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Reviewing
“community preparedness
diagnostic survey”
based on test theory

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Past achievement: Community preparedness diagnostic survey

- *Diagnostic survey* is to check the status-quo, and to externalize hidden local knowledge. In this phase, we note that the name “diagnostic survey” itself has a special meaning ... the metaphor of the patient-doctor relationship as indicated by “diagnosis” helps us illustrate the characteristics of our scientific approach. (Matsuda and Okada, 2006)

地域防災力診断シート

近頃、東海地震や南海地震が起る危険性が指摘されています。また、震動は地震が起ると大きな被害が予想される地域です。お住まいの自治体や地域は地震に対してどのくらい備えができていますか？

このシートはみなさんの回答を集計して地域の防災の備えを診断するものです。質問は約50問あります。お答えに当たっては、できるだけご回答の上、このシートの上、代表の方がお答えくださるようお願いいたします。

まずは、ご自宅や地域の今の防災をよく思い出して、準備に対する備えについて「十分は備えている」を10点、「全く備えていない」を1点として自己採点してみてください。

1	あなたの自宅の地震に対する備えは10点満点で何点ですか？	1-2-3-4-5-6-7-8-9-10	点
2	あなたが住む地域の地震に対する備えは10点満点で何点ですか？	1-2-3-4-5-6-7-8-9-10	点

では、以下の質問について当てはまる項目1つに○をつけてください。

3	震度6以上の地震で、自宅はどの程度の被害を受けたか？	被害はほとんどなかった	被害が軽かった	被害が中程度だった	被害が重かった	被害が非常に重かった
4	自治体の地震の危険性を知っていますか？	よく知っている	少し知っている	あまり知らない	知らない	
5	自治体の地震の危険性を知りたいですか？	はい	いいえ	どちらでもない	いいえ	
6	自治体の地震対策を知りたいですか？	はい	いいえ	どちらでもない	いいえ	
7	自治体の防災訓練に参加したいですか？	はい	いいえ	どちらでもない	いいえ	
8	地域の自治体の防災は進んでいると思いますか？	進んでいる	少し進んでいる	進んでいない	わからない	

- Housing Safety
- Storage
- Shelter
- Special Support
- Community linkage
- Fire
- Emergency contact

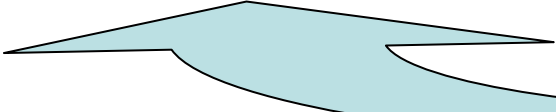
A priori subscale



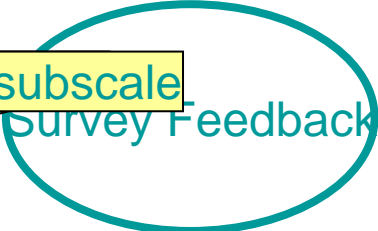
Survey design



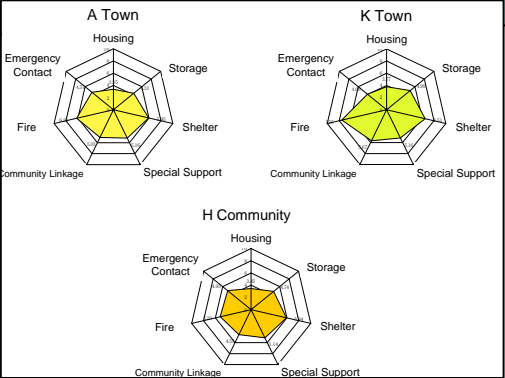
NGO



A priori subscale



Survey feedback



Red: Community knowledge

Green: Practical knowledge

Questions & research objective

- A priori scale based on the NGO's practical knowledge and residents' view of "community disaster preparedness" may not be identical. (implied by data).
- To decompose the measuring scale designed by NGO's practical knowledge, and reconstruct the scale by the residents' survey response.
- To discuss how we interpret and deal with the two obtained scales.

- Housing Safety
- Storage
- Shelter
- Special Support
- Community linkage
- Fire
- Emergency contact

A priori subscale

Survey design



Survey response

reconstructed subscale



Survey Feedback

Red: Community knowledge

Green: Practical knowledge

Test theory

- Theory of psychological tests and measurements. (McDonald, 1999)
- Collection of techniques to evaluate tests.
- Test consists of **items** (questions) to measure **scale(s)**.
- Good **scales** satisfies **reliability** and **validity**.
- **Reliability**: To hold the same level of measurement from different populations.
- **Validity**: To measure what the analyst wants to measure.

(Techniques in use)

- Factor analysis to select reliable (sub)scales.

Reliability of a priori subscale

Subscale	No.	Examples of Preparedness Index Questions (3- or 4-point Likert scale)	# of items	α
Housing Safety	4	Do you know about geological layers around your house?	6	0.45
	6	Have you reinforced your house?		
Storage	11	Is your emergency kit placed where you can easily access?	6	0.73
	14	Does your community store emergency supplies?		
Shelter	15	Do you know your designated shelter nearby?	6	0.59
	16	Do you know a route to the shelter?		
Special Support	22	Do you know that many of dead and injured are elderly people?	7	0.49
	26	Do you know what kind of support the elderly, handicapped and infants need?		
Community linkage	28	Do you think residents in your community are aware of earthquakes?	8	0.7
	29	Do you think your neighbors can rescue each other in case of emergency?		
Fire	35	Do you know how to treat with a fire extinguisher?	8	0.43
	39	Do you know the word "initial fire fighting"?		
Emergency contact	43	Do you discuss emergency contacts with your family?	3	0.44
	44	Do you know about emergency message dial service "171"?		

Chronbach's α : internal reliability index, recommended to be 0.7-0.8 for practical use of the scale.

Low reliability = Low correlations between items.

→ Factor Analysis to extract latent variables (subscales) embedded in the survey response.

Factor analysis results

reconstructed subscale vs. a priori subscale

Reconstructed subscale	A priori subscale	Item attributes		Item #	Question	Factor				
		Type*	Action level**			1	2	3	4	
1. In-family storage	Storage	B	F	Q9	Do you prepare an emergency kit?	.922	-.009	-.040	-.009	
	Storage	B	F	Q11	Is your emergency kit placed where you can easily access?	.896	.003	.007	-.033	
	Storage	B	F	Q10	Do you examine the contents of your emergency kit?	.728	.017	.052	.039	
2. Community linkage	Community linkage	E	C	Q30	Does your community have a reliable person for disaster preparedness?	-.011	.661	-.020	-.006	
	Community linkage	E	C	Q33	Do you have communication with your neighbors?	.006	.571	-.027	.073	
	Community linkage	E	C	Q32	Do you have anyone who can consult with about disaster preparedness?	.008	.562	-.008	.031	
	Community linkage	B	C	Q31	Do you talk about disaster preparedness in your community?	.038	.543	-.034	.023	
	Community linkage	K	C	Q29	Do you think your neighbors can rescue each other in case of emergency?	-.057	.450	.048	-.003	
	Community linkage	K	C	Q28	Do you think residents in your community are aware of earthquakes?	.040	.407	-.002	-.026	
3. Knowledge for emergency	Special support	K	C	Q26	Do you know what kind of support the elderly, handicapped and infants need?	.020	.059	.610	-.074	
	Special support	K	C	Q25	Do you know how to guide hearing- or sight-impaired people?	-.034	.054	.517	-.126	
	Shelter	K	C	Q20	Do you know about management of shelters?	-.020	.105	.453	-.033	
	Fire	K	F	Q39	Do you know the word "initial fire fighting"?	.018	-.137	.415	.125	
	Fire	K	F	Q35	Do you know how to treat with a fire extinguisher?	.010	-.100	.396	.087	
	Shelter	K	C	Q19	Do you know in what condition a shelter is provided?	.006	.034	.388	.043	
	Special support	K	F	Q22	Do you know that many of dead and injured are elderly people?	.029	-.015	.362	.129	
4. Evacuation route check	Shelter	K	F	Q15	Do you know your designated shelter nearby?	-.006	.009	.009	.847	
	Shelter	K	F	Q16	Do you know a route to the shelter?	-.003	.023	.049	.697	
Correlations between factors						1	1	.182	.125	.230
						2	.182	1	.416	.217
						3	.125	.416	1	.343
						4	.230	.217	.343	1



* Type B= Behavior, E= Environment, K=Knowledge

** Action level F=Family, C=Community

Extraction Method: Principal Axis Factoring / Rotation Method: Promax

- Latent common factors embedded in the response.
- Items in the subscale 1, 2, 4 originate from the uniform a priori subscale, but not all of the items in the initial subscale are included.
- Among 1 to 4, factor 1 has stronger similarity (bigger correlations).
- Correlations between factors 2 and 3 is strong (.416).

NGO and residents' worldview of community disaster preparedness

	NGO	Residents
Perspective	Functional	Concentric ring structure
		
	"To-Do List"	"Living space"

Findings

reconstructed subscale vs. a priori subscale

Reconstructed subscale	A priori subscale of included items	Type of item questions	Action level (Who acts?)	# of items	α
In-family stoage	Stoage	Behavioral	Family	3	0.88
Community linkage	Community linkage	Mixed	Community	7	0.71
Knowledge for emergency	Mixed (Special support, shlter, fire)	Knowledge	Family	7	0.62
Evacuation route check	Shelter	Knowledge	Family	2	0.77

- Internal reliability index are improved in the reconstructed subscales. (meet criteria for practical use)
- Items in “housing safety” are all eliminated during the scale revision process.
(Reasons)
 - Low internal reliability of the items in housing safety.
 - Similarity of the items with other scales is low.
 - The items have high difficulty to agree (say “yes”), so that they are eliminated because of extreme distribution.

Discussions

- Residents' worldview of community disaster preparedness is not identical to an externally given scale.
- To respect residents' view, the reconstructed scale is superior.
- In disaster management, NGO's practical knowledge should be appreciated in some cases.

(Ex.) **Housing safety** is the most important factor based on NGOs' experience.

Interview to 10 NGO representatives:
6 of them replied "Housing safety" is the most important factors for earthquake preparedness. (Itotani, 2005)

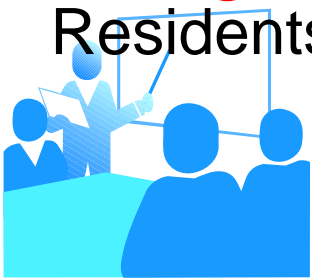
- For all agents, it is necessary to share others' latent structure, provided in forms of subscales.

Discussions (cont'd)

- For external agents (i.e., NGOs), to know residents' scale is beneficial with no reservations.
- For all stakeholders, the outcome helps finding implementable solution.
- Diagnostic survey has the function to communicate both knowledges by documentation.

Community
knowledge
(daily life)

Residents



Practical
knowledge
(experience)



NGO

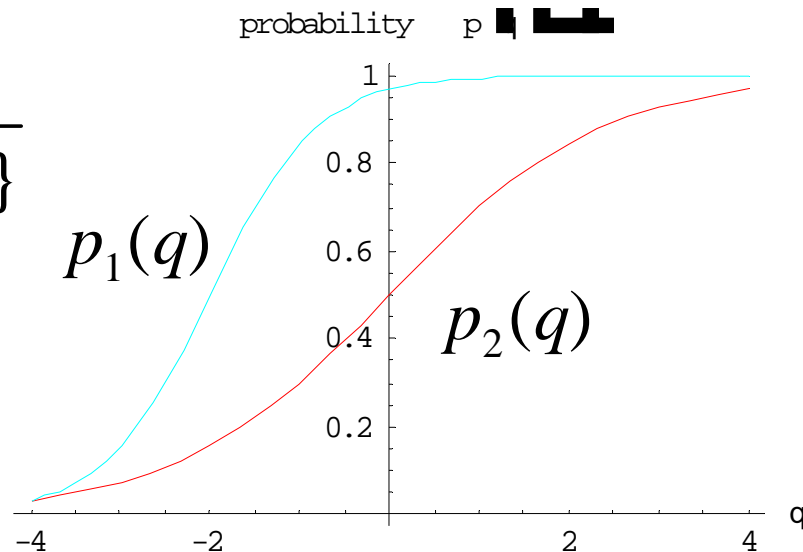
- When multiple agents are involved in the process to find a better solution, how do they share, exchange, and combine the knowledges?

Item Characteristics Curve in item response theory

- Assuming a logistic curve on the probability of endorsing a positive item j , $p_j(q)$ as a function of an individual's position on the estimated latent trait q .
- Using response patterns to the items in the scale, estimates the item parameters of b_j (difficulty) and a_j (discriminating power).

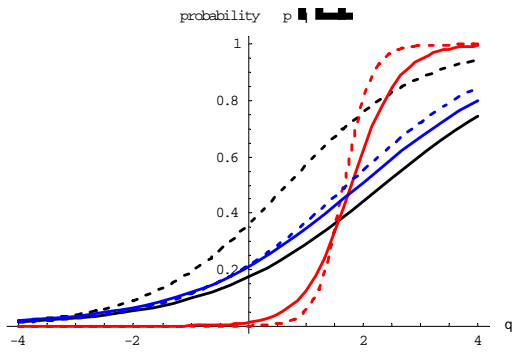
$$p_j(q) = \frac{1}{1 + \exp\{-1.7 \times a_j(q - b_j)\}}$$

j	a_j	b_j
1	1.0	-2.0
2	0.5	0

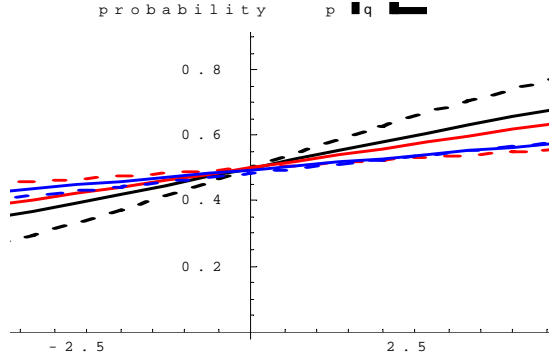


IRT estimation results

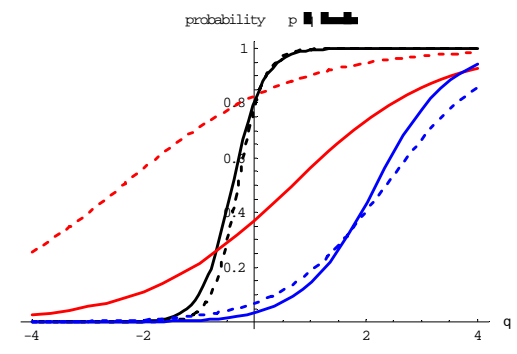
Housing safety



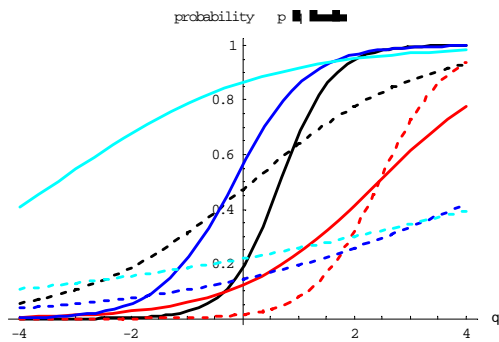
Storage (failed estimation)



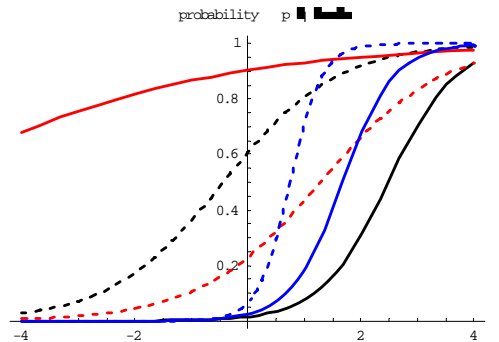
Shelter



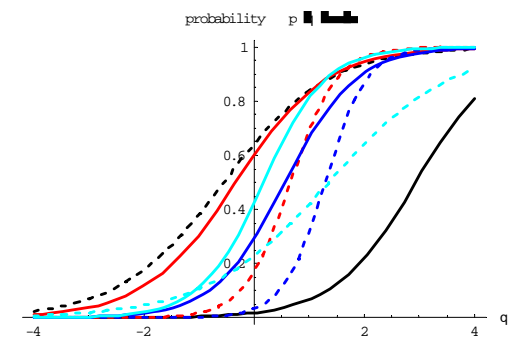
Special support



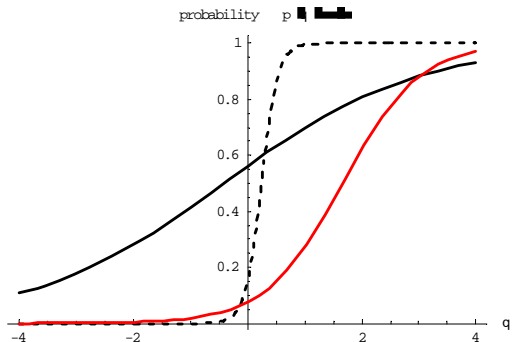
Community linkage



Fire

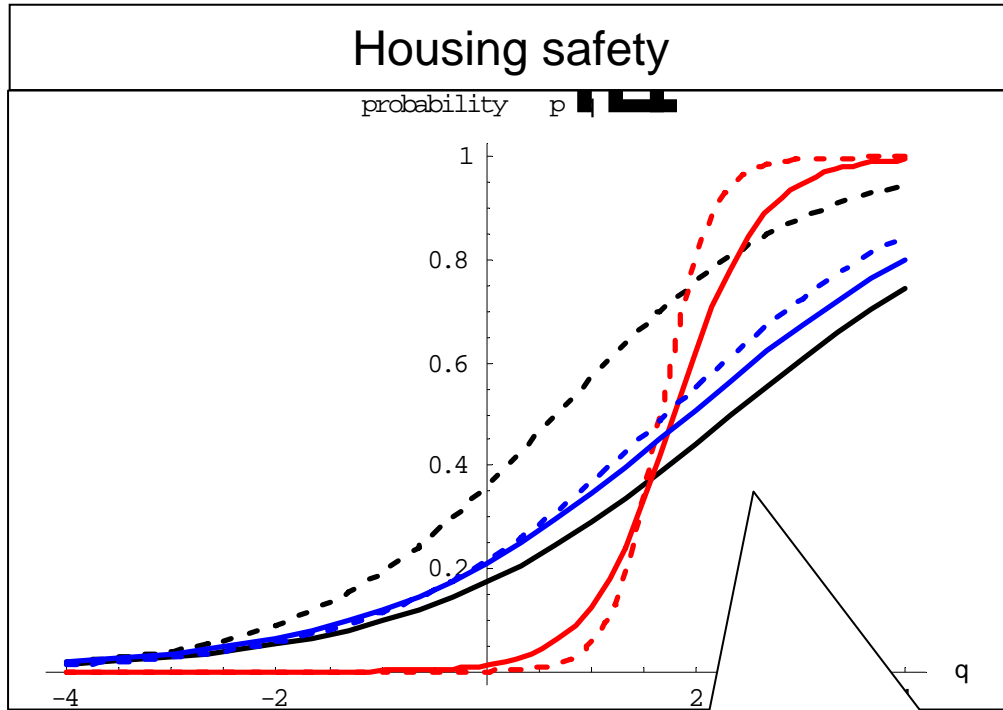


Emergency contact



1. Black solid
2. Black dash
3. Red solid
4. Red dash
5. Blue solid
6. Blue dash
7. Aqua solid
8. Aqua dash

ICC estimation results



Black dash: Do you know about geological layers around your house?

Red solid: earthquake-proof diagnosis

Red dash: reinforcement