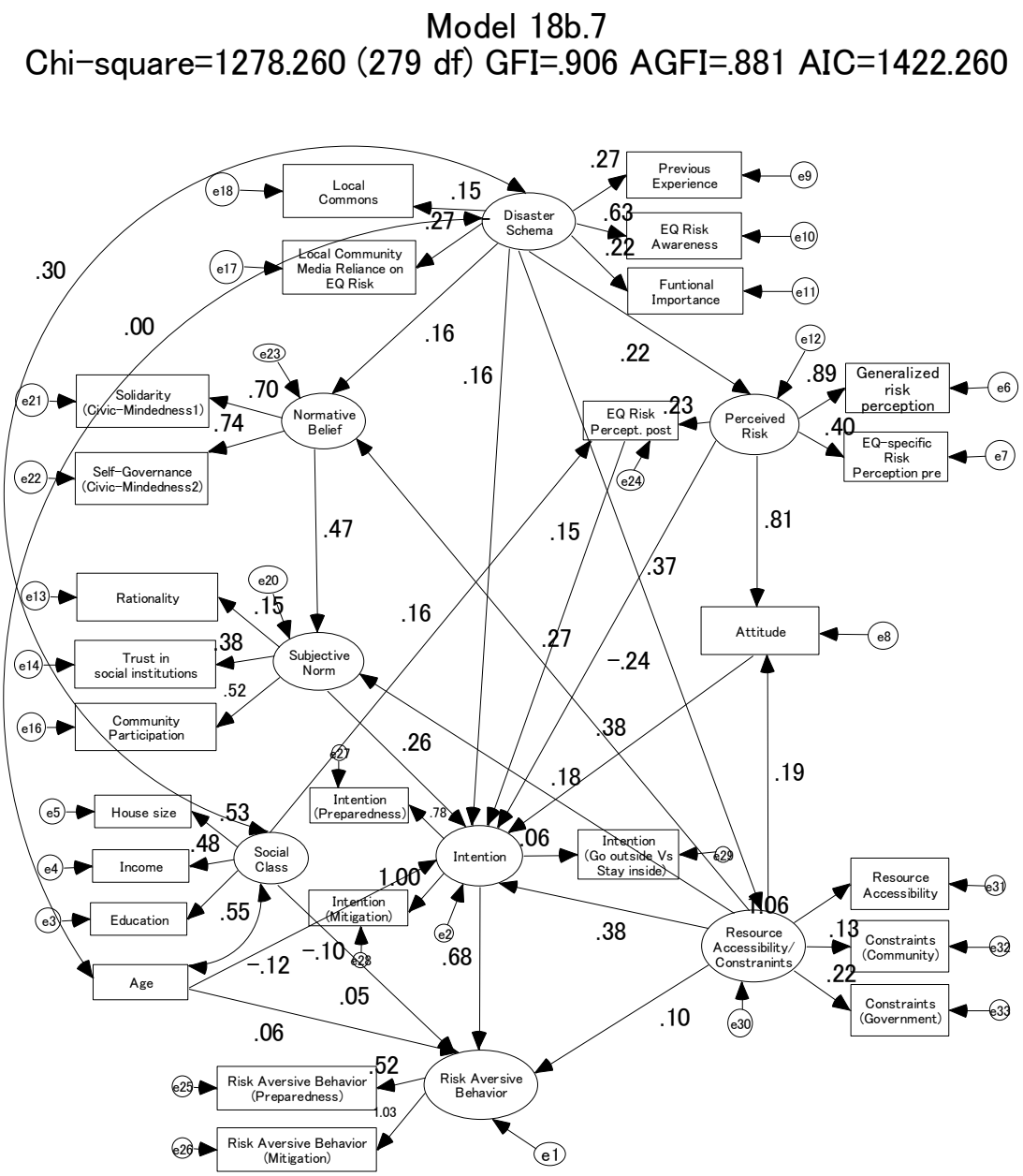

Figure 3. Results of structural equation modeling with latent variables

At the same abstract level as normative belief, risk perception was postulated as an important person level predictor that influences attitude toward risk aversive behavior.

SEM results showed that this causal relation turned out to be very strong (β=.81, p<.001). Perceived risk as a latent variable was measured by three observable

variables,whose factor loadings were moderate to high. A factor loading for subjective probability and consequence estimates of major disasters in general was .89 (fixed). The loading for earthquake-specific risk perception before the brief lecture was .40 ($p<.001$). After surveyors gave a brief lecture about the West Valley fault and its predicted seismic intensity with regard to the respondent's area if the fault raptures, the factor loading for earthquake-specific perception lowered to .23 ($p<.001$). This is mainly due to the fact that social class also acted to influence the post-lecture earthquake risk perception ($\beta=.16$, $p<.001$). This means that the richer people became more perceptive about earthquake specific risk in their neighborhood and Marikina city after the brief lecture. One further interesting causal relation was found between perceived risk and intention. SEM results show that latent risk perception in general has negative impact upon intention ($\beta=-.24$, $p<.01$). However, post-lecture earthquake specific risk perception positively predicted intention ($\beta=.15$, $p<.001$). It can be argued that even the five to ten minutes of knowledge sharing with local people conducted by University of Philippines students had a significant impact to increase risk aversive intention as measured by willingness to initiate preparedness and mitigation actions.

Concept of disaster schema is derived originally from the works of Neisser (1978). It is postulated to guide individuals to construct certain phenomena as disasters and orients them to prioritize what is to be saved in such a time. SEM results indicated that disaster schema was one of the strongest exogenous predictors that influence perceived risk ($\beta=.22$, $p<.001$), normative belief ($\beta=.16$, $p<.05$), a sense of resource accessibility ($\beta=.37$, $p<.001$) and intention ($\beta=.16$, $p<.01$). Disaster schema was measured using several scales. A factor loading of previous experiences of various disasters was .27 (fixed), that of earthquake risk awareness of the area .63 ($p<.001$), that of functional importance of critical facilities at the time of earthquake .22 ($p<.001$), that of the degree of local community media reliance on earthquake risk information .15 ($p<.001$), and that of a sense of co-ownership of shared community resources or local commons .27 ($p<.01$).

Finally, a sense of resource accessibility in the time of disasters was also important intervening latent variable that influence four major latent traits in the current working model. It significantly predicted normative belief ($\beta=.27$, $p<.001$), intention ($\beta=.38$, $p<.001$), subjective norm ($\beta=.18$, $p<.01$) and risk aversive behavior ($\beta=.10$, $p<.01$). A factor loading for resource accessibility was 1.0 ($p<.001$), that of a sense of constraint to use formal/governmental resources .22 (fixed) and that of informal/community resources, .13 ($p<.001$). Two further points need to be noted. First, as opposed to access/radical perspective expectations, social class was not a significant predictor of resource accessibility at the time of disaster. Second, instead of social class, the current study indicates that disaster schema influences the formation of a sense of resource accessibility ($\beta=.37$, $p<.01$). As far as the current findings are concerned, it seems that not social class but rather the formation of a disaster schema may be one of the "root causes" that can be managed by societal efforts.

4. CONCLUSIONS

This paper has built and examined a working model that predicts personal risk aversive behaviors against possible earthquake disasters using social survey data collected in Marikina city, Philippines. A view of sustainable disaster mitigation proposed by Mileti (1999) was employed as a general paradigm that leads to form and test working models to explain earthquake risk aversion specific behavior. Among the nine major components that were incorporated into the current model, disaster schema associated with a sense of accessibility to and constraints of both formal and informal resources turned out to be the major target areas that require the most attentions in order to increase public awareness of locally specific disasters and environmental sustainability for local resiliency and responsibility.

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