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# ITEM RESPONSE MODEL FOR ANALYZING ITEM RESPONSES IN THE INSTRUMENT OF CHANGE MANAGEMENT AND ORGANIZATIONAL CULTURE

**Dian Handayani[1*], Muhammad Alief Ghifari[2], Vera Maya Santi[3], Rahfa Qur'aniyatin Dhuha[4]**

*[1,3,4]Study Program of Statistics, Faculty of Natural Sciences and Mathematics, State University of Jakarta, Jl. Rawamangun Muka, Jakarta, 13220, Indonesia*
*[2]Campaign Operation Associate - PT. Pintarnya Solusi Teknologi*

Corresponding author's e-mail: * ***dianh@unj.ac.id***

ABSTRACT

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Item Response Theory (IRT) is an approach that can be used to analyze the responses/answers given by respondents to a measurement instrument. Unlike the classical test theory (CTT) approach that measures the latent traits of respondents based on the total score, IRT measures latent traits based on the responses given by respondents to each item. Another difference between CTT and IRT is that the CTT approach is theory-based while IRT is model-based. The purpose of this study is to apply Item Response Theory (IRT) to analyze the item responses of the employees of the Kementerian Desa, Pembangunan Daerah Tertinggal, dan Transmigrasi/KDPDTTT (Ministry of Village, Development of Disadvantaged Regions and Transmigration) on the items in the instrument/questionnaire which was administered to the employees, in order to understand their attitudes towards the changes management and organizational culture in the KDPDTT.

We applied item response theory to analyze the answers provided by the respondents to the items. These responses were modelled based on the dichotomous IRT models, namely the 1PL, 2PL, and 3PL models. The IRT modeling in this study is based on the results of a survey conducted by KDPDTTT in 2020. Among the three models, the 2PL model is the most suitable for our item responses data because it has the smallest AIC, BIC, and $G^2$. Based on the 2PL model, the probability for endorsing the items related to the change management ranges from 0.68 to 0.95. Meanwhile, the probability for endorsing items related to organizational culture ranges from 0.87 to 0.98. Although each item in the instrument has three response options, namely "disagree", "undecided (neutral)", and "agree", we will treat them as dichotomous. We classify the "undecided" answer as the "disagree" category. The reason is that many Indonesian people usually find it hard to say "disagree" for a question related to the evaluation of a policy. They tend to feel safer by choosing "undecided". Therefore, the item responses that have been analyzed in our study are dichotomous, that is, "agree" or "disagree". The novelty of this research is utilizing a non-classical approach, namely IRT, which has several advantages over Classical Test Theory (CTT), including that item characteristics do not depend on respondent characteristics, and vice versa.



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## 1. INTRODUCTION

In an organization, some individuals typically feel comfortable with the existing organizational culture, while others may desire changes. Organizational culture refers to the habits and norms which are accepted as truths by all individuals in an organization/institution [1]. Those who wish for changes are usually caused by significant events that make them feel uncomfortable. The strategy to prepare and support individuals in an institution to adopt the changes that the institution will advance is called change management [2], [3].

Kementerian Desa, Pembangunan Daerah Tertinggal, dan Transmigrasi/KDPDTT (Ministry of Villages, Development of Disadvantaged Regions, and Transmigration) of the Republic of Indonesia conducted a survey on change management and organizational culture in 2020 to find out some opinions or attitudes from employees, both civil servants (Aparatur Sipil Negara/ASN) and non-civil servants (Non-ASN), regarding change management and organizational culture in the ministry. The instrument/ questionnaire in the survey consists of 26 items (13 items were designed to assess respondents' opinions on change management, while the remaining 13 items were designed to understand their attitudes toward organizational culture). Each item has three response options, namely disagree, undecided/neutral, and agree [4].

Item Response Theory (IRT) is an approach that can be used to understand the latent characteristics underlying respondents' answers to the items in a questionnaire [5], [6], [7], [8], [9]. In contrast to CTT, which focuses solely on the total score of a respondent across all items in the instrument, IRT focuses on the responses of the respondent to each item in the instrument. The CTT is theory-based, whereas IRT is model-based [7]. IRT models usually assume unidimensionality. It means that the answer given by a respondent to an item is influenced by only one latent trait. IRT also assumes local independence, meaning that a respondent's answer to one item in the instrument does not influence their responses to other items within the same instrument [10].

The common IRT models for dichotomous item responses are logistic models, including the one-parameter logistic model (1PL), the two-parameter logistic model (2PL), and the three-parameter logistic model (3PL). The names of these dichotomous logistic models are based on the number of item characteristics which is assumed to affect respondent performance [6], [7]. Research related to the application of IRT models for analyzing item responses in questionnaires/research instruments has been extensively conducted in various fields, such as health [11], [12], agriculture [13], education [14], [15], marketing [16], management [17], etc.

Our study aims to fit the 1PL, 2PL, and 3PL models to the item responses in the instrument of the survey on change management and organizational culture in KDPDTT. Among the three models, we select the model that is the most suitable for analyzing item responses in the instrument. Based on the selected model, we estimate some item characteristics, such as item difficulty, discrimination, and lower asymptote. Moreover, we also estimate the latent traits of respondents, specifically the level of acceptance/approval of organizational culture and change management in KDPTT.

## 2. METHODS

The data that was analyzed in our research was KDPDTT employees' responses to the items in the questionnaire on change management and organizational culture. The questionnaire was administered in a survey that was conducted in 2020. The respondents were 3125 employees of KDPDTT, both state civil servants (ASN) and non-state civil servants (non-ASN). The questionnaire consists of 26 items, of which 13 items are related to change management, and the remaining 13 items are related to the organizational culture.

### IRT Models for Dichotomous Item Responses

The IRT models commonly used for dichotomous item responses are logistic models, including the one-parameter logistic (1PL), two-parameter logistic (2PL), and three-parameter logistic (3PL) models. The 1-Parameter Logistic (1PL) model is an IRT model that involves only one item characteristic, namely difficulty item ($b$). The 1PL model is represented by the following equation [5], [6]:

$$P_i(\theta) = \frac{e^{(\theta - b_i)}}{1 + e^{(\theta - b_i)}} \tag{1}$$

The 2-Parameter Logistic (2PL) model is an IRT model that involves two item characteristics, namely difficulty item $(b)$ and discrimination item $(a)$. The 2PL model is represented by the following equation [5], [6]:

$$P_i(\theta) = \frac{e^{Da_i(\theta - b_i)}}{1 + e^{Da_i(\theta - b_i)}} \tag{2}$$

The 3-Parameter Logistic (3PL) model is an IRT model that incorporates three item characteristics, namely difficulty item $(b)$, discrimination item $(a)$ and lower asymptote item $(c)$. The 3PL model is defined by the following equation [5], [6]:

$$P_i(\theta) = c_i + (1 - c_i)\frac{e^{Da_i(\theta - b_i)}}{1 + e^{Da_i(\theta - b_i)}} \tag{3}$$

**Item Information Function and Test Information Function**

Item information function (IIF) is a function that describes how much information can be provided by a given item for estimating the latent traits of respondents. The information of a given item is inversely proportional to its standard error. It means that the greater thee information provided by an item for estimating the respondent's latent traits, the smaller the standard error of the latent traits estimates.

The IIF for $i^{th}$ item is given as follows [7]:

$$I_i(\theta) = \sum_{i=1}^{n} \frac{[P_i'(\theta)]^2}{P_i(\theta)[1 - P_i(\theta)]} \tag{4}$$

where $P_i(\theta)$ is the probability that a respondent with a latent trait $\theta$ will give a correct answer on $i^{th}$ item. This probability is calculated under the specified IRT model. The latent trait in our study is the level of acceptance or endorsement of the respondent/employee in the KDPDTT toward the change management and organizational culture in KDPDTT, $[P_i'(\theta)]$ is the first derivative for $P_i(\theta)$ subject to the $\theta$.

The test information function (*test information function*/TIF) is the summation from all of IIF [7]:

$$TIF(\theta) = \sum_{i=1}^{n} I_i(\theta) \tag{5}$$

The standard error/SE for the estimates of latent traits θ is given by [7]:

$$SE(\theta) = \frac{1}{\sqrt{TIF(\theta)}} \tag{6}$$

**Parameter Estimation for Dichotomous IRT Models**

The method that can be used to estimate parameters in the dichotomous IRT model, both parameters related to respondents and those related to items, is the maximum likelihood (ML) method. The maximum likelihood estimate (MLE) for a given parameter is obtained such that it maximizes a likelihood function. For the responses that are given by $N$ respondents to $n$ items, the likelihood function is given by [6]:

$$L(x_1, x_2, \dots, x_n|\theta) = \prod_{j=1}^{N}\prod_{i=1}^{n} P_{ij}^{x_{ij}} Q_{ij}^{1-x_{ij}} \tag{7}$$

where $P_{ij}$ is the probability of the $j^{th}$ respondent give a correct answer on the $i^{th}$ item, $Q_{ij}$ is the probability of the $j^{th}$ respondent give incorrect answer on the $i^{th}$ item, $x_{ij}$ is the response given by the $j^{th}$ respondent on the $i^{th}$ item with $x_{ij}$= 1 (for a correct response/answer) or $x_{ij} = 0$ (for an incorrect response), $i$ represents the index of items ($i = 1,2, \dots, n$), $j$ represents the index of respondent ($j = 1,2, \dots, N$), $P_{ij}$ and $Q_{ij}$ are functions of latent traits ($\theta$) and item parameters (*a,b,c*).

Based on (7), the logarithm likelihood function can be obtained as follows:

$$\begin{aligned} l = \ln L\,(x_1, x_2, \dots, x_n|\theta) &= \ln\left(\prod_{j=1}^{N}\prod_{i=1}^{n} P_{ij}^{x_{ij}} Q_{ij}^{1-x_{ij}}\right) \\ &= \sum_{j=1}^{N}\sum_{i=1}^{n}\left(x_{ij}\ln P_{ij} + (1 - x_{ij}) lnQ_{ij}\right) \end{aligned} \tag{8}$$

where $P_{ij}$ and $Q_{ij}$ are functions of $\lambda = (\theta.a, b, c)^T$. The estimates of $\lambda = (\theta.a, b, c)^T$ can be obtained by calculating $\frac{\partial l}{\partial \lambda} = 0$.

The function $\frac{\partial l}{\partial \lambda}$ is a nonlinear function, so the closed-form solution for $\frac{\partial l}{\partial \lambda} = 0$ is difficult to be obtained. Therefore, a numerical iteration method, such as Newton-Raphson iteration is required to obtain the solution [5],[6],[7]. The Newton-Raphson iteration process to obtain the maximum likelihood estimator of the latent characteristics $\theta$ and the item characteristics $\delta = (a, b, c)^T$ are [5],[6],[7]:

$$\hat{\theta}^{t+1} = \hat{\theta}^t - \frac{f(\hat{\theta}^t)}{f'(\hat{\theta}^t)} = \hat{\theta}^t - \frac{\frac{\partial}{\partial\theta} lnL(\underline{\boldsymbol{x}}|\theta^t)}{\frac{\partial^2}{\partial\theta^2} lnL(\underline{\boldsymbol{x}}|\theta^t)} \tag{9}$$

$$\hat{\delta}_j^{t+1} = \hat{\delta}_j^t - \frac{f(\hat{\delta}_j^t)}{f'(\hat{\delta}_j^t)} = \hat{\delta}_j^t - \frac{\frac{\partial}{\partial\delta} lnL(\underline{\boldsymbol{x}}|\delta_j^t)}{\frac{\partial^2}{\partial\delta^2} lnL(\underline{\boldsymbol{x}}|\delta_j^t)} \tag{10}$$

where $\hat{\theta}^t$ is the estimator of the respondent's latent characteristics at the $t^{th}$ iteration ($t = 0,1,2, \dots, T$) and $\hat{\delta}_j^t$ is the estimator of item characteristics at the $t^{th}$ iteration ($t = 0,1,2, \dots, T$). $T$ is the number of iterations, and the process will stop when the difference between the results of the $(t + 1)^{th}$ iteration and the $t^{th}$ iteration approaches zero.

**Goodness of Fit**

The goodness of fit test in IRT includes the item fit, person fit, and model fit [18]. The item fit test is conducted by using the $\chi^2$ statistic as follows [6]:

$$\chi^2 = \sum_{j=1}^{J} N_j \frac{(O_j - E_j)^2}{E_j(1 - E_j)} \tag{11}$$

where $O_j$ is the probability of a correct response in respondents' groups with the $j^{th}$ latent trait, $E_j$ is the expected value of the probabilities of a correct response in respondents' groups with the $j^{th}$ latent trait, and $N_j$ is the number of respondents with the $j^{th}$ latent trait. If the $\chi^2$ statistic $<$ critical value of chi-square or p-value $> \alpha$, it can be concluded that the item may fit with the specified IRT model adequately.

The person fit test refers to the alignment between the respondent's response pattern and the IRT model chosen to model the response data [18]. The person fit test was conducted by using $Z_h$ statistic as follows [18],[19]:

$$Z_h = \frac{\sum[\log L|\theta_j - \sum E(\log L \mid \theta_j)]}{\sqrt{(\sum V(\log L \mid \theta_j))}} \quad (12)$$

where $\log L \mid \theta_j$ is the logarithmic likelihood value for the pattern responses of $j^{th}$ respondent who has latent traits $\theta_j$. $E(\log L \mid \theta_j)$ is the average logarithmic likelihood value for the pattern responses of $j^{th}$ respondent who has latent traits $\theta_j$, and $V(\log L \mid \theta_j)$ is the variance logarithmic likelihood value for the pattern responses of $j^{th}$ respondent who has latent traits $\theta_j$. $Z_h$ in (12) follows a standard normal distribution. If the $Z_h$ statistic $< -2$, it indicates that the person may misfit with the specified IRT model.

The selection of the best model can be accomplished by comparing a model with other models. Model comparison can be accomplished using the $G^2$ statistics as follows [20]:

$$G^2 = -2\ln\frac{l(a)}{l(c)} = -2\ln[l(a) - l(c)] \quad (13)$$

where $l(a)$ is the likelihood function values of an augmented model, $l(c)$ is the likelihood function values of a compact model. Model selection can also be accomplished by calculating the AIC (Akaike's Information Criterion) and BIC (Bayesian Information Criterion) [21], [22]. The model with the minimum AIC and BIC values is selected as the best model.

The steps of our research are as follows:

1. Explore the data to find out the percentage and frequency of respondent responses for each response category.
2. Check the assumption of unidimensional and local independence.
3. Specify the dichotomous IRT model (1PL, 2PL, and 3PL).
4. Estimate the parameters of the dichotomous IRT model using the maximum likelihood estimation (MLE) method. The parameters that are estimated are item-related parameters (difficulty, discrimination, lower asymptote) and respondent-related parameters (latent traits). In our research, the latent traits are the level of employee acceptance/endorsement at KDPDTT towards change management and organizational culture.
5. Evaluate the model fit to the data based on the AIC, BIC, or $G^2$ statistics.
6. Evaluate the item fit based on the $\chi^2$ statistic and the person fit based on the $Z_h$ statistic.
7. Make an interpretation and prediction of item-related parameters and respondent-related parameters based on the best model.
8. Analyse the relationship between respondent characteristics and the probability of answering "agree" to an item based on the item characteristic curve (ICC).
9. Determine the item information function to evaluate how much information an item measures the latent trait.
10. Determine the test information function to evaluate how the test can distinguish the respondents based on their latent trait levels.

## 3. RESULTS

Based on the results in Table 1, Item 1 is the most endorsed by the respondents (84.58%) in the change management assessment, whereas Item 10 is the least endorsed by the respondents (58.94%), On the other hand, for the items related to organizational culture, Item 23 is the most endorsed by the respondents (82.24%) whereas Item 15 is the least endorsed (71.07%).

**Table 1. Percentage of Disagree or Agree Responses on Items**

| Item | Change Management | | Item | Organizational Culture | |
|---|---|---|---|---|---|
| | Percentage of Responses | | | Percentage of Responses | |
| | Disagree (0) | Agree (1) | | Disagree (0) | Agree (1) |
| Item 1 | 15.42 | 84.58 | Item 14 | 25.98 | 74.02 |
| Item 2 | 18.30 | 81.70 | Item 15 | 28.93 | 71.07 |
| Item 3 | 17.50 | 82.50 | Item 16 | 23.36 | 76.64 |
| Item 4 | 24.26 | 75.74 | Item 17 | 25.12 | 74.88 |
| Item 5 | 30.02 | 69.98 | Item 18 | 21.47 | 78.53 |
| Item 6 | 25.86 | 74.14 | Item 19 | 25.76 | 74.24 |
| Item 7 | 29.44 | 70.56 | Item 20 | 24.77 | 75.23 |
| Item 8 | 22.27 | 77.73 | Item 21 | 17.98 | 82.02 |
| Item 9 | 36.86 | 63.14 | Item 22 | 19.52 | 80.48 |
| Item 10 | 41.06 | 58.94 | Item 23 | 17.76 | 82.24 |
| Item 11 | 29.25 | 70.75 | Item 24 | 19.55 | 80.45 |
| Item 12 | 27.78 | 72.22 | Item 25 | 18.05 | 81.95 |
| Item 13 | 30.34 | 69.66 | Item 26 | 21.54 | 78.46 |

Table 2 shows the distribution of frequency (number of respondents) who agree (or endorse) to zero items, one item, two items, up to all items (13 items), which are each related to change management and organizational culture. It can be seen that there are 105 respondents (employees) who answered ‘disagree’ for all items related to measuring the attitude towards change management. There are 227 employees who answered ‘disagree’ for all items related to measuring the attitude towards organizational culture.

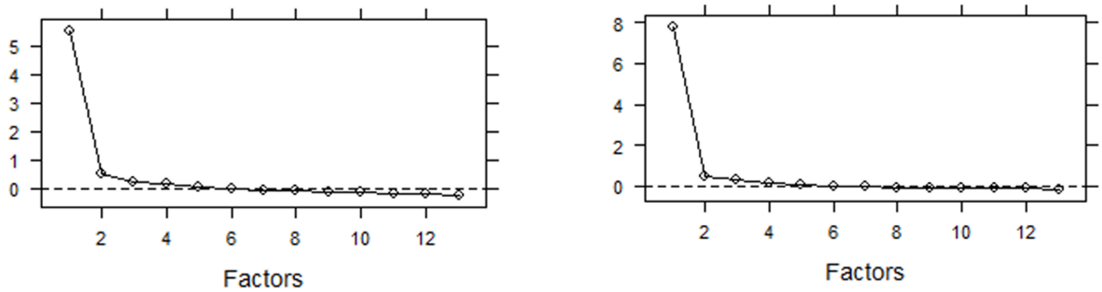
The number of employees who answered ‘agree’ only for one item, out of 13 items for measuring the attitude towards change management, was 64 employees. The number of employees who answered ‘agree’ for two items, out of 13 items for measuring the attitude towards change management, was 74 employees. Furthermore, the number of employees who answered ‘agree’ for all items (13 items) for measuring the attitude towards change management was 1074 employees. On the other hand, the number of employees who answered ‘agree’ for all items (13 items) for measuring the attitude towards organizational culture was 1636 employees.

**Table 2. Frequency Distribution of Responses on Items**

| Change Management | | Organizational Culture | |
|---|---|---|---|
| Response | Frequency | Response | Frequency |
| 0 | 105 | 0 | 227 |
| 1 | 64 | 1 | 64 |
| 2 | 74 | 2 | 50 |
| 3 | 94 | 3 | 67 |
| 4 | 116 | 4 | 64 |
| 5 | 113 | 5 | 75 |
| 6 | 147 | 6 | 76 |
| 7 | 137 | 7 | 78 |
| 8 | 168 | 8 | 90 |
| 9 | 202 | 9 | 116 |
| 10 | 225 | 10 | 130 |
| 11 | 371 | 11 | 185 |
| 12 | 335 | 12 | 267 |
| 13 | 1074 | 13 | 1636 |

### Diagnostics The Assumption of Unidimensionality and Local Independence

In IRT, two assumptions should be fulfilled, namely unidimensionality and local independence. One method for assessing the unidimensional assumption is by examining the scree plot generated from an exploratory factor analysis (EFA). Based on Figure 1(a) and (b), the eigenvalue of the first factor is greater than the eigenvalue of the second factor, with the plot forming an 'elbow' of the second factor. This indicates that the 13 items on the measurement of change management and organizational culture can be reduced to one latent factor. It suggests that the assumption of unidimensionality is fulfilled for both sets of items. Moreover, it implies that the local independence assumption is also fulfilled [6].




**(a)** **(b)**

**Figure 1. Scree Plot for Diagnostics of Unidimensional Assumption of Change Management (a) and Organizational Culture (b)**

### Model Comparison

Once it is known that the assumptions of unidimensionality and local independence are fulfilled, the next step is to fit the dichotomous item response models 1PL, 2PL, and 3PL. We select the best IRT model based on Akaike information criterion (AIC), Bayesian information criterion (BIC), and $G^2$ statistics [22]. The model that has the smallest values of these criterias will be selected as the best model. Table 3 shows that the 2PL model has the smallest AIC, BIC, and $G^2$ values compared to the 1PL and 3PL models for both change management and organizational culture. Therefore, the 2PL IRT model will be selected as the best model to analyse our item responses data.

**Table 3. The AIC, BIC, and $G^2$ for Model Comparison**

| Instrument | Model | AIC | BIC | $G^2$ |
|---|---|---|---|---|
| Change Management | 1PL | 33448.18 | 33532.84 | 4479.13 |
| | 2PL | 33310.59 | 33467.82 | 4317.55 |
| | 3PL | 33336.85 | 33572.69 | 4317.81 |
| Organizational Culture | 1PL | 23887.73 | 23972.40 | 3520.97 |
| | 2PL | 23834.80 | 23992.02 | 3444.04 |
| | 3PL | 23860.99 | 24096.83 | 3444.23 |

### Item Parameter Estimation

Based on Table 4, all the item discrimination ($a$) for the change management and organizational culture items are non-negative, indicating that none of these items need to be eliminated. The item difficulty ($b$) for all items related to the change management and the organizational culture are negative (close to -1). This indicates that the items for measuring the attitude toward change management as well as the organizational culture tend to be endorsed easily by respondents. Based on the 2PL model, the ranges of probability for endorsing the items related to the change management are from 0.68 to 0.95. Meanwhile, the ranges of probability for endorsing items related to organizational culture are from 0.87 to 0.98.

**Table 4. Estimates of Item Parameters based on 2PL Model**

| Item | Estimates of Item parameters for Change management | | | Probability of Answering "Agree" $P_i(\theta)$ | Item | Estimates of Item parameters for Organizational Culture | | | Probability of Answering "Agree" $P_i(\theta)$ |
|---|---|---|---|---|---|---|---|---|---|
| | *a* | *b* | *c* | | | *a* | *b* | *c* | |
| Item 1 | 2.48 | -1.24 | 0 | 0.95 | Item 14 | 3.25 | -0.732 | 0 | 0.89 |
| Item 2 | 2.84 | -1.05 | 0 | 0.95 | Item 15 | 3.76 | -0.617 | 0 | 0.87 |
| Item 3 | 2.02 | -1.23 | 0 | 0.92 | Item 16 | 4.04 | -0.790 | 0 | 0.94 |
| Item 4 | 2.11 | -0.90 | 0 | 0.87 | Item 17 | 4.55 | -0.719 | 0 | 0.94 |
| Item 5 | 2.18 | -0.67 | 0 | 0.81 | Item 18 | 4.37 | -0.846 | 0 | 0.96 |
| Item 6 | 2.70 | -0.77 | 0 | 0.89 | Item 19 | 4.23 | -0.705 | 0 | 0.92 |
| Item 7 | 2.83 | -0.64 | 0 | 0.86 | Item 20 | 4.01 | -0.744 | 0 | 0.93 |
| Item 8 | 1.94 | -1.02 | 0 | 0.88 | Item 21 | 4.85 | -0.961 | 0 | 0.98 |
| Item 9 | 3.04 | -0.40 | 0 | 0.77 | Item 22 | 5.30 | -0.893 | 0 | 0.98 |
| Item 10 | 2.56 | -0.29 | 0 | 0.68 | Item 23 | 4.96 | -0.967 | 0 | 0.98 |
| Item 11 | 2.99 | -0.64 | 0 | 0.87 | Item 24 | 4.74 | -0.905 | 0 | 0.97 |
| Item 12 | 3.394 | -0.67 | 0 | 0.91 | Item 25 | 4.53 | -0.968 | 0 | 0.98 |
| Item 13 | 2.958 | -0.61 | 0 | 0.86 | Item 26 | 3.91 | -0.860 | 0 | 0.95 |

**Goodness-of-Fit**

The item fit test is conducted by using the chi-square ($\chi^2$) statistic. Table 5 shows the results of diagnostics of item fit under the 2PL model. Based on Table 5, all the items in the change management and organizational culture have a p-value $> \alpha = 0{,}05$. Thus, we can conclude that all items fit the 2PL model.

**Table 5. Diagnostics of Item Fit Based on 2PL Model**

| Item | Chi-square | p-value | Item | Chi-square | p-value |
|---|---|---|---|---|---|
| Item 1 | 15.53 | 0.11 | Item 14 | 7.43 | 0.69 |
| Item 2 | 12.48 | 0.25 | Item 15 | 8.83 | 0.55 |
| Item 3 | 10.16 | 0.43 | Item 16 | 15.98 | 0.1 |
| Item 4 | 11.54 | 0.32 | Item 17 | 9.14 | 0.52 |
| Item 5 | 4.30 | 0.93 | Item 18 | 12.73 | 0.24 |
| Item 6 | 14.30 | 0.16 | Item 19 | 10.91 | 0.37 |
| Item 7 | 19.70 | 0.32 | Item 20 | 11.36 | 0.33 |
| Item 8 | 12.99 | 0.22 | Item 21 | 10.16 | 0.43 |
| Item 9 | 4.46 | 0.88 | Item 22 | 13.58 | 0.19 |
| Item 10 | 14.88 | 0.14 | Item 23 | 6.33 | 0.79 |
| Item 11 | 9.84 | 0.46 | Item 24 | 15.78 | 0.11 |
| Item 12 | 7.01 | 0.73 | Item 25 | 8.12 | 0.62 |
| Item 13 | 10.63 | 0.39 | Item 26 | 6.56 | 0.77 |

The person fit test is conducted by using the $Z_h$ statistic. Based on the person fit test, it can be identified that 54 respondents' response patterns are not aligned with the 2PL model for the items related to change management, whereas 17 respondents' response patterns are not aligned with the 2PL related to the items related to organizational culture. The patterns are not aligned with the 2PL model because their $Z_h$ statistic wer less than -2.

**Item Characteristics Curve (ICC)**

The item characteristic curve (ICC) in Figures 2 and Figure 3 shows that the respondents with a low latent trait (i.e., with less information value about change management or organizational culture) have a low probability of responding ‘agree’ to an item, but respondents with a high latent trait (i.e., with more information value about change management or organizational culture) have a high probability of responding ‘agree’ to an item.

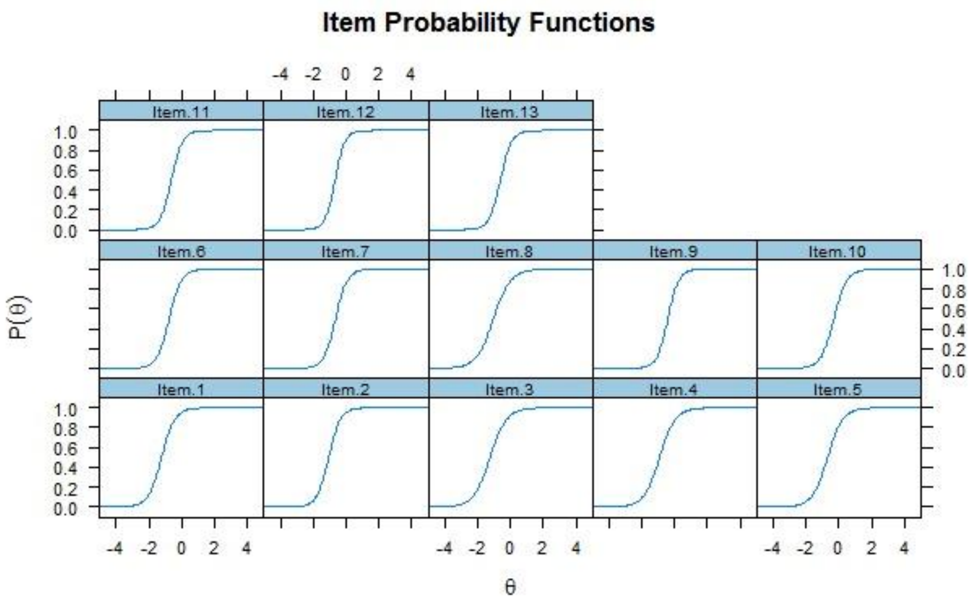



**Figure 2. Item Characteristics Curve (ICC) of Change Management**

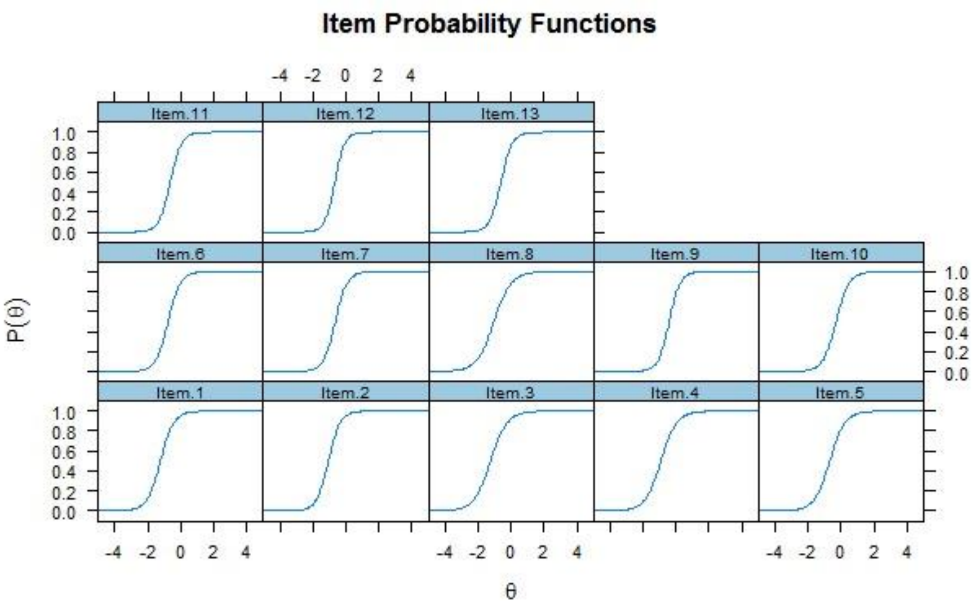



**Figure 3. Item Characteristic Curve (ICC) of Organizational Culture**

The slope of ICC in Figure 2 and Figure 3 represents the discrimination item for change management and organizational culture respectively. Based on Figure 2, the significant slope can be seen at Item 9, 12, and 13. On the other hand, the significant slope of the ICC in Figure 3 can be seen in items 21, 22, and 23. They indicate that the discrimination items are able to distinguish respondents with a high latent trait from those with a low latent trait.

**Item Information Function (IIF)**

The item information function (IIF) is a measurement of how much information is provided by assessing a latent trait. The item information function in this study indicates the information provided by an item in revealing the respondent's latent trait, namely the extent to which the respondent understands change management and organisational culture in KDPDTT.

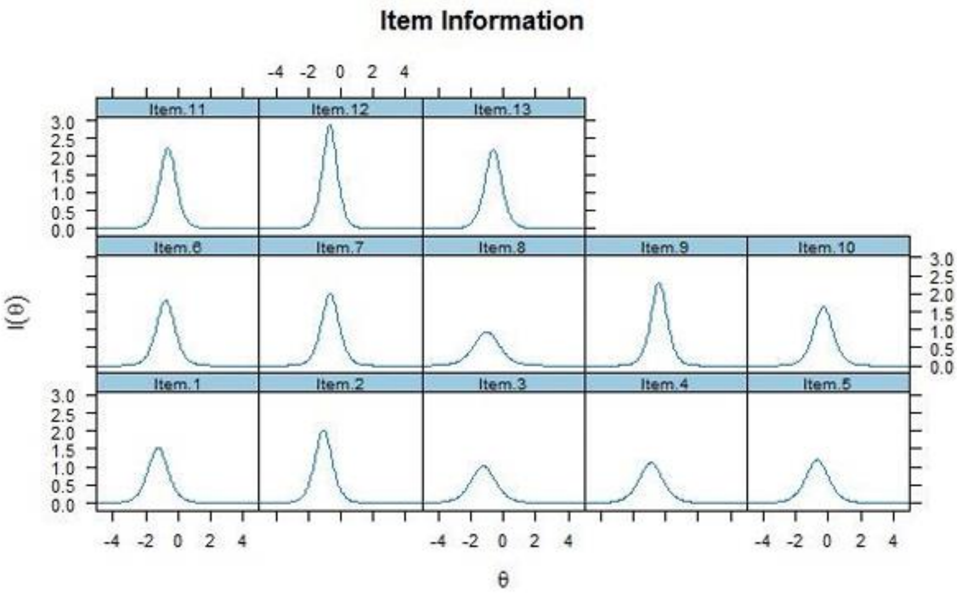



**Figure 4. Item Information Function (IIF) of Change Management**

Figure 4 shows the item information functions for items 1 to 13. Item 12 provides the highest information when the respondent's latent trait $\theta = -1.5$. Most of the items related to change management provide the highest information on the latent trait in the range $-4 \leq \theta \leq 0$. This indicates that the change management items provide maximum information on the respondents' understanding of change management in KDPDTT when the questionnaire is answered by respondents with a low latent trait compared to respondents with a high latent trait.

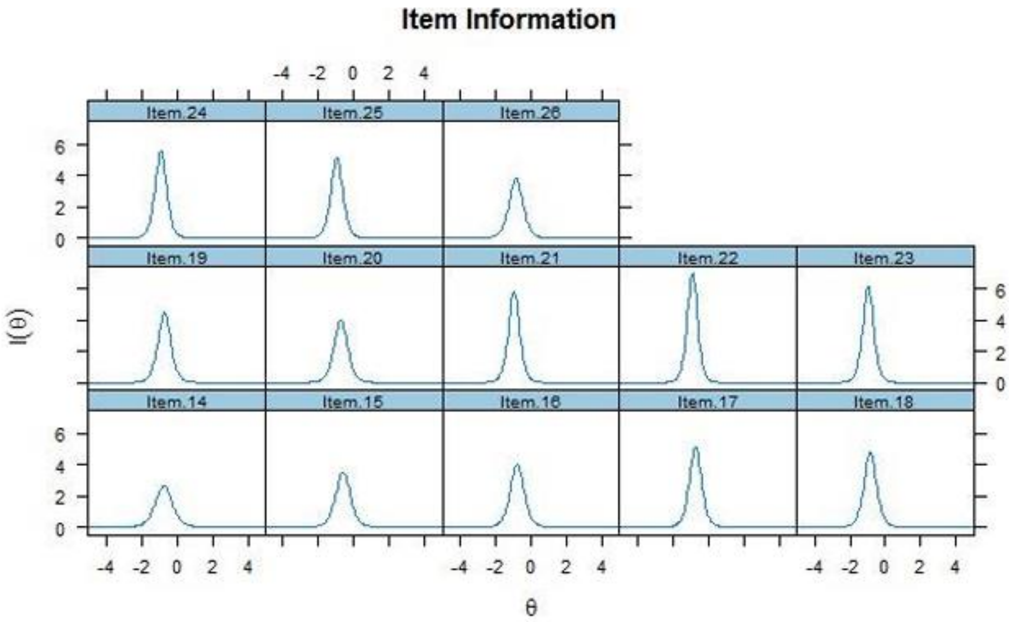
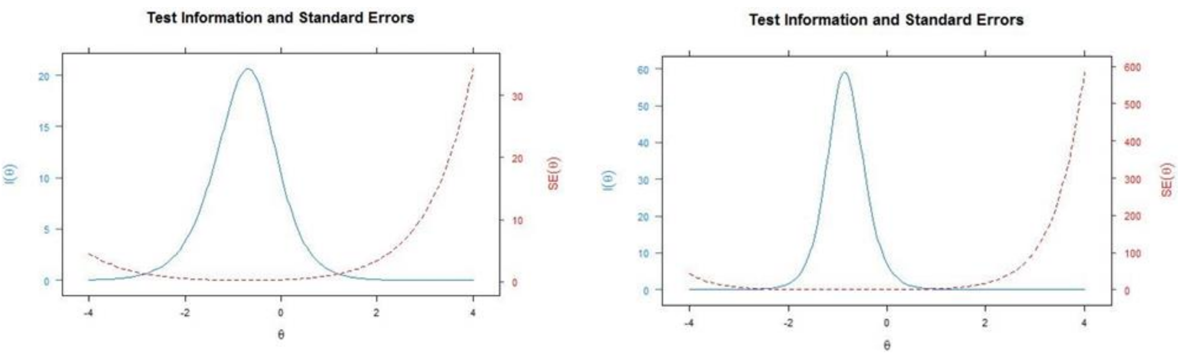



**Figure 5. Item Information Function (IIF) of Organizational Culture**

Figure 5 illustrates that item 22 provides the highest information when the respondent's latent trait $\theta = -0.75$. Most of the items related to organizational culture provide the highest information on the latent trait in the range $-4 \leq \theta \leq 0$. This indicates that the organizational culture questionnaire provides maximum information on the respondents' understanding of organizational culture in KDPDTT when the questionnaire is answered by respondents with a low latent trait compared to respondents with a high latent trait.

**Test Information Function (TIF) and Standard Error of Measurement (SEM)**

The test information function (TIF) is the sum of the item information functions. In this study, TIF represents how the test can discriminate the respondents at a given latent trait level. The higher the item information, the more information that item provides. Figure 6 illustrates the curves of TIF, and standard error of measurements based on the change management and organizational culture questionnaire.




**(a)** **(b)**

**Figure 6. Test Information Function (TIF) and Standard Error of Measurement (SEM) for Change Management (a) and Organizational Culture (b)**

Figure 6(a) shows that the items related to the change management questionnaire can provide the most information at the respondents' level with a latent trait of $\theta = -0.9$. Meanwhile, Figure 6(b) shows that the items related to the organizational culture questionnaire can provide the most information at the respondents' level with a latent trait of $\theta = -0.75$.

## 4. DISCUSSIONS

The number of items to determine the level of endorsement for organizational culture and change management is 13 respectively. Each item response is analyzed as a dichotomous, scored “1” for an "agree" and scored “0” for "disagree" or "undecided/neutral" responses. A respondent who disagrees with all 13 items related to change management will have a total score of zero, while a respondent who agrees with all these items will have a total score of 13. The same applies to the 13 items related to organizational culture, resulting in a score range of 0 to 13.

If the Classical Test Theory (CTT) approach is used to analyze respondents' answers, where the focus of CTT is on the total score, respondents with a total score close to 13 are considered to have a very high level of endorsement with the organizational culture (or change management) in KDPTT. However, the accuracy of the CTT’s results cannot be estimated. In contrast, the results from IRT, which are based on the probability model and assume that item characteristics are independent of respondent characteristics, allow for the accuracy of estimates for both respondent characteristics and item characteristics. The accuracy of respondent characteristics estimates as well as item characteristics estimates can be measured by standard errors.

Based on the AIC, BIC, and $G^2$ statistics, the 2PL model is selected as the best model compared to 1PL and 3PL. It implies that discrimination item ($\alpha$) has a large contribution to estimating latent traits of respondents. In the 2PL model, the maximum of item information will be located at the item location. Furthermore, the amount of maximum item information may be varied among items because the discrimination item ($\alpha$) under the 2PL model was also varied.

It should be noted that models with more parameters often tend to fit the data better than models with fewer parameters, but this is not always the case in every analysis. Our research has shown that the 2PL model is a better fit than the 3PL, model which has more parameters (more complex). Thus, comparing the goodness of fit among all models may not produce the good decision about the best model. [18] mentioned that model selection should not be based only on the goodness of fit model or diagnostics of theoretical assumptions about the instrument (questionnaire).

## 5. CONCLUSION

Based on our results, it can be concluded that the 2PL IRT model is the best-fit model to analyze the items of the change management and organizational culture in the questionnaire. The item discrimination item (α) for both questionnaires is non-negative, indicating that none of these items need to be eliminated. The item difficulty ($b$) for all items related to the change management and the organizational culture are negative (close to -1). This indicates that the items for measuring the attitude toward change management as well as the organizational culture tend to be endorsed easily by respondents. The probability of endorsing the items related to the change management ranges from 0.68 to 0.95. On the other hand, the probability of endorsing items related to organizational culture ranges from 0.87 to 0.98.

The analysis results presented in this study are based on the results of the 2020 survey, where the conclusions may be different in current conditions. However, if the Ministry of KDPDTTT conducts a similar survey at a different time, the principles of IRT modeling used in this study can still be implemented for analyzing the item responses.

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