General Linear Model Analyses of Life Recovery Factors in the 2001 Kobe Panel Survey Data

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Abstract

The seven element model of life recovery from the Kobe Earthquake was formed as a result of grass root workshops in the Kobe Total-Quality-Management-based Assessment. The seven elements included housing, social ties, land use planning, physical/mental health, preparedness, economic/financial situation, and relation to government. This study aimed to verify the life recovery critical elements model by a random sample survey of the impacted people. The sample consists of 1,203 adults over the age of twenty who resided in the Kobe-Hanshin region at the time of the 1995 Kobe earthquake. Measures were developed for each life recovery element, and General Linear Model analyses were conducted to examine the effects of hazard, demography and life recovery elements factors on life recovery. Significant hazard-by-demography interaction effects were found. The least recovered among the young aged group were those whose houses were fully damaged and those who engaged in small business as proprietors. As for the middle aged, the least recovered were 1) those whose houses were half damaged and those who engaged in small business (as proprietors or sales clerks) and 2) those whose houses were fully damaged and those who were unemployed. Among the seven critical element variables, four elements significantly predicted the level of life recovery. Those four included social ties (civic-mindedness, community participation and family system functioning), land use planning (awareness of urban commons or a sense of attachment to *locale*), physical/mental health, and economic/financial situation. Housing, preparedness and relation to government did not predict the level of life recovery.

Introduction

This paper reports major findings from the 2001 Kobe panel survey study. This is the second time that the current authors conducted the questionnaire survey on life recovery among the 1995 Kobe earthquake survivors. The research frame of the 2001 survey was based partly on the findings from the 1999 disaster process survey (Tatsuki & Hayashi, 2000). The research frame building for the 2001 survey study was, however, more strongly guided by the major findings from the qualitative research project that the current authors conducted in the summer of 1999 following the 1999 survey. The aim of this qualitative study (the Kobe TQM assessment) was to identify major factors that determine life recovery among those who experienced damage in the 1995 Kobe earthquake. The 1999 summer qualitative research identified seven critical factors that influence long-term recovery. Based on the seven elements model, the current study constructed scales and items that measured the critical factors and it tested their empirical impacts upon life recovery among those who experienced damage from the 1995 Kobe earthquake.

The 1999 Disaster Process Survey

The 1999 disaster process survey study aimed to identify determinants of the changes of residence and life reconstruction among the 1995 Kobe earthquake victims. Based on findings from the preceding ethnographic research (Aono, Tanaka, Hayashi, Shigekawa, and Miyano, 1998; Tanaka, Hayashi, and Shigekawa, 1999), the questionnaire was designed to inquire about residence location, source of help, sense of citizenship, family cohesion and adaptability at the 10th, 100th, and 1000th hour as well as at the six months point after the onset of the earthquake. These time points were found to correspond with critical boundaries, which segmented phases of the disaster victims' behavior. The survey questionnaires were administered in March of 1999. The 1999 survey data generally supported the phases of disaster response processes among the Kobe earthquake victims. It also confirmed that the citizens who experienced the earthquake disaster became more civic-minded. Their scores on self-governance and community solidarity dimensions showed a statistically significant increase. Furthermore, those who were high on civic-mindedness showed better life recovery and fewer physical or mental stress symptoms (Tatsuki & Hayashi, 2000).

Two research recommendations were made from the 1999 study. First, there was a clear need for continued research efforts. Panel surveys that incorporated standardized measures and scales were therefore recommended in order to monitor long-term life recovery processes among the residents in the studied areas. Second, the research design needed to be improved so that more representative subjects would be sampled for the future study.

TQM-based Assessment of Life Recovery after 1995 Kobe earthquake

TQM (Total Quality Management)-based assessment of life recovery assistance programs was conducted four and a half years after the Kobe earthquake from summer of 1999 to 2000. The objective of the assessment was 1) to extract and sort out new policy measures and programs that need to be taken, and 2) to provide measurable indices that would

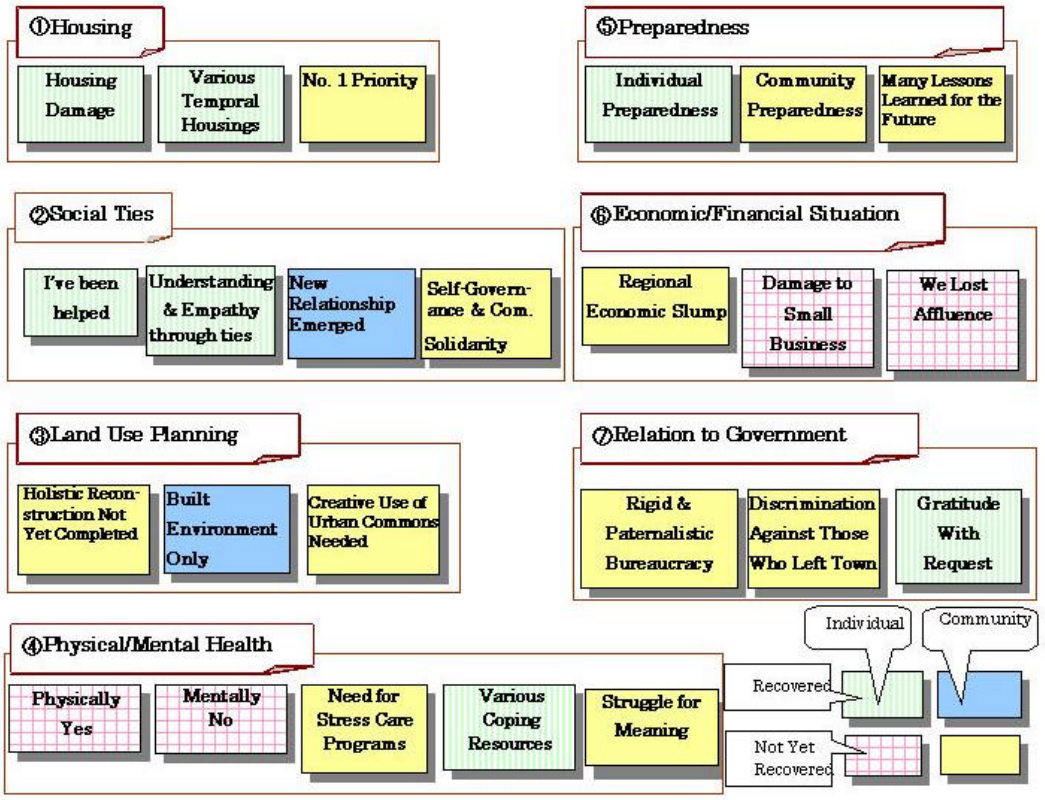

Figure 1. Seven Critical Elements for Everyday Life Recovery.

residents will be constantly and objectively monitored. The use of TQM tools allowed the operationalize policy objectives so that levels of life recovery among various groups of Kobe sorting out of verbal data from Kobe citizens, stimulating creativity in identifying major constructs that explain recovery of everyday life, putting complex problems of life recovery into solvable form, and ensuring that nothing was left out when planning. The assessment process involved utilizing three of the seven new quality control tools, namely affinity, relation, and tree (Kobe City Research Committee on Disaster Recovery , 2000).

Residents from Kobe's all nine wards and three special interest groups provided their assessment concerning life recovery from the earthquake at a grass roots workshop sessions. This yielded 1,623 opinion cards. From one perspective, the TQM-based assessment workshops allowed face-to-face bottom-up collection of opinions from impacted people. After providing opinion cards, workshop participants were asked to group similar opinions. This conceptual clustering process helped each participant obtain a rough bird's eye view of life recovery tasks. Based on this rough view, participants were encouraged to re-examine each opinion card's membership in the corresponding category. Sometimes, opinion cards were re-grouped and new categories were formed. From another perspective, therefore, the TQM-based assessment involved top-down sense-making of everyday life. Once participants gained a bird's eye view, they themselves were able to make better sense of the "life place" in which they were recovering their lives. TQM-based assessment involved both bottom-up collection of personal opinions about everyday life and top down recognition of the life recovery place as a whole. The process was reciprocal until a workable alignment between cards and categories was reached. In the end, seven mutually exclusive categories were formed. Those were housing, social ties, land use planning, physical and mental health, preparedness, economic and financial situation, and relation to government. Those seven categories turned out to be the most critical in assessing recovery of everyday life among earthquake survivors (see **Figure 1**).

Among the seven categories, only homes and human ties contained more than 400 opinion cards. This suggested that housing and social ties were the two most critical factors when people evaluated recovery of everyday life from the earthquake disaster (see **Figure 2**).

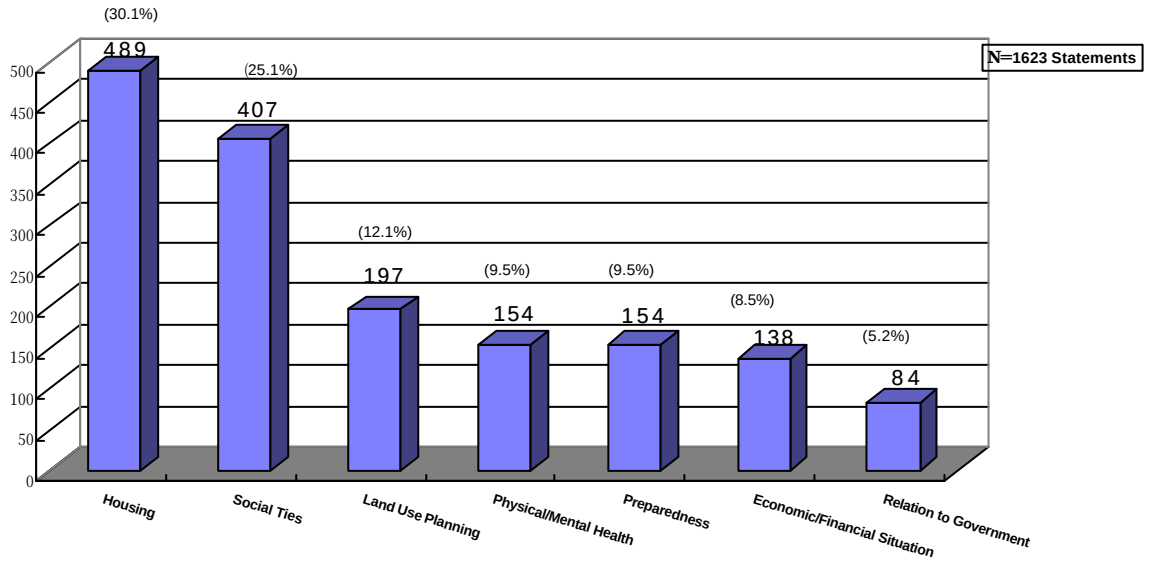

Figure 2. Number of Opinion Cards for Each Life Recovery Category

The 1999 Kobe disaster process study quantitatively verified the 10th, 100th, and 1000th hour changes in human relationships in the aftermath of a disaster. The same phenomena were also qualitatively cross-validated by the Kobe TQM assessment study. **Figure 3** shows the causal relation diagram of social relationship change within the social ties element. The following points became evident in this diagram. 1) The amount and quality of social network directly impacted the vulnerability of people, 2) Those who were resistant to and resilient from disaster damage utilized multiplex social ties, while those who were vulnerable tended to rely on a single network. 3) Social ties had changed according to the expected time boundaries of 10th, 100th, and 1,000th hours.

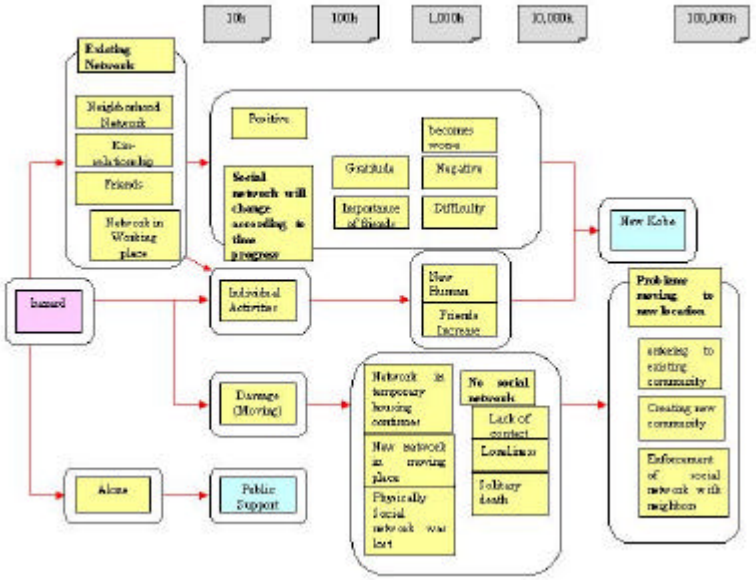

Figure 3. Changes in human relationship caused by the earthquake.

Though social ties were the critical factor for individual recovery, it was the most difficult factor for government to intervene. The Kobe TQM assessment remarked that the government countermeasures against the damage/loss of social ties were concentrated to the most vulnerable population who lacked a personal social network and were forced to reside in temporary shelters and were later moved to a public restoration housing complex.

Thanks to the utilization of various social ties, the majority of the population showed resistance to and resilience from the earthquake damage. After reviewing the immediate disaster process that lasted the first 1,000 hours, the earthquake survivors collectively mentioned the renewed sense of community ("New Kobe"). **Figure 4** shows the sub-set affinity diagram of the "New Kobe" within the social ties. The Kobe assessment study named these renewed sense of active citizenship as civil society ethos of New Kobe and concluded that this ethos is the key for community building.

Objectives of the Study

The current study has three objectives. First, to construct valid and reliable measures of the seven critical life recovery elements that can be repeatedly used to monitor the long-term recovery of the citizens who experienced the 1995 Kobe earthquake damages. Second, to test which variables or what combinations of variables best predict the level of life recovery among the impacted citizens. And third, to assess the effectiveness of some of the governments' recovery assistance policy initiatives and to provide future policy implications.

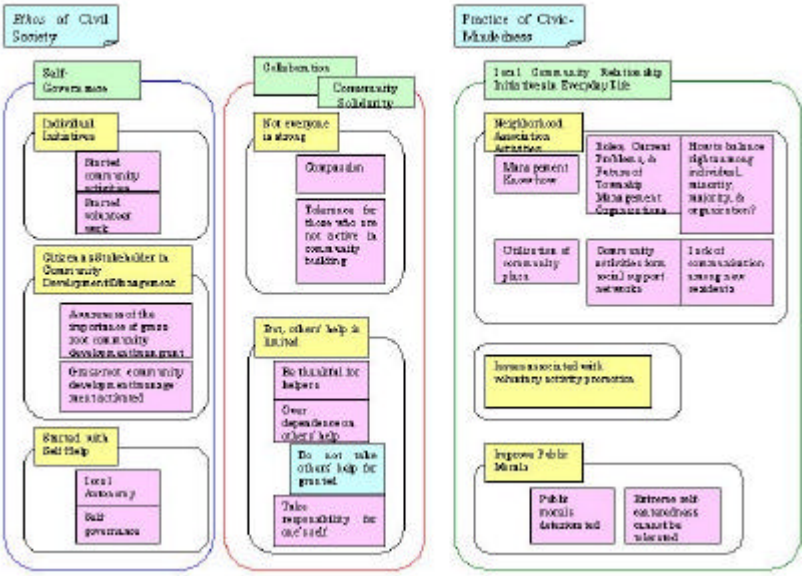

Figure 4. Ethos of Civil Society Characterizes "New Kobe"

Method

Sample

The sample consists of 1,203 adults over the age of twenty who resided in the Kobe-Hanshin region at the time of the 1995 Kobe earthquake. 3,300 questionnaires were sent by mail and 1,203 with valid responses were returned (36.5%). Originally, it was intended that the same respondents that participated in the 1999 survey were again to be studied in the 2001 survey. However, due to the confidentiality requirements made by the Hyogo Prefecture government that partly sponsored both 1999 and 2001 survey, it became clear that mailing new questionnaires to the same respondents would violate the prefecture's privacy protection policy because of the lack of signed consent from the 1999 survey participants. For the 2001 survey, therefore, ten new subjects were sampled from each of the same 250 research points that the 1999 study used. These 250 points were randomly selected from the area in which the shaking intensity of JMA (Japanese Metrological Agency) Scale 7 was recorded and/or the city gas supplies were interrupted for more than three months after the earthquake. In addition, 80 extra points in North and West wards of Kobe were included. Those two wards were the only two out of the total of nine wards that were not surveyed in the previous survey. The residents in these new points did not experience as devastating an earthquake impact as the residents in the other 250 points. However, they have also suffered from the same degree of socio-economic impact as that which hit the entire Kobe-Hanshin region. Like the other 250 points, ten subjects were randomly selected from each of the new 80 points. Efforts were also made to ensure gender balance in the surveyed sample. The 2001 study targeted men and women over the age of twenty as opposed to the 1999 study, which surveyed heads of households. This caused the sample to be unequally male-dominated in the 1999 survey data. The sampled men and woman over the age of twenty who reside in the selected 330 (original 250 plus 80 new) survey points will be repeatedly asked the same set of questions in January of 2001, 2003 and 2005. The results from this panel survey will be able to identify the long-term longitudinal processes of life recovery from the 1995 Kobe earthquake. The survey was conducted from January 15, 2001 to February 5, 2001.

Instrument

The Kobe TQM assessment proposed seven critical factors that determined life recovery among the Kobe earthquake survivors. Scales/items were constructed to capture each of

these seven elements. These scales/items were designed as the predictor variables in the current research design. As for the criterion/dependent variable, the life recovery scale that was first constructed in the 1999 survey was again used for the current study.

Life Recovery Scale. The life recovery scale consists of 14 five-points Likert scale that asks 1) the recovery of daily activity, social relationship, subjective well-being (7 items), 2) life satisfaction and quality of life (6 items), and 3) optimistic/pessimistic prospect of life that is one year from now (1 item). These 14 items were originally developed in the 1999 Kobe survey and showed unidimensionality with high reliability (Cronbach's alpha was .91) (Tatsuki & Hayashi, 2000).

Table 2. Overview of the predictor and criterion variables

Variables/Factors	Description
Housing	Acceptance/Satisfaction of the current housing condition
Social Ties	Self-Governance, Community Solidarity, Community Participation, Family Cohesion and Adaptability
Land Use Planning	Awareness of Urban Commons
Physical/Mental Health	Physical and Mental stress symptom checklist
Preparedness	Awareness/Preparedness for the next major earthquake
Economic/Financial Situation	Increase/decrease in household income, expenditure, and savings
Relation to Government	Paternalistic, liberal, and communitarian views of government
Life Recovery	Life satisfaction, QOL, daily activity level, optimism
Social Desirability	MMPI lie scale

Housing. One item was designated to ask the respondent's willingness to settle at the current residence or to move to some other location.

Social Ties. The citizenship scale is an 8 question dichotomous instrument that measures self-governance and community solidarity. This scale was originally developed for the 1999 study and was based on conceptual clustering of the preceding literature on civil society and civic-mindedness (Tatsuki & Hayashi, 2000). The scale's content dimensions were then qualitatively confirmed by the Kobe TQM assessment study which suggested that self-governance and community solidarity were the two crucial ethos for active citizenship and community building. For the purpose of the current study, 8 items were further selected from the original 20 item citizenship scale. Item selection was based on the face validity analysis of the original items. Changes were also made from trichotomous to dichotomous response options. A neutral answer option ("cannot decide either") was excluded for the current study. Each dimension is bipolar. The self-governance dimension contrasts strong sense of individuality/self-control (self-governance) with weak sense of individuality/ self-control. The community solidarity dimension contrasts cooperation (community solidarity) with non-cooperation. For each of 8 items, respondents chose one of the bipolar options on either dimension.

Four items were prepared to ask the level of community participation in neighborhood clubs and associations (question 40) , and involvements in neighborhood events such as festivals and neighborhood sports day (sub-questions A to C in question 37) . Question 40 was a yes-no item while 3 sub-questions in question 37 were a 3-point (always, sometimes, never) Likert scale.

FACESKGIV-16 is a 16-item Thurstone scale, which measures the Circumplex model's two dimension, family adaptability and cohesion (Olson, Russell, & Sprenkle, 1979; Tatsuki, 1999). Family adaptability is defined as a family system's ability to change its power structure, role relations, and relationship rules in response to a situational and developmental stress. Family cohesion is the emotional bonding that family members feel to each other. Under normal circumstances, the Circumplex model assumes that a moderate level of family adaptability and cohesion is optimal; too much or too little adaptability or cohesion is considered to be dysfunctional. However, families are known to become extreme on either dimension in order to adjust to crisis situations. FACESKGIV-16 is a shorter and common item version of FACESKGIV (Tatsuki, 1999) and was constructed for the 1999 study (Tatsuki & Hayashi, 2000).

Land Use Planning. The Kobe TQM assessment concluded that "community feeling" (MacIver, 1924) was closely associated with and could be promoted by a sense of communal ownership of things like neighborhood landscape, street trees and flowers, *jizo* (street corner statue of a Buddhist guardian) and *hokora* (street corner mini shrine), traditional festivals, and local history. People develop a sense of attachment to the local landscape or landmarks, history and communal events and they naturally tend to think that those socio-cultural goods are owned communally rather than by private individuals or by public/government bodies (Tamura, 1999). The Kobe TQM assessment named those communally owned goods as "urban commons" and indicated that richly embedded urban commons can facilitate active citizenship for community-based land use planning and community development (Maki, Hayashi, Tatsuki, & Takashima, 2000). For the current study, 11 concrete urban commons were listed and included rich green trees, neighborhood parks that he/she has a sense of attachment, favorite neighborhood landscape or landmarks, local gathering space, local community events, sidewalks upon which one feels free to chat with local people, resident associations and volunteer groups, unique environmental atmosphere, earthquake memorial statues, historical buildings or local stories, and *jizos* and *hokoras*. The respondents were asked to check if they had a sense of communal ownership to any of these 11 items.

Physical and Mental Health. Subjects' judgments on their physical and mental health were measured by physical and mental stress scales. Physical and psychological stress scale consists of 6 physical and 6 psychological stress items. They were selected from a total of 111 stress symptom items that were parts of the 1995 Japan Red Cross Stress Study (Hayashi, Nishio, Sugawara, Monma, Kohno, Makishima, Numata, & Nemoto, 1996). Factor analysis with a varimax rotation of these 12 items in the original Japan Red Cross Study data showed a clear two factor simplex structure with psychological stress on the first factor and physiological stress on the second. These 12 items were again used in the 1999 Kobe survey study (Tatsuki & Hayashi, 2000). The scale consists of physical and mental stress subscales. The physical stress subscale is a 6 item 5-point Likert scale and its Cronbach's alpha in the 1999 study was .88. Mental stress subscale is a 6 item 5-point Likert scale. Cronbach's alpha in the 1999 study was .91.

Preparedness. Subjects were asked about the perceived risk of damage that may be caused by the Nankai-Tohnankai earthquake that is expected to occur in the next fifty years. The 6 item 5-point Likert scale (least probable to highly probable) asked about damage such as personal injury or the death of significant others, serious housing damage, damages to household income and assets, long recovery time, wide damage to public facilities, and major changes in community relations.

Economic and Financial Situation. According to macro economic statistics, local economic activities were said to have returned to the pre-earthquake level. However, at a micro economic level, Kobe citizens often claim that their household financial situations are at the eighty per cent of the pre-earthquake level. In order to identify subjective evaluation of household financial situation, respondents were asked to choose either increase, decrease or no change for their household income, expenditure and saving levels after the earthquake.

Relation to Government. The 1999 disaster process study illustrated a significant increase in civic-mindedness among some citizens. At the same time, the Kobe TQM assessment indicated the other people still maintained a paternalistic view to the government and they felt frustrated because the government did not and could not respond fully to their particular needs. Okamoto (1997) classified the relation to government into three typologies. Those were paternalistic, liberal and communitarian views of the government. Four trichotomous items were prepared to ask respondents' views of the government in either paternalistic, liberal, or communitarian orientations. Specific situations asked included how to enforce rules to separate different types of garbage, how to vitalize community activities, how to save lives at the time of major disaster, and how to promote community development.

Social Desirability. Questionnaire survey is known to be affected by response biases such as social desirability and defensiveness. In order to estimate and statistically control the response bias, 10 yes-no social desirability items were selected from the MMPI lie scale (Oguchi, 2001).

Analysis

The predictor variables in the current study included earthquake hazard, demographic variables and identified critical elements. Their effects on life recovery scores were examined. Because some predictors were categorical variables such as house damage (fully, half, partial, no damages), sex (male, female), generation (young adult, middle, old), occupation (classified into 10 categories), and household financial situation (increase, decrease, no change), and the other predictors were scaled values (e.g., indices for social ties, local commons, preparedness, physical and mental health, relation to government, and social desirability), General Linear Model (GLM) was used to examine their individual as well as interaction effects on life recovery scores. Separate analyses were first conducted to examine the proportions of life recovery variance (R^2 and adjusted R^2) that were explained by hazard, demographics, hazard-by-demographics, critical elements, and the integrated models. Relative effect sizes of the integrated model components (partial η^2) were then analyzed.

Results

Life Recovery

Principal component analysis was conducted on 14 five-point life recovery scale items. The first solution accounted for 39.5 % of the total variance. There was a clear drop of variance accounted for from the first to the second solution (14.4 %), suggesting a unidimensional structure. Cronbach's alpha for the current study data was .836.

Model Comparisons

Table 3 summarizes the proportions of life recovery variance that were explained by hazard (model 1), demographics (model 2), hazard and demographics (model 3), hazard, demographics and hazard-by-demographics interaction (model 4), life recovery elements (model 5), and the integrated model that incorporated models 4 and 5. Two statistics were used for the comparison. The first was a coefficient of determination (squared multiple

correlation R^2). R^2 becomes automatically larger with more a greater number of predictors in the model ($R^2=1-SS_e/SS_t$). In order to compare explained variances among models with a different number of predictors, squared multiple correlation adjusted to the degrees of freedom R^{*2} ($R^{*2}=1-MS_e/MS_t$) was also presented. Although all the models listed in **Table 3** showed statistically significant effects, the integrated model 6 that incorporated hazard, demographics, hazard-by-demographics, and life recovery elements was found to explain about nearly one half (47 %) of the total variance. This was the largest variance explained (both R^2 and R^{*2}) among all the models compared.

Table 3. Comparisons of General Linear Models to Predict Life Recovery

Model	Type III SS	df	MS	F value	P	R^2	R^{*2}
1.House Damage Model	11.106	3	3.702	3.727	0.011	0.009	0.007
2.Demography Model	79.713	12	6.643	7.044	0.000	0.066	0.057
3.House Damage and Demography Model	88.896	15	5.926	6.320	0.000	0.074	0.062
4.House Damage, Demography & Interaction Model	205.093	104	1.972	2.172	0.000	0.171	0.092
5.Critical Elements Alone Model	437.873	27	16.218	24.938	0	0.364	0.350
6.Integrated Model (Models 4 & 5)	564.617	131	4.310	7.242	0	0.470	0.405
Total	1202.000	1203					
Corrected Total	1202.000	1202					

The Integrated Model: Hazard, Demography and Critical Elements Predictors

Table 4 shows a list of predictors that were included in the final integrated model, corresponding type III sum of squares (SS), degrees of freedom (df), mean sum of squares (MS), F values, and p values. Partial $?^2$ for each component was also added to the GLM results. Partial $?^2$ ($SS_b/(SS_b + SS_e)$) indicates a relative size of variance explained by a given component in the GLM equations.

Hazard, Demography, and Hazard-by-Demography Interaction: The GLM analysis identified that gender and generation had significant main effects on a sense of life recovery. As illustrated in **Figure 5,** women were significantly better recovered than men ($F_{1, 1071}=5.294$, $p<.05$). **Figure 6** compares means of life recovery scores among three different generations. Young adults (those in their 20's and 30's) were significantly better recovered than the middle (40's and 50's) or old age (60 and over) groups (($F_{2,1071}=16.483$, $p<.001$). Occupation by itself did not show any significant main effects on life recovery.

With regard to the impact directly caused by earthquake hazard (i.e., house damage), the employed model showed that house damage *per se* did not have any significant main effects on a sense of life recovery. However, this does not mean that house damage did not have *any* impact. As **Table 4** shows, significant hazard-by-demography interaction effects were found. The psycho-social impact of the earthquake hazard differed significantly among different occupations in different age groups ($F_{86, 1071}=1.538$, $p<.01$). **Figures 7, 8 and 9** illustrate house-damage-by-occupation-by-generation interaction on life recovery. Young adults were found to be better recovered among most occupational categories. However those young adults whose houses were fully damaged and those who were proprietors were found to be having difficulty recovering their lives (see **Figure 7**). For those who were in their 40's or 50's, two groups were found to be having difficulty (see **Figure 8**). One group consisted of those whose houses were fully damaged and those who were currently unemployed. The other group consisted of those whose houses were half-damaged and those who were proprietors. For the old (over age of 60) whose houses were fully, half, or partially damaged, those who engaged in clerical or sales clerk jobs were the least recovered

(see **Figure 9**).

House damage had also differential impacts on life recovery between men and women. As is shown in **Figure 10,** a linear relation between the level of house damage and life recovery was found among women (i.e., the more severe the damage, the less recovered). However, this was not the case for men. It was the fully and the half damaged that reported rather higher levels of recovery.

Critical Elements

As for the critical elements that were identified by the Kobe TQM assessment, all components were entered into the GLM model. Except housing and relation to government categories, the five other components turned out to show significant main effects on life recovery. The effects of critical elements on life recovery are described in the following paragraphs.

Housing. As **Table 4** shows, Settled-ness which was used as a measure for housing did not have significant effect. It turned out that 85 % of the all respondent answered that they felt being settled in the current dwelling. **Figure 11** illustrates a univariate comparison of life recovery scores between the settled and the unsettled. Although the distribution of recovery scores for the unsettled was centered around the median score with very few outliers, many outlier observations characterized the recovery score distribution of the settled. Because of this high variability, it was suspected that no significant housing effect was detected despite the fact that a box and whisker plot for the unsettled seems to be slightly lower positioned than that of the settled. This suggests that the level of life recovery cannot be singularly explained by a housing element variable, whether one feels settled or not, rather many other factors need to be considered for life recovery six year after the Kobe earthquake.

Social Ties. Two scales were used as measures of social ties. Dual scaling (Nishisato, 1980) was used to scale response options and scaled scores were obtained for each of civic-mindedness and community participation scales. Dual scaling of 8 items civic-mindedness scale yielded a two dimensional structure, in which 4 items were loaded high on the first dimension and they reflected community cohesion, while the other 4 items were loaded high on the second self-governance dimension. Cronbach's alpha for 4 item community solidarity subscale was .543 while that for the other 4 item self-governance subscale was .147. The community participation items were Dual-scaled and the 3 item scale provided Cronbach's alpha .848. Similarly, 8 items for each of family adaptability and cohesion were Dual-scaled and the scaled scores were used as measures for family adaptability and cohesion. Cronbach's alphas for family adaptability and cohesion were .916 and .942, respectively.

All variables designated to social ties showed significant effects on life recovery. Those include a sense of civic-mindedness that consists of self-governance (see **Figure 12**, $F_{1, 1071}=7.181$, $p<.01$) and community solidarity (see **Figure 13**, $F_{1, 1071}=8.795$, $p<.01$) as well as the degree of actual community participation (See **Figure 14**, $F_{1, 1071}=15.435$, $p<.001$). Family system was also found to facilitate life recovery. The Circumplex model of marital and family systems defines family cohesion and adaptability as being the two major factors to decide family relationship functioning (Olson, Russell, & Sprenkle, 1979; Tatsuki, 1999; Tatsuki & Hayashi, 2000). Those whose family cohesion was characterized by moderate levels of family cohesion ($F_{3, 1071}=16.148$, $p<.001$, **Figure 15**) and family adaptability ($F_{3, 1071}=16.024$, $p<.001$, **Figure 16**) reported higher level of life recovery.

Land Use Planning. Dual scaling analysis of 11 items for urban commons yielded a two dimensional structure, where the first dimension contrasted "no" to "yes" and "do not know" while the second dimension contrasted "yes" to "no" and "do not know". The first dimension was interpreted to reflect "definitive versus non-definitive" attitude, which was a part of response biases. On the contrary, the scaled values for "yes", "no" and "do not know" options in the second dimension appeared in a linear order. Because of this, the second dimension solution was used as the scaled score for urban commons. Cronbach's alpha for urban commons scale was .726 for the current data.

One cannot sense a recovery of everyday life in no man's land. It was hypothesized that recovery of everyday life was partly attributed to by an increased sense of stakeholdership to local urban commons. A sense of stakeholdership would increase people's involvement in community affairs and thus would help increase a sense of normalcy in community life. GLM analysis results supported this hypothesis and showed that the more one was aware of the urban commons, the better one was recovered, $F_{1,1071}=5.905$, $p<.05$ (see **Figure 17**).

Physical and Mental Health. Subjects' judgments on their physical and mental health were measured by physical and mental stress scales. 6 items were used to measure each of physical and mental stress. Cronbach's alphas for physical and mental stress scales were .894 and .943, respectively for the current data.

Physical stress was found to be a moderate predictor of life recovery, $F_{1,1071}=2.854$ $p<.10$. As shown in **Figure 18,** the lower the physical stress, the better one tended to sense the recovery of everyday life. Mental stress, on the other hand, was found to be a very strong predictor of life recovery $F_{1,1071}=182.764$, $p<.0001$ (see **Figure 19**). The size of variance accounted for by mental stress was largest among all the predictors. The integrated model 6 as a whole accounted for a little less than a half of the total variance ($?^2=.474$), of which the mental stress accounted for more than 30 % (partial $?^2 = .146$).

Preparedness. The Kobe TQM assessment suggested that a sense of life recovery was accompanied by the heightened sense of preparedness for future disaster. The 2001 panel survey thus asked the degree of damages that respondents anticipated from the soon-to-occur Nankai-Tohnankai earthquake. Principal component analysis of the 6 items showed that the first solution accounted for 71.2 % of the total variance and the only first eigenvalue (4.27) was larger than 1, suggesting a clear unidimensional structure. The 6 items scale provided Cronbach's alpha .918.

On the contrary to the hypothesis expectation, it was found that the pessimistic expectation on the future disaster (the higher expectation of personal injuries, death of significant others, serious damages on housing, income and assets, the longer recovery time, and the wider damages on public facilities and community relations) was significantly associated with lower level of life recovery among the studied subjects ($F_{1,1071}=4.657$, $p<.05$, see **Figure 20**).

Economic and Financial Situation. Subjects were asked to compare between the pre-earthquake and current levels of household income, expenditure and savings. Results showed that changes in income and savings were significant predictors of life recovery $F_{3,1071}=12.579$, $p<.0001$ and $F_{3,1071}=4.383$, $p<.01$, respectively. Expenditure, on the other hand, did not predict life recovery ($F_{3,1071}=1.491$, n.s.). **Figure 21** shows the relation between household income and saving changes on one hand, and life recovery on the other. The better off one was in terms of income and saving, the better recovery he or she reported.

Relation to Government. 4 trichotomous items were prepared to ask respondents' views of the government in either paternalistic, liberal, or communitarian orientations. Dual scaling analysis of the 4 items revealed a 2 dimensional structure, where the first solution contrasted liberalism versus paternalism and the second solution differentiated communitarianisum from the other two views. Cronbach's alphas for liberalism-paternalism and communitarianism subscales were .362 and .345, respectively. As **Table 4** shows, however, neither liberalism-paternalism or communitarianism subscales was a significant predictor of life recovery.

Social Desirability. 10 items social desirability scale showed three factor solutions where the first factor represented a common factor and accounted for 20.7% of total variance, while specific dimensions were emphasized in the second and the third solutions. The variance accounted for for the next two solutions were 11.4 % and 10.2 %, respectively. This rationalized to combine all 10 items to obtain general common score for social desirability. Cronbach's alpha for all 10 items was .536.

Table 4. Life Recovery Factors General Linear Model Analysis Results

Source of Variance	Type III SS	df	MS	F value	P	partial $?^2$
Corrected Model	564.617	131	4.310	7.242	0	0.470
Intercept	0.313	1	0.313	0.526	0.468	0.000
Hazard						
House Damage	2.407	3	0.802	1.348	0.257	0.004
Demographics						
Gender	3.150	1	3.150	5.294	0.022	0.005
Generation	19.618	2	9.809	16.483	0.000	0.030
Occupation	7.832	9	0.870	1.462	0.157	0.012
Hazard-by-Demographic						
House Damage * Gender	7.785	3	2.595	4.360	0.005	0.012
House Damage * Generation * Occupation	78.720	86	0.915	1.538	0.002	0.110
Critical Elements						
Settled-Ness	0.813	2	0.406	0.683	0.505	0.001
Self Governance	4.274	1	4.274	7.181	0.007	0.007
Community Solidarity	5.234	1	5.234	8.795	0.003	0.008
Community Partcipation	9.186	1	9.186	15.435	0.000	0.014
Family Cohesion	16.148	3	5.383	9.045	0.000	0.025
Family Adaptability	16.024	3	5.341	8.975	0.000	0.025
Urban Commons	3.514	1	3.514	5.905	0.015	0.005
Physical Stress	1.698	1	1.698	2.854	0.091	0.003
Mental Stress	108.768	1	108.768	182.764	0.000	0.146
Future Earthquake Risk	2.771	1	2.771	4.657	0.031	0.004
Income	22.459	3	7.486	12.579	0.000	0.034
Savings	7.825	3	2.608	4.383	0.004	0.012
Expendititure	2.662	3	0.887	1.491	0.215	0.004
Paternalism Vs. Liberalism	0.031	1	0.031	0.053	0.819	0.000
Communitarianism	1.135	1	1.135	1.907	0.168	0.002
Social Desirability	7.328	1	7.328	12.313	0.000	0.011
Error	637.383	1071	0.595			
Total	1202	1203				
Corrected Total	1202	1202				

As **Table 4** shows, social desirability effect was significant on life recovery responses (subjects ($F_{1,1071}$=12.313, p<.001). This suggests that studied subjects responses were significantly influenced by social desirability bias. Partial contribution of social desirability to the total variance (partial η^2) was .011. This means that although a portion of life recovery variances was influenced by social desirability, its size was only 2.4 % of the total variance (η^2=.474) that the integrated model as a whole accounted for in the employed model 6. In other words, 97.6 % of the total variance that was accounted for by the integrated model was free from social desirability.

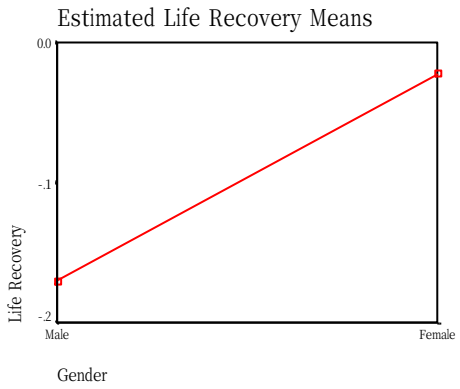

Figure 5. Life Recovery by Gender

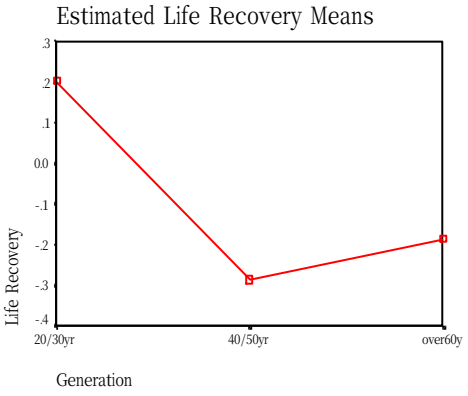

Figure 6. Life Recovery Means by Generation

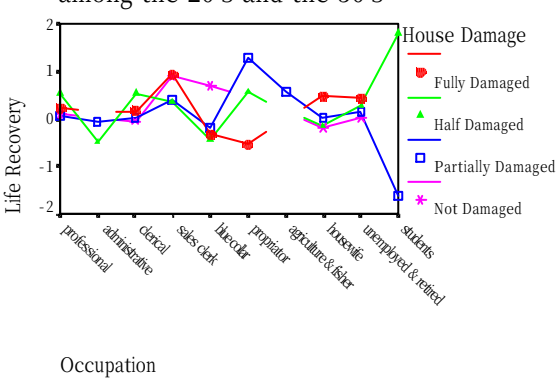

Figure 7. Life Recovery Means by Occupation by House Damage (the 20' & the 30')

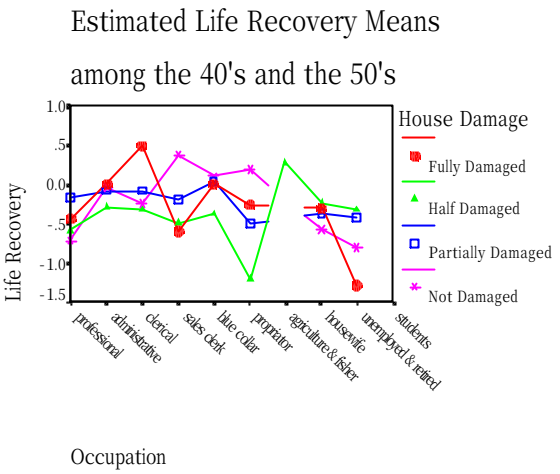

Figure 8. Life Recovery Means by Occupations by House Damage (the 40's and the 50's)

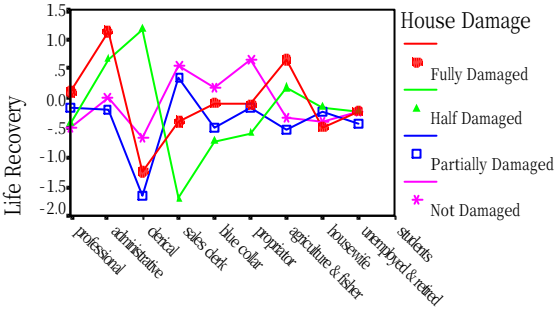

Figure 9. Life Recovery Means by Occupations by House Damage (over age 60)

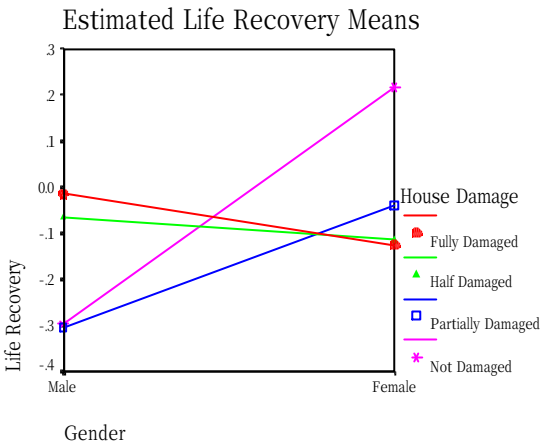

Figure 10. Life Recovery Means by Gender by House Damage

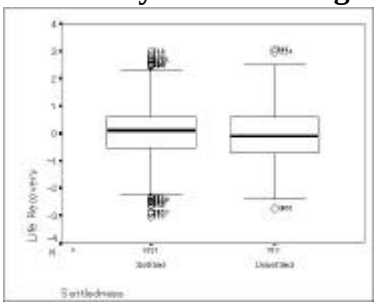

Figure 11. Settled-ness and Life Recovery

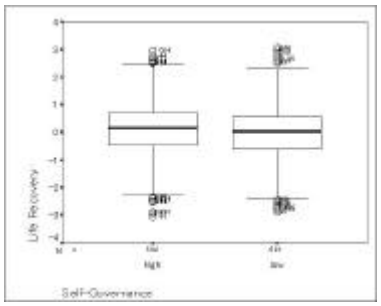

Figure 12. Self-Governance and Life Recovery

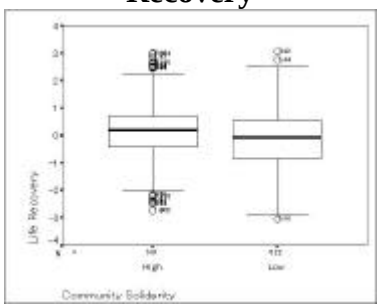

Figure 13. Community Solidarity and Life Recovery

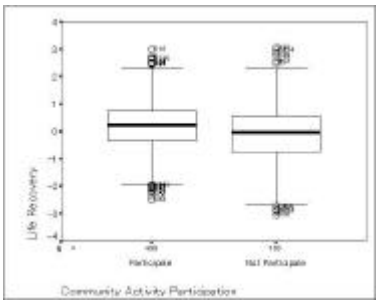

Figure 14. Community Participation and Life Recovery

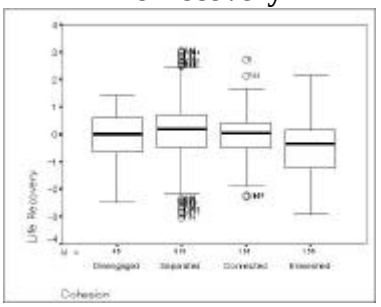

Figure 15. Family Cohesion and Life Recovery

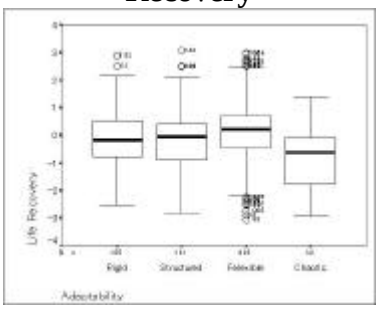

Figure 16. Family Adaptability and Life Recovery

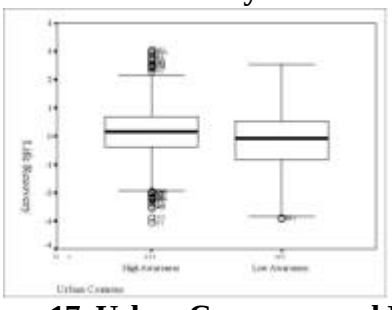

Figure 17. Urban Commons and Life Recovery

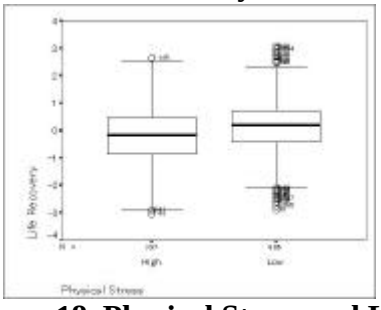

Figure 18. Physical Stress and Life Recovery

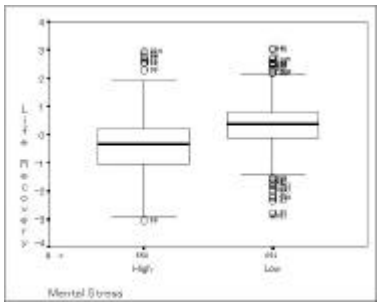

Figure 19. Mental Stress and Life Recovery

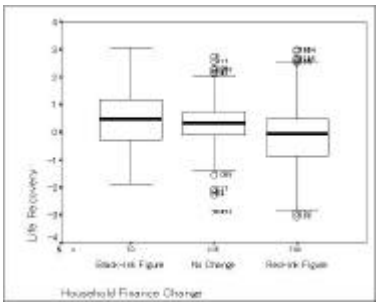

Figure 21. Household Financial Situation and Life Recovery

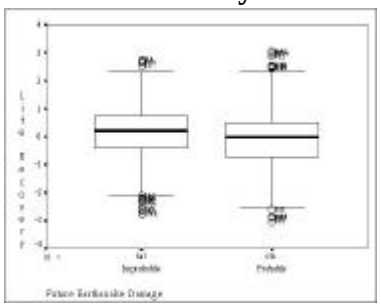

Figure 20. Perceived Risk of Future Disaster and Life Recovery

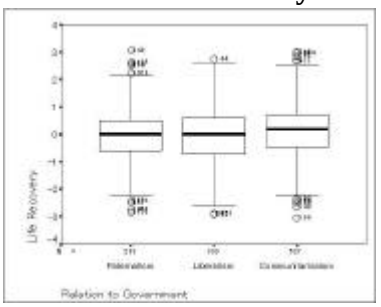

Figure 22. Relation to Government and Life Recovery

Discussion

Life Recovery Critical Elements Model

This study generally supported the validity of the seven critical elements model that was developed in the 1999 Kobe TQM assessment. **Figure 23** compares the sizes of variance (adjusted R^2) that the studied general linear models accounted for. This graph clearly shows that critical elements accounted for about four times larger variance (adjusted R^2=.364) than the model that incorporated hazard, demography and their interaction (adjusted R^2=.092).

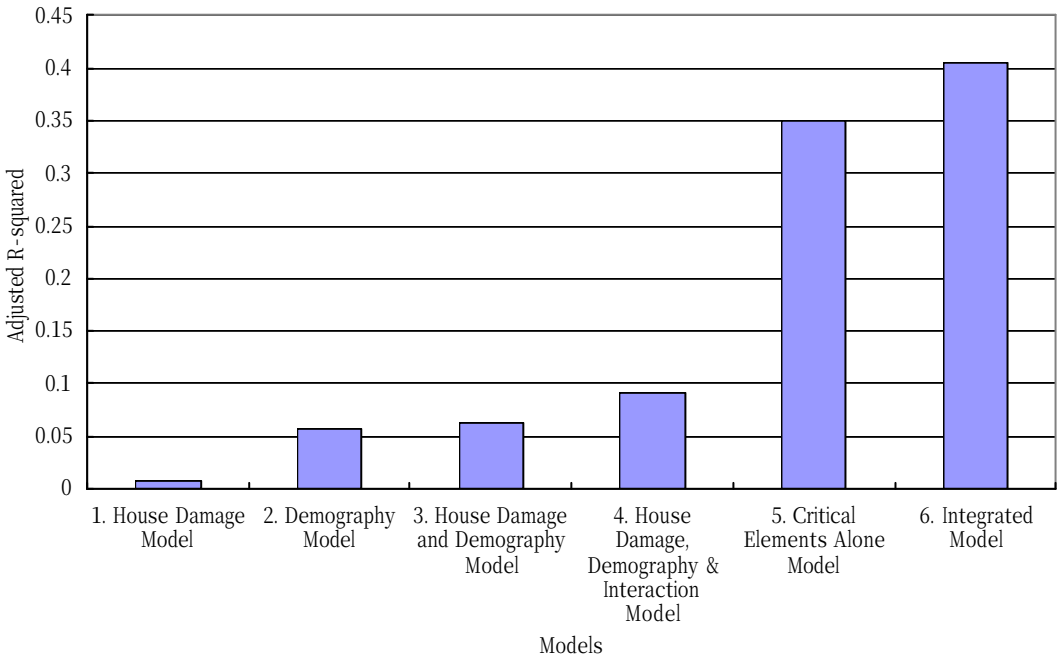

Figure 23. A Comparison of Adjusted R^2 among the Studied General Linear Models.

Development of Measures for Life Recovery Critical Elements

Table 5 summarizes measures for each life recovery critical element, a number of items for each measure, its significance level as a predictor of life recovery in the integrated model, and Cronbach's alphas. Measures for social ties, land use planning, physical and mental health, and economic and financial situation were significant predictors of life recovery. Measures for housing (settled-ness) and relation to government (liberal-paternalistic and communitarian views) did not have significant effect on life recovery.

There is a reason to explain why a measure for housing did not predict life recovery. According to Maki et al. (2000), the lost amount of housing units due to the 1995 Kobe earthquake had already been recovered in the first two years. If the present study had been conducted in 1995 or 1996 when a need for housing was far stronger, a measure for settled-ness might have been a significant predictor of life recovery.

As for a measure for relation to government, a significance test probability for each of liberal-paternalistic and communitarian view was supplemented. It appears that if alpha level for communitarian view were to be improved by increasing number of items, it would become a significant predictor. This remains, however, to be untested until the scheduled 2003 panel survey.

Preparedness to the Nankai-Tohnankai earthquake was found to be a significant predictor but the direction of its impact on life recovery was contrary to the original design. It is suspected that the employed scale measured a sense of pessimistic expectation of the future disaster caused by the Tohnankai earthquake. The result implies that those who were pessimistic about the future disaster were less recovered and the optimist were better recovered. In order to capture the core content domain for preparedness, a more behavior-based measure or check list may need to be constructed.

Table 5. Summary of Life Recovery Critical Element Measures

Elements	Scale/Variable	# of Items	Sig.	Alpha	Comment
Housing	Settled-ness	1	n.s.	n.a.	
Social Ties	Self-Governance	4	***	.147	
	Community Solidarity	4	***	.543	
	Community Participation	3	****	.848	
	Family Cohesion	8	****	.942	
	Family Adaptability	8	****	.919	
Land Use Planning	Awareness of Urban Commons	11	**	.726	
Physical/Mental	Physical Stress	6	*	.894	
Health	Mental stress	6	****	.943	
Preparedness	(Pessimistic)Views of future damage	6	**	.918	Opposite Direction
Economic/Financial	Household income	1	****	n.a.	
Situation	Household expenditure	1	n.s.	n.a.	
	Household savings	1	***	n.a.	
Relation to	Liberal-Paternalistic view	4	n.s.	.362	p=.819
Government	Communitarian view	4	n.s.	.345	p=.168

* P<.10 ** P<.05 *** P<.01 **** P<.001

Strong Predictors of Life Recovery

The present study aimed to test what combinations of variables best predicted the level of life recovery among the impacted citizens. As was shown in Figure 23, the integrated model that include hazard, demography, hazard-by-demography interaction as well as life recovery critical elements accounted for the larges variance (R^2=.470 and adjusted R^2= .405). In a general linear model design, squared multiple correlation (R^2) and squared correlation ratio(η^2) are identical. They both indicate a portion of variance that is explained by the entire model. An η^2 can be decomposed into several partial η^2's, each of which represents each given predictor's partial effect on the dependent variable. By comparing partial η^2's, therefore, one can identify which predictors best explained the life recovery variance. **Figure 24** clearly shows that mental stress and generation-by-house-damage-by-occupation interaction were the two strongest predictors within the integrated model and that they accounted for about a quarter of the total variance in life recovery or about a half of the variance that the entire model accounted for (η^2=.470) . By adding 5 more predictors (income, generation, family cohesion and adaptability and community participation) to these top 2 predictors, about 80 % of the model variance can be explained. This result suggests that, because of their relatively stronger effects on life recovery, it is worth concentrating further policy intervention concerns and efforts on mental health, hazard-by-demography-interaction as well as generation, household income, and social tie variables (family system and community participation).

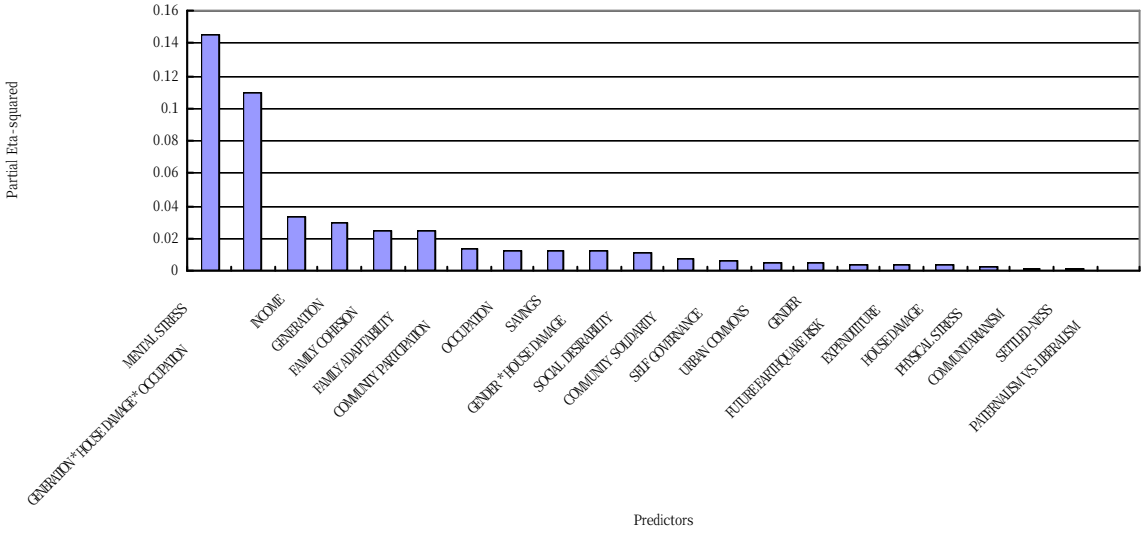

Figure 24. A Comparison of Relative Variance Size That was explained by Each Predictor in the Integrated Model.

Policy Implications

Mental stress was the strongest predictor of life recovery. Hayashi et al. (1996) reported that the elderly earthquake victims received support for their mental health through informal social support network and that paid professionals were hardly used for their mental health needs. This finding may apply not only to the elderly but also to all other generations. Policy measures that strengthen everyday social ties are the key to lower mental stress among the impacted citizens. On this basis, more policy concerns should be paid to assist family systems and to facilitate more active community participation. Programs that encourage family units or parts of family units rather than individual members to participate in community affairs may be the suggested policy direction.

The other social ties and related variables that need to be considered are community solidarity, self-governance and urban commons. These variables were found to increase a sense of life recovery. Government-and-resident partnership programs should be further encouraged in deciding, building, maintaining local public facilities. Programs to provide resources in order to embed more local commons in neighborhoods may assist the empowerment of civic-mindedness.

The hazard-by-demography-interaction and income were the second and the third strongest predictor of life recovery. 1) Young and middle aged small business owners who reside in the severely impacted areas, 2) the middle aged unemployed, and 3) the old aged who are employed in the local small business were found to be the least recovered These results imply that the impacts of natural hazards to local economy are long term because they often change the customer base. Drastic changes in business practice are needed in order to adapt to new local economic realities. Direct and indirect programs are desperately needed to revitalize local economy. Local business suffering due to natural hazards has been repeatedly observed in the natural hazard hit areas in the US (Dahlhamer and Tierney, 1996; Alesch, Holly, Mittler, and Nagy, 2001). The local economy revitalization programs that the US has employed in recent natural disasters may provide possible policy alternatives to improve local business environments.

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