Seven Critical Element Model of Life Recovery: General Linear Model Analyses of 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, townscape, physical/mental health, preparedness, economic/financial situation, and relation to government. This study aimed to verify the life recovery critical element model by a random sample survey of 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 housing damage, demography and life recovery elements factors on life recovery. Significant house damage-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. All seven critical element variables predicted the level of life recovery with moderate to strong significance. Those included housing (types of housing and housing structure), social ties (civic-mindedness, community participation and family system functioning), townscape (awareness of urban commons or a sense of attachment to *locale*), mind and body (mental stress, physical and mental stress interaction, and general health practices), preparedness (optimistic expectation of future earthquake damage), economic/financial situation (income and savings), and relation to government (willingness to pay, and self governance and communitarianism interaction) . The final model which incorporated housing damage, demography, and the seven critical elements accounted for nearly 60 % of the life recovery variance.

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 element 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, & Miyano, 1998; Tanaka, Hayashi, & 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 operationalize policy objectives so that levels of life recovery among various groups of Kobe residents will be constantly and objectively monitored. The use of TQM tools allowed sorting out 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 all of Kobe's nine wards and three special interest groups provided their assessments concerning life recovery from the earthquake at grassroots workshop sessions. This yielded 1,623 opinion cards. From one perspective, the TQM-based assessment workshops allowed a 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, townscape, 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**).
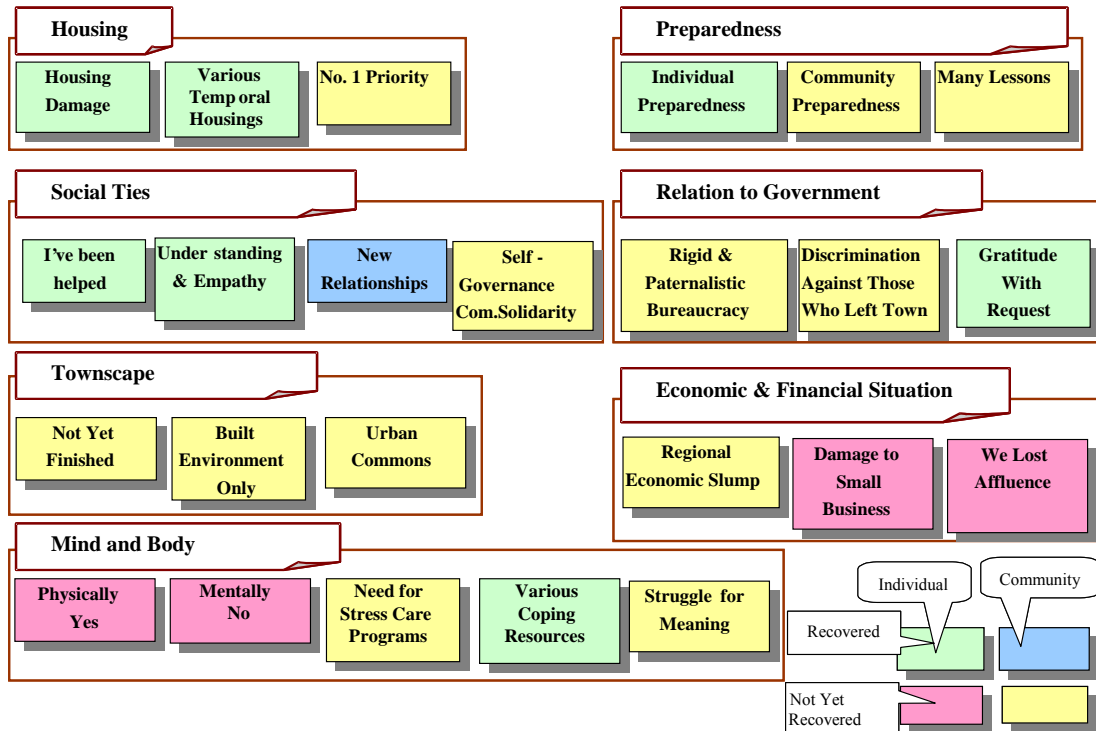
Housing

| Housing Damage | Various Temporal Housings | No. 1 Priority |

Preparedness

| Individual Preparedness | Community Preparedness | Many Lessons |

Social Ties

| I've been helped | Under standing & Empathy | New Relationships | Self - Governance Com.Solidarity |

Relation to Government

| Rigid & Paternalistic Bureaucracy | Discrimination Against Those Who Left Town | Gratitude With Request |

Townscape

| Not Yet Finished | Built Environment Only | Urban Commons |

Economic & Financial Situation

| Regional Economic Slump | Damage to Small Business | We Lost Affluence |

Mind and Body

| Physically Yes | Mentally No | Need for Stress Care Programs | Various Coping Resources | Struggle for Meaning |

Individual — Community

Recovered

Not Yet Recovered

Figure 1. Seven Critical Elements for Everyday Life Recovery.

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**).
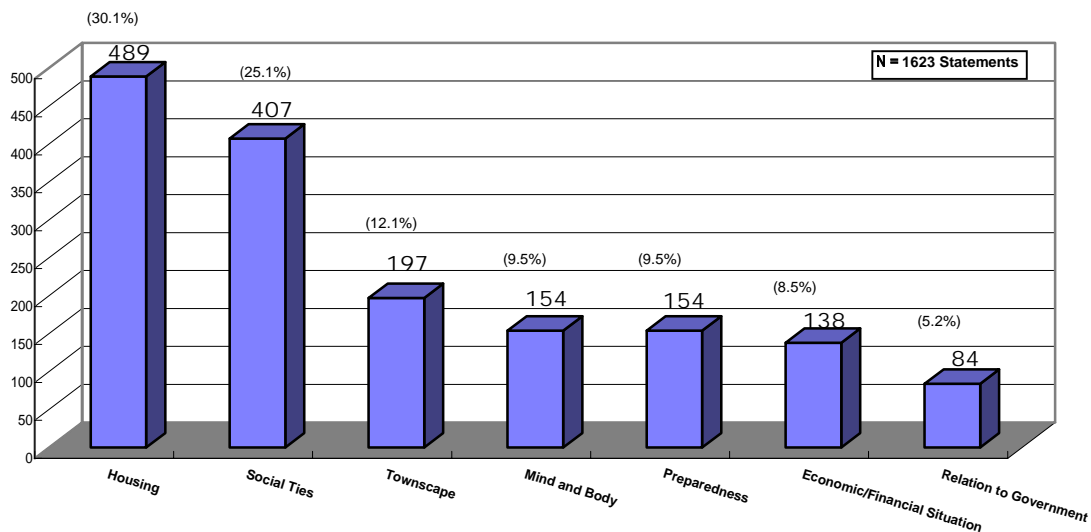
1623 Statements

Category	Value	Percent
Housing	489	(30.1%)
Social Ties	407	(25.1%)
Townscape	197	(12.1%)
Mind and Body	154	(9.5%)
Preparedness	154	(9.5%)
Economic/Financial Situation	138	(8.5%)
Relation to Government	84	(5.2%)

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.
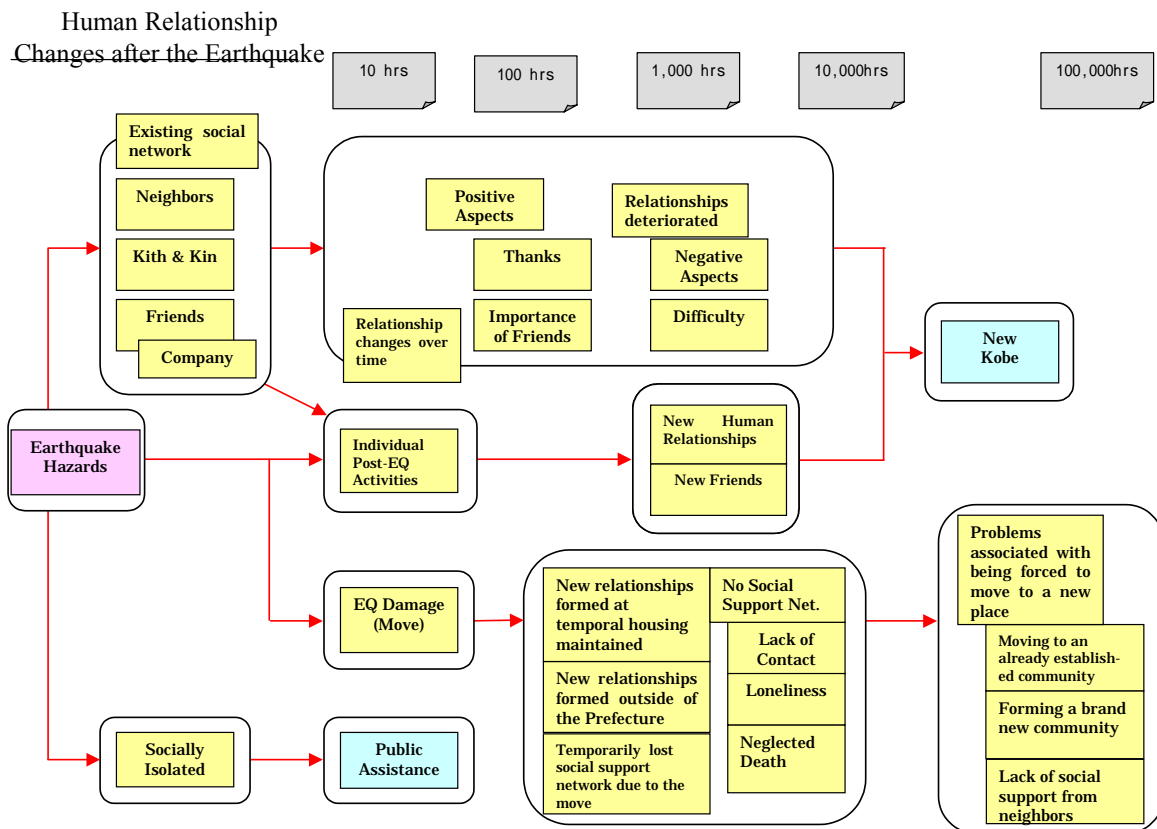
Though social ties were the critical factor for individual recovery, it was the most difficult factor for government to intervene.   The Kobe TQM assessment remarked that the government countermeasures against the damage/loss of social ties were concentrated to the most vulnerable population who lacked 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.
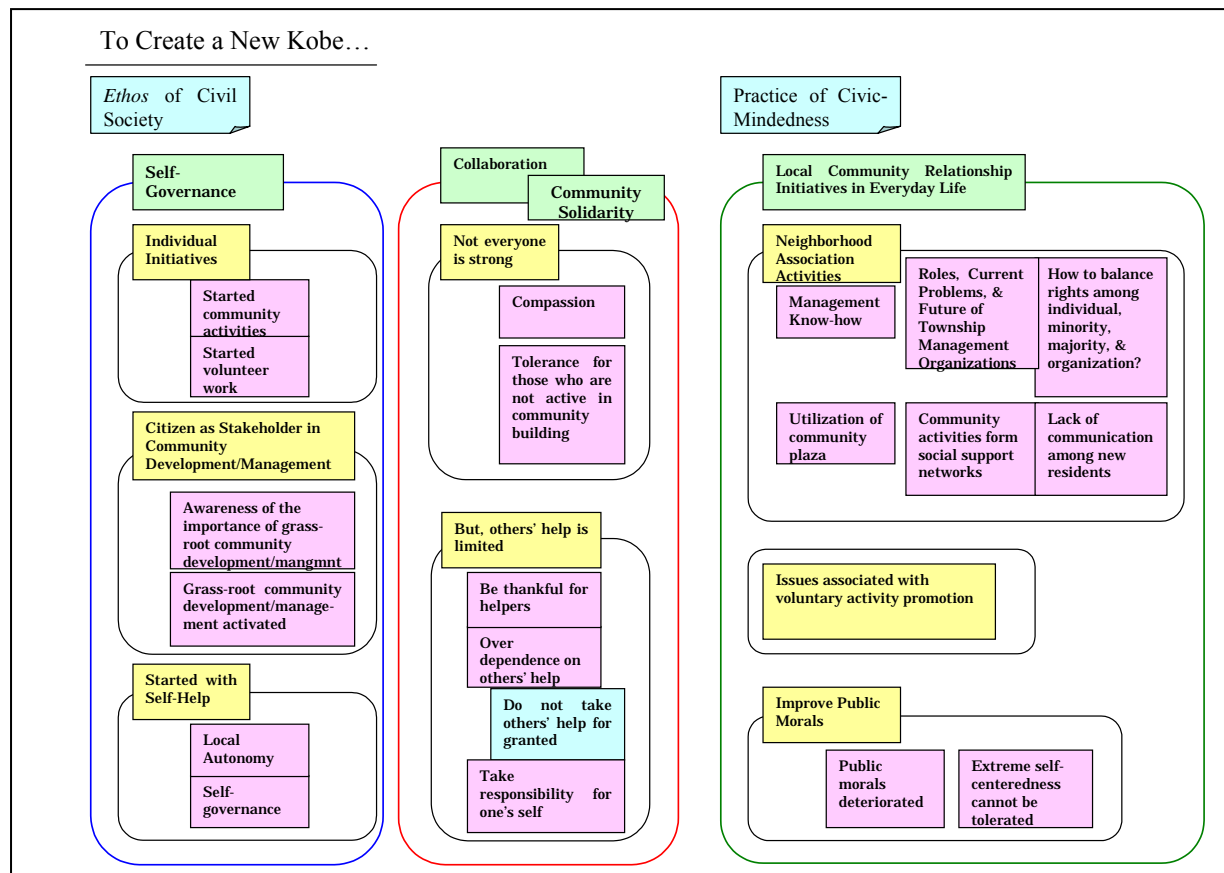

Figure 4. Ethos of Civil Society Characterizes "New Kobe"

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 those which resided in the rest of the 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.   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 first panel 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-point Likert scale items that ask about 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 prospects of life one year from the present (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	Types of Housing, Housing Structure
Social Ties	Self-Governance, Community Solidarity, Community Participation, Social Trust, Family Cohesion and Adaptability
Townscape	Awareness of Urban Commons
Mind and Body	Physical and Mental Stress Symptom Checklist, General Health Practices Index
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,Willingness to Pay (WTP)
Life Recovery	Life satisfaction, QOL, Daily Activity level, Optimism
Social Desirability	MMPI Lie Scale

Housing.   Types of housing inhabited by the respondents were categorized as 1) owned house on an owned lot, 2) owned condominium apartment, 3) owned apartment, 4) public housing rental apartment, 5) company housing, 6) owned house on a rented lot, 7) rented house, 8) private rental housing apartment.   The structure of housing unit was also asked about and they were classified as 1) detached house, 2) row house, 3) wooden two-story multi-family housing, and 4) RC unit.

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 a 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.

Two items measured the degree of social trust, which enables a person to go beyond his or her own personal boundary and communicate with strangers. Those items were "Most people are trustworthy" and "Other people may exploit me if I am not careful (reverse item)." Those two yes-no items were selected from general social trust scale as reported by Yamagishi (1998).

FACESKGIV-16 is a 16-item Thurstone scale, which measures the Circumplex model's two dimensions, 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).

Townscape. 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 townscape 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.

Mind and Body. 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. In order to measure respondents' general health practices, 8 items were prepared to ask the degree of daily activities such as drinking, physical exercise, smoking, sleep length, balanced dietary, regular breakfast intake, work hour length and stress symptom awareness (cf., Belloc & Breslow, 1972).

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. Okamoto (1997) classified the relation to government into paternalistic, liberal and communitarian orientations. Based on his model, four questions were asked with regard to how to enforce garbage separation rules, how to vitalize community activities, how to save lives at the time of major disaster, and how to promote community development. Elsewhere, respondents were also asked how much money and time they are willing to spend in order to maintain their community. The amount of money and time that they are willing to pay (WTP) for local park maintenance, community festivals, and neighborhood activities was used as a six item scale of communitarian orientation.

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 ^{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 house damage and economic damage (model 1 and model 2, respectively), demographics (model 3), house damage, economic damage and demographic (model 4), damage, demographic and damage-by-demographic interaction (model 5), life recovery elements (model 6), and the integrated model that incorporated models 5 and 6. 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 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 7 that incorporated damage, demographics, damage-by-demographics, and life recovery elements was found to explain about 60 % of the total variance. This was the largest variance explained (both R^2 and R^{*2}) among all the models compared.

The Integrated Model: Damage, 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 η^2 for each component was also added to the GLM results. Partial η^2 ($SS_b/(SS_b + SS_e)$) indicates a relative size of variance explained by a given component in the GLM equations.

Damage, Demography, and Damage-by-Demography Interaction: With regard to the damages directly or indirectly caused by earthquake hazard (i.e., house and economic damage, respectively), the employed model showed that neither house or economic damage *per se* had any significant main effects on a sense of life recovery.

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.Economic Damage Model	24.359	9	2.707	2.742	0.004	0.020	0.013
3.Demography Model	103.539	28	3.698	3.952	0.000	0.086	0.064
4.House Damage, Economic Damage and Demography Model	122.438	40	3.061	3.295	0.000	0.102	0.071
5.House Damage, Economic Damage, Demography and Interaction Model	345.869	248	1.395	1.554	0.000	0.288	0.103
6.Critical Elements Alone Model	504.568	59	8.552	14.016	0.000	0.420	0.39
7.Integrated Model (Models 5 & 6)	713.293	307	2.323	4.255	0.000	0.593	0.454
Total	1202.000	1203					

Generation and occupation were two most significant predictors among the demographic variables. **Figure 5** 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 ($F_{2,1202}$=8.449, p<.001). Occupation main effect was also significant ($F_{9,1202}$=3.076, p<.005). As Figure 6 illustrates, those who were in agriculture/fishery, students, and administrative jobs were better recovered than those who were unemployed/retired, in blue color or sales clerk jobs.
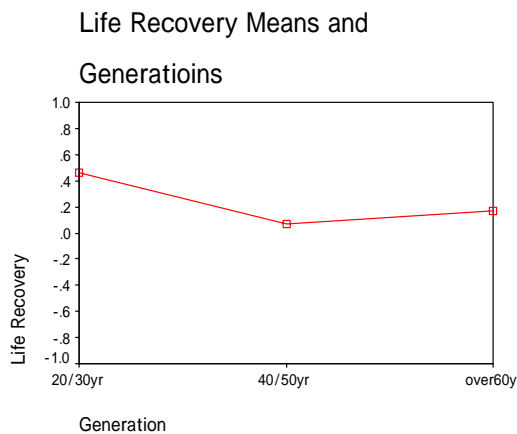
Figure 5. Life Recovery Means by Generation
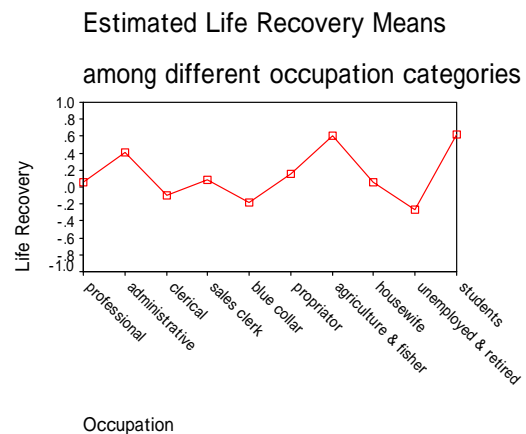
Figure 6. Life Recovery Means by Occupation

As was shown, damage main effects were not significant. However, this does not mean that direct or indirect damages did not have *any* impact. As **Table 4** shows, significant damage-by-demography interaction effects were found. The psycho-social impact of the house damage differed significantly among different occupations in different age groups ($F_{86, 1202}$=1.455, p<.01). Similarly, economic damage-by-locality interaction was found to be a moderate predictor of life recovery ($F_{128, 1202}$=1.188, p<.10). **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**).
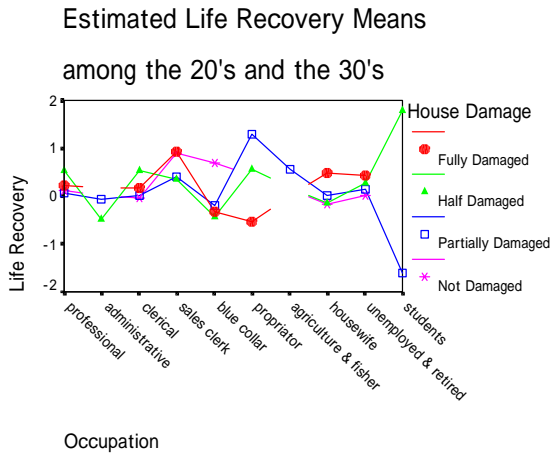

Figure 7. Life Recovery Means by Occupation by House Damage (the 20' & the 30')
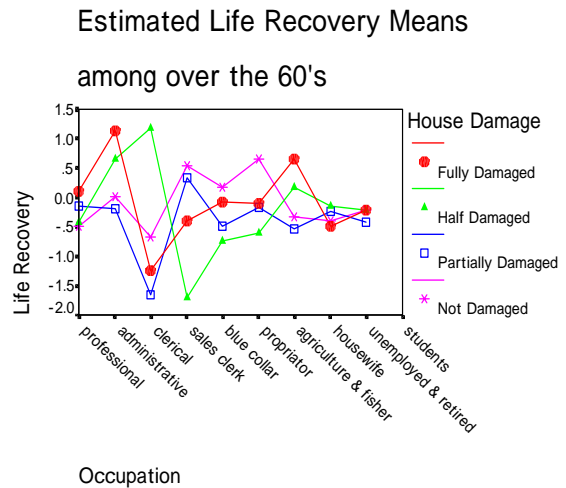
Figure 9. Life Recovery Means by Occupations by House Damage (over age 60)
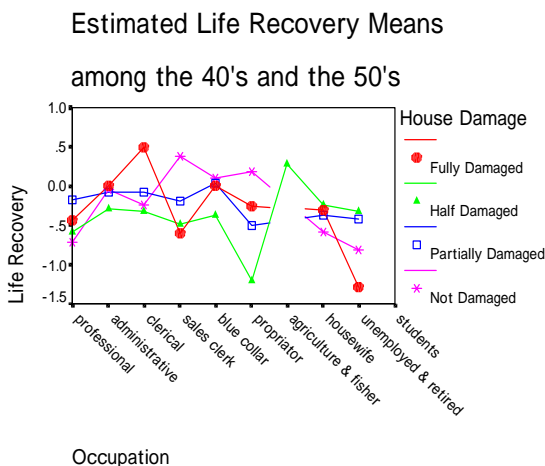
Figure 8. Life Recovery Means by Occupations by House Damage (the 40's and the 50's)
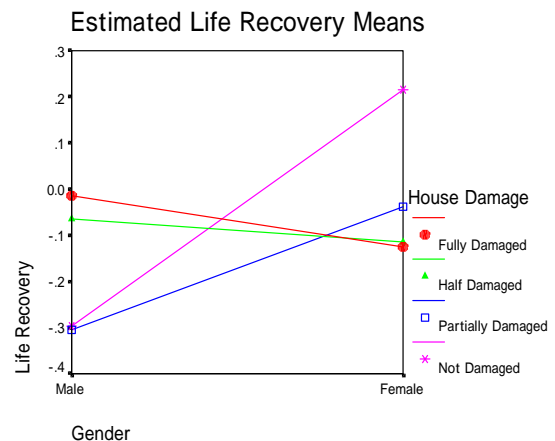
Figure 10. Life Recovery Means by Gender by House Damage

Although the sex main effect was not statistically significant ($F_{1, 1202}=2.102$, n.s.), house damage tended to have differential impacts on life recovery between men and women ($F_{3, 1202}=1.381$, p=.056). 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. There was a mild locality-by-economic damage interaction effect on life recovery ($F_{128, 1202}=1.188$, p=.089). It was found that those whose economic damage exceeded 200 % of their annual income and those who resided in Chuo-ku and Nada-ku, central business parts of Kobe city, tended to be the least recovered.

Critical Elements

As for the critical elements that were identified by the Kobe TQM assessment, all components were entered into the GLM model. All of the seven critical 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, housing types and structure were used as measures for housing. The housing types tended to influence a sense of life recovery ($F_{8, 1202}$=1.891, p=.058). According to **Figure 11**, public housing tended to have positive impact to facilitate sense of life recovery.

Estimated Life Recovery Means among housing types
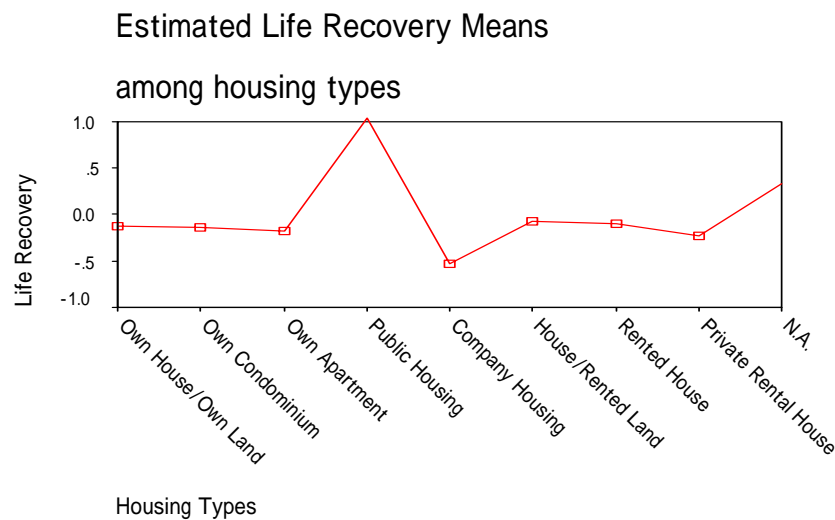
Figure 11. Housing Type and Life Recovery

Social Ties. Social ties component was measured by 1) civic-mindedness scale, 2) community participation scale, 3) social trust scale and 4) family adaptability and cohesion scales. 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, two item social trust scale was Dual-scaled and the two item scale showed Cronbach's alpha .411. Finally, 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 moderate to strong effects on life recovery. Those include a sense of civic-mindedness that consists of self-governance (see **Figure 12**, $F_{1, 1202}$=3.713, p=.054) and community solidarity (see **Figure 13**, $F_{1, 1202}$=7.505, p<.01), the degree of actual community participation (See **Figure 14**, $F_{1, 1071}$=15.435, p<.001) and social trust (See **Figure 15,** $F_{1, 1202}$=15.336, p<.001).
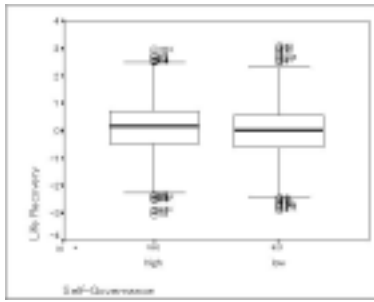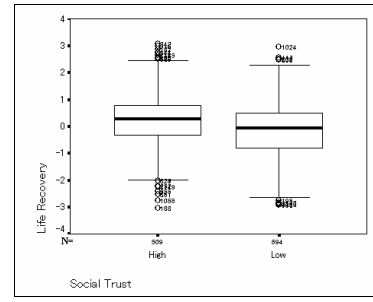
Figure 12. Self-Governance and Life Recovery

Figure 13. Community Solidarity and Life Recovery

Figure 14. Community Participation and Life Recovery
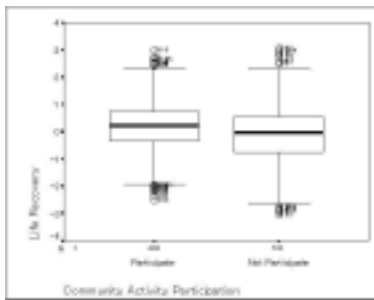

Figure 15. Social Trust and Life Recovery

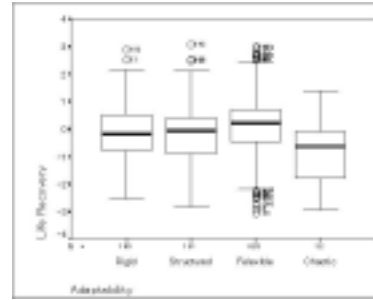**Figure 16. Family Cohesion and Life Recovery**

Figure 17. Family Adaptability and Life Recovery

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 16**) and family adaptability ($F_{3, 1071}$=16.024, p<.001, **Figure 17**) reported higher level of life recovery.

Townscape. 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 stake-holdership to

local urban commons.   A sense of stake-holdership 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, $F_{1,1202}=3.34$, p=.068 (see **Figure 18**).
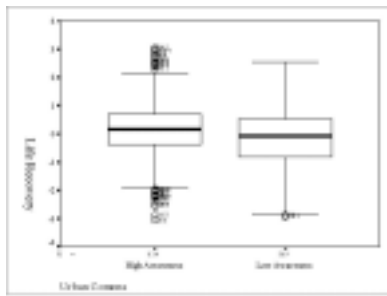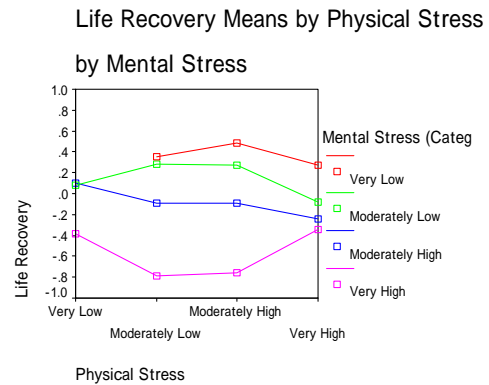

Figure 18. Urban Commons and Life Recovery

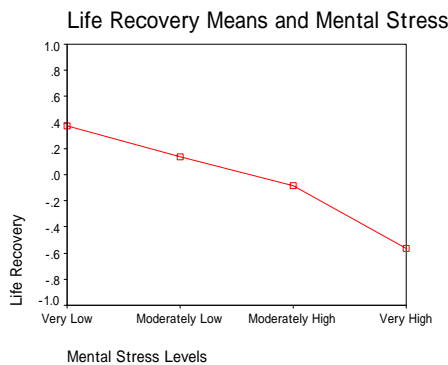**Figure 20. Mental and Physical Stress Interaction on Life Recovery**

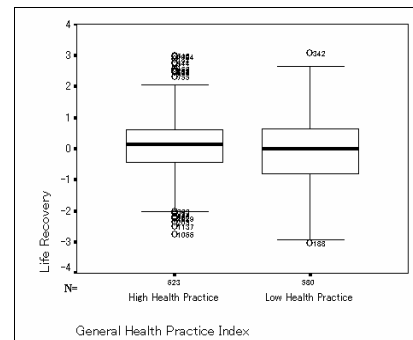**Figure 19. Mental Stress and Life Recovery**

Figure 21. General Health Practice and Life Recovery

Mind and Body.   Subjects' judgments on their physical and mental health as well as the degree of daily health practices were measured by physical stress scale, mental stress scale, and general health practice index, respectively.   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. Meanwhile, respondents' general health practices were measured by 8 item scale.   Cronbach's alpha for general health practices was .537.

Mental stress was a very strong predictor of life recovery ($F_{1,1202}=34.88$, p<.0001, see **Figure 19**).   It turned out to be the single most influential predictors of life recovery among all the predictors.   The integrated model 7 as a whole accounted for 59.3% of the total variance ($\eta^2=.593$), one sixth of which was accounted for by the mental stress (partial $\eta^2 = .105$). Meanwhile, physical stress was found not to have much impact upon life recovery ($F_{1,1202}=.519$, n.s.).   General linear model analyses, however, revealed that there was a significant physical-by-mental stress interaction ($F_{1,1202}=3.615$, p<.0001). As shown in **Figure 20,** for those whose mental stress were very low or moderately low, it turned out that moderately low to moderately high level of physical stress tended to further facilitate sense of life recovery.   Finally the degree of general health practices was a significant predictor of life recovery ($F_{1,1202}=10.391$, p<.001, see **Figure 21**).

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 ($F_{1,1202}$=6.951, p<.01, see **Figure 22**).
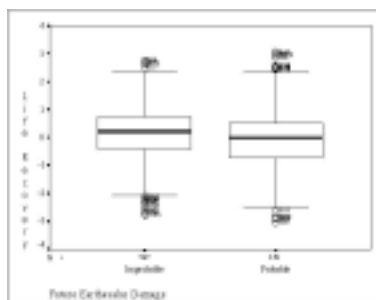

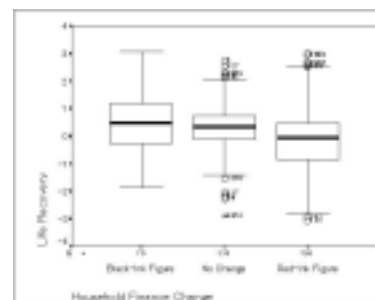**Figure 22. Perceived Risk of Future Disaster and Life Recovery**

Figure 23. Household Incom and Life Recovery

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 was a significant predictor of life recovery $F_{3,1202}$=11.086, p<.0001). Saving and expenditure, on the other hand, did not predict life recovery ($F_{3,1202}$=1.155, n.s. and $F_{3,1202}$=1.295, n.s., respectively).   **Figure 23** shows the relation between household income and and life recovery.   The better off one was in terms of income, the better recovery he or she reported.
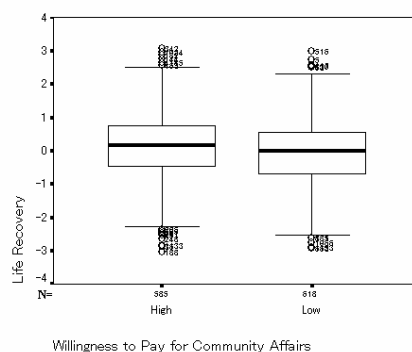
Figure 24. Willingness to Pay for Community Affairs and Life Recovery

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 communitarian from the other two orientations.   Cronbach's alphas for liberalism-paternalism and communitarianism subscales were .362 and .345, respectively.   GLM analyses revealed that neither liberalism-

paternalism or communitarian subscales was a significant predictor of life recovery.   There was only a weak interaction effect (F1) between communitarianism and self-governance. On the contrary, six item Willingness to Pay Scale for community affairs (Cronbach's alpha was .899) was a significant predictor of life recovery.   Those who are willing to pay more money and time for community affairs were found to be better recovered (F1, 1202 =6.49, p<.05, see**Figure 24**).

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 η^2
Corrected Model		713.293	307	2.323	4.255	0.000	0.593
Intercept		0.517	1	0.517	0.947	0.331	0.001
Damage	House Damage	1.202	3	0.401	0.734	0.532	0.002
Demography	Locality	7.834	16	0.490	0.897	0.573	0.016
	Locality*Economic Damage	83.035	128	0.649	1.188	0.089	0.145
	Sex	1.148	1	1.148	2.102	0.147	0.002
	Generation	16.898	2	8.449	15.473	0.000	0.033
	Occupation	15.115	9	1.679	3.076	0.001	0.030
	House Damage*Sex	4.144	3	1.381	2.530	0.056	0.008
	House Damage*Generation*Occupation	68.308	86	0.794	1.455	0.006	0.123
Housing	Types of Housing	8.260	8	1.033	1.891	0.058	0.017
	Housing Types*Housing Structure	14.954	12	1.246	2.282	0.007	0.030
Social Ties	Family Cohesion	11.449	3	3.816	6.989	0.000	0.023
	Family Adaptability	6.574	3	2.191	4.013	0.008	0.013
	Self Governance	2.028	1	2.028	3.713	0.054	0.004
	Community Solidarity	4.098	1	4.098	7.505	0.006	0.008
	Community Activity Participation	6.398	1	6.398	11.718	0.001	0.013
	Social Trust	8.374	1	8.374	15.336	0.000	0.017
Townscape	Urban Commons	1.824	1	1.824	3.340	0.068	0.004
Mind and Body	Physical Stress	0.850	3	0.283	0.519	0.669	0.002
	Mental Stress	57.138	3	19.046	34.880	0.000	0.105
	Physical * Mental Stress	15.790	8	1.974	3.615	0.000	0.031
	General Health Practice	5.674	1	5.674	10.391	0.001	0.011
Preparedness	Future Earthquake Damage	3.795	1	3.795	6.951	0.009	0.008
Economic/Financial Situation	Income	18.161	3	6.054	11.086	0.000	0.036
	Savings	1.892	3	0.631	1.155	0.326	0.004
	Expenditure	2.121	3	0.707	1.295	0.275	0.004
Relation to Government	Willingness to Pay	3.544	1	3.544	6.490	0.011	0.007
	Self Governance * Communitarianism	1.358	1	1.358	2.488	0.115	0.003
Social Desirability Bias		2.278	1	2.278	4.172	0.041	0.005
Error		488.707	895	0.546			
Total		1202	1203	(Corrected Total=1202)			

As **Table 4** shows, social desirability effect was significant on life recovery responses (subjects ($F_{1,1202}$=4.172, p<.05). 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 .005. This means that although a portion of life recovery variances was influenced by social desirability, its size was only .78 % of the total variance (η^2=.593) that the integrated model as a whole accounted for in the employed model 6. In other words, 99.2 % of the total variance that was accounted for by the integrated model was free from social desirability.

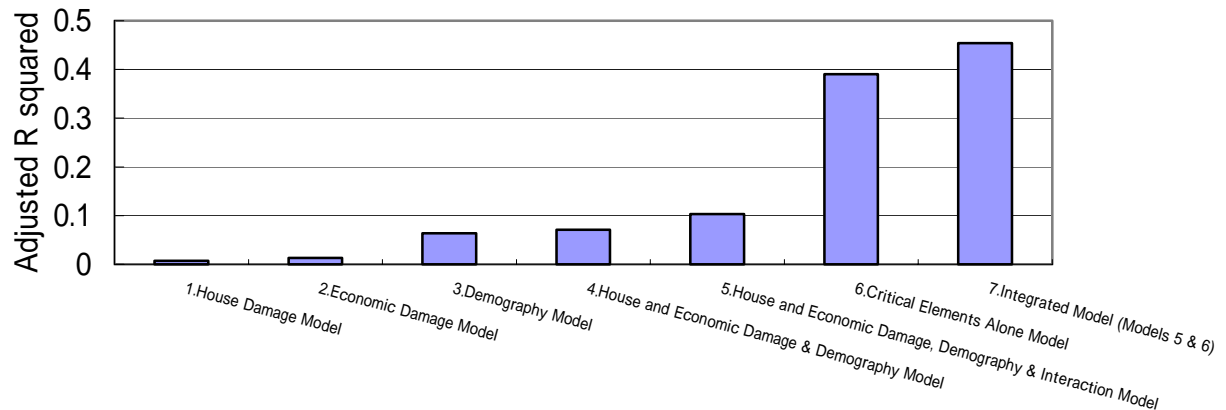Comparisons of Adjusted R-Squared among the General Linear Models

Figure 25. A Comparison of Adjusted R^2 among the Studied General Linear Models.

Discussion

Life Recovery Critical Elements Model

This study empirically validated the seven critical elements model that was developed in the 1999 Kobe TQM assessment. **Figure 25** 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=.39) than the model that incorporated damages, demography and their interaction (adjusted R^2=.103).

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, townscape, 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.

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. In comparison, a six item Willingness to Pay scale for community affairs showed a high internal consistency reliability (Cronbach's alpha = .899). This scale captured the essence of civic-mindedness, particularly in the component of civic responsibility, and this component was found important to promote life recovery.

Table 5. Summary of Life Recovery Critical Element Measures

Elements	Scale/Variable	# of Items	Sig.	Alpha
Housing	Types of Housing	1	*	n.a.
Social Ties	Self-Governance	4	*	.147
	Community Solidarity	4	***	.543
	Community Activity Participation	3	***	.848
	Social Trust	2	****	.411
	Family Cohesion	8	****	.942
	Family Adaptability	8	***	.919
Townscape	Awareness of Urban Commons	11	*	.726
Mind and Body	Physical Stress	6	n.s.	.894
	Mental stress	6	****	.943
	General Health Practices	8	***	.537
Preparedness	(Pessimistic)Views of future damage	6	**	.918
Economic/	Household income	1	****	n.a.
Financial Situation	Household expenditure	1	n.s.	n.a.
	Household savings	1	n.s.	n.a.
Relation to	Liberal-Paternalistic view	4	n.s.	.362
Government	Communitarian view	4	n.s.	.345
	Willingness to Pay	6	**	.899

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

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.

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 25**, the integrated model that include damages, demography, damages-by-demography interaction as well as life recovery critical elements accounted for the largest variance (R^2=.593 and adjusted R^2= .454). 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 estimates each given predictor's partial effect on the dependent variable. By comparing partial η^2 estimates, therefore, one can examine which predictors best explained the life recovery variance. **Figure 26** clearly shows that indices related to housing and economic damages as well as mental stress (locality-by-economic-damage, generation-by-house-damage-by-occupation interaction and mental stress) were the three outstandingly strong predictors and that they accounted for more than a half of the variance (η^2=.593). The next five strong predictors consisted of demographic/socioeconomic variables (income, generation and occupation) plus physical-by-mental-stress and housing-type-by-housing structure interactions. The third strongest set of predictors consisted mainly of the critical elements

variables such as social ties (family cohesion and adaptability, social trust, community activity participation), housing (types of housing) and mind/body (general health practices). This result suggests that, because of their relatively stronger effects on life recovery, it is worth concentrating policy interventions on 1) damage assistance and mental health support, 2) socioeconomic/demography based measures, and 3) social tie strengthening, housing and public health education measures.
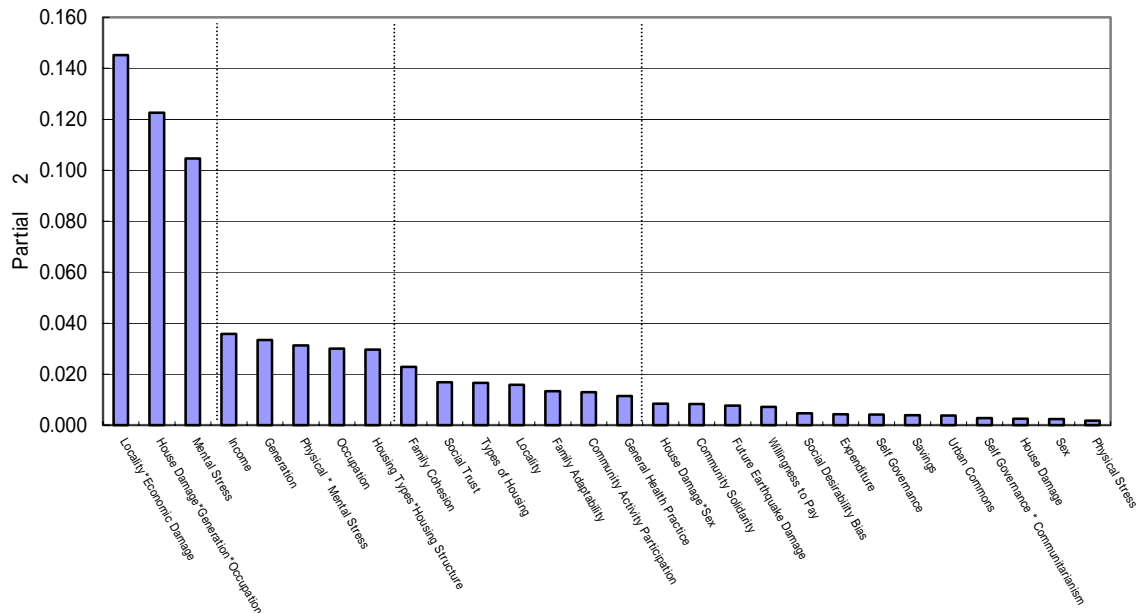

Figure 26. A Comparison of Relative Variance Size That was explained by Each Predictor in the Integrated Model.

Policy Implications

Mental stress was the single 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 seem to be 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, urban commons and communitarian orientation. 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 damages-by-demography-interaction were the top two strongest predictors 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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