

**Mining the latent information by
the Affinity Diagram Method
quantificated by
QM3 (Correspondence Analysis)**

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1. Introduction

- Conventionally, QM3 or Correspondence Analysis has been used for the analysis of the inside structure of the table which consists of two different items such as samples and categories.
- In ISO 16355, QM3 is introduced as a method for analyzing the Quality Table which comprises of quality requirements and quality elements.
- **In this paper, we propose a new application of QM3.**

1. Introduction

- **So far, Quality Requirements Table has been composed by applying the Affinity Diagram Method to Voice of Customers.**
- As the result, we can get a spatial arrangement of VOC and a quality deployment table for quality requirement.
- **However, the result cannot be uniquely determined.**
- **That's because the Affinity Diagram Method is largely dependent on practitioners.**
- **Besides, it is difficult to detect and understand the latent Quality Requirements.**

- **The new application method proposed here will contribute to overcome such difficulties no more than before.**
- In the paper, it is described how to mine the latent information by quantificating the Affinity Diagram Method (KJTM-like method).
- Moreover, an experiment to examine the effectiveness of the method will be described.

2. Background of the problem

- From the beginning of QFD, it has been of theoretical and practical importance to understand the real Quality Requirements.
- For the purpose of helping understand them, Quality Deployment table for quality requirements was proposed, where the Affinity Diagram Method, or KJTM-like method was conveniently employed.
- In those days, other method available was not known. It should be astonished that the method has been used with QFD for over forty years from the beginning.

- **We think that it is useful to do KJ™-like method qualitatively.**
- Another problem is an eternal one, namely, how could we detect and understand the latent Quality Requirements.
- **"latent" means that even customers are not aware of the Quality Requirement. Therefore, they are not being reflected in VOC.**

- Nevertheless, we cannot help but regard VOC as the key to detect and understand latent information.
- **We propose a new application method of QM3, i.e., applying QM3 to the relationship itself between items of Quality Requirement.**
- The results obtained help us multi-dimensionally understand the structure of relationship between Quality Requirements.
- **Moreover, based on the structure, latent Quality Requirements can be examined.**

3. Preparation: Quantification Method of Type 3

- QM3 or Correspondence Analysis is one of quantification methods which analyzes the inside structure of a table.
- Usually the table consists of two different items such as samples and categories.
- However, we try to apply QM3 to analyze free answers obtained through a questionnaire survey. That is, there is no distinction between samples and categories.
- QM3 is applied to the relationships themselves between free answers.

- The aims of this attempt are as follows:

1. Enabling the Affinity Diagram Method more quantitative and effective.
2. Detecting latent and invisible information by examining the inside structure obtained by QM3.

Explanation of procedure

Table 1 An example of the text data

- ① Each free answer is transformed to simple sentences.
- ② Transformed simple sentences are listed up with numbered by practitioners as shown in Table 1.

item
1.AAA
2.BB
3.C
4.DDDD
5.EEEEE
6.FFFFFFF
7.GGGG
8.HHH
9.II

- ③ The relationship between free answers are expressed as shown in Table 2.

Table 2 The relationship data

i	j	v
1	2	1
1	5	1
2	3	1
2	4	1
2	8	1
3	5	1
3	6	1
4	5	1
4	7	1
4	9	1
5	6	1
7	8	1
8	9	1

- ④ The data to which QM3 should be applied, is composed as a symmetric matrix by referring to Table 2 data.

Header i, j , and v indicate item no.

No. i relates to item no. j with relationship strength v .

In the paper, strengths are all set to be equal to 1.

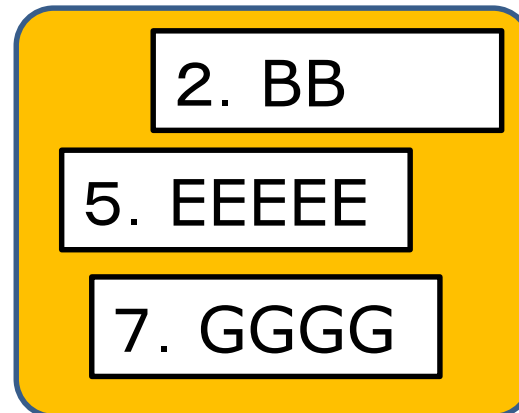
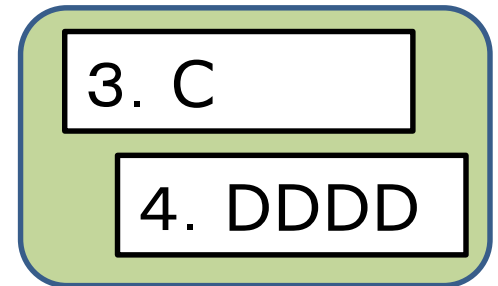
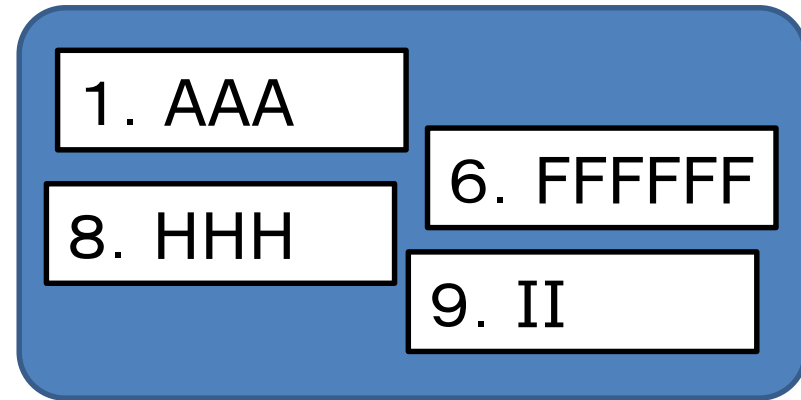
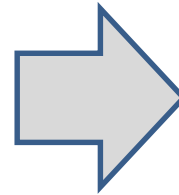
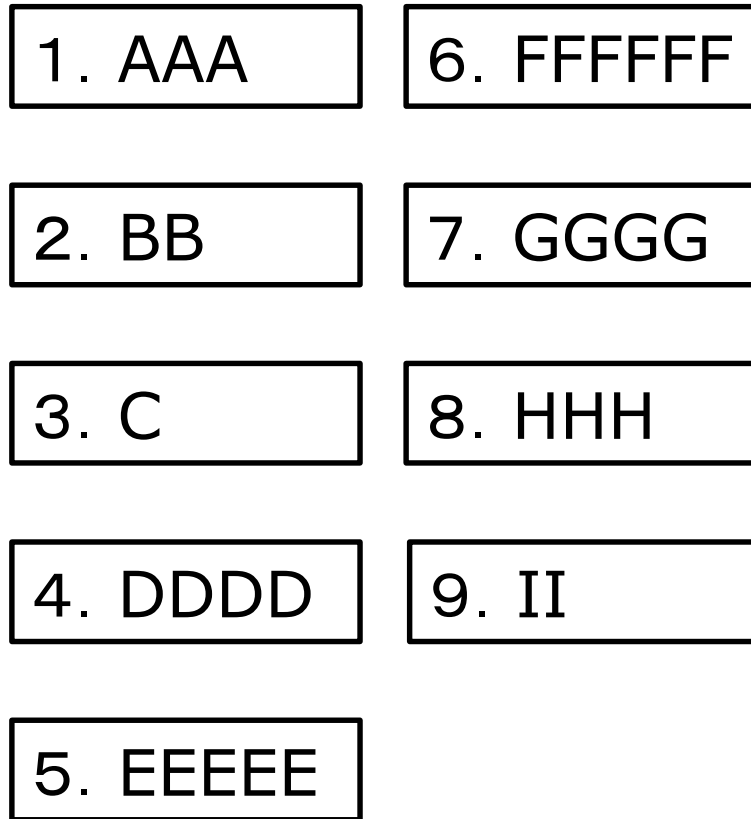
Table 2 The relationship data

For example, the second row indicates the number 1 item relates to item 2 with relationship strength 1 and the third row indicates the number 1 item relates to item 5 with relationship strength 1.

Therefore, the symmetric matrix is composed so that the elements $(1,1), (1,2), (2,1), (1,5),$ and $(5,1)$ may set to be 1.

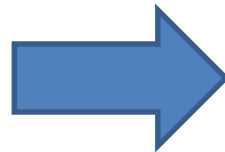
i	j	v
1	2	1
1	5	1
2	3	1
2	4	1
2	8	1
3	5	1
3	6	1
4	5	1
4	7	1
4	9	1
5	6	1
7	8	1
8	9	1

Affinity Diagram Method (KJTM-like method).



Quantification Method of Type 3

	AAA	BB	C	DDDD	EEEE	FFFFFF	GGGG	HHH	II
AAA		○		○				○	
BB	○		○						○
C						○			
DDDD	○	○						○	○
EEEE					○				○
FFFFFF	○		○	○				○	
GGGG						○	○		○
HHH	○	○		○					○
II					○				○



	AAA	BB	HHH	DDDD	C	II	FFFFFF	EEEE	GGGG
AAA		○	○	○					
HHH	○	○		○		○			
DDDD	○	○	○			○			
FFFFFF	○		○	○	○				
BB	○				○	○			
C							○		
II						○		○	
EEEE						○		○	
GGGG						○	○		○

- ⑤ Applying QM3 to the symmetric matrix, Scores belonging to eigen values No.2, No.3, and No.4 are obtained as shown in Table 3.

Table 3 Items and Scores

item	x-score	y-score	z-score
1.AAA	0.673	2.395	-0.888
2.BB	0.002	1.058	1.216
3.C	1.118	-0.678	-0.718
4.DDDD	-0.575	-0.113	-1.254
5.EEEEE	0.919	-0.028	0.891
6.FFFFFFF	1.490	-1.643	-0.073
7.GGGG	-1.307	-0.593	1.009
8.HHH	-1.211	-0.141	-1.142
9.II	-1.307	-0.593	1.009

- ⑥ For convenience, they are called x,y,and z scores. The biplots x-y and x-z are illustrated in Fig. 1 and 2, respectively.

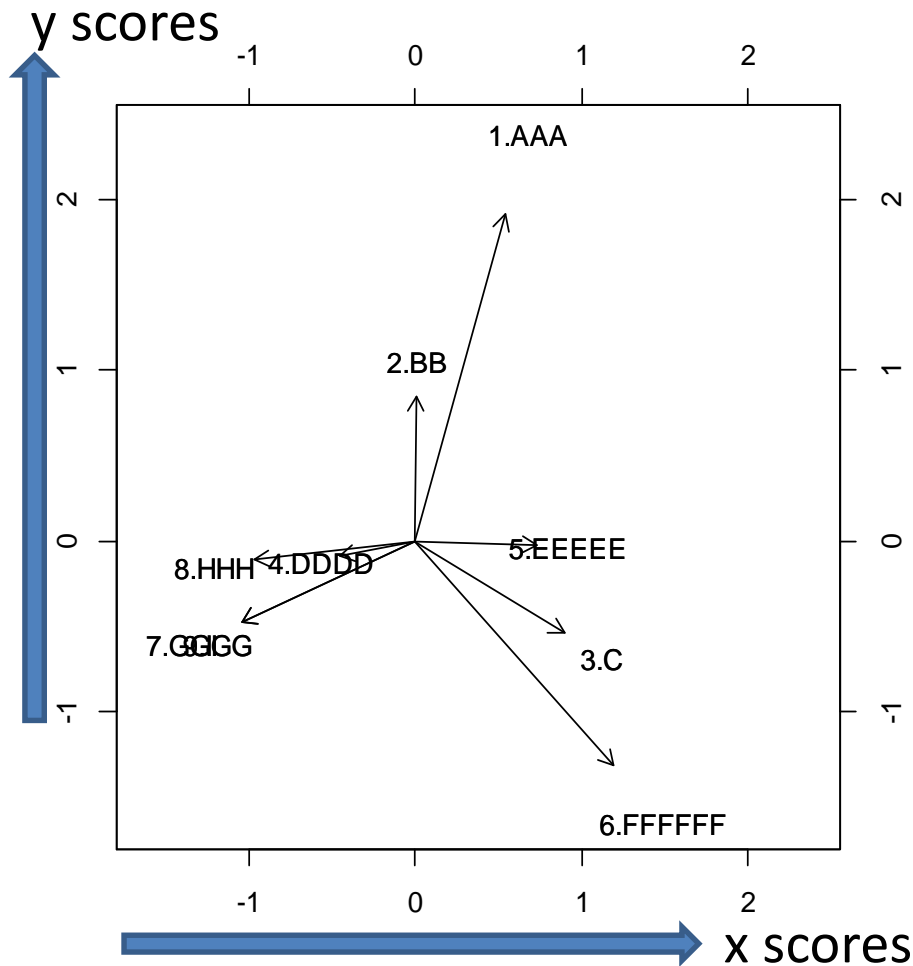


Fig. 1 biplot x-y scores

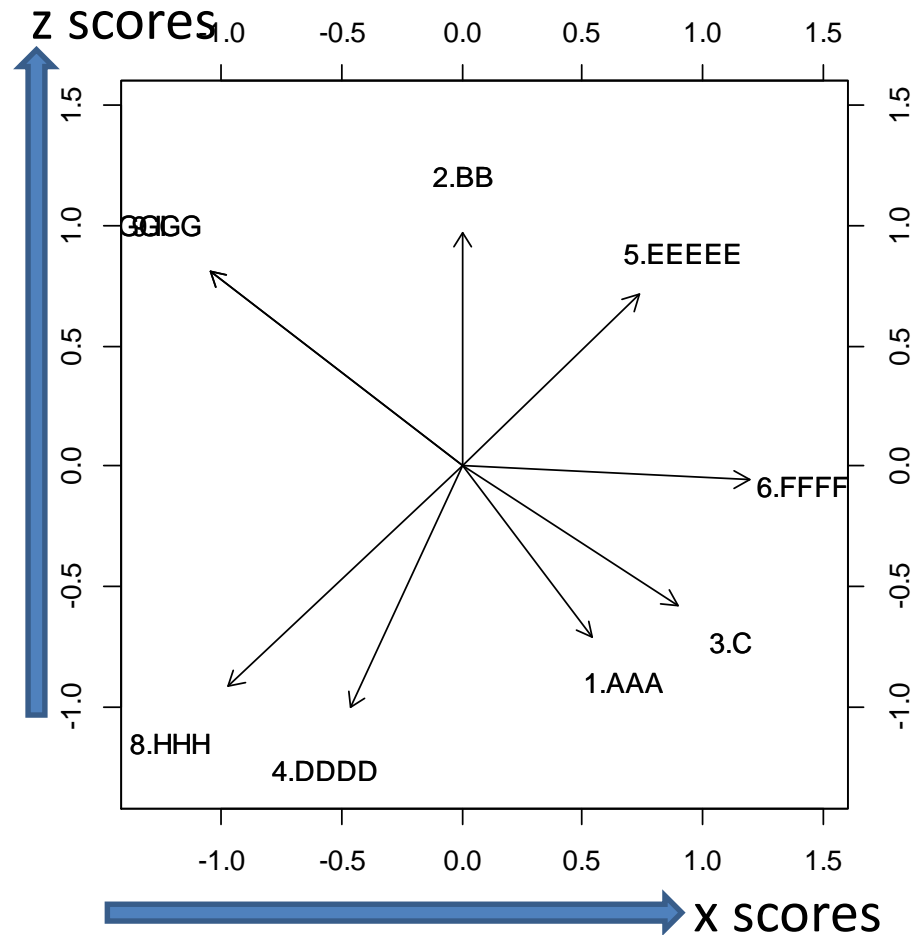


Fig. 2 biplot x-z scores

- ⑦ Incidentally, three-dimensional scatter diagram is shown in Fig. 3.

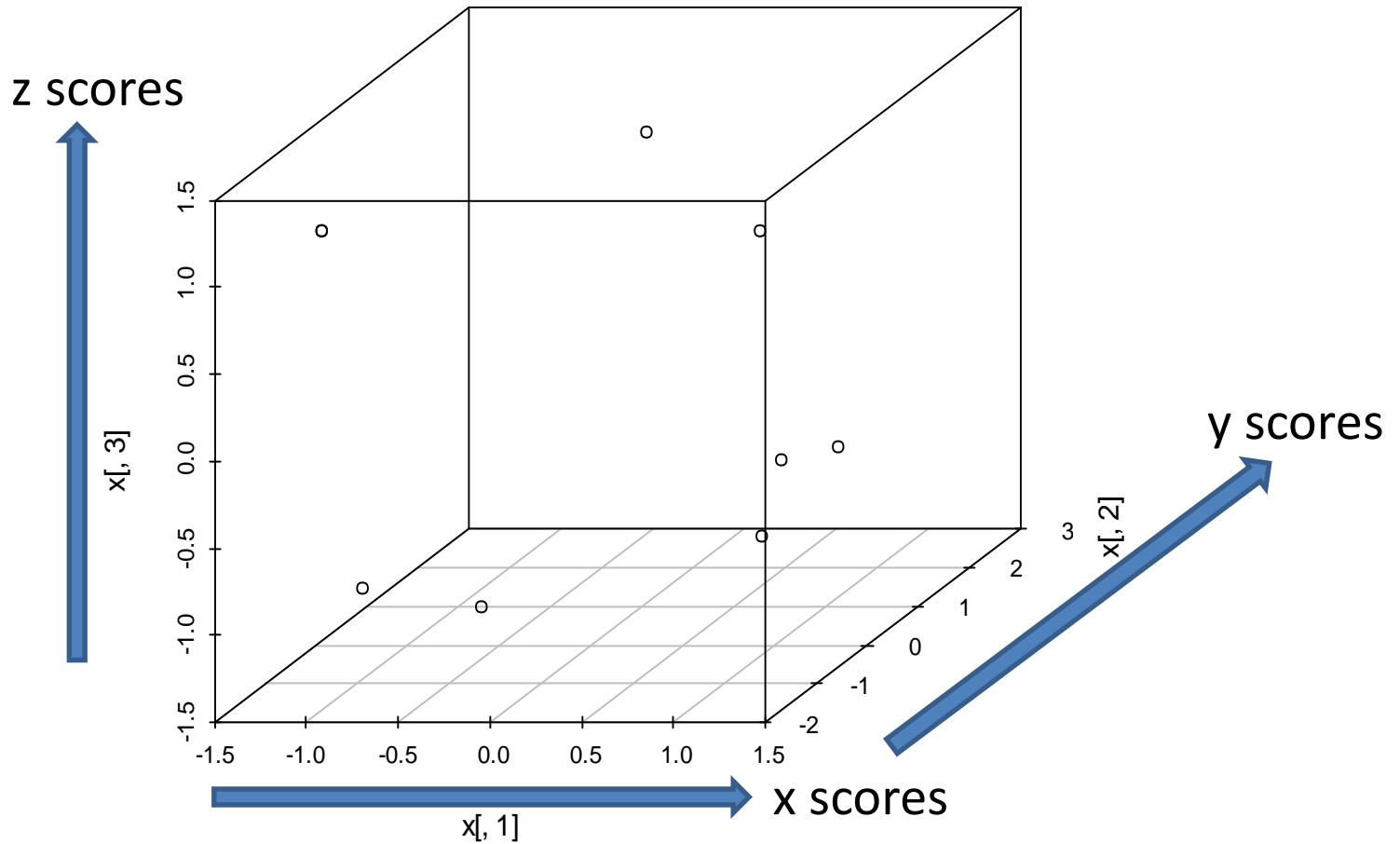


Fig.3 3-D scattering

A case study

- Globalization is bringing about an extension of poverty.
- After all, this influences poor families and children.
- Above all, Children in poor family are seriously damaged. Government and local governments in Japan are confronting solving such problems.
- We were asked by a certain city to grasp the present problem and thereby how to make countermeasures.

- For considering the problem, hearing to members of a child committee was executed.
 - The morpheme analysis was applied to the data obtained by hearing.
 - The result was helpful for us to understand the problems as a whole.
 - Taking the result of the analysis into consideration, the data was transformed into 31 simple sentences (items) as is employed in QFD as shown in Table 4.
- The next page shows 31 simple sentences.

31 simple sentences

1. Parents do not open the mind

2. Parents do not know kinds and contents of support

3. Parents have shame and resistance to receiving support

4. There is an influence that parents grew up without proper education

5. No places to work

6. When finding jobs, the working conditions are disadvantageous

7. Become a parent without knowing adult society

8. Unable to raise children by working and getting income

9. Because of poor Japanese, accurate information can not be got

10. Taking care of brothers without going to school

11. Children of foreign nationality can not keep up with learning

12. Support outside of school is necessary

13. Reluctant to attend government-led top-down meetings

14. Encourage them to create a gathering of fellows voluntarily

15. The government supports gatherings made voluntarily

31 simple sentences

16. Government should respond well

17. Don't rely on good intentions

18. Child committee is hard to move without request from administration

19. Should extend learning support including meals

20. No support system has been developed

21. An opportunity from the outside is necessary for making a support system

22. The understanding of the support recipient is necessary

23. Financial support should be provided first

24. It is worth considering the support of goods such as uniforms

25. Need to expand the scholarship system

26. Learning support is needed with children in not poor families

27. Improve after-school learning support

28. The idea of getting a qualification and a job is both necessary

29. It is good to be able to support learning and food

30. Gift certificates are better than retort foods

31. Cooperation of medical college and company is good in learning support

Table 2 The relationship data

- Moreover, these simple sentences were related to each other so that the relationship was expressed as a set of triplets (i, j, v) , which indicates the item i is related to the item j with degrees of relevance v .
- The number of triplet data became 56.

i	j	v
1	2	1
1	5	1
2	3	1
2	4	1
2	8	1
3	5	1
3	6	1
4	5	1
4	7	1
4	9	1
5	6	1
7	8	1
8	9	1

Table 5 results of QM3

No.	eigen value	percentage	cummulative percentage
1	0.9276	14.44	14.44
2	0.8947	13.93	28.37
3	0.7231	11.26	39.63
4	0.6846	10.66	50.29
5	0.6095	9.49	59.78
6	0.4432	6.90	66.68
7	0.3894	6.06	72.74
8	0.3496	5.44	78.18
9	0.3003	4.67	82.85
10	0.2062	3.21	86.06

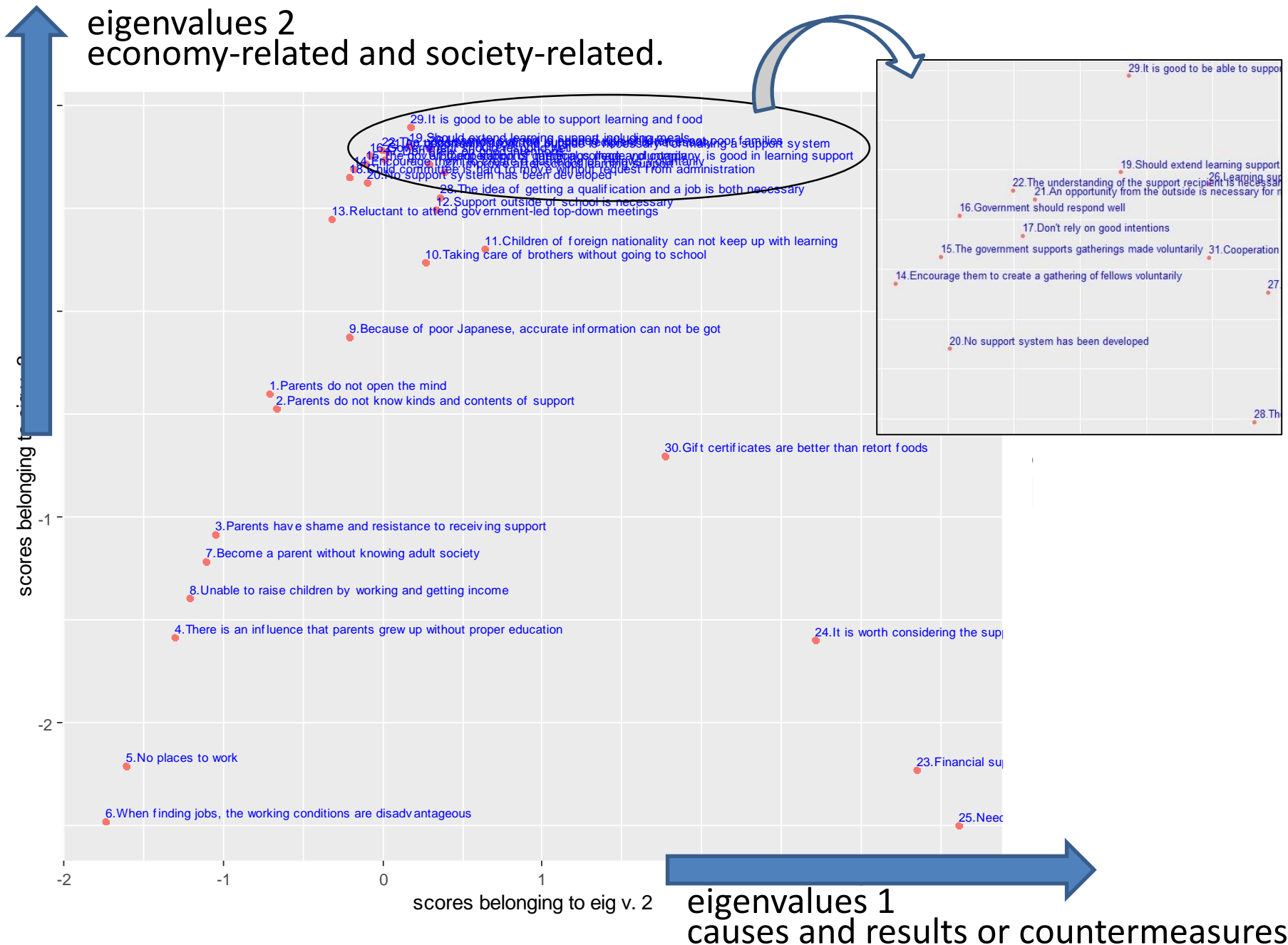


Fig. 4 A scatter diagram of scores

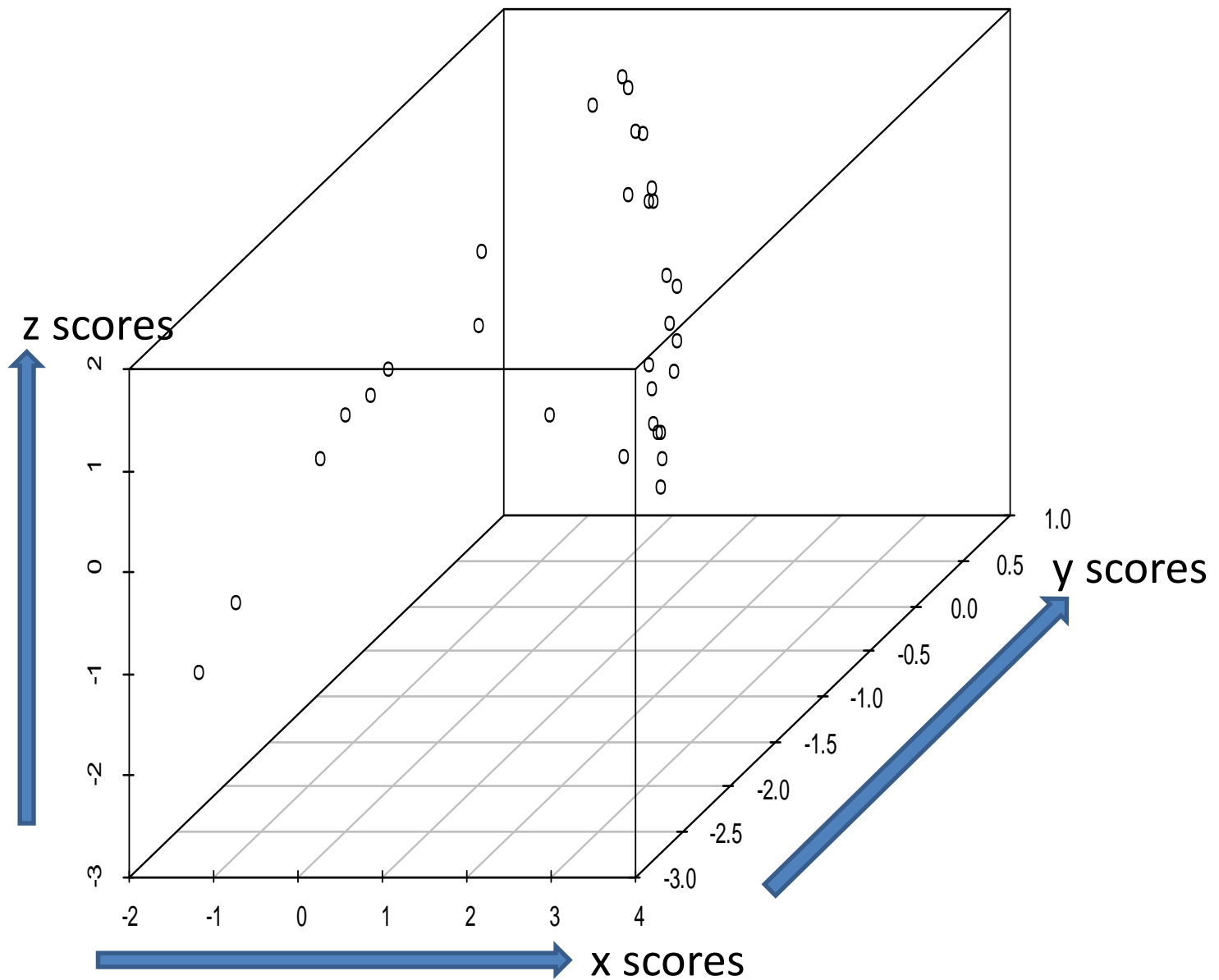


Fig. 5 A 3-D scattering

An experiment

- Another aim of the paper is to show that the quantification Affinity Diagram Method is able to detect or find latent information through the scatter diagram of scores. However, it is difficult to directly show the effectiveness.
- We therefore employ so-called capture-recapture method as is sometimes used in software testing.
- The method begins with capturing bugs in the software.
- After some of them are intentionally put back in the software, recapturing them is requested to evaluate the power of detection of bugs.

The experiment was executed as follows:

- Items No.5 and No.30 were removed and consequently their relationship data were also removed.
- The newly created two-way data included 29 items.

No.6

6. When finding jobs, the working conditions are disadvantageous

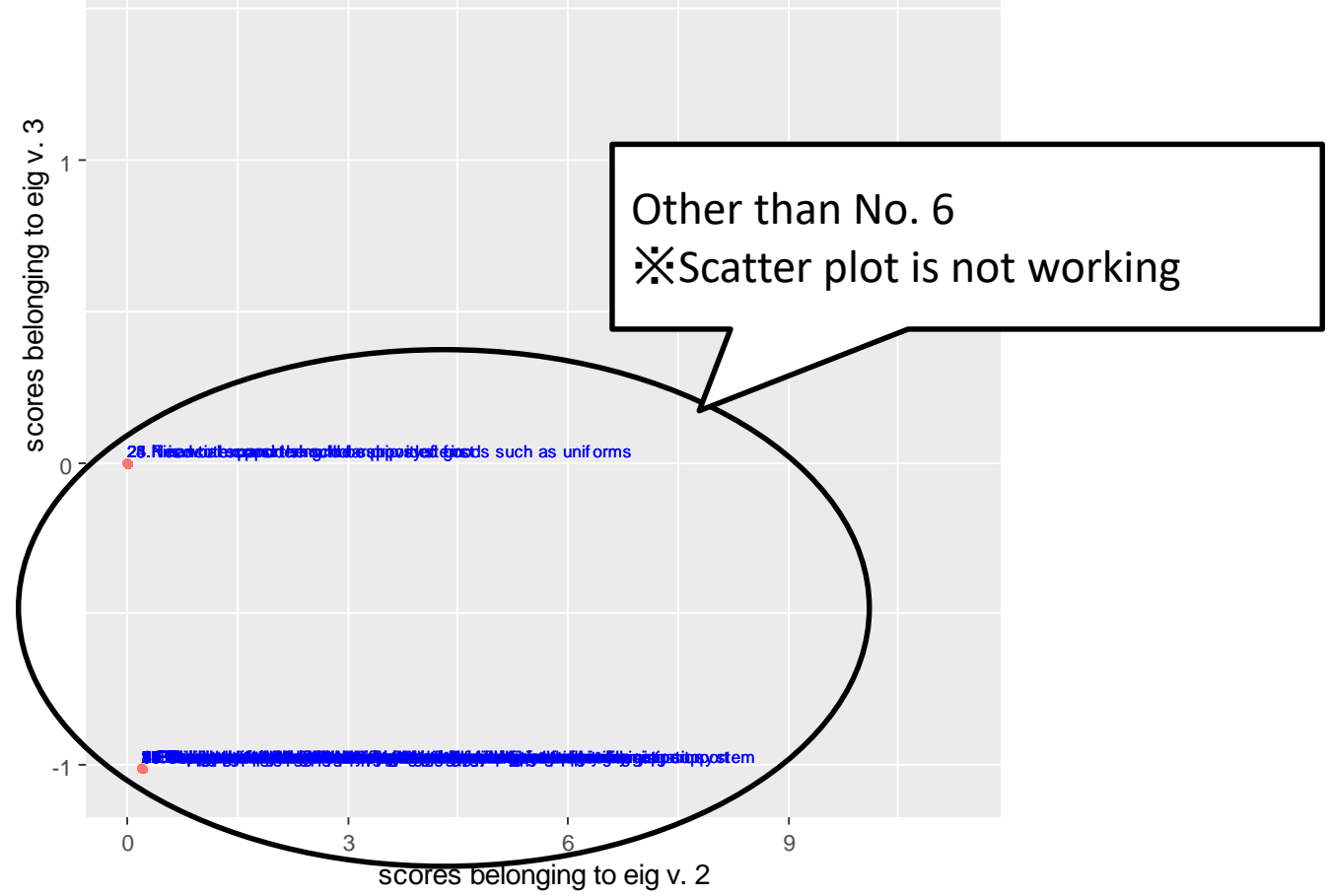


Fig. 6 A scatter diagram (excluded No.5 and 30)

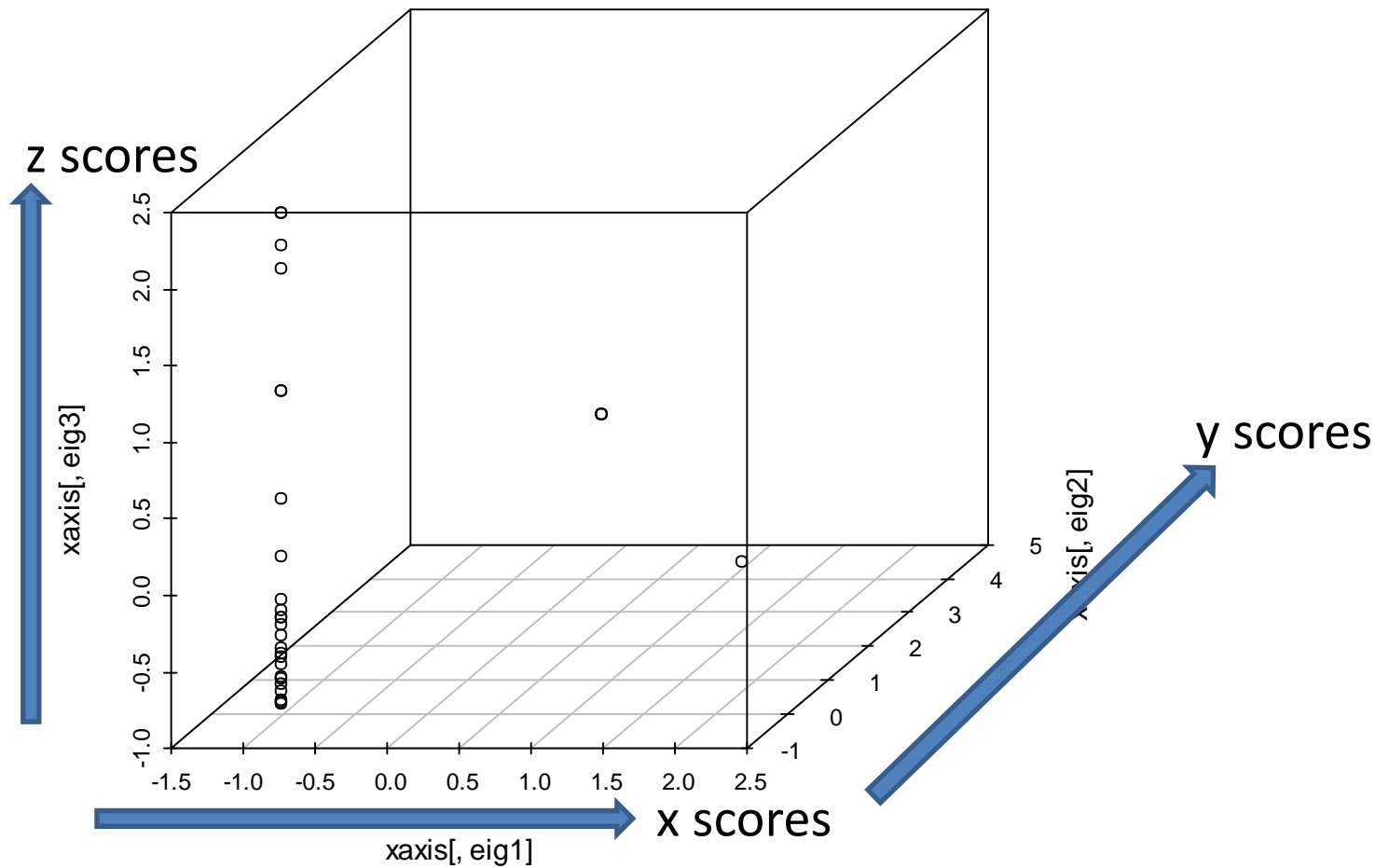


Fig. 7 The 3-D scattering

Then the item No. 6 and its related data were removed so that more information could be examined.

23. Financial support should be provided first
 24. It is worth considering the support of goods such as uniforms
 25. Need to expand the scholarship system

Group 1

Group 2

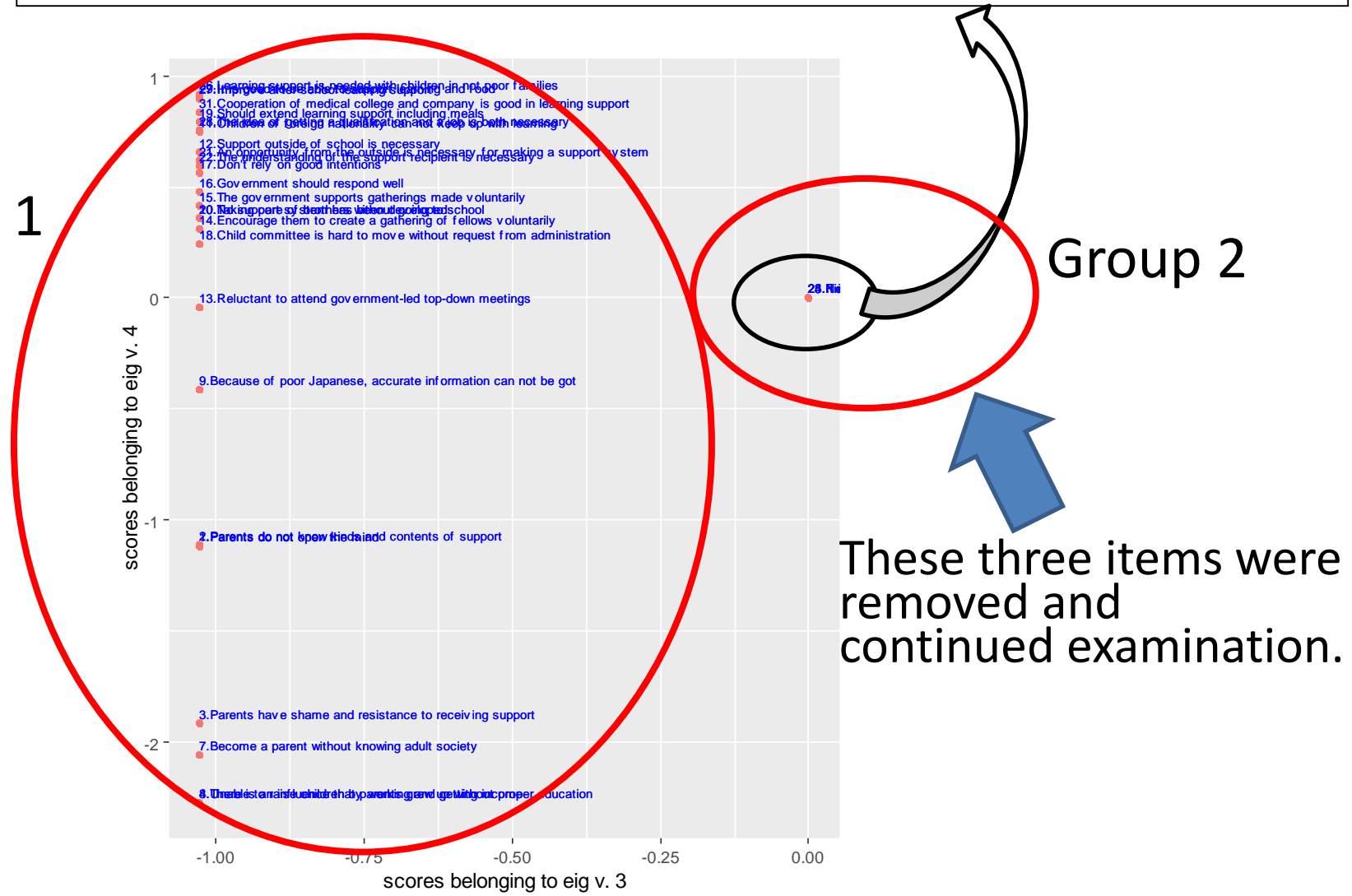


Fig. 8 The scatter diagram

- z1 1. Parents do not open the mind
- z2 2. Parents do not know kinds and contents of support
- z3 3. Parents have shame and resistance to receiving support
- z4 4. There is an influence that parents grew up without proper education
- z5 7. Become a parent without knowing adult society
- z6 8. Unable to raise children by working and getting income

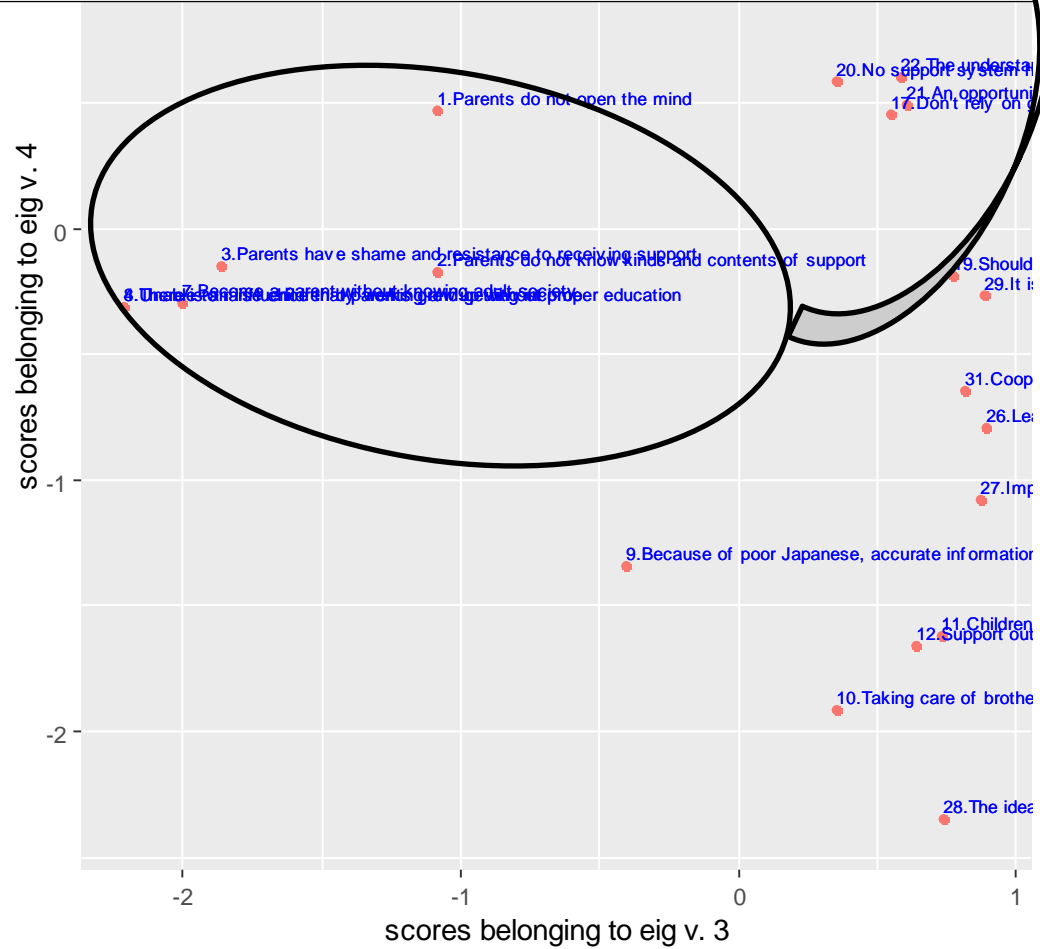


Fig. 9 The scatter diagram

- The left group is a group of items as follows.

z1 1. Parents do not open the mind
z2 2. Parents do not know kinds and contents of support
z3 3. Parents have shame and resistance to receiving support
z4 4. There is an influence that parents grew up without proper education
z5 7. Become a parent without knowing adult society
z6 8. Unable to raise children by working and getting income

- Taking these items into consideration, it can be said **"inclined to be between jobs, or no places to work"**.
- In fact, the original item list had **"No places to work" as No.5.**

- **As the result, we could detect the information that were intendedly hidden (item of No.5).**
- Although the other information could not find, it may be possible to examine more specifically by the proposed method.

Concluding remarks

- From the beginning of QFD, it has been emphasized the significance to grasp the real needs of customers or voice of customers.
- KJ™-like method, or Affinity Diagram Method has been usefully employed to arrange the information regarding customer needs.
- **Since KJ™-like method is recommended to use with feelings or emotions, the result is not always definitely unique.**

- We recognize it is not a demerit of KJ™-like method, or Affinity Diagram method.
- It is of practical importance the classified sub groups include different values of various customers.
- **The paper proposed a new application of KJ™-like method, or Affinity Diagram Method by using Quantification Method of type three.**

- **The proposed method enables us to make structures of sense of values and understand the whole customer needs.**
- **Moreover, the structure may give a chance to detect or find the latent information as was illustrated in the paper.**

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