# L2-Regularized Nonlinear Regression-Based Fuzzy Clustering for Satisfaction Survey Analysis in the Academy Services

Ryota Kozakai† ††
†AKKODiS Consulting. Ltd, 3F Granpark Tower, 3-4-1 Shibaura, Minato-ku, Tokyo 108-0023, Japan
††Graduate School of Science, Nagoya City University, 1 Yamanohata, Mizuho-cho, Mizuhoku, Nagoya 467-8501, Japan
ryouta039@gmail.com

***Abstract:*** This study analyzes satisfaction survey data collected from 108 users of AKKODiS Academy's talent development services over the period from June 2024 to January 2026. In the survey, respondents rated six items—likelihood to recommend, program content, overall quality, contribution to skill improvement, support system, and cost performance—on ordinal scales, and provided free-text responses describing what they found positive and what they would like to see improved. Using keywords extracted from the free-text responses as explanatory variables, we constructed an L2-regularized nonlinear fuzzy cluster regression model to represent the ordinal scale ratings. The number of clusters was determined to be four by the elbow method applied to the cost function, with the stability of the solution verified over ten random initializations. Respondents were classified into four latent customer groups based on the regression coefficients, and the characteristics of each group as well as the differences across evaluation items were visualized. The analysis revealed that the cost performance rating is structurally lower than the other five items, and that 89.9% of the valid respondents changed their dominant cluster across the six evaluation items, which demonstrates empirically that satisfaction structure cannot be captured by a single membership assigned at the respondent level. These findings are intended to inform future improvements to the service.

***Keywords:*** Customer satisfaction survey, text mining, fuzzy clustering, nonlinear regression, regularization

## 1. INTRODUCTION

With the rapid advancement of the AI and data science (DS) fields, the development of related human resources has been positioned as a national priority in Japan from the standpoint of strengthening industrial competitiveness. Based on the "AI Strategy 2019" [1] and "AI Strategy 2022" [2], the Ministry of Education, Culture, Sports, Science and Technology has set targets of producing approximately 500,000 people per year with literacy-level education in mathematics, data science, and AI, and approximately 250,000 people per year at the applied foundational level, and has been operating the "Mathematics, Data Science, and AI Education Program Accreditation System (MDASH)" [3] since fiscal year 2021, thereby advancing systematic AI talent development at the higher education level. However, the rapidly expanding demand for talent in industry cannot be met through the supply of new graduates alone, and reskilling (retraining) of existing employees to build capability is considered essential.

Against this social backdrop, AKKODiS (formerly Modis) has worked to address the shortage of digital talent facing industry as a global company providing solutions that integrate digital technology and engineering across 30 countries worldwide. Its Japanese subsidiary, AKKODiS Consulting Co., Ltd., employs more than 7,000 tech consultants (engineers) and, under the vision of "Transforming Japanese companies into global companies, starting from frontline transformation," supports companies in achieving frontline transformation and AI transformation [4]. Through its "Academy" business, the company provides made-to-order technical training and talent development services tailored to corporate needs, ranging from IT literacy training to the AI and data science domain, with the goal of developing and producing digital talent, thereby also playing a role in promoting reskilling. In this way, AKKODiS's Academy business supports, at a practical level, the reskilling of existing employees to build capability in response to industry's demand for digital talent that cannot be met through the supply of new graduates alone. Accordingly, this study analyzed satisfaction survey data from 108 users of AKKODiS Academy's talent development services. Respondents rated six items—likelihood to recommend, program content, overall quality, contribution to skill improvement, support system, and cost performance—on ordinal scales, and provided free-text responses describing what they found positive and what they would like to see improved. We then constructed an L2-regularized nonlinear fuzzy cluster regression model to visualize the data. As a result, we obtained several pieces of information that may be useful for future consideration of service improvements.

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## 2. RELATED WORKS

Applied research on fuzzy cluster regression and related methods in the domains of customer satisfaction and marketing has also progressed. Wedel & Steenkamp (1991) [5] applied fuzzy clusterwise regression to benefit segmentation, simultaneously estimating market structure and cluster-specific regression coefficients based on consumer preference data. Hathaway & Bezdek (1993) [6] proposed a general fuzzy c-regression framework applicable to both linear and nonlinear models; however, the nonlinear functional forms they demonstrate are limited to illustrative numerical examples, and no functional form specifically designed for bounded response variables such as ordinal rating scales is addressed. Suk & Hwang (2010) [7] improved estimation stability by incorporating ridge regularization into fuzzy clusterwise regression, but their approach remains within the linear model framework. Meanwhile, in recent years Sivaguru & Punniyamoorthy (2020) [8] and Marín Díaz (2025) [9] have discussed dynamic customer segmentation using fuzzy c-means applied to behavioral and purchasing data such as RFM metrics, and research on applications of fuzzy clustering itself continues to be actively pursued. As for research directly targeting customer satisfaction surveys, Si (2026) [10] proposed an evaluation system based on fuzzy logic, reconstructing the evaluation structure through a mixed-methods approach combining questionnaire surveys and interviews. However, all of these prior studies either (a) do not adopt a bounded nonlinear (logistic) functional form that explicitly incorporates the upper limit of an ordinal rating scale into the cluster-specific regression equation, or demonstrate applicability to nonlinear models only as an illustrative possibility without combining it with L2 regularization (Hathaway & Bezdek, 1993; Suk & Hwang, 2010), (b) target only structured numerical data such as behavioral and purchase history (Sivaguru & Punniyamoorthy, 2020; Marín Díaz, 2025), or (c) even when handling unstructured data such as free-text responses, rely on qualitative supplementation through interviews rather than integrating text mining and numerical evaluation into a single statistical model (Si, 2026). In addition, cluster membership is presupposed to be uniquely determined at the level of the subject (respondent), and no framework allowing different memberships across evaluation items has been found. The subjects of this study are personnel at client companies using the talent development services provided by AKKODiS Academy, and the data structure differs from that of the aforementioned prior studies in that both numerical evaluations (recommendation score, quality, cost performance, etc.) and free-text responses (positive points, improvement suggestions) were obtained from the same respondents. To the best of our knowledge, no domestic study has applied fuzzy cluster regression or a similar statistical model to satisfaction surveys of training and talent development services, and this study is positioned as an empirical investigation addressing this gap.

## 3. DATA COLLECTION

The same questionnaire items were used across surveys conducted from June 2024 to January 2026. A total of 108 respondents participated in the survey, of whom 9 did not provide free-text responses, resulting in 99 valid respondents for the free-text-based fuzzy clustering analysis, and consent for the use of the data was obtained. The questionnaire was designed to assess satisfaction with the service, and consisted of the following items.

Ordinal scale rating item (0–10 scale):

- If an acquaintance's company were looking for talent development or training services, how likely would you be to recommend AKKODiS Academy? (Recommendation score: NPS)

Ordinal scale rating items (0–5 scale):

- Program content and speed of proposals
- Overall quality
- Extent to which the service is likely to contribute to employees' skill improvement and job performance
- Quality of follow-up and support
- Cost performance

Free-text items:

- Please describe specifically anything you found particularly good or memorable about AKKODiS Academy's talent development services.
- Are there any additions or improvements you would like to see in AKKODiS Academy's talent development services? Please feel free to write any ideas for new training programs or suggestions for a better learning experience.

Keywords capable of appropriately characterizing the content of the free-text items were generated and extracted using an in-house AI system based on a large

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language model. For each respondent, the system was instructed to output short noun phrases (at least three per free-text item) summarizing the content of the response; the extracted phrases were then consolidated across respondents so that expressions with the same meaning were unified into a single keyword. This procedure yielded 74 distinct keywords in total, consisting of 34 keywords derived from the positive-point item and 40 keywords derived from the improvement-suggestion item. Each respondent was represented by a binary vector indicating whether each keyword appeared in that respondent's free-text response, and this vector was used as the explanatory variable in the model described in Section 4.

## 4. L2-REGULARIZED NONLINEAR FUZZY CLUSTER REGRESSION MODEL

The model was applied to subjects for whom responses to the questionnaire items were obtained. Let $i=1,\ldots,N$ denote the number of samples, $j=1,\ldots,M$ denote the number of evaluation questionnaire items, and $k=1,\ldots,n$ denote the number of clusters. A fuzzy clustering-based L2-regularized nonlinear regression model was applied by minimizing the following cost function:

$$J=\sum_{i,j,k} u_{ijk}^2 d_{ijk}+\gamma\sum_{k,l}\beta_{kl}^2+\eta\sum_{j} b_j^2$$

where $\gamma,\eta>0$, $0\le u_{ijk}\le 1$, and $\sum_k u_{ijk}=1$.

The values of $\gamma$ and $\eta$ were empirically selected so that the coefficients were not excessively constrained, and both were set to 0.1 in the calculation. The reason for adopting L2 regularization was that keywords with extremely low occurrence frequencies were removed beforehand, allowing the effects of the remaining keywords to be evaluated evenly. $N_j$ represents the maximum value of the rating scale for each questionnaire item and takes values of either 5 or 10 depending on the questionnaire item. The coefficients are defined as follows ($\varepsilon=10^{-8}$):

$$\mu_{ijk}=N_j/\left(1+\exp\left(-\left(\sum_l x_{il}\beta_{kl}-b_j\right)\right)\right)$$

- $d_{ijk}=\left(y_{ij}-\mu_{ijk}\right)^2+\varepsilon$: error value
- $\beta_{kl}$: regression coefficient for keyword $l$ in cluster $k$
- $x_{il}$: binary matrix indicating whether keyword $l$ appears in the free-text response of sample $i$
- $y_{ij}$: rating value for questionnaire item $j$
- $b_j$: characteristic coefficient of questionnaire item $j$
- $u_{ijk}$: fuzzy membership degree, taking values from 0 to 1

The parameters were estimated using an alternating optimization method. The iterative procedure was performed as follows.

1. The parameters $\beta_{kl}$ and $b_j$ that minimize the cost function $J$ were obtained using the quasi-Newton method (BFGS) with the analytic gradient of $J$ supplied.
2. The fuzzy membership values were updated as $u_{ijk}=\left(1/d_{ijk}\right)/\sum_h\left(1/d_{ijh}\right)$.

These steps were repeated until convergence was achieved. The convergence criterion was defined such that the calculation was terminated when either the change in the cost function value became smaller than $10^{-6}$ or the number of iterations reached 300.

### 4.1. INTERPRETATION OF THE FUZZY MEMBERSHIP DEGREE

The fuzzy membership degree $u_{ijk}$ expresses the degree to which respondent $i$ belongs to cluster $k$ with respect to evaluation item $j$. Minimizing the cost function with respect to $u$ under the constraint $\sum_k u_{ijk}=1$ yields the update rule of step 2 in closed form: applying the method of Lagrange multipliers gives $2u_{ijk}d_{ijk}=\lambda_{ij}$, and hence

$$u_{ijk}=\frac{d_{ijk}^{-1}}{\sum_h d_{ijh}^{-1}}$$

The membership degree is therefore inversely proportional to the error $d_{ijk}$ and normalized over the clusters, so that the cluster whose predicted rating lies closest to the observed rating receives the largest membership.

It should be noted that the membership degree carries an index for the evaluation item whereas the regression coefficient $\beta_{kl}$ does not. Because the linear predictor

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$\sum_l x_{il}\beta_{kl}$ is item-invariant, cluster $k$ maps the keywords of a respondent to a single latent satisfaction level, and the item-specific coefficient $b_j$ converts that level into a predicted rating $\mu_{ijk}$ for each of the six items. What varies with the item is therefore the error $d_{ijk}$, and consequently $u_{ijk}$ may differ from item to item for the same respondent. A cluster is accordingly to be understood as a way of reading the keywords of a free-text response, and $u_{ijk}$ as an indication of which reading best explains the rating that the respondent actually gave to a particular item, rather than as a type fixed at the level of the respondent. Substituting the above closed form back into the cost function yields an objective that is a function of $(\beta, b)$ alone, so that the estimator is well defined even though $u$ is not treated as a free parameter. The extent to which the dominant cluster in fact varies across evaluation items is reported in Section 7.

## 4.2. DETERMINATION OF THE NUMBER OF CLUSTERS

Because the objective function is nonconvex, a solution obtained from a single initialization cannot be distinguished from an arbitrary local minimum, and the difference in the cost function between two values of $n$ cannot be attributed to a genuine improvement. For each $n=2,\dots,7$ the alternating optimization was therefore run from ten independent random initializations. Writing $J^{(r)}(n)$ for the cost value obtained from the $r$-th initialization, we adopted

$$J(n)=\min_r J^{(r)}(n),$$

$$W(n)=\max_r J^{(r)}(n)-\min_r J^{(r)}(n)$$

where $W(n)$ is the variation attributable to the choice of initial values. None of the 60 runs reached the iteration limit, so convergence was confirmed for every initialization.

The number of clusters was then determined by the elbow method. Four criteria of differing character were applied to $J(n)$. Writing $\Delta J(n)=J(n-1)-J(n)$ for the marginal reduction and $\rho(n)=\Delta J(n)/J(n-1)$ for the reduction rate, the criteria are: (i) the second difference $D(n)=J(n-1)-2J(n)+J(n+1)$, maximized at the point of sharpest curvature; (ii) the Kneedle distance $d(n)=(1-\tilde{n})-\tilde{J}(n)$, where $\tilde{n}$ and $\tilde{J}$ denote $n$ and $J(n)$ normalized to $[0,1]$, measuring the vertical distance from the chord joining the two endpoints; (iii) the reduction rate $\rho(n)$; and (iv) the requirement $\Delta J(n)>W(n)$, which excludes improvements that cannot be distinguished from the variation across initializations. Criteria (iii) and (iv) do not depend on the search range, whereas (i) and (ii) do; the range was fixed at $n=2,\dots,7$.

Table 1. Cost function values and elbow diagnostics for different numbers of clusters (ten random initializations)

| Number of clusters | Cost $J$ | Range $W$ | Reduction $\Delta J$ |
|---|---|---|---|
| 2 | 92.076 | 5.670 | — |
| 3 | 49.576 | 3.181 | 42.500 |
| 4 | 31.715 | 4.323 | 17.861 |
| 5 | 25.707 | 1.821 | 6.008 |
| 6 | 20.832 | 2.283 | 4.875 |
| 7 | 18.069 | 1.226 | 2.762 |

| Number of clusters | Reduction rate | Second difference | Kneedle distance |
|---|---|---|---|
| 2 | — | — | 0.000 |
| 3 | 46.2% | 24.639 | 0.374 |
| 4 | 36.0% | 11.853 | **0.416** |
| 5 | 19.0% | 1.133 | 0.297 |
| 6 | 19.0% | 2.113 | 0.163 |
| 7 | 13.3% | — | 0.000 |

The Kneedle distance attains its maximum at $n=4$, and the difference from $n=3$ (0.416 versus 0.374) is approximately 2.5 times the variation attributable to initialization when expressed on the same normalized scale. The marginal reduction also falls most sharply on entering $n=5$: the ratio of successive reductions is 0.420 at $n=4$ and 0.336 at $n=5$, the smallest value in the range, so $n=4$ is the last number of clusters that yields a substantial improvement. The second difference is maximized at $n=3$. Criterion (iv) was satisfied at every $n$ in the range, with $\Delta J(n)/W(n)$ decreasing from 13.4 at $n=3$ to 2.25 at $n=7$; this criterion therefore confirms that the cost curve is not an artifact of optimizer instability but does not by itself identify an upper bound. Criterion (iii) did not fall below 5% within the range. Taken together, the criteria that identify a specific number of clusters indicate $n=3$ or $n=4$, and we adopted $n=4$, which is supported by the Kneedle distance and by the behaviour of the marginal reduction.

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## 5. RESULTS AND DISCUSSION OF THE REGRESSION COEFFICIENTS $\beta_{kl}$

The characteristics of each cluster were investigated based on the estimated keyword-related coefficients $\beta_{kl}$. The estimation results for each cluster are presented below (Tables 2–5).

Table 2. Estimation Results for $\beta_{1l}$ (Type: "Positive" = positive-point item, "Improvement" = improvement-suggestion item)

| Rank | Type | Keyword | $\beta_{1l}$ |
|---|---|---|---|
| Top 5 | Positive | Proposal capability | 1.741 |
| | Positive | Experiential knowledge | 1.658 |
| | Improvement | Matters for consideration | 1.498 |
| | Improvement | Shift to online | 1.272 |
| | Positive | Positive evaluation | 1.144 |
| Bottom 5 | Improvement | Continued support | −0.728 |
| | Improvement | Comprehension checks | −0.778 |
| | Positive | Practical application | −0.800 |
| | Improvement | Cost improvement | −0.942 |
| | Improvement | New technical domains | −1.586 |

Table 3. Estimation Results for $\beta_{2l}$

| Rank | Type | Keyword | $\beta_{2l}$ |
|---|---|---|---|
| Top 5 | Positive | Proposal capability | 0.818 |
| | Improvement | Shift to online | 0.768 |
| | Improvement | Review support | 0.750 |
| | Positive | Participant satisfaction | 0.647 |
| | Positive | Training quality | 0.443 |
| Bottom 5 | Positive | Service quality | −0.515 |
| | Improvement | Customer requests | −0.641 |
| | Positive | Comprehension facilitation | −0.723 |
| | Improvement | MOS-style certification | −0.763 |
| | Positive | Feedback sharing | −1.098 |

Table 4. Estimation Results for $\beta_{3l}$

| Rank | Type | Keyword | $\beta_{3l}$ |
|---|---|---|---|
| Top 5 | Positive | Training quality | 1.964 |
| | Positive | Courteous response | 1.302 |
| | Positive | Participant satisfaction | 1.301 |
| | Improvement | No improvements needed | 1.206 |
| | Improvement | Maintain current status | 1.206 |
| Bottom 5 | Improvement | Advance sharing | −0.864 |
| | Improvement | Customer requests | −0.877 |
| | Positive | Feedback sharing | −0.906 |
| | Positive | Positive evaluation | −0.954 |
| | Positive | Individualized support | −0.990 |

Table 5. Estimation Results for $\beta_{4l}$

| Rank | Type | Keyword | $\beta_{4l}$ |
|---|---|---|---|
| Top 5 | Positive | Comprehension facilitation | 1.216 |
| | Positive | Individualized support | 0.863 |
| | Improvement | Practice reinforcement | 0.788 |
| | Improvement | Effectiveness measurement | 0.632 |
| | Improvement | Expanded program menu | 0.511 |
| Bottom 5 | Positive | Courteous response | −0.743 |
| | Improvement | Material improvement | −0.785 |
| | Positive | In-house instructors | −0.797 |
| | Improvement | Industry trends | −0.834 |
| | Improvement | Customer requests | −1.385 |

Based on the $\beta_{kl}$ coefficients (keywords with strongly positive or negative effects in each cluster), each cluster was interpreted as representing the characteristics of the corresponding respondent groups as follows.

**Cluster 1 (Consultative-Value-Oriented Type):** This cluster highly values "proposal capability" and "experiential knowledge," and is also characterized by positive coefficients for the improvement-related keywords "matters for consideration" and "shift to online." In contrast, "new technical domains" and "cost improvement" carry the strongest negative coefficients. This group appreciates the consultative value of the proposals and the knowledge the provider brings, and raises points for consideration on the delivery format rather than demanding expansion into new technical areas or a reduction in price.

**Cluster 2 (Learning-Environment-Oriented Type):** This cluster values "proposal capability" together with the improvement-related keywords "shift to online" and "review support," and evaluates "participant satisfaction" and "training quality" positively. "Feedback sharing," "MOS-style certification," and "comprehension facilitation" carry negative coefficients. This group is oriented towards the learning environment itself, seeking flexibility of delivery and opportunities for review rather than intervention in the learning process.

**Cluster 3 (Highly Satisfied and Status-Quo-Oriented Type):** This cluster is characterized by the largest positive coefficient of all clusters for "training quality," and by positive coefficients for "courteous response," "participant satisfaction," "no improvements needed," and "maintain current status." "Individualized support" and "advance sharing" carry negative coefficients. This group is satisfied with the service as currently delivered and expresses no substantive dissatisfaction, representing a stable group.

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**Cluster 4 (Individualized and Practice-Oriented Type):** This cluster highly values "comprehension facilitation" and "individualized support," and demands "practice reinforcement," "effectiveness measurement," and an "expanded program menu." "Customer requests" carries the strongest negative coefficient of all coefficients in this cluster. This group evaluates the service by how far it reaches the individual learner and by whether the effect can be measured, rather than by whether its own requests were accommodated.

## 6. RESULTS AND DISCUSSION OF THE BIAS TERMS $b_j$

The estimated bias terms $b_j$ are presented in Table 6, together with the observed mean score share of each item, obtained by normalizing the maximum rating value of each scale as 100%.

Table 6. Estimated bias terms $b_j$ and observed mean score share by evaluation item

| Evaluation item | $b_j$ | Observed mean score share |
|---|---|---|
| Recommendation score (NPS) | −1.415 | 82.0% |
| Program content and speed of proposals | −1.408 | 85.6% |
| Overall quality | −1.398 | 84.3% |
| Contribution to skill improvement and job performance | −1.390 | 82.4% |
| Quality of follow-up and support | −1.387 | 85.7% |
| Cost performance | −0.494 | 73.5% |

The bias terms showed relatively large negative values for the recommendation score (−1.415), program content (−1.408), overall quality (−1.398), contribution (−1.390), and follow-up support (−1.387). These five values fall within a range of only 0.028, indicating that the five items share an almost identical baseline level. In contrast, only cost performance exhibited a notably larger value (closer to zero) of −0.494, which differs from the least negative of the other five by 0.893. The observed mean score shares were 82.0% for the recommendation score, 85.6% for program content, 84.3% for overall quality, 82.4% for contribution, and 85.7% for follow-up support, whereas cost performance was clearly lower at 73.5%. Therefore, the model results were consistent with the trends observed in the actual measurements: the five items form a single baseline group, and cost performance is separated from it.

## 7. RESULTS AND DISCUSSION OF THE MEMBERSHIP DEGREES $u_{ijk}$

Several tendencies were identified based on the estimated fuzzy membership degrees $u_{ijk}$. For each combination of a respondent and an evaluation item, the largest membership degree among the four clusters, $max_k u_{ijk}$, was defined as the confidence. Averaged over the 594 combinations formed by the 99 valid respondents and the six evaluation items, the confidence was 0.958, with a median of 0.991. Cases in which the difference between the largest and the second largest membership degree was smaller than 0.15 were regarded as balanced memberships, and only 4 such cases were observed among the 594 respondent–item combinations. The four-cluster solution therefore assigns almost every respondent–item combination decisively to a single cluster.

### 7.1. VARIATION OF THE DOMINANT CLUSTER ACROSS EVALUATION ITEMS

As described in Section 4.1, the membership degree carries an index for the evaluation item whereas the regression coefficient does not, so the same respondent may be assigned to different clusters depending on the item. To assess the extent of this variation empirically, we identified the cluster with the largest membership degree for each respondent and each item, and counted the number of distinct clusters appearing across the six items for each respondent. The results are shown in Table 7.

Table 7. Number of distinct dominant clusters across the six evaluation items

| Number of distinct dominant clusters | Number of respondents | Share |
|---|---|---|
| 1 | 10 | 10.1% |
| 2 | 32 | 32.3% |
| 3 | 47 | 47.5% |
| 4 | 10 | 10.1% |
| Total | 99 | 100.0% |

Only 10 of the 99 valid respondents (10.1%) retained the same dominant cluster across all six evaluation items; the remaining 89 respondents (89.9%) changed their dominant cluster at least once, and 47 respondents (47.5%) were assigned to three different clusters across the six items. This result demonstrates empirically that the satisfaction structure of a respondent cannot be captured by a single membership determined at the level of the respondent, and it constitutes the principal justification for indexing the membership degree by the

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evaluation item, which is the point on which the present formulation differs from prior fuzzy clusterwise regression models.

### 7.2. BALANCED-MEMBERSHIP CASES

Two respondents accounted for the four balanced-membership cases.

Case I (program content and speed of proposals, overall quality, and quality of follow-up and support): Cluster 3 and Cluster 1 showed competing memberships (0.542 versus 0.395) for three of the six items. The positive-point keywords were “flexible response,” “prompt response,” “courteous response,” “hands-on,” and “customer understanding,” while the improvement suggestions were “shift to online,” “expanded program menu,” and “improvement suggestions.” The respondent evaluates the current delivery highly, which is characteristic of the status-quo-oriented type (Cluster 3), while simultaneously raising points for consideration on the delivery format, which is characteristic of the consultative-value-oriented type (Cluster 1). The membership is balanced only for the three items that concern the content and the support of the service, and not for the recommendation score or cost performance.

Case II (cost performance): Cluster 1 and Cluster 2 showed competing memberships (0.503 versus 0.358). The positive-point keywords were “flexible response,” “prompt response,” and “positive evaluation,” and no improvement suggestion was given. The absence of an improvement suggestion leaves the respondent between the consultative-value-oriented type (Cluster 1) and the learning-environment-oriented type (Cluster 2), and the balance appears only for cost performance, the item for which the bias term is closest to zero.

### 7.3. CLUSTER SIZE AND EVALUATION LEVEL BY ITEM

The overall tendencies were summarized as follows. By considering each phenomenon based on the combination of cluster size (the share of respondents assigned to the cluster) and evaluation level (mean score share), the clusters can be interpreted using a four-quadrant framework:

- Large clusters with low evaluations: these clusters have the highest priority for improvement because they affect a large number of customers.
- Small clusters with low evaluations: these clusters represent potential problems, but their overall impact is limited.
- Small clusters with high evaluations: these clusters represent niche groups that are highly satisfied despite their small size.
- Large clusters with high evaluations: these clusters represent stable core customer groups.

Tables 8–13 present, for each evaluation item, the size share of each cluster (the share of respondents assigned to it) and the mean score share of that cluster, together with the average confidence and the number of balanced-membership cases.

Table 8. Cluster Size Share and Mean Score Share (Recommendation Score / NPS). Cluster sizes (n): 28 / 26 / 23 / 22. Average confidence: 0.981 (highest). Balanced memberships: 0 (fewest).

| Cluster Type | Size Share | Mean Score Share |
|---|---|---|
| 1:Consultative-Value-Oriented Type | 28.3% | 88.9% |
| 2:Learning-Environment-Oriented Type | 26.3% | 80.8% |
| 3:Highly Satisfied and Status-Quo-Oriented Type | 23.2% | 83.0% |
| 4:Individualized and Practice-Oriented Type | 22.2% | 73.6% |

Table 9. Cluster Size Share and Mean Score Share (Program Content and Speed of Proposals). Cluster sizes (n): 31 / 24 / 28 / 16. Average confidence: 0.954. Balanced memberships: 1.

| Cluster Type | Size Share | Mean Score Share |
|---|---|---|
| 1:Consultative-Value-Oriented Type | 31.3% | 90.3% |
| 2:Learning-Environment-Oriented Type | 24.2% | 80.0% |
| 3:Highly Satisfied and Status-Quo-Oriented Type | 28.3% | 90.7% |
| 4:Individualized and Practice-Oriented Type | 16.2% | 80.0% |

Table 10. Cluster Size Share and Mean Score Share (Overall Quality). Cluster sizes (n): 27 / 18 / 37 / 17. Average confidence: 0.955. Balanced memberships: 1.

| Cluster Type | Size Share | Mean Score Share |
|---|---|---|
| 1:Consultative-Value-Oriented Type | 27.3% | 92.6% |
| 2:Learning-Environment-Oriented Type | 18.2% | 76.7% |
| 3:Highly Satisfied and Status-Quo-Oriented Type | 37.4% | 89.2% |

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| Cluster Type | Size Share | Mean Score Share |
|---|---|---|
| 4:Individualized and Practice-Oriented Type | 17.2% | 74.1% |

Table 11. Cluster Size Share and Mean Score Share (Contribution to Employee Skill Improvement and Job Performance). Cluster sizes (n): 33 / 21 / 27 / 18. Average confidence: 0.954. Balanced memberships: 0.

| Cluster Type | Size Share | Mean Score Share |
|---|---|---|
| 1:Consultative-Value-Oriented Type | 33.3% | 89.1% |
| 2:Learning-Environment-Oriented Type | 21.2% | 73.3% |
| 3:Highly Satisfied and Status-Quo-Oriented Type | 27.3% | 84.4% |
| 4:Individualized and Practice-Oriented Type | 18.2% | 78.9% |

Table 12. Cluster Size Share and Mean Score Share (Quality of Follow-up and Support). Cluster sizes (n): 32 / 22 / 30 / 15. Average confidence: 0.942 (lowest). Balanced memberships: 1.

| Cluster Type | Size Share | Mean Score Share |
|---|---|---|
| 1:Consultative-Value-Oriented Type | 32.3% | 92.5% |
| 2:Learning-Environment-Oriented Type | 22.2% | 76.4% |
| 3:Highly Satisfied and Status-Quo-Oriented Type | 30.3% | 92.7% |
| 4:Individualized and Practice-Oriented Type | 15.2% | 77.3% |

Table 13. Cluster Size Share and Mean Score Share (Cost Performance). Cluster sizes (n): 29 / 28 / 23 / 19. Average confidence: 0.963. Balanced memberships: 1.

| Cluster Type | Size Share | Mean Score Share |
|---|---|---|
| 1:Consultative-Value-Oriented Type | 29.3% | 82.8% |
| 2:Learning-Environment-Oriented Type | 28.3% | 67.1% |
| 3:Highly Satisfied and Status-Quo-Oriented Type | 23.2% | 77.4% |
| 4:Individualized and Practice-Oriented Type | 19.2% | 66.3% |

The values shown above were calculated as follows.

**Cluster size (number of respondents assigned, by evaluation item):** because the membership degrees differ from item to item, respondents cannot be allocated to clusters once and for all. For each evaluation item, the cluster with the highest membership degree was therefore regarded as the assignment for that item, and the 99 respondents with valid free-text responses were allocated to the four clusters. Since the same respondent may be counted in different clusters for different items, the composition differs across Tables 8–13, but the total is always 99. The tables present the share out of these 99 respondents.

**Average confidence:** for each combination of a respondent and an evaluation item, the highest fuzzy membership degree among the four clusters, $max_k u_{ijk}$, was defined as the confidence. The values reported in Tables 8–13 are the averages over the 99 valid respondents for that evaluation item; the overall average across the six items is 0.958. A value closer to 1 indicates that the clusters are clearly separated.

**Mean score share:** for each cluster defined by the above assignment, the raw evaluation scores given by the respondents belonging to that cluster were averaged and then divided by the maximum possible score for the item (10 points for the NPS item and 5 points for all others), expressed as a percentage.

**Balanced memberships:** for each respondent the membership degrees were sorted in descending order, and cases in which the difference between the highest and the second highest was smaller than 0.15 were counted.

The analysis results can be summarized as follows. First, the confidence averaged over the 594 respondent–item combinations was 0.958 with a median of 0.991, and only 4 of these combinations exhibited balanced memberships, confirming that the four-cluster classification is stable and clearly separated. Second, and in contrast, only 10.1% of the respondents retained the same dominant cluster across all six evaluation items, so the clear separation holds at the level of the individual respondent–item combination and not at the level of the respondent. Third, a consistent tendency was observed across evaluation items: the recommendation score, which is a comprehensive item, exhibited the highest item-level average confidence (0.981) and no balanced memberships, whereas the quality of follow-up and support, which is a composite item, exhibited the lowest (0.942). Finally, the four-quadrant analysis based on cluster size and evaluation level revealed that Cluster 1 combines the largest or nearly the largest share with the highest mean score share in five of the six items, and therefore constitutes the stable core customer group. In contrast, Cluster 2 and Cluster 4 recorded the two lowest mean score shares for cost performance (67.1% and 66.3%) while together accounting for 47% of the size share, which identifies cost performance as the issue of highest improvement priority. Cluster 4 also records the

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lowest mean score share for the recommendation score (73.6%), indicating that the individualized and practice-oriented group is the least likely to recommend the service.

## 8. CONCLUSION

In this study, the L2-regularized nonlinear fuzzy cluster regression model was developed using keywords extracted from free-text responses as explanatory variables to analyze customer satisfaction survey data collected from 108 users of the AKKODiS Academy human resource development service. By integrating quantitative rating scores with qualitative free-text comments, both types of information were analyzed simultaneously. The number of clusters was determined to be four by the elbow method applied to the cost function; ten random initializations were performed at each candidate value, none of which reached the iteration limit, and the marginal reduction in the cost function exceeded the variation across initializations throughout the examined range. The parameters $\beta_{kl}$, $b_j$, and $u_{ijk}$ were estimated using an alternating optimization method. The results revealed that the respondents could be classified into four latent customer groups: Consultative-Value-Oriented, Learning-Environment-Oriented, Highly Satisfied and Status-Quo-Oriented, and Individualized and Practice-Oriented.

Furthermore, analyses of both the estimated bias terms and the observed data consistently indicated that cost performance was evaluated systematically lower than the other five evaluation items. In addition, analysis of the fuzzy membership degrees showed that 89.9% of the valid respondents changed their dominant cluster across the six evaluation items, which demonstrates empirically that the satisfaction structure of a respondent is not captured by a single membership assigned at the respondent level, and that combining cluster size with the evaluation level in a four-quadrant framework is useful for identifying issues that should be prioritized for improvement.

These findings suggest that service improvement for the AKKODiS Academy human resource development service should not rely on a uniform strategy. Instead, it is necessary to distinguish between issues common to all customers, such as improving communication regarding cost performance, and cluster-specific measures that address the particular requests of each cluster, such as strengthening review support and flexibility of the delivery format for the learning-environment-oriented cluster, and reinforcing individualized support and the measurement of training effectiveness for the individualized and practice-oriented cluster. Therefore, the proposed approach provides useful guidance for future service improvement and customer relationship management.

This study also has several limitations. First, the regularization parameters $(\gamma, \eta)$ were selected empirically. Since the model predicts the rating $y_{ij}$, a held-out procedure can in principle be constructed in which a subset of respondent–item pairs is masked, the model is fitted to the remaining pairs, and $\gamma$ and $\eta$ are chosen by the prediction error on the masked pairs. The design of such a procedure is, however, not straightforward: the membership $u_{ijk}$ is determined by the residual of the very pair being predicted, so the membership of a masked pair must be supplied from the remaining items of the same respondent. Future work should first confirm the stability of the regression coefficients and of the cluster assignments through a sensitivity analysis over multiple candidate values, and then examine the selection based on the prediction error described above. Second, the number of parameters, $nL + M$, exceeds the number of respondents, which is why L2 regularization is required; in this regime the bias-correction term of information criteria such as the generalized information criterion cannot be estimated reliably, and the determination of the number of clusters was therefore based on the elbow method together with an explicit assessment of optimizer stability. Third, the analysis was conducted using data from only 108 users of a single company's human resource development service (AKKODiS Academy), limiting the generalizability of the findings. In addition, the keywords used as explanatory variables were automatically extracted using an in-house AI system, and although the extraction procedure has been described in Section 3, the validity of the keyword extraction process requires further investigation, for example by comparing the automatically extracted keywords with manual annotation on a subsample.

Future research should validate the proposed model using larger datasets collected over multiple periods and evaluate its practical effectiveness by examining changes in customer satisfaction after implementing cluster-specific improvement strategies.

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use company information in this study and to AKKODiS Consulting Ltd. for providing Data.

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## APPENDIX: ESTIMATED FUZZY MEMBERSHIP DEGREES AND REGRESSION COEFFICIENTS (K = 4)

Tables A1–A6 list the estimated fuzzy membership degrees $u_{ijk}$ for all 108 respondents, for each of the six evaluation items. Respondent numbers are the identifiers of the original survey data and correspond to those used in the main text (Cases I and II are respondents 45 and 82). Respondents for whom the membership degree takes the same value (0.250) across all four clusters did not provide free-text responses and are excluded from calculations such as the mean score share ($i$ = 1, 2, 13, 58, 61, 74, 91, 101, 112); the 99 remaining respondents constitute the valid sample. All values are rounded to three decimal placese.

**Table A1. ESTIMATED FUZZY MEMBERSHIP DEGREES FOR RECOMMENDATION SCORE (NPS)**

| ID | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| 1 | 0.250 | 0.250 | 0.250 | 0.250 |
| 2 | 0.250 | 0.250 | 0.250 | 0.250 |
| 3 | 0.000 | 0.000 | 1.000 | 0.000 |
| 4 | 0.000 | 1.000 | 0.000 | 0.000 |
| 5 | 0.000 | 0.000 | 0.001 | 0.999 |
| 6 | 0.000 | 0.000 | 1.000 | 0.000 |
| 7 | 0.002 | 0.006 | 0.991 | 0.001 |
| 8 | 0.000 | 0.997 | 0.000 | 0.003 |
| 9 | 0.000 | 0.000 | 0.000 | 0.999 |
| 10 | 0.995 | 0.002 | 0.002 | 0.001 |
| 11 | 1.000 | 0.000 | 0.000 | 0.000 |
| 12 | 0.025 | 0.005 | 0.969 | 0.001 |
| 13 | 0.250 | 0.250 | 0.250 | 0.250 |
| 14 | 0.999 | 0.000 | 0.000 | 0.000 |
| 15 | 0.000 | 1.000 | 0.000 | 0.000 |
| 16 | 0.000 | 0.999 | 0.001 | 0.000 |
| 17 | 0.987 | 0.006 | 0.006 | 0.002 |
| 18 | 0.000 | 0.000 | 0.000 | 1.000 |
| 19 | 0.996 | 0.001 | 0.002 | 0.000 |
| 20 | 0.000 | 0.000 | 0.000 | 1.000 |
| 21 | 0.001 | 0.002 | 0.997 | 0.001 |
| 22 | 0.000 | 0.000 | 0.000 | 1.000 |
| 23 | 0.000 | 1.000 | 0.000 | 0.000 |
| 28 | 0.004 | 0.009 | 0.982 | 0.005 |
| 29 | 0.007 | 0.844 | 0.106 | 0.044 |
| 30 | 0.983 | 0.002 | 0.001 | 0.015 |
| 31 | 0.038 | 0.936 | 0.024 | 0.003 |
| 32 | 0.000 | 0.999 | 0.000 | 0.000 |
| 33 | 0.986 | 0.010 | 0.001 | 0.003 |
| 34 | 0.000 | 0.999 | 0.000 | 0.000 |
| 35 | 0.994 | 0.004 | 0.002 | 0.000 |
| 36 | 0.000 | 1.000 | 0.000 | 0.000 |
| 37 | 0.010 | 0.005 | 0.001 | 0.985 |
| 38 | 0.993 | 0.006 | 0.000 | 0.001 |
| 39 | 0.899 | 0.100 | 0.001 | 0.000 |
| 40 | 0.003 | 0.002 | 0.989 | 0.006 |
| 41 | 0.001 | 0.998 | 0.001 | 0.000 |
| 42 | 0.005 | 0.951 | 0.025 | 0.018 |
| 43 | 0.000 | 1.000 | 0.000 | 0.000 |
| 44 | 0.001 | 0.960 | 0.034 | 0.005 |
| 45 | 0.001 | 0.998 | 0.001 | 0.000 |
| 46 | 0.989 | 0.007 | 0.001 | 0.003 |
| 47 | 0.004 | 0.002 | 0.990 | 0.005 |

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| ID | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| 48 | 0.024 | 0.002 | 0.974 | 0.000 |
| 49 | 0.000 | 0.000 | 0.000 | 1.000 |
| 50 | 0.022 | 0.001 | 0.048 | 0.929 |
| 51 | 0.023 | 0.003 | 0.936 | 0.037 |
| 52 | 0.957 | 0.000 | 0.043 | 0.000 |
| 53 | 0.000 | 0.001 | 0.002 | 0.996 |
| 54 | 0.001 | 0.000 | 0.998 | 0.001 |
| 55 | 0.007 | 0.003 | 0.973 | 0.016 |
| 56 | 0.988 | 0.008 | 0.001 | 0.002 |
| 57 | 0.019 | 0.004 | 0.976 | 0.001 |
| 58 | 0.250 | 0.250 | 0.250 | 0.250 |
| 59 | 0.000 | 0.999 | 0.000 | 0.000 |
| 60 | 0.012 | 0.980 | 0.007 | 0.001 |
| 61 | 0.250 | 0.250 | 0.250 | 0.250 |
| 62 | 0.002 | 0.996 | 0.002 | 0.001 |
| 63 | 0.000 | 0.000 | 0.000 | 1.000 |
| 64 | 0.931 | 0.001 | 0.000 | 0.068 |
| 65 | 0.000 | 0.999 | 0.000 | 0.000 |
| 66 | 0.000 | 1.000 | 0.000 | 0.000 |
| 67 | 1.000 | 0.000 | 0.000 | 0.000 |
| 68 | 0.000 | 0.000 | 0.000 | 1.000 |
| 69 | 0.024 | 0.057 | 0.021 | 0.898 |
| 71 | 0.790 | 0.013 | 0.188 | 0.009 |
| 73 | 0.007 | 0.983 | 0.005 | 0.005 |
| 74 | 0.250 | 0.250 | 0.250 | 0.250 |
| 76 | 0.002 | 0.005 | 0.989 | 0.004 |
| 77 | 0.000 | 0.999 | 0.000 | 0.001 |
| 78 | 0.995 | 0.000 | 0.000 | 0.005 |
| 79 | 0.019 | 0.004 | 0.976 | 0.001 |
| 80 | 0.000 | 0.000 | 0.000 | 1.000 |
| 81 | 0.000 | 0.000 | 0.000 | 1.000 |
| 82 | 0.001 | 0.002 | 0.988 | 0.009 |
| 83 | 0.999 | 0.000 | 0.000 | 0.001 |
| 84 | 1.000 | 0.000 | 0.000 | 0.000 |
| 85 | 0.000 | 0.000 | 0.000 | 1.000 |
| 86 | 0.000 | 0.002 | 0.000 | 0.998 |
| 87 | 0.000 | 0.000 | 0.000 | 1.000 |
| 88 | 0.889 | 0.012 | 0.088 | 0.011 |
| 89 | 0.018 | 0.002 | 0.920 | 0.059 |
| 90 | 0.975 | 0.015 | 0.008 | 0.002 |
| 91 | 0.250 | 0.250 | 0.250 | 0.250 |
| 92 | 0.000 | 0.000 | 1.000 | 0.000 |
| 95 | 0.000 | 0.000 | 0.000 | 0.999 |
| 96 | 0.045 | 0.077 | 0.868 | 0.010 |
| 97 | 0.996 | 0.003 | 0.000 | 0.001 |
| 98 | 0.001 | 0.997 | 0.001 | 0.000 |
| 99 | 0.000 | 1.000 | 0.000 | 0.000 |
| 100 | 0.000 | 0.999 | 0.001 | 0.001 |
| 101 | 0.250 | 0.250 | 0.250 | 0.250 |
| 102 | 0.001 | 0.011 | 0.001 | 0.988 |
| 103 | 0.000 | 0.000 | 0.000 | 1.000 |
| 104 | 1.000 | 0.000 | 0.000 | 0.000 |
| 105 | 0.946 | 0.041 | 0.009 | 0.004 |
| 106 | 0.000 | 0.000 | 1.000 | 0.000 |
| 107 | 0.000 | 0.000 | 0.977 | 0.023 |
| 108 | 0.000 | 0.000 | 1.000 | 0.000 |
| 109 | 0.000 | 1.000 | 0.000 | 0.000 |
| 110 | 0.989 | 0.007 | 0.001 | 0.004 |
| 111 | 0.991 | 0.002 | 0.006 | 0.001 |
| 112 | 0.250 | 0.250 | 0.250 | 0.250 |
| 113 | 0.000 | 0.000 | 0.000 | 1.000 |
| 114 | 0.950 | 0.017 | 0.023 | 0.010 |
| 116 | 1.000 | 0.000 | 0.000 | 0.000 |
| 117 | 0.000 | 0.000 | 0.970 | 0.030 |
| 118 | 0.000 | 0.000 | 0.000 | 1.000 |

## Table A2. ESTIMATED FUZZY MEMBERSHIP DEGREES FOR PROGRAM CONTENT AND SPEED OF PROPOSALS

| ID | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| 1 | 0.250 | 0.250 | 0.250 | 0.250 |
| 2 | 0.250 | 0.250 | 0.250 | 0.250 |
| 3 | 0.001 | 0.991 | 0.008 | 0.001 |
| 4 | 1.000 | 0.000 | 0.000 | 0.000 |
| 5 | 0.000 | 1.000 | 0.000 | 0.000 |
| 6 | 0.000 | 1.000 | 0.000 | 0.000 |
| 7 | 0.912 | 0.070 | 0.015 | 0.002 |
| 8 | 0.000 | 0.832 | 0.000 | 0.168 |
| 9 | 0.001 | 0.000 | 0.000 | 0.999 |
| 10 | 0.001 | 0.967 | 0.000 | 0.033 |
| 11 | 1.000 | 0.000 | 0.000 | 0.000 |
| 12 | 0.025 | 0.005 | 0.969 | 0.001 |
| 13 | 0.250 | 0.250 | 0.250 | 0.250 |
| 14 | 1.000 | 0.000 | 0.000 | 0.000 |
| 15 | 0.000 | 0.999 | 0.001 | 0.000 |
| 16 | 0.994 | 0.002 | 0.004 | 0.001 |
| 17 | 0.987 | 0.006 | 0.006 | 0.002 |
| 18 | 0.001 | 0.999 | 0.000 | 0.000 |
| 19 | 0.035 | 0.008 | 0.954 | 0.004 |
| 20 | 0.000 | 0.999 | 0.000 | 0.000 |
| 21 | 0.001 | 0.002 | 0.997 | 0.001 |
| 22 | 0.000 | 0.000 | 1.000 | 0.000 |
| 23 | 0.000 | 1.000 | 0.000 | 0.000 |
| 28 | 0.002 | 0.994 | 0.001 | 0.004 |
| 29 | 0.002 | 0.011 | 0.952 | 0.035 |
| 30 | 0.989 | 0.001 | 0.001 | 0.009 |
| 31 | 0.001 | 0.002 | 0.005 | 0.991 |
| 32 | 0.167 | 0.046 | 0.521 | 0.265 |
| 33 | 0.986 | 0.010 | 0.001 | 0.003 |
| 34 | 0.000 | 0.999 | 0.001 | 0.000 |
| 35 | 0.994 | 0.004 | 0.002 | 0.000 |
| 36 | 0.000 | 0.000 | 0.999 | 0.001 |
| 37 | 0.001 | 0.997 | 0.001 | 0.002 |
| 38 | 0.218 | 0.719 | 0.014 | 0.049 |
| 39 | 0.958 | 0.042 | 0.000 | 0.000 |
| 40 | 0.001 | 0.996 | 0.003 | 0.001 |
| 41 | 0.001 | 0.996 | 0.002 | 0.000 |
| 42 | 0.001 | 0.009 | 0.987 | 0.003 |
| 43 | 0.152 | 0.023 | 0.821 | 0.004 |
| 44 | 1.000 | 0.000 | 0.000 | 0.000 |
| 45 | 0.395 | 0.053 | 0.542 | 0.010 |
| 46 | 0.989 | 0.007 | 0.001 | 0.003 |
| 47 | 0.001 | 0.981 | 0.002 | 0.016 |
| 48 | 0.000 | 0.999 | 0.000 | 0.000 |
| 49 | 0.000 | 0.000 | 0.000 | 1.000 |
| 50 | 0.007 | 0.000 | 0.011 | 0.982 |
| 51 | 0.023 | 0.003 | 0.936 | 0.037 |
| 52 | 0.112 | 0.029 | 0.115 | 0.744 |
| 53 | 0.003 | 0.009 | 0.948 | 0.039 |
| 54 | 0.000 | 0.000 | 0.001 | 0.999 |
| 55 | 0.007 | 0.003 | 0.973 | 0.016 |
| 56 | 0.988 | 0.008 | 0.001 | 0.002 |
| 57 | 0.917 | 0.013 | 0.066 | 0.005 |
| 58 | 0.250 | 0.250 | 0.250 | 0.250 |
| 59 | 0.000 | 0.000 | 0.000 | 1.000 |
| 60 | 0.004 | 0.009 | 0.984 | 0.004 |
| 61 | 0.250 | 0.250 | 0.250 | 0.250 |
| 62 | 0.000 | 0.001 | 0.000 | 0.999 |
| 63 | 0.994 | 0.003 | 0.001 | 0.002 |
| 64 | 0.977 | 0.000 | 0.000 | 0.023 |
| 65 | 0.000 | 1.000 | 0.000 | 0.000 |
| 66 | 0.999 | 0.000 | 0.001 | 0.000 |
| 67 | 1.000 | 0.000 | 0.000 | 0.000 |
| 68 | 0.007 | 0.006 | 0.958 | 0.029 |
| 69 | 0.309 | 0.026 | 0.661 | 0.004 |
| 71 | 0.790 | 0.013 | 0.188 | 0.009 |
| 73 | 0.167 | 0.008 | 0.822 | 0.002 |

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| ID | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| 74 | 0.250 | 0.250 | 0.250 | 0.250 |
| 76 | 0.840 | 0.014 | 0.031 | 0.115 |
| 77 | 0.000 | 1.000 | 0.000 | 0.000 |
| 78 | 0.021 | 0.001 | 0.000 | 0.977 |
| 79 | 0.001 | 0.005 | 0.001 | 0.992 |
| 80 | 0.965 | 0.005 | 0.010 | 0.020 |
| 81 | 0.001 | 0.012 | 0.000 | 0.987 |
| 82 | 0.009 | 0.957 | 0.008 | 0.026 |
| 83 | 0.007 | 0.018 | 0.964 | 0.011 |
| 84 | 0.000 | 0.000 | 0.000 | 1.000 |
| 85 | 0.000 | 0.000 | 0.999 | 0.000 |
| 86 | 0.000 | 0.001 | 0.998 | 0.001 |
| 87 | 0.000 | 0.000 | 0.999 | 0.001 |
| 88 | 0.889 | 0.012 | 0.088 | 0.011 |
| 89 | 0.018 | 0.002 | 0.920 | 0.059 |
| 90 | 0.002 | 0.005 | 0.007 | 0.986 |
| 91 | 0.250 | 0.250 | 0.250 | 0.250 |
| 92 | 0.000 | 0.000 | 1.000 | 0.000 |
| 95 | 0.907 | 0.014 | 0.055 | 0.024 |
| 96 | 0.045 | 0.077 | 0.868 | 0.010 |
| 97 | 0.002 | 0.009 | 0.000 | 0.989 |
| 98 | 0.001 | 0.996 | 0.002 | 0.001 |
| 99 | 0.001 | 0.002 | 0.004 | 0.993 |
| 100 | 0.000 | 0.000 | 1.000 | 0.000 |
| 101 | 0.250 | 0.250 | 0.250 | 0.250 |
| 102 | 0.946 | 0.030 | 0.005 | 0.018 |
| 103 | 0.000 | 0.000 | 0.000 | 0.999 |
| 104 | 1.000 | 0.000 | 0.000 | 0.000 |
| 105 | 0.946 | 0.041 | 0.009 | 0.004 |
| 106 | 0.000 | 0.000 | 0.999 | 0.000 |
| 107 | 0.000 | 0.000 | 0.997 | 0.003 |
| 108 | 0.178 | 0.744 | 0.034 | 0.043 |
| 109 | 0.993 | 0.001 | 0.000 | 0.006 |
| 110 | 0.989 | 0.007 | 0.001 | 0.004 |
| 111 | 0.991 | 0.002 | 0.006 | 0.001 |
| 112 | 0.250 | 0.250 | 0.250 | 0.250 |
| 113 | 0.000 | 1.000 | 0.000 | 0.000 |
| 114 | 0.950 | 0.017 | 0.023 | 0.010 |
| 116 | 1.000 | 0.000 | 0.000 | 0.000 |
| 117 | 0.000 | 0.000 | 0.995 | 0.005 |
| 118 | 0.052 | 0.948 | 0.000 | 0.000 |

## Table A3. ESTIMATED FUZZY MEMBERSHIP DEGREES FOR OVERALL QUALITY

| ID | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| 1 | 0.250 | 0.250 | 0.250 | 0.250 |
| 2 | 0.250 | 0.250 | 0.250 | 0.250 |
| 3 | 0.000 | 0.001 | 0.003 | 0.995 |
| 4 | 0.998 | 0.001 | 0.000 | 0.001 |
| 5 | 0.000 | 0.000 | 0.000 | 1.000 |
| 6 | 0.000 | 0.999 | 0.001 | 0.001 |
| 7 | 0.912 | 0.070 | 0.015 | 0.002 |
| 8 | 0.000 | 0.021 | 0.000 | 0.979 |
| 9 | 0.001 | 0.001 | 0.001 | 0.997 |
| 10 | 0.044 | 0.012 | 0.933 | 0.011 |
| 11 | 1.000 | 0.000 | 0.000 | 0.000 |
| 12 | 0.025 | 0.005 | 0.968 | 0.001 |
| 13 | 0.250 | 0.250 | 0.250 | 0.250 |
| 14 | 0.999 | 0.000 | 0.000 | 0.001 |
| 15 | 0.000 | 0.997 | 0.002 | 0.001 |
| 16 | 0.000 | 1.000 | 0.000 | 0.000 |
| 17 | 0.987 | 0.006 | 0.006 | 0.002 |
| 18 | 0.000 | 1.000 | 0.000 | 0.000 |
| 19 | 0.035 | 0.008 | 0.954 | 0.004 |
| 20 | 0.000 | 1.000 | 0.000 | 0.000 |
| 21 | 0.001 | 0.002 | 0.997 | 0.001 |
| 22 | 0.000 | 0.000 | 1.000 | 0.000 |
| 23 | 0.000 | 0.999 | 0.001 | 0.000 |
| 28 | 0.031 | 0.124 | 0.799 | 0.045 |
| 29 | 0.001 | 0.008 | 0.964 | 0.027 |
| 30 | 0.036 | 0.176 | 0.734 | 0.054 |
| 31 | 0.000 | 0.001 | 0.999 | 0.000 |
| 32 | 0.167 | 0.046 | 0.521 | 0.265 |
| 33 | 0.986 | 0.010 | 0.001 | 0.003 |
| 34 | 0.001 | 0.997 | 0.002 | 0.000 |
| 35 | 0.994 | 0.004 | 0.002 | 0.000 |
| 36 | 0.000 | 0.001 | 0.996 | 0.003 |
| 37 | 0.001 | 0.994 | 0.001 | 0.003 |
| 38 | 0.005 | 0.002 | 0.001 | 0.992 |
| 39 | 0.997 | 0.003 | 0.000 | 0.000 |
| 40 | 0.882 | 0.003 | 0.015 | 0.100 |
| 41 | 0.003 | 0.991 | 0.005 | 0.000 |
| 42 | 0.001 | 0.009 | 0.987 | 0.003 |
| 43 | 0.152 | 0.023 | 0.820 | 0.004 |
| 44 | 1.000 | 0.000 | 0.000 | 0.000 |
| 45 | 0.395 | 0.053 | 0.542 | 0.010 |
| 46 | 0.989 | 0.007 | 0.001 | 0.003 |
| 47 | 0.000 | 0.991 | 0.001 | 0.008 |
| 48 | 0.001 | 0.996 | 0.001 | 0.001 |
| 49 | 0.000 | 0.000 | 0.000 | 0.999 |
| 50 | 0.002 | 0.000 | 0.002 | 0.996 |
| 51 | 0.024 | 0.003 | 0.936 | 0.037 |
| 52 | 0.001 | 0.000 | 0.999 | 0.000 |
| 53 | 0.003 | 0.009 | 0.948 | 0.039 |
| 54 | 0.984 | 0.001 | 0.012 | 0.003 |
| 55 | 0.007 | 0.003 | 0.973 | 0.016 |
| 56 | 0.988 | 0.008 | 0.001 | 0.002 |
| 57 | 0.917 | 0.013 | 0.066 | 0.005 |
| 58 | 0.250 | 0.250 | 0.250 | 0.250 |
| 59 | 0.000 | 0.000 | 0.000 | 1.000 |
| 60 | 0.003 | 0.006 | 0.988 | 0.003 |
| 61 | 0.250 | 0.250 | 0.250 | 0.250 |
| 62 | 0.001 | 0.002 | 0.001 | 0.997 |
| 63 | 0.000 | 0.000 | 0.999 | 0.001 |
| 64 | 1.000 | 0.000 | 0.000 | 0.000 |
| 65 | 0.000 | 1.000 | 0.000 | 0.000 |
| 66 | 0.019 | 0.074 | 0.043 | 0.865 |
| 67 | 0.999 | 0.000 | 0.000 | 0.000 |
| 68 | 0.007 | 0.006 | 0.958 | 0.029 |
| 69 | 0.309 | 0.026 | 0.661 | 0.004 |
| 71 | 0.790 | 0.013 | 0.188 | 0.009 |
| 73 | 0.167 | 0.008 | 0.822 | 0.002 |
| 74 | 0.250 | 0.250 | 0.250 | 0.250 |
| 76 | 0.001 | 0.002 | 0.996 | 0.002 |
| 77 | 0.000 | 1.000 | 0.000 | 0.000 |
| 78 | 0.021 | 0.001 | 0.000 | 0.977 |
| 79 | 0.917 | 0.013 | 0.066 | 0.005 |
| 80 | 0.000 | 1.000 | 0.000 | 0.000 |
| 81 | 0.001 | 0.001 | 0.997 | 0.001 |
| 82 | 0.008 | 0.965 | 0.006 | 0.021 |
| 83 | 0.007 | 0.018 | 0.964 | 0.011 |
| 84 | 0.000 | 0.001 | 0.000 | 0.999 |
| 85 | 0.001 | 0.000 | 0.998 | 0.000 |
| 86 | 0.001 | 0.003 | 0.995 | 0.002 |
| 87 | 0.731 | 0.215 | 0.011 | 0.042 |
| 88 | 0.889 | 0.012 | 0.088 | 0.011 |
| 89 | 0.018 | 0.002 | 0.920 | 0.059 |
| 90 | 0.975 | 0.015 | 0.008 | 0.002 |
| 91 | 0.250 | 0.250 | 0.250 | 0.250 |
| 92 | 0.000 | 0.000 | 0.999 | 0.000 |
| 95 | 0.000 | 0.996 | 0.001 | 0.003 |
| 96 | 0.045 | 0.077 | 0.868 | 0.010 |
| 97 | 0.003 | 0.015 | 0.001 | 0.980 |
| 98 | 0.000 | 0.000 | 0.000 | 0.999 |
| 99 | 0.002 | 0.004 | 0.006 | 0.988 |
| 100 | 0.000 | 0.000 | 1.000 | 0.000 |
| 101 | 0.250 | 0.250 | 0.250 | 0.250 |
| 102 | 0.946 | 0.030 | 0.005 | 0.018 |
| 103 | 0.001 | 0.001 | 0.000 | 0.998 |
| 104 | 0.001 | 0.998 | 0.000 | 0.000 |
| 105 | 0.945 | 0.041 | 0.009 | 0.004 |
| 106 | 0.000 | 0.001 | 0.997 | 0.002 |

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| ID | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| 107 | 0.000 | 0.000 | 0.995 | 0.005 |
| 108 | 0.001 | 0.000 | 0.979 | 0.020 |
| 109 | 0.993 | 0.001 | 0.000 | 0.006 |
| 110 | 0.989 | 0.007 | 0.001 | 0.004 |
| 111 | 0.991 | 0.002 | 0.006 | 0.001 |
| 112 | 0.250 | 0.250 | 0.250 | 0.250 |
| 113 | 0.000 | 0.000 | 0.000 | 1.000 |
| 114 | 0.950 | 0.017 | 0.023 | 0.010 |
| 116 | 0.004 | 0.024 | 0.972 | 0.001 |
| 117 | 0.000 | 0.000 | 0.997 | 0.003 |
| 118 | 0.014 | 0.986 | 0.000 | 0.000 |

## Table A4. ESTIMATED FUZZY MEMBERSHIP DEGREES FOR CONTRIBUTION TO EMPLOYEE SKILL IMPROVEMENT AND TASK ACHIEVEMENT

| ID | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| 1 | 0.250 | 0.250 | 0.250 | 0.250 |
| 2 | 0.250 | 0.250 | 0.250 | 0.250 |
| 3 | 0.997 | 0.002 | 0.001 | 0.000 |
| 4 | 0.997 | 0.002 | 0.001 | 0.001 |
| 5 | 0.001 | 0.003 | 0.994 | 0.003 |
| 6 | 0.000 | 0.997 | 0.001 | 0.001 |
| 7 | 0.912 | 0.070 | 0.015 | 0.003 |
| 8 | 0.000 | 0.050 | 0.000 | 0.950 |
| 9 | 0.002 | 0.001 | 0.001 | 0.995 |
| 10 | 0.044 | 0.012 | 0.933 | 0.011 |
| 11 | 0.999 | 0.001 | 0.000 | 0.000 |
| 12 | 0.025 | 0.005 | 0.968 | 0.001 |
| 13 | 0.250 | 0.250 | 0.250 | 0.250 |
| 14 | 0.997 | 0.001 | 0.000 | 0.002 |
| 15 | 0.001 | 0.995 | 0.003 | 0.001 |
| 16 | 0.000 | 0.999 | 0.001 | 0.000 |
| 17 | 0.987 | 0.006 | 0.006 | 0.002 |
| 18 | 0.000 | 1.000 | 0.000 | 0.000 |
| 19 | 0.006 | 0.985 | 0.002 | 0.007 |
| 20 | 0.000 | 0.000 | 0.997 | 0.002 |
| 21 | 0.002 | 0.992 | 0.002 | 0.005 |
| 22 | 0.000 | 0.001 | 0.998 | 0.001 |
| 23 | 0.000 | 0.998 | 0.001 | 0.000 |
| 28 | 0.033 | 0.131 | 0.789 | 0.047 |
| 29 | 0.061 | 0.568 | 0.213 | 0.158 |
| 30 | 0.999 | 0.000 | 0.000 | 0.001 |
| 31 | 0.902 | 0.079 | 0.015 | 0.004 |
| 32 | 0.167 | 0.047 | 0.521 | 0.265 |
| 33 | 0.000 | 0.000 | 1.000 | 0.000 |
| 34 | 0.926 | 0.009 | 0.063 | 0.002 |
| 35 | 0.001 | 0.001 | 0.002 | 0.997 |
| 36 | 0.966 | 0.021 | 0.005 | 0.008 |
| 37 | 0.900 | 0.017 | 0.004 | 0.079 |
| 38 | 0.001 | 0.001 | 0.994 | 0.003 |
| 39 | 0.999 | 0.001 | 0.000 | 0.000 |
| 40 | 0.882 | 0.003 | 0.015 | 0.100 |
| 41 | 0.005 | 0.986 | 0.008 | 0.001 |
| 42 | 0.001 | 0.009 | 0.987 | 0.003 |
| 43 | 0.152 | 0.023 | 0.820 | 0.004 |
| 44 | 1.000 | 0.000 | 0.000 | 0.000 |
| 45 | 0.022 | 0.060 | 0.021 | 0.896 |
| 46 | 0.988 | 0.007 | 0.001 | 0.003 |
| 47 | 0.863 | 0.021 | 0.085 | 0.031 |
| 48 | 0.001 | 0.993 | 0.003 | 0.003 |
| 49 | 0.000 | 0.001 | 0.000 | 0.998 |
| 50 | 0.027 | 0.000 | 0.016 | 0.957 |
| 51 | 0.024 | 0.003 | 0.936 | 0.038 |
| 52 | 0.000 | 1.000 | 0.000 | 0.000 |
| 53 | 0.000 | 0.999 | 0.000 | 0.000 |
| 54 | 0.000 | 1.000 | 0.000 | 0.000 |
| 55 | 0.007 | 0.004 | 0.973 | 0.016 |
| 56 | 0.988 | 0.008 | 0.001 | 0.002 |
| 57 | 0.917 | 0.013 | 0.066 | 0.005 |
| 58 | 0.250 | 0.250 | 0.250 | 0.250 |
| 59 | 0.000 | 0.000 | 0.000 | 0.999 |
| 60 | 0.002 | 0.005 | 0.991 | 0.002 |
| 61 | 0.250 | 0.250 | 0.250 | 0.250 |
| 62 | 0.001 | 0.003 | 0.001 | 0.995 |
| 63 | 0.002 | 0.992 | 0.001 | 0.005 |
| 64 | 0.994 | 0.000 | 0.000 | 0.006 |
| 65 | 0.001 | 0.005 | 0.002 | 0.991 |
| 66 | 0.000 | 0.995 | 0.004 | 0.001 |
| 67 | 0.999 | 0.001 | 0.000 | 0.000 |
| 68 | 0.999 | 0.001 | 0.000 | 0.000 |
| 69 | 0.309 | 0.026 | 0.661 | 0.004 |
| 71 | 0.790 | 0.013 | 0.188 | 0.009 |
| 73 | 0.001 | 0.004 | 0.001 | 0.993 |
| 74 | 0.250 | 0.250 | 0.250 | 0.250 |
| 76 | 0.000 | 0.001 | 0.998 | 0.001 |
| 77 | 0.000 | 0.999 | 0.000 | 0.001 |
| 78 | 0.022 | 0.001 | 0.000 | 0.977 |
| 79 | 0.067 | 0.640 | 0.251 | 0.042 |
| 80 | 0.965 | 0.005 | 0.010 | 0.020 |
| 81 | 0.009 | 0.102 | 0.000 | 0.888 |
| 82 | 0.007 | 0.971 | 0.005 | 0.018 |
| 83 | 0.978 | 0.004 | 0.001 | 0.017 |
| 84 | 0.000 | 0.002 | 0.000 | 0.997 |
| 85 | 0.002 | 0.001 | 0.997 | 0.000 |
| 86 | 1.000 | 0.000 | 0.000 | 0.000 |
| 87 | 0.000 | 0.000 | 1.000 | 0.000 |
| 88 | 0.888 | 0.012 | 0.088 | 0.012 |
| 89 | 0.019 | 0.002 | 0.920 | 0.059 |
| 90 | 0.975 | 0.015 | 0.008 | 0.002 |
| 91 | 0.250 | 0.250 | 0.250 | 0.250 |
| 92 | 0.000 | 0.001 | 0.998 | 0.001 |
| 95 | 0.000 | 0.000 | 1.000 | 0.000 |
| 96 | 0.001 | 0.001 | 0.001 | 0.997 |
| 97 | 0.001 | 0.001 | 0.997 | 0.001 |
| 98 | 0.002 | 0.990 | 0.006 | 0.002 |
| 99 | 0.002 | 0.005 | 0.009 | 0.983 |
| 100 | 0.001 | 0.007 | 0.002 | 0.991 |
| 101 | 0.250 | 0.250 | 0.250 | 0.250 |
| 102 | 0.000 | 0.001 | 0.000 | 0.999 |
| 103 | 0.026 | 0.132 | 0.837 | 0.005 |
| 104 | 0.001 | 0.999 | 0.000 | 0.000 |
| 105 | 0.000 | 0.000 | 0.999 | 0.000 |
| 106 | 0.001 | 0.002 | 0.993 | 0.004 |
| 107 | 0.000 | 0.000 | 0.979 | 0.020 |
| 108 | 0.001 | 0.001 | 0.952 | 0.047 |
| 109 | 0.993 | 0.001 | 0.000 | 0.006 |
| 110 | 0.989 | 0.007 | 0.001 | 0.004 |
| 111 | 0.991 | 0.002 | 0.006 | 0.001 |
| 112 | 0.250 | 0.250 | 0.250 | 0.250 |
| 113 | 0.000 | 0.000 | 0.000 | 0.999 |
| 114 | 0.949 | 0.017 | 0.023 | 0.010 |
| 116 | 0.998 | 0.001 | 0.000 | 0.001 |
| 117 | 0.774 | 0.158 | 0.036 | 0.032 |
| 118 | 0.002 | 0.998 | 0.000 | 0.000 |

## Table A5. ESTIMATED FUZZY MEMBERSHIP DEGREES FOR QUALITY OF FOLLOW-UP AND SUPPORT

| ID | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| 1 | 0.250 | 0.250 | 0.250 | 0.250 |
| 2 | 0.250 | 0.250 | 0.250 | 0.250 |
| 3 | 0.000 | 0.998 | 0.001 | 0.000 |
| 4 | 0.996 | 0.002 | 0.001 | 0.001 |
| 5 | 0.001 | 0.002 | 0.995 | 0.002 |
| 6 | 0.001 | 0.996 | 0.002 | 0.002 |
| 7 | 0.912 | 0.070 | 0.015 | 0.003 |
| 8 | 0.000 | 0.085 | 0.000 | 0.915 |

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| ID | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| 9 | 0.031 | 0.108 | 0.857 | 0.004 |
| 10 | 0.044 | 0.012 | 0.933 | 0.011 |
| 11 | 0.005 | 0.002 | 0.001 | 0.992 |
| 12 | 0.025 | 0.005 | 0.968 | 0.001 |
| 13 | 0.250 | 0.250 | 0.250 | 0.250 |
| 14 | 0.004 | 0.024 | 0.963 | 0.009 |
| 15 | 0.988 | 0.001 | 0.002 | 0.009 |
| 16 | 0.994 | 0.002 | 0.004 | 0.001 |
| 17 | 0.987 | 0.006 | 0.006 | 0.002 |
| 18 | 0.001 | 0.999 | 0.000 | 0.000 |
| 19 | 0.035 | 0.008 | 0.953 | 0.004 |
| 20 | 0.771 | 0.136 | 0.034 | 0.059 |
| 21 | 0.001 | 0.002 | 0.997 | 0.001 |
| 22 | 0.000 | 0.001 | 0.998 | 0.001 |
| 23 | 0.000 | 0.998 | 0.002 | 0.000 |
| 28 | 0.003 | 0.987 | 0.001 | 0.008 |
| 29 | 0.007 | 0.907 | 0.054 | 0.031 |
| 30 | 0.036 | 0.176 | 0.733 | 0.054 |
| 31 | 0.000 | 0.000 | 1.000 | 0.000 |
| 32 | 0.167 | 0.047 | 0.521 | 0.265 |
| 33 | 0.000 | 0.000 | 1.000 | 0.000 |
| 34 | 0.001 | 0.995 | 0.003 | 0.001 |
| 35 | 0.993 | 0.004 | 0.002 | 0.000 |
| 36 | 0.969 | 0.019 | 0.004 | 0.008 |
| 37 | 0.001 | 0.002 | 0.997 | 0.001 |
| 38 | 0.007 | 0.003 | 0.002 | 0.987 |
| 39 | 0.996 | 0.004 | 0.000 | 0.000 |
| 40 | 0.882 | 0.003 | 0.015 | 0.100 |
| 41 | 0.006 | 0.984 | 0.010 | 0.001 |
| 42 | 0.011 | 0.015 | 0.003 | 0.971 |
| 43 | 0.003 | 0.995 | 0.002 | 0.001 |
| 44 | 1.000 | 0.000 | 0.000 | 0.000 |
| 45 | 0.395 | 0.053 | 0.542 | 0.010 |
| 46 | 0.988 | 0.007 | 0.001 | 0.003 |
| 47 | 0.000 | 0.997 | 0.000 | 0.002 |
| 48 | 0.002 | 0.992 | 0.003 | 0.003 |
| 49 | 0.000 | 0.002 | 0.000 | 0.997 |
| 50 | 0.043 | 0.001 | 0.022 | 0.935 |
| 51 | 0.024 | 0.003 | 0.936 | 0.038 |
| 52 | 0.110 | 0.000 | 0.890 | 0.000 |
| 53 | 0.000 | 0.999 | 0.000 | 0.001 |
| 54 | 0.000 | 0.000 | 0.000 | 1.000 |
| 55 | 0.007 | 0.004 | 0.973 | 0.016 |
| 56 | 0.988 | 0.008 | 0.001 | 0.002 |
| 57 | 0.917 | 0.013 | 0.066 | 0.005 |
| 58 | 0.250 | 0.250 | 0.250 | 0.250 |
| 59 | 1.000 | 0.000 | 0.000 | 0.000 |
| 60 | 0.843 | 0.120 | 0.029 | 0.008 |
| 61 | 0.250 | 0.250 | 0.250 | 0.250 |
| 62 | 0.001 | 0.004 | 0.001 | 0.994 |
| 63 | 0.002 | 0.991 | 0.001 | 0.005 |
| 64 | 0.989 | 0.000 | 0.000 | 0.010 |
| 65 | 0.000 | 0.999 | 0.001 | 0.000 |
| 66 | 0.000 | 0.994 | 0.004 | 0.001 |
| 67 | 0.018 | 0.110 | 0.871 | 0.002 |
| 68 | 0.998 | 0.002 | 0.000 | 0.000 |
| 69 | 0.309 | 0.026 | 0.661 | 0.004 |
| 71 | 0.790 | 0.013 | 0.188 | 0.009 |
| 73 | 0.167 | 0.008 | 0.822 | 0.002 |
| 74 | 0.250 | 0.250 | 0.250 | 0.250 |
| 76 | 0.840 | 0.014 | 0.031 | 0.116 |
| 77 | 0.000 | 0.998 | 0.000 | 0.001 |
| 78 | 0.022 | 0.001 | 0.000 | 0.977 |
| 79 | 0.917 | 0.013 | 0.066 | 0.005 |
| 80 | 0.000 | 0.997 | 0.002 | 0.001 |
| 81 | 0.001 | 0.001 | 0.997 | 0.001 |
| 82 | 0.006 | 0.972 | 0.005 | 0.016 |
| 83 | 0.007 | 0.018 | 0.964 | 0.011 |
| 84 | 0.998 | 0.000 | 0.000 | 0.001 |
| 85 | 0.002 | 0.001 | 0.996 | 0.000 |
| 86 | 0.001 | 0.005 | 0.991 | 0.004 |
| 87 | 0.731 | 0.215 | 0.011 | 0.042 |
| 88 | 0.888 | 0.012 | 0.088 | 0.012 |
| 89 | 0.019 | 0.002 | 0.920 | 0.059 |
| 90 | 0.975 | 0.015 | 0.008 | 0.002 |
| 91 | 0.250 | 0.250 | 0.250 | 0.250 |
| 92 | 0.947 | 0.026 | 0.007 | 0.020 |
| 95 | 0.000 | 0.000 | 1.000 | 0.000 |
| 96 | 0.045 | 0.077 | 0.868 | 0.010 |
| 97 | 0.005 | 0.023 | 0.002 | 0.970 |
| 98 | 0.000 | 0.000 | 0.000 | 1.000 |
| 99 | 0.002 | 0.006 | 0.010 | 0.981 |
| 100 | 0.001 | 0.008 | 0.002 | 0.990 |
| 101 | 0.250 | 0.250 | 0.250 | 0.250 |
| 102 | 0.000 | 0.000 | 0.000 | 1.000 |
| 103 | 0.026 | 0.132 | 0.837 | 0.005 |
| 104 | 0.000 | 0.999 | 0.000 | 0.000 |
| 105 | 0.945 | 0.041 | 0.009 | 0.004 |
| 106 | 0.001 | 0.003 | 0.992 | 0.004 |
| 107 | 0.000 | 0.000 | 0.973 | 0.027 |
| 108 | 0.178 | 0.744 | 0.035 | 0.044 |
| 109 | 0.993 | 0.001 | 0.000 | 0.006 |
| 110 | 0.989 | 0.007 | 0.001 | 0.004 |
| 111 | 0.991 | 0.002 | 0.006 | 0.001 |
| 112 | 0.250 | 0.250 | 0.250 | 0.250 |
| 113 | 0.001 | 0.997 | 0.002 | 0.000 |
| 114 | 0.949 | 0.017 | 0.023 | 0.010 |
| 116 | 0.016 | 0.006 | 0.004 | 0.974 |
| 117 | 0.774 | 0.158 | 0.036 | 0.032 |
| 118 | 0.001 | 0.999 | 0.000 | 0.000 |

## Table A6. ESTIMATED FUZZY MEMBERSHIP DEGREES FOR COST PERFORMANCE

| ID | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| 1 | 0.250 | 0.250 | 0.250 | 0.250 |
| 2 | 0.250 | 0.250 | 0.250 | 0.250 |
| 3 | 0.990 | 0.004 | 0.003 | 0.002 |
| 4 | 0.982 | 0.014 | 0.001 | 0.003 |
| 5 | 0.002 | 0.989 | 0.007 | 0.002 |
| 6 | 0.002 | 0.978 | 0.015 | 0.006 |
| 7 | 0.008 | 0.988 | 0.004 | 0.001 |
| 8 | 0.994 | 0.001 | 0.004 | 0.001 |
| 9 | 0.002 | 0.001 | 0.001 | 0.996 |
| 10 | 0.939 | 0.018 | 0.028 | 0.015 |
| 11 | 0.000 | 1.000 | 0.000 | 0.000 |
| 12 | 0.031 | 0.008 | 0.958 | 0.003 |
| 13 | 0.250 | 0.250 | 0.250 | 0.250 |
| 14 | 0.003 | 0.978 | 0.004 | 0.014 |
| 15 | 0.001 | 0.991 | 0.005 | 0.002 |
| 16 | 0.990 | 0.003 | 0.005 | 0.001 |
| 17 | 0.979 | 0.009 | 0.009 | 0.004 |
| 18 | 0.001 | 0.003 | 0.996 | 0.000 |
| 19 | 0.042 | 0.012 | 0.938 | 0.007 |
| 20 | 0.989 | 0.007 | 0.001 | 0.002 |
| 21 | 0.002 | 0.992 | 0.001 | 0.005 |
| 22 | 0.002 | 0.011 | 0.967 | 0.020 |
| 23 | 0.002 | 0.001 | 0.997 | 0.000 |
| 28 | 0.000 | 0.999 | 0.000 | 0.001 |
| 29 | 0.005 | 0.894 | 0.066 | 0.035 |
| 30 | 0.911 | 0.010 | 0.005 | 0.074 |
| 31 | 0.878 | 0.090 | 0.023 | 0.009 |
| 32 | 0.039 | 0.923 | 0.015 | 0.023 |
| 33 | 0.000 | 0.002 | 0.000 | 0.997 |
| 34 | 0.001 | 0.995 | 0.002 | 0.001 |
| 35 | 0.013 | 0.065 | 0.907 | 0.016 |
| 36 | 0.991 | 0.006 | 0.001 | 0.002 |
| 37 | 0.002 | 0.992 | 0.001 | 0.005 |
| 38 | 0.002 | 0.001 | 0.002 | 0.996 |
| 39 | 0.002 | 0.998 | 0.000 | 0.000 |
| 40 | 0.003 | 0.002 | 0.989 | 0.006 |
| 41 | 0.005 | 0.986 | 0.008 | 0.002 |
| 42 | 0.003 | 0.001 | 0.000 | 0.996 |

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| ID | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| 43 | 0.949 | 0.014 | 0.035 | 0.002 |
| 44 | 0.007 | 0.004 | 0.002 | 0.988 |
| 45 | 0.015 | 0.968 | 0.012 | 0.004 |
| 46 | 0.000 | 0.002 | 0.001 | 0.996 |
| 47 | 0.830 | 0.030 | 0.098 | 0.041 |
| 48 | 0.003 | 0.976 | 0.006 | 0.016 |
| 49 | 0.000 | 0.000 | 0.999 | 0.000 |
| 50 | 0.000 | 0.000 | 1.000 | 0.000 |
| 51 | 0.029 | 0.005 | 0.922 | 0.044 |
| 52 | 0.018 | 0.004 | 0.019 | 0.960 |
| 53 | 0.001 | 0.004 | 0.005 | 0.990 |
| 54 | 0.977 | 0.002 | 0.016 | 0.005 |
| 55 | 0.010 | 0.006 | 0.964 | 0.021 |
| 56 | 0.979 | 0.013 | 0.004 | 0.005 |
| 57 | 0.889 | 0.021 | 0.079 | 0.011 |
| 58 | 0.250 | 0.250 | 0.250 | 0.250 |
| 59 | 0.005 | 0.986 | 0.002 | 0.006 |
| 60 | 0.001 | 0.998 | 0.001 | 0.000 |
| 61 | 0.250 | 0.250 | 0.250 | 0.250 |
| 62 | 0.002 | 0.004 | 0.002 | 0.993 |
| 63 | 0.001 | 0.991 | 0.002 | 0.006 |
| 64 | 0.003 | 0.000 | 0.000 | 0.996 |
| 65 | 0.000 | 0.000 | 1.000 | 0.000 |
| 66 | 0.004 | 0.959 | 0.035 | 0.003 |
| 67 | 0.992 | 0.005 | 0.002 | 0.002 |
| 68 | 0.009 | 0.006 | 0.012 | 0.974 |
| 69 | 0.310 | 0.029 | 0.656 | 0.005 |
| 71 | 0.777 | 0.017 | 0.194 | 0.012 |
| 73 | 0.001 | 0.996 | 0.001 | 0.001 |
| 74 | 0.250 | 0.250 | 0.250 | 0.250 |
| 76 | 0.024 | 0.003 | 0.010 | 0.963 |
| 77 | 0.003 | 0.003 | 0.993 | 0.001 |
| 78 | 0.998 | 0.000 | 0.000 | 0.002 |
| 79 | 0.072 | 0.018 | 0.903 | 0.006 |
| 80 | 0.954 | 0.008 | 0.014 | 0.025 |
| 81 | 0.011 | 0.930 | 0.000 | 0.059 |
| 82 | 0.503 | 0.358 | 0.052 | 0.088 |
| 83 | 0.964 | 0.008 | 0.001 | 0.026 |
| 84 | 0.003 | 0.968 | 0.015 | 0.014 |
| 85 | 0.954 | 0.007 | 0.035 | 0.005 |
| 86 | 0.001 | 0.011 | 0.979 | 0.009 |
| 87 | 0.016 | 0.034 | 0.010 | 0.941 |
| 88 | 0.010 | 0.002 | 0.986 | 0.002 |
| 89 | 0.024 | 0.004 | 0.905 | 0.067 |
| 90 | 0.000 | 0.005 | 0.994 | 0.000 |
| 91 | 0.250 | 0.250 | 0.250 | 0.250 |
| 92 | 0.000 | 1.000 | 0.000 | 0.000 |
| 95 | 0.004 | 0.007 | 0.964 | 0.025 |
| 96 | 1.000 | 0.000 | 0.000 | 0.000 |
| 97 | 0.007 | 0.038 | 0.001 | 0.955 |
| 98 | 0.001 | 0.996 | 0.002 | 0.001 |
| 99 | 0.001 | 0.005 | 0.003 | 0.991 |
| 100 | 0.001 | 0.002 | 0.000 | 0.997 |
| 101 | 0.250 | 0.250 | 0.250 | 0.250 |
| 102 | 0.000 | 0.002 | 0.995 | 0.003 |
| 103 | 0.986 | 0.008 | 0.003 | 0.003 |
| 104 | 0.000 | 0.000 | 0.998 | 0.001 |
| 105 | 0.001 | 0.999 | 0.000 | 0.000 |
| 106 | 0.017 | 0.961 | 0.015 | 0.007 |
| 107 | 0.000 | 0.000 | 0.019 | 0.981 |
| 108 | 0.996 | 0.002 | 0.001 | 0.001 |
| 109 | 0.000 | 0.000 | 0.000 | 1.000 |
| 110 | 0.000 | 0.999 | 0.000 | 0.001 |
| 111 | 0.988 | 0.003 | 0.008 | 0.002 |
| 112 | 0.250 | 0.250 | 0.250 | 0.250 |
| 113 | 0.007 | 0.002 | 0.991 | 0.000 |
| 114 | 0.939 | 0.021 | 0.027 | 0.014 |
| 116 | 0.989 | 0.004 | 0.001 | 0.005 |
| 117 | 0.000 | 0.000 | 0.011 | 0.989 |
| 118 | 0.890 | 0.109 | 0.000 | 0.001 |

## Table A7. ESTIMATED REGRESSION COEFFICIENTS $\beta_{kl}$ FOR ALL KEYWORDS

| Keyword | C1 | C2 | C3 | C4 |
|---|---|---|---|---|
| ***Keywords from the positive-point item (34)*** | | | | |
| Cost-effectiveness | 0.672 | 0.157 | −0.482 | −0.313 |
| Positive evaluation | 1.144 | 0.031 | −0.954 | −0.348 |
| Service quality | 0.299 | −0.515 | 0.923 | −0.617 |
| Prompt response | 0.365 | −0.109 | −0.724 | −0.143 |
| Courteous response | −0.709 | −0.031 | 1.302 | −0.743 |
| Instructor quality | 0.394 | 0.430 | 0.870 | −0.011 |
| Hands-on practice | 1.033 | −0.242 | 0.223 | 0.079 |
| Comprehension facilitation | 0.062 | −0.723 | 0.258 | 1.216 |
| Handling of questions | −0.032 | −0.230 | 0.168 | −0.065 |
| Flexible response | 0.640 | 0.166 | 0.708 | −0.082 |
| Understanding of the customer | −0.134 | −0.022 | −0.276 | −0.463 |
| Proposal capability | 1.741 | 0.818 | −0.427 | −0.396 |
| Templates | −0.257 | 0.000 | 0.000 | 0.058 |
| Support | 0.873 | 0.080 | −0.832 | 0.338 |
| Training quality | −0.402 | 0.443 | 1.964 | −0.335 |
| Facility environment | 0.977 | 0.407 | 0.090 | −0.180 |
| Feedback sharing | 0.636 | −1.098 | −0.906 | 0.318 |
| Participant satisfaction | 0.507 | 0.647 | 1.301 | −0.078 |
| In-house instructors | −0.013 | 0.068 | 0.000 | −0.797 |
| Front-line perspective | 0.815 | −0.426 | −0.782 | −0.640 |
| Experiential knowledge | 1.658 | 0.091 | 0.004 | 0.003 |
| Individualized support | −0.090 | 0.160 | −0.990 | 0.863 |
| Subject-matter expertise | 0.633 | −0.179 | −0.263 | 0.178 |
| Customer satisfaction | −0.309 | −0.513 | −0.008 | −0.447 |
| Learning roadmap | −0.211 | 0.349 | −0.649 | 0.159 |
| On-site delivery | 0.314 | −0.176 | 0.000 | 0.242 |
| Practical application | −0.800 | −0.002 | 0.265 | 0.122 |
| Online delivery | 0.544 | 0.010 | 0.805 | 0.032 |
| Skill assessment | 0.233 | −0.132 | 1.010 | 0.005 |
| Facilitation of dialogue | 0.513 | −0.045 | 0.026 | 0.109 |
| Skill-level understanding | 0.015 | 0.001 | 0.755 | 0.048 |
| Learning environment | 0.362 | −0.287 | 0.000 | −0.549 |
| Lecture pacing | 0.362 | −0.287 | 0.000 | −0.549 |
| Ease of attendance | 0.362 | −0.287 | 0.000 | −0.549 |
| ***Keywords from the improvement-suggestion item (40)*** | | | | |
| Shift to online | 1.272 | 0.768 | 0.089 | 0.178 |
| Material improvement | 0.082 | −0.251 | 0.026 | −0.785 |
| Advance sharing | 0.325 | −0.407 | −0.864 | 0.193 |
| New technical domains | −1.586 | 0.014 | 0.336 | −0.335 |
| MOS-style certification | 0.459 | −0.763 | −0.482 | −0.660 |
| Effectiveness measurement | 0.267 | −0.192 | −0.735 | 0.632 |
| Comprehension checks | −0.778 | −0.005 | 1.045 | 0.138 |
| Review support | −0.629 | 0.750 | −0.148 | 0.119 |
| Workplace retention of learning | −0.004 | −0.208 | 0.255 | 0.125 |
| Improvement proposals | −0.590 | 0.135 | 0.322 | 0.506 |
| Matters for consideration | 1.498 | 0.315 | 0.135 | −0.024 |
| Customer requests | 0.000 | −0.641 | −0.877 | −1.385 |
| Practice reinforcement | 0.617 | −0.004 | 0.254 | 0.788 |
| Proactive proposals | 0.545 | −0.247 | −0.176 | 0.126 |
| Expanded program menu | 0.000 | 0.140 | 0.397 | 0.511 |
| AI training | 0.338 | 0.181 | 1.113 | −0.119 |
| DX (digital transformation) training | −0.108 | 0.083 | 0.081 | −0.165 |
| Job-specific programs | −0.326 | 0.166 | 0.112 | 0.436 |
| Ongoing consultation | 1.103 | 0.040 | 0.253 | 0.196 |
| Operational improvement | −0.529 | 0.324 | −0.283 | 0.129 |
| Faster invoicing | 0.000 | 0.045 | −0.358 | 0.063 |
| Program design improvement | 1.019 | −0.248 | −0.690 | −0.164 |
| No improvements needed | −0.728 | 0.152 | 1.206 | 0.276 |
| Maintain current status | −0.728 | 0.152 | 1.206 | 0.276 |
| Continued support | −0.728 | 0.152 | 1.206 | 0.276 |
| Consistency across instructors | −0.426 | 0.003 | 0.046 | −0.150 |
| Per-participant pricing | 0.040 | 0.000 | −0.085 | 0.157 |
| Corporate approval process | 0.040 | 0.000 | −0.085 | 0.157 |

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| Keyword | C1 | C2 | C3 | C4 |
|---|---|---|---|---|
| Cost improvement | −0.942 | −0.032 | −0.030 | 0.470 |
| Power outlets at venues | −0.505 | 0.071 | 0.000 | 0.000 |
| Administrative departments | 0.095 | 0.216 | −0.057 | 0.010 |
| Childcare and nursing care | 0.266 | 0.002 | 0.000 | 0.336 |
| Handling of absences | 0.000 | −0.214 | 0.000 | 0.038 |
| Industry trends | 0.000 | −0.228 | 0.108 | −0.834 |
| Price transparency | 0.517 | −0.133 | −0.684 | 0.389 |
| LMS introduction | −0.693 | 0.018 | 0.154 | 0.000 |
| Training on actual equipment | 0.361 | 0.139 | 0.004 | −0.027 |
| Research and development | 0.271 | −0.021 | 0.268 | 0.004 |
| Annual training plan | 0.000 | 0.000 | −0.065 | 0.140 |
| NDA handling | 0.000 | 0.218 | 0.367 | −0.209 |

*All 74 keywords used as explanatory variables are listed (34 from the positive-point item and 40 from the improvement-suggestion item). Values are rounded to three decimal places.* *C1–C4 denote Clusters 1–4.*

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