

# Senior worker report

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## Summary

The purpose of the analysis is to identify how demographic, organizational and learning factors are associated with numeracy and literacy scores of South Korean senior workers. By applying model selection methods, result shows that gender, education level, work flexibility, active learning, public sector or private sector are important variables that are associated with both numeracy score and literacy scores of senior workers in South Korean. There is one additional variable that is associated with numeracy score, that is age.

## Introduction

Many senior workers in South Korea still participate in the labour market due to the reason of rapid aging. Knowing which factors are associated with senior workers' skills at the first place will help improve the performance of senior worker. Thus, the objective of this study is to identify how demographic, organizational and learning factors are associated with numeracy and literacy skills of South Korean senior workers, which is also the interests of our client.

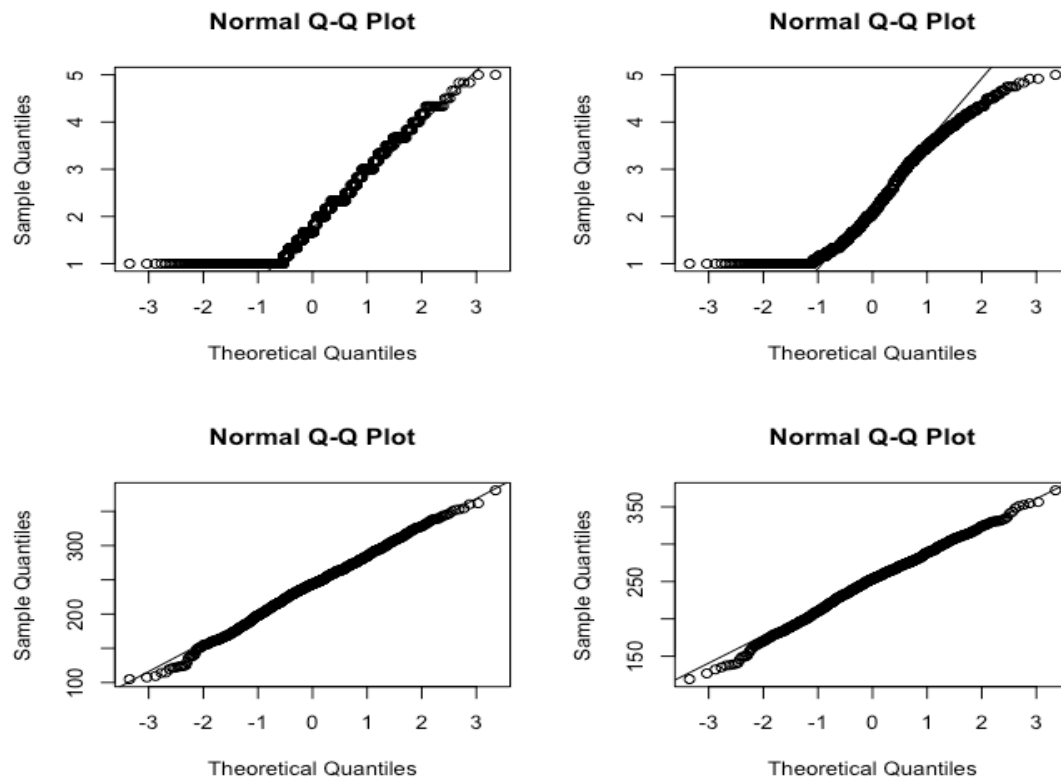
In the next part of the report, I include the description of the data, methods used to test the hypothesis and the corresponding results.

## Data Description

The data set was obtained from the open source of the Programme for the International Assessment of Adult Competencies. These data were collected from questionnaires that measured two key cognitive skills: literacy and numeracy. Based on the study's objective, employees aged 50-65 year-old on the private sector in South Korea were included.

The raw dataset has 4 response variables - num\_use, lit\_use, pvnumM and pvlitM. Num\_use and lit\_use are the frequency of the utilization of certain Numeracy and literacy skills. They are calculated by taking the average of some sub-items which are measured by likert scale: 1,2,3,4,5. The top two plots in Figure-1 show that num\_use and lit\_use do not follow normal distributions. PvnumM and pvlitM are proficiency test scores for numeracy and literacy. The bottom two plots in Figure-1 show that pvnumM and pvlitM follow normal distributions. Since handling response variables that do not follow normal distribution

needs further research, we will only focus on the analysis of pvnumM and pvlitM in this report.



**Figure-1**

There are three different categories of explanatory variables.

1. Demographic factors:
  - Age[AGE\_R]
  - Gender[Gender\_R]: 1-male, 2-female
  - Education[Education Level]: 1-middle, 2-high, 3-college, 4-graduate
  - Employment type[full\_part]: 1-fulltime, 2-part-time
  - Work experiences (years) [Year\_wl]: continuous
  - Public vs. private sector [pub\_piv]: 1-private, 2-public
2. Organizational contexts:
  - Work flexibility[work\_flexM] - average of four likert scores: sequence of tasks, how to do the work, speed of work and working hours
  - Learning opportunity[work\_lrn] - average of three likert scores: learning from peers/supervisors, learning by doing, keeping up to date
  - Managing others[Mgr]: 1-yes, 2-no
  - Managing how many[Mgr\_c]: 1:0'-5, 2:6-10, 3:11-24, 4:25-99, 5:more than 100

### 3. Learning/Education:

- Active learning strategies[Act\_lrn] - average of sub-items:relate new ideas, learning new things, attribute something new, bottoming of difficult things, fit different ideas together, look additional info(using likert scale-1,2,3,4,5)
- Participation in non-formal education [NFE12]: 0-not; 1-yes
- Participation in formal or non-formal adult education program [FNFAET12]:0-no; 1-yes
- Participation in formal or non-formal education(job-related) [FNFET12JR]:0-no; 1-yes
- Participation in formal or non-formal adult education program (job-related)[FNFAET12JR]: 0-no; 1-yes
- Participation in formal or non-formal adult education program (non job-related)[FNFAET12NJR]:0-no; 1-yes
- Number of hours of participation in non-formal education[NFEHRS]: continuous

By observing the summary statistics, an unusual value was found. The max of num\_use is 5 but one of the data entry has num\_use of value 7, which indicate that the data entry may not have the accurate values. Also, there are other four missing values in this observation. Thus, this data entry is excluded from the whole dataset. Another issue about the dataset is that there are 501 missing value in the 'Mgr' column and 1015 missing value in the 'Mgr\_c' column. It is reasonable to ignore Mgr and Mgr\_c because almost half of the values are missing.

Figure-2 shows the correlation among all continuous variables. There is a strong correlation between pvlitM and pvnumM. Other correlations are either moderate or low.

Figure-3 shows the correlation among all categorical variables. There is a strong correlation between NFE12 and FNFAET12JR. Other correlations are either moderate or low.

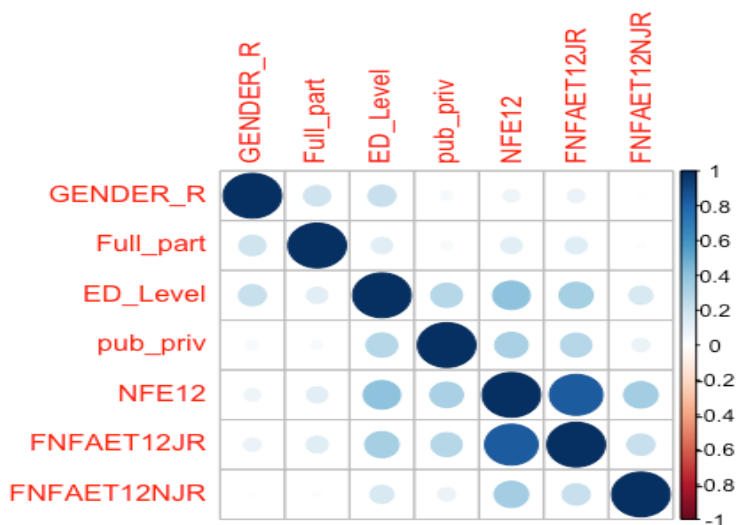


Figure-2

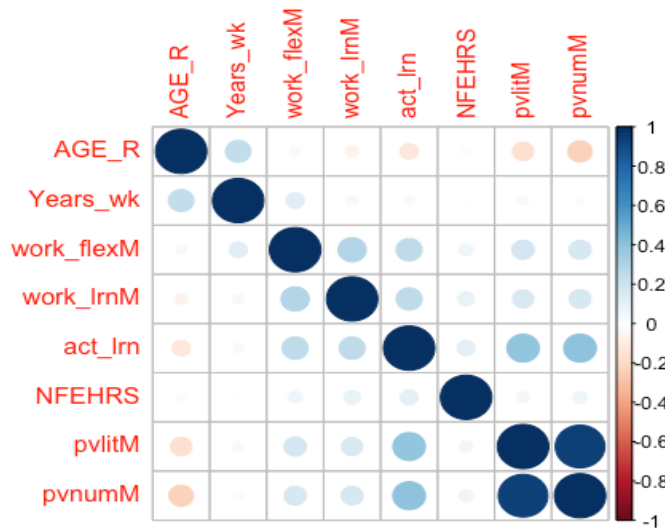


Figure-3

## Methods

Methods being used to do variable selection are stepwise AIC and stepwise adjusted  $R^2$ . Stepwise means to select variables sequentially. Two types of stepwise methods are used here: forward selection and backward selection. In terms of forward selection, it starts with null model (a model with no variables), then among all variables, it finds the one that is the best to improve the value of criterion. Criterion is AIC if using stepwise AIC, and criterion is adjusted R-square if using stepwise adjusted R-square. It keeps adding new variables until no more variables could be added to improve the criterion. Backward stepwise uses the same technique, but it starts from the full model (a model with all variables) and take one variable out of the model until no variables can be removed.

To verify the result, nested anova test is being used. Nested anova allows us to compare one model with a few variables (for example A+B+C) to another model with the same variables and an additional variable (for example A+B+C+D).

## Results

### 1. Results for numeracy score

Stepwise adjusted R-square picks GENDER\_R, AGE\_R, ED\_Level, pub\_priv, work\_flexM, act\_lrn, NFEHRS, NFE121, FNFAET12JR1 and FNFAET12NJR1. AIC picks the same variables except for NFE121, FNFAET12JR1 and FNFAET12NJR1. Nested anova was applied here to test whether these three variables should be included in the model or not.

Result shows the p-values for all the three variables are greater than 0.05. Thus, none of these three variables is significant.

Then, we run model diagnostic by fitting a linear regression model with the selected variable: GENDER\_R, AGE\_R, ED\_Level, pub\_priv, work\_flexM, act\_lrn, NFEHRS.

The adjusted R-squared of the final model is 0.356, which means the picked variables could explain 35.6% of the variances in numeracy score. Table-1 summarizes the coefficient of all selected variables. The p value of each coefficient indicates the significance of each variable. The smaller the p-value is, the more significant the variable is. Thus, education level and act\_lrn are the top variables. NFEHRS has a p-value greater than 0.05. Thus, it is an optional variable, meaning that whether included it or not is up to the customer.

Overall, GENDER\_R, AGE\_R, ED\_Level, pub\_priv, work\_flexM, act\_lrn, NFEHRS (optional) are variables that are associated with numeracy score.

#### Coefficients:

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	259.04415	14.65463	17.68	< 2e-16	***
ED_Level2	22.60912	2.44159	9.26	< 2e-16	***
ED_Level3	47.16264	3.21517	14.67	< 2e-16	***
ED_Level4	57.56368	14.79274	3.89	0.00011	***
act_lrn	8.73426	1.20946	7.22	9.1e-13	***
AGE_R	-1.15477	0.24545	-4.70	2.8e-06	***
work_flexM	1.94509	0.81360	2.39	0.01697	*
GENDER_R2	-5.47547	2.18280	-2.51	0.01226	*
pub_priv2	9.67951	3.32811	2.91	0.00370	**
NFEHRS	-0.00328	0.00221	-1.49	0.13733	

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**Table-1**

## 2. Results for literacy score

Stepwise adjusted R-square gives the same result for both backward, forward direction. It picks gender, age, ED\_level, pub\_priv, work\_flexM, act\_lrn, NFEHRS. Stepwise AIC also picks GENDER\_R, AGE\_R, ED\_Level, pub\_priv, work\_flexM, act\_lrn, NFEHRS. Forward and backward direction gives the same result too.

Since stepwise AIC and stepwise adjusted R-square lead to the same result, so we conclude that GENDER\_R, AGE\_R, ED\_Level, pub\_priv, work\_flexM, act\_lrn, NFEHRS are variables that are associated with literacy score.

Same as literacy score, we run model diagnostics by fitting a linear regression model with the selected variable. The adjusted R-squared of the final model is 0.304, which means the picked variables could explain 30.4% of the variances in literacy score. NFEHRS again has a p-value greater than 0.05. Thus, it becomes an optional variable for literacy score too.

## Conclusions

Education level, gender, age, public vs private sector, work flexibility, active learning strategies are associated with both numeracy and literacy score.