DANA 4830 Team Project:

Exploring Leadership Styles in the Australian Public Sector

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Summary

Organizations in the modern world are facing complexity and challenges due to the rapid change in work environment and leaders have to work more efficiently to help employees and themselves to generate creative solutions. This study analyzes the employee satisfaction surveys conducted by the Australian Public Service (APS) in the years 2014 and 2021 and explores the leadership styles that are regarded as significant in the public sector. It aims to find if there is any relationship between the leadership styles and the organization's performance with respect to innovation, creativity, employee satisfaction, and engagement to cope with challenges and hardships.

The survey questions were first selected based on the requirements of our research and the datasets were cleaned. Thereafter, the missing values and outliers were taken care of before further analysis. The datasets were then used for preliminary analysis to determine the relationship and responses of the participants to the selected questions, followed by exploratory factor analysis (EFA) to establish the appropriate number of latent variables for identifying leadership styles.

In the next step, the regression model to determine the impact of different leadership styles on employee innovation, engagement, and satisfaction was discussed. The report is concluded by sharing the overall research findings and providing recommendations to the Australian government on ways to improve the organization’s performance.

Overview

An annual employee perception survey has been conducted by the Australian Public Service (APS) since 2012. The survey captures the attitude and opinion data on important issues such as innovation, leadership, wellbeing, learning and development, and engagement of the APS workforce. It allows all APS employees to voice their opinions about their workplace and contribute to making the public sector a better place to work.

This information is used by agencies and the APSC to target plans for improving APS workplace competence today and in the future. It is used to assess, adjust, and improve APS employees' workplace conditions and environment.

All available APS staff were asked to participate in the 2014 APS employee census. The census took place from May 12 to June 15, 2014. The employee census had 99,392 responses, representing a 68 percent response rate. (Australian Public Service Commission, 2015)

From May 10th, through June 11th, 2021, 42,493 employees from 101 APS agencies were invited to participate. A total of 109,537 APS employees responded, representing a 77 percent response rate. (Australian Public Service Commission, 2021)

This census method gives a complete picture of the APS and assures that no eligible respondents are left out of the survey sample, eliminating sampling bias and minimizing sample error.

Introduction

Consideration leadership is a type of leadership that focuses on the commitment to building personal relationships with followers, care and concern for others, willingness to pay attention to subordinates' individual preferences and work styles, and fostering collaboration among team members. Transformational leadership is a management style that encourages, inspires, and motivates people to innovate and generate change in order to help the organization grow and influence its future success. (White, 2018) The capacity to inspire and motivate others to accomplish their best work toward a common goal is known as Interpersonal leadership. (Poulsen, 2021) Entrepreneurial leadership entails organizing and encouraging a group of people to work toward a common goal through innovation, risk management, seizing opportunities, and managing a dynamic organizational environment. (*10 Entrepreneurial Leadership Characteristics*, 2022)

The major research questions set for our analysis are:

- What are the leadership styles that participants regard as significant for innovation in the public sector in Australia?
- Can leadership styles be used to predict employees that strive for creativity and innovation?
- Is the statement, “Australia departments recruit supervisors who have transformation and consideration styles” still valid?
- What are characteristics associated with transformational and/or consideration leaders?
- Does leadership style impact on employee creativity differ for different groups? (gender, age, job level group)
- Does leadership style impact employee engagement and satisfaction?

Descriptive Analysis

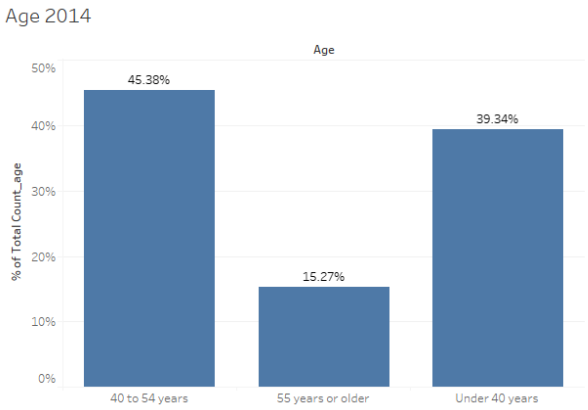
In this report, two datasets consisting of the responses to the employee satisfaction survey questionnaires for the years 2014 and 2021 respectively are taken. The dataset for the year 2014 has ***99392 rows*** and ***225 columns*** whereas, for the 2021 dataset, there are **109537** rows and **23** columns.

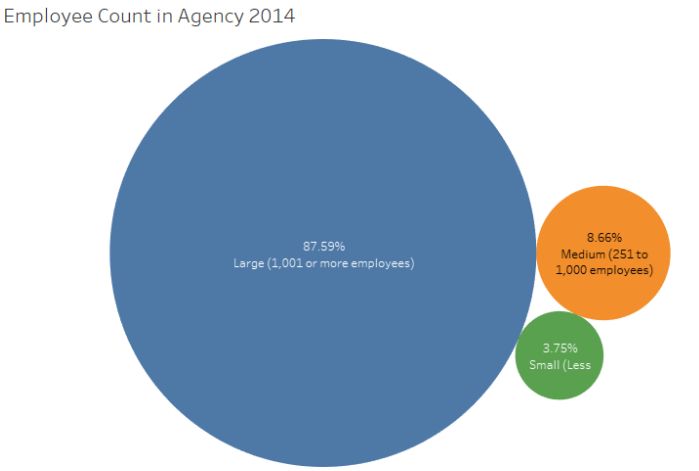
Demographic Profiles

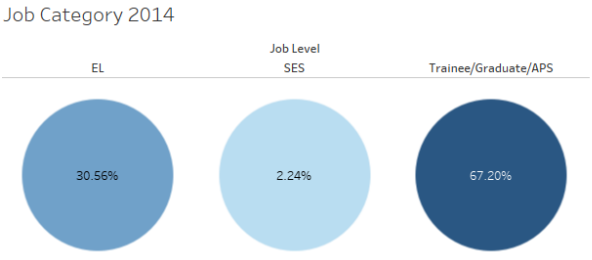
Size of agency, gender, age, and classification level

The demographic profiles of the census participants can be classified as four variables, which are agency size, gender, age, and classification level. From the analysis, the major key takeaways are:

For 2014 dataset



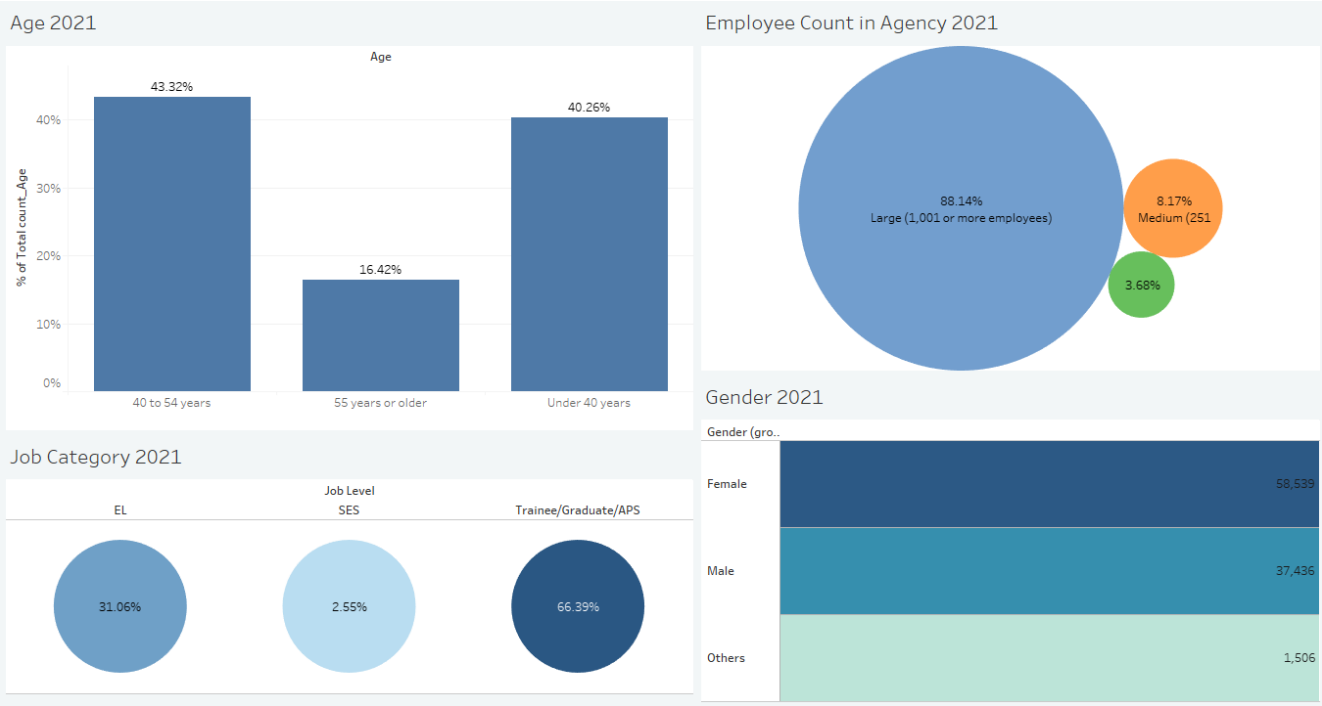




- Around 87% of the participants are from a large agency
- Around 81% of the participants are under 54 years old
- Around 57% of the participants are females

- Around 68% of the participants are under the category of subordinates (Trainee/Graduate/APS)

For 2021 dataset



- Around 88.14% of the participants are from a large agency
- Around 66.39% of the participants are under the category of subordinates (Trainee/Graduate/APS)
- Around 83.58% of the participants are under 54 years old
- Around 60.05% of the participants are females

Column Selection

The following columns related to leadership and response variables are selected to measure employee innovation and engagement.

For 2014 dataset

Question Number	Question Description	Category
'ï..AS'	agency	Demographics
q1	gender	Demographics
q2	age	Demographics
q6@	level	Demographics
q20a	My supervisor provides me with regular and constructive feedback	Leadership
q20b	My supervisor appropriately deals with employees that perform poorly	Leadership
q20c	My supervisor works effectively with people from diverse backgrounds	Leadership
q20d	My supervisor is committed to workplace safety	Leadership
q20e	My supervisor is accepting of people from diverse backgrounds	Leadership
q20f	My supervisor treats people with respect	Leadership
q20g	My supervisor communicates effectively regarding the business risks that impact my workgroup	Leadership
q55a	a. Achieves results	Leadership
q55b	b. Cultivates productive working relationships	Leadership
q55c	c. Exemplifies personal drive and integrity	Leadership
q55d	d. Shapes strategic thinking	Leadership
q55e	e. Communicates with influence	Leadership
q55f	f. Sets direction	Leadership
q55g	g. Motivates people (e.g. encourages people to understand how work fits with the strategic direction of the agency and the APS)	Leadership
q55h	h. Encourages innovation (e.g. encourages people to find new ways of doing work and solving problems)	Leadership
q55i	i. Develops people (e.g. encourages people to learn from work and develop new skills).	Leadership
q55j	j. Is open to continued self-learning	Leadership
q62f	a. My supervisor is open to new ideas	Leadership
q62a	a. I believe that improving the quality of my work is my responsibility	Employee Innovation Response
q18d	My job gives me a feeling of personal accomplishment	Employee Engagement Predictor Response
q18h	I have a clear understanding of how my work group's role contributes to my agency's strategic directions	Employee Engagement Response

For 2021 dataset

Question Number	Question Description	Category
'ï..AS'	agency	Demographics
q1	gender	Demographics
q2@	age	Demographics
q5@	level	Demographics
q19a	My supervisor communicates effectively	Leadership
q19b	My supervisor engages with staff on how to respond to future challenges	Leadership
q19c	My supervisor can deliver difficult advice whilst maintaining relationships	Leadership
q19d	My supervisor encourages my team to regularly review and improve our work	Leadership
q19e	My supervisor is invested in my development	Leadership
q19f	My supervisor provides me with helpful feedback to improve my performance	Leadership
q19g	My supervisor actively supports people from diverse backgrounds	Leadership
q19h	My supervisor ensures that my workgroup delivers on what we are responsible for	Leadership
q19i	My supervisor invites a range of views, including those different to their own	Leadership
q33c	My immediate supervisor encourages me	Leadership
q34e	My immediate supervisor encourages me for my health and wellbeing	Leadership
q48b	My immediate supervisor encourages me to come up with new or better ways of doing things	Leadership
q17g	I suggest ideas to improve our way of doing things	Employee Innovation
q17b	The work I do gives me a sense of accomplishment	Employee Engagement
q17j	I understand how my role contributes to achieving an outcome for the Australian public	Employee Engagement
q17h	I am happy to go the ‘extra mile’ at work when required	Employee Engagement
q17i	Overall, I am satisfied with my job	Employee Satisfaction

Transforming the data

The questions chosen for the analysis are based on the Likert scale and thus needed to be converted to numeric values for evaluating the summary statistics.

Satisfaction Level			Numeric Value
Strongly Disagree	Never	Very Dissatisfied	1
Disagree	Rarely	Dissatisfied	2
Neither Agree nor Disagree	Sometimes	Neither satisfied nor dissatisfied	3
Agree	Often	Satisfied	4
Strongly Agree	Always	Very Satisfied	5

Cleaning the datasets

Two new datasets are formed using the chosen questions as the columns. The new datasets for 2014 and 2021 have 99392 rows and 24 columns, and 97481 rows and 23 columns respectively.

Since the data is the response value for a survey, we decided not to impute the missing values with mean, median, or any other measure to avoid bias. Therefore, the missing values throughout the columns are removed before proceeding with the analysis.

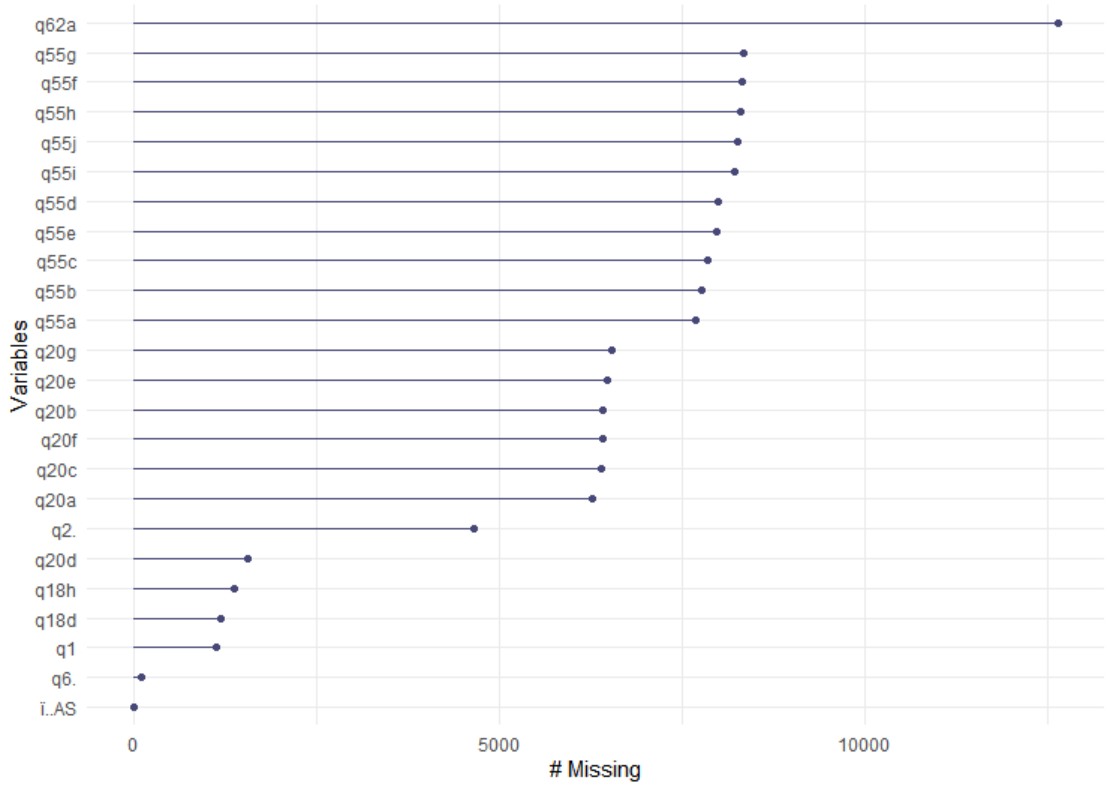
The below tables indicate the number of missing (null) values in all the columns for the years 2014 and 2021

For 2014 dataset

We encountered a total of 21406 missing values in our dataset.

- **MCAR checking and row-wise deletion**

  Number of missing *column-wise*:



  The number of missing *row-wise*:

```
> #checking null value row wise
> miss_rowwise <- sum(!complete.cases(data_2014_a)) / nrow(data_2014_a)
> miss_rowwise
[1] 0.2153694
```

  Number of employees that have complete answers on all variables:

```
> compl.data <- sum(complete.cases(data_2014_a))
> compl.data
[1] 77986
```

- **Performing Missing at Random Test to see if we can perform row-wise deletion**

```
> mcar_test(data_2014_a[5:21])
# A tibble: 1 x 4
  statistic    df p.value missing.patterns
      <dbl> <dbl>   <dbl>            <int>
1     3872.  3770   0.121              335
```

We will go ahead in deleting row-wise because

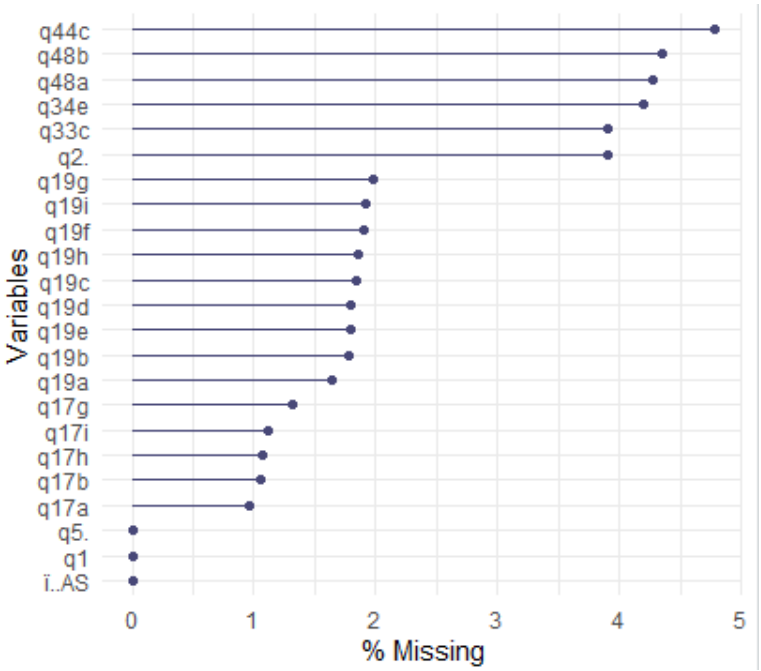
- MCAR test shows no sign that the missing data are not at random, therefore, we can either impute the data or drop the data and it will not change the population
- There are still 77000 remaining rows in the data. The practical guide in EFA states that we only need at least 200 respondents for each of the variables that we need to perform EFA on. Since we are only checking for 11 leadership variables, 77000 is more than enough.

<u>For 2021 dataset</u>

We encountered a total of 52000 missing values.

- **MCAR checking and row-wise deletion**

Number of missing *column-wise*:



The number of missing *row-wise*:

```
> missrowwise <- sum(!complete.cases(data_2021_b)) / nrow(data_2021_b)
> missrowwise
[1] 0.1100633
```

Number of employees that have complete answers on all variables:

```
> compl.data <- sum(complete.cases(data_2021_b))
> compl.data
[1] 97481
```

- **Performing Missing at Random Test to see if we can perform row-wise deletion**

```
> mcar_test(data_2021_b[5:23])
# A tibble: 1 x 4
  statistic    df p.value missing.patterns
      <dbl> <dbl>   <dbl>            <int>
1     7970.  6422       0              514
```

We will go ahead in deleting row-wise because

- MCAR test shows no sign that the missing data are not at random, therefore, we can either impute the data or drop the data and it will not change the population
- We still have 97481 remaining rows in the data. The practical guide in EFA states that 200 respondents for each of the variables are required to perform EFA.

The columns were checked for the percentage of missing values, and we concluded that the missing values were less than 5% in each column.

variable	n_miss	pct_miss	variable	n_miss	pct_miss
q44c	5233	4.777381	q19e	1969	1.797566
q48b	4768	4.352867	q19b	1949	1.779307
q48a	4677	4.26979	q19a	1800	1.64328
q34e	4602	4.20132	q17g	1449	1.322841
q33c	4282	3.909181	q17i	1220	1.113779
q2.	4278	3.90553	q17h	1171	1.069045
q19g	2167	1.978327	q17b	1157	1.056264
q19i	2092	1.909857	q17a	1052	0.960406
q19f	2087	1.905292	q5.	12	0.010955
q19h	2038	1.860559	q1	7	0.006391
q19c	2020	1.844126	ï..AS	0	0
q19d	1970	1.798479			

Summary Statistics

We determined the summary statistics of the two datasets to check for any inconsistencies in the data. The snapshot for the same is provided below.

For 2014 dataset

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
ï..AS*	1	77986	1.161644	0.4588932	1	1.030149	0.0000	1	3	2	2.9026492	7.64463098	0.001643249
q1*	2	77986	1.440053	0.5086701	1	1.417359	0.0000	1	3	2	0.3819006	-1.50931926	0.001821495
q2.*	3	77986	1.939605	0.9185007	2	1.924507	1.4826	1	3	2	0.1196040	-1.80405767	0.003289055
q6.*	4	77986	2.366425	0.9183576	3	2.458022	0.0000	1	3	2	-0.7874100	-1.34937816	0.003288543
q20a	5	77986	3.735004	0.9999012	4	3.833900	1.4826	1	5	4	-0.8452204	0.30719896	0.003580542
q20b	6	77986	3.384300	1.0146490	3	3.420452	1.4826	1	5	4	-0.4206100	-0.16202125	0.003633352
q20c	7	77986	4.034019	0.7810241	4	4.098109	0.0000	1	5	4	-0.9168499	1.74835559	0.002796766
q20d	8	77986	4.078450	0.7094924	4	4.129332	0.0000	1	5	4	-0.7521325	1.68627161	0.002540618
q20e	9	77986	4.147296	0.7221836	4	4.218272	0.0000	1	5	4	-0.8998881	1.98874800	0.002586064
q20f	10	77986	4.094043	0.8695831	4	4.216269	0.0000	1	5	4	-1.2711723	2.16701544	0.003113887
q20g	11	77986	3.866720	0.9513975	4	3.987177	0.0000	1	5	4	-0.9726969	0.87875366	0.003406855
q55a	12	77986	3.890211	0.9043786	4	3.988027	0.0000	1	5	4	-0.9437443	1.03245778	0.003238486
q55b	13	77986	3.826943	1.0089834	4	3.953053	1.4826	1	5	4	-0.9277335	0.55442798	0.003613064

For 2021 dataset

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
Year	1	64717	2021.000000	0.0000000	2021	2021.000000	0.0000	2021	2021	0	NaN	NaN	0.000000000
Agency*	2	64717	1.135343	0.4223046	1	1.005872	0.0000	1	3	2	3.2449684	9.9628580	0.001660033
Gender*	3	64717	3.920562	1.4323799	5	4.028064	0.0000	1	5	4	-0.5929129	-1.6275958	0.005630527
Age*	4	64717	2.067417	0.9096904	2	2.084268	1.4826	1	3	2	-0.1331775	-1.7784802	0.003575892
Level*	5	64717	3.000000	0.0000000	3	3.000000	0.0000	3	3	0	NaN	NaN	0.000000000
q19a	6	64717	4.062302	0.9536252	4	4.218677	1.4826	1	5	4	-1.2563452	1.5203496	0.003748595
q19b	7	64717	4.012624	0.9500691	4	4.153356	1.4826	1	5	4	-1.1294910	1.1954873	0.003734616
q19c	8	64717	4.006984	0.9553740	4	4.141941	1.4826	1	5	4	-1.1186874	1.2184398	0.003755469
q19d	9	64717	4.036729	0.9106652	4	4.159594	1.4826	1	5	4	-1.1237432	1.4101921	0.003579724
q19e	10	64717	3.954062	1.0339322	4	4.111309	1.4826	1	5	4	-1.0276423	0.6562154	0.004064273
q19f	11	64717	3.962174	0.9953955	4	4.108238	1.4826	1	5	4	-1.0410632	0.8106893	0.003912789
q19g	12	64717	4.116924	0.8465109	4	4.204288	1.4826	1	5	4	-0.9664364	1.2613638	0.003327540
q19h	13	64717	4.183167	0.8034548	4	4.294157	0.0000	1	5	4	-1.2624597	2.5435954	0.003158292
q19i	14	64717	4.032712	0.9450061	4	4.164635	1.4826	1	5	4	-1.1453516	1.3552237	0.003714714
q48b	15	64717	3.851028	0.9210168	4	3.945727	1.4826	1	5	4	-0.8407731	0.6969442	0.003620415
q48a	16	64717	4.036760	0.7652032	4	4.107986	0.0000	1	5	4	-0.9254539	1.6512405	0.003007929
q17b	17	64717	3.850781	0.9076764	4	3.964867	0.0000	1	5	4	-1.0507805	1.1958168	0.003567976
q17g	18	64717	3.972557	0.7328320	4	4.018967	0.0000	1	5	4	-0.7884261	1.5013128	0.002880682
q17h	19	64717	4.230171	0.7231329	4	4.325524	0.0000	1	5	4	-1.1755025	2.8576401	0.002842555
q17i	20	64717	3.761438	0.9457914	4	3.865901	0.0000	1	5	4	-0.9845646	0.8681595	0.003717801
q17a	21	64717	3.922988	0.8451767	4	4.028662	0.0000	1	5	4	-1.1906875	1.9060541	0.003322296
q33c	22	64717	4.073288	1.0053737	4	4.220647	1.4826	1	5	4	-1.0126611	0.4897309	0.003952013
q44c	23	64717	3.482578	0.9802078	4	3.533037	1.4826	1	5	4	-0.4436047	0.1000733	0.003853088
q34e	24	64717	4.172459	0.9404366	4	4.326644	1.4826	1	5	4	-1.3845913	2.0230443	0.003696752

where

- n is the total number of observations.
- Mean shows the average level of satisfaction among workers for each question, and our scale of 1 to 5 denotes worst to best. As a result, higher mean values represent better satisfaction levels.
- Standard Deviation is the measure of how close the data is to the mean value. As our scale of 1 to 5 denotes worst to best, higher values represent that the data points are far away from the mean while lower values represent that the data points are closer to the mean values.
- The trimmed mean eliminates a tiny fraction of the maximum and minimum values before computing the mean and higher mean values represent better satisfaction levels for our dataset.
- Mad (Mean Absolute Deviation) describes the average of the magnitudes of the errors or deviations so the lower the values, the better.
- Min represents the minimum value for each question which is 1 as scale is from 1 to 5.
- Max represents the maximum value for each question which is 5 as our scale is from 1 to 5 while for demographic questions, the value is 3.
- The range represents the difference between the maximum and minimum values. As our scale of 1 to 5 denotes worst to best, so higher the number, the better.
- Skewness describes the form of each data's distribution, and a positive number indicates that data is right-skewed, while a negative value indicates that it is left-skewed. In our data, the closer the values are to zero or to the left, the higher the level of satisfaction.
- Kurtosis is a measure that describes the extent to which outliers are distributed in the data. Higher kurtosis levels in our dataset imply that there are more outliers in the distribution that are distant from the mean. Extreme values are less likely to appear in distributions with smaller values.

- SE is the standard error which is a measure of how closely the mean of the sample resembles the mean of the population. The higher the value, the more the means are spread out.

Diagnosis of Outliers

Outlier detection is commonly done using the Mahalanobis distance. However, because the data solely consists of Likert scale values, the outliers discovered by the Mahalanobis distance are not classified as outliers in this study. Outliers aren't represented by values like "Strongly disagree" and "Strongly agree". Outliers are observations that are significantly different from the rest of the data. The scale of responses in the dataset, on the other hand, is pre-designed to a specific number of scale points, such as 1 to 5 on a "Strongly disagree" to "Strongly agree" scale. As a result, no outliers need to be removed, and the outliers are preserved for further research.

For 2014 dataset

Through Mahalanobis distance, we observed there are 3067 outliers.

```
> ###outliers checking
> #outliers are only 5.36% which means they can be ignored
> mahal_2014 <- mahalanobis(d2014[,5:21], colMeans(d2014[,5:21], na.rm=FALSE), cov(d2014[,5:21], use="pairwise.complete.obs"))
> cutoff <- qchisq(1-.001, ncol(d2014))
> cutoff
[1] 52.61966
> summary(mahal_2014 < cutoff)
   Mode   FALSE    TRUE
logical    3067   74919
```

Now, we will check if removing the outliers will have an impact on the mean. The difference ranges from 0.015 to 0.057, which is not exceeding 0.20 thus we can say that it doesn't have an impact on the population. Therefore, keeping the outliers.

```
> sort(noout$mean - reg$mean)
 [1] 0.01562496 0.01621426 0.02636629 0.03275908 0.03625550 0.03730091 0.03860741 0.04090704 0.04228952 0.04246225 0.04476364 0.04612374
[13] 0.04794854 0.04854105 0.05109136 0.05257992 0.05735843
```

For 2021 dataset

```
> #Mahalanobis
> ###outliers checking
> #outliers are only 5.36% which means they can be ignored
> mahal_2021 <- mahalanobis(d2021[,6:24], colMeans(d2021[,6:24], na.rm=FALSE), cov(d2021[,6:24], use="pairwise.co
mplete.obs"))
> cutoff <- qchisq(1-.001, ncol(d2021))
> cutoff
[1] 51.1786
> summary(mahal_2021 < cutoff)
   Mode   FALSE    TRUE
logical    5365   92116
```

```
> d2021_noout <- d2021[mahal_2021<cutoff,6:24] #remove outliers and see if it make difference in the mean
> noout <- data.frame(psych::describe(d2021_noout))
> reg <- data.frame(psych::describe(d2021[,6:24]))
> sort(noout$mean - reg$mean)
 [1] 0.01003786 0.01304174 0.02170667 0.04345157 0.04439928 0.04465761 0.05160972 0.05330775 0.06056218
[10] 0.06120847 0.06336875 0.06741802 0.06835826 0.07093324 0.07318227 0.07688927 0.07749307 0.07970621
[19] 0.08103982
```

We used “dlookr” package to check for the outliers in the selected columns. Most of the columns had an outliers ratio of less than 10 except for one question ‘q17b’ which had an outlier ratio of 43.99. We decided not to treat the outliers as the data is ordinal with a minimum value equal to 1 and a maximum value equal to 5 and these outliers may be due to the exceptional frequency of certain responses.

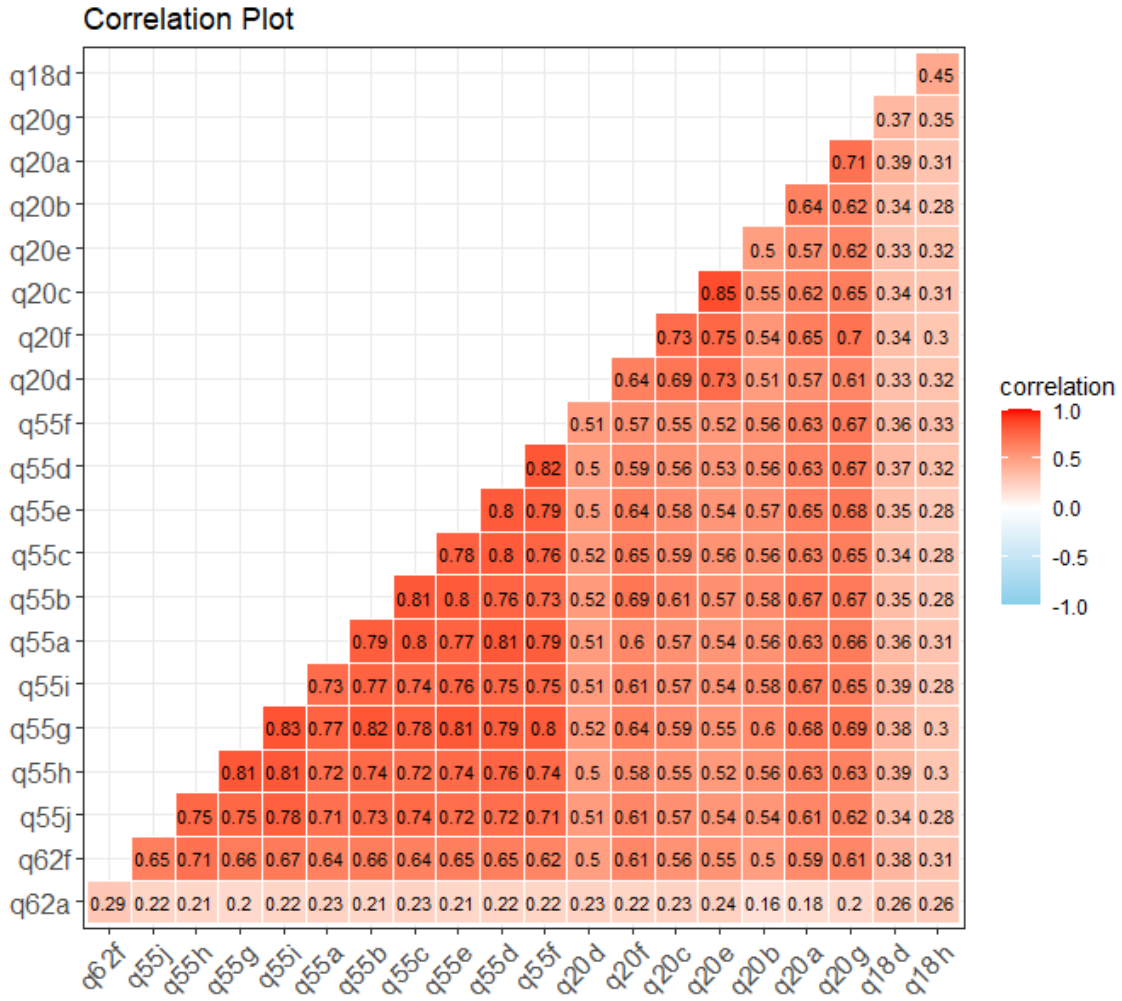
variables	outliers_cnt	outliers_ratio	outliers_mean	with_mean	without_mean
Year	0	0	NA	2021	2021
q19a	8406	8.623219	1.713062	4.061273	4.282874
q19b	8326	8.541152	1.72772	4.016095	4.229802
q19c	7588	7.784081	1.667633	4.01906	4.217548
q19d	6578	6.747982	1.717543	4.044973	4.213392
q19e	0	0	NA	3.954001	3.954001
q19f	9378	9.620336	1.69823	3.940553	4.179233
q19g	2990	3.067264	1.566221	4.127061	4.208094
q19h	3731	3.827413	1.666845	4.194387	4.294976
q19i	6850	7.02701	1.641022	4.055375	4.237855
q48b	7237	7.424011	1.748653	3.919902	4.094023
q48a	3046	3.124711	1.822062	4.153281	4.228475
q17b	42888	43.99627	3.824217	3.922662	4
q17g	2768	2.839528	1.835983	4.073932	4.139337
q17h	2302	2.361486	1.722415	4.288077	4.35013
q17i	2780	2.851838	1	3.808999	3.891458
q17a	6679	6.851592	1.792783	4.022476	4.186483
q33c	7561	7.756383	1.738394	4.090007	4.287745
q44c	3756	3.853059	1	3.513792	3.614532

Preliminary Analysis

A correlation test is used to evaluate the association between two or more variables. Values ranging from 0.5 to 1 indicate a very good association, 0.3 to 0.5 is medium and lower than 0.3 indicates poor association. The correlation would be beneficial for the succeeding factor analysis to determine the underlying leadership styles. In addition, the correlation tests below show the relationship of the leadership questions to our response variables or employee perceptions (innovation, engagement, and satisfaction).

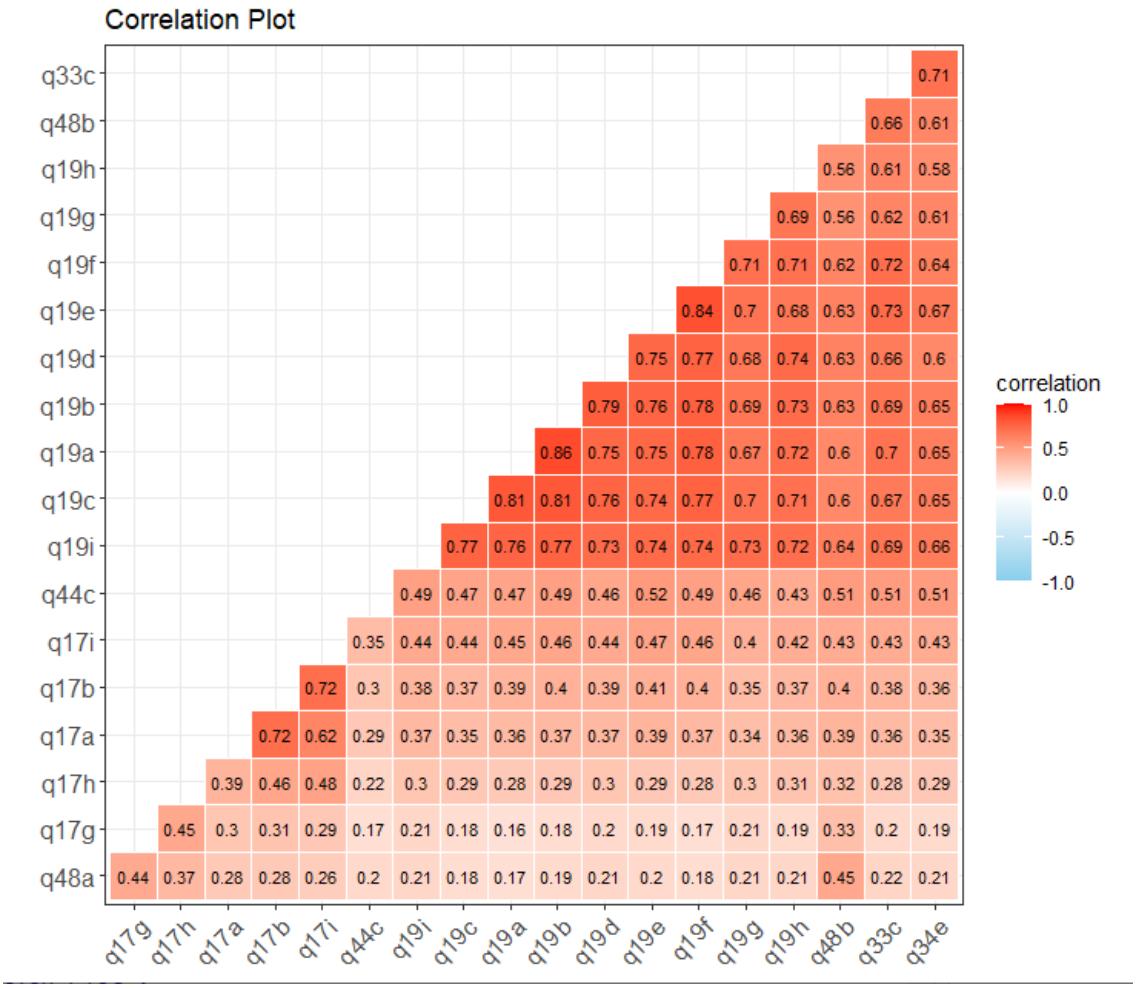
For 2014 dataset

From the below graph, we can see that the variables have a high correlation which is good for the exploratory factor analysis (EFA).



For 2021 dataset

From the below graph, we can see that the variables have a high correlation which is good for the exploratory factor analysis (EFA).



Responses to the leadership questions and employees' level of innovation, engagement, and satisfaction were further analyzed using Tableau visualization. The key takeaway is that the employees have a positive response to the perception of their immediate supervisors, and also to the questions which measure their level of satisfaction, engagement, and innovation.

2014 Leadership | 2014 Creativity | 2014 Job Levels | 2021 Leadership | 2021 Creativity | 2021 Job Levels

Is there any difference on the response among different job levels?

Questions	Question Description	Job Level: Trainee/Graduate/APS	Job Level: EL	Job Level: SES
Q17B	The work I do gives me a sense of accomplishment	3.8508	4.0301	4.4857
Q17G	I suggest ideas to improve our way of doing things	3.9726	4.2521	4.5433
Q17H	I am happy to go the 'extra mile' at work when required	4.2302	4.3781	4.6998
Q17I	Overall, I am satisfied with my job	3.7614	3.8694	4.3111
Q19A	My supervisor communicates effectively	4.0623	4.0411	4.2801
Q19B	My supervisor engages with staff on how to respond to future challenges	4.0126	4.0053	4.2378
Q19C	My supervisor can deliver difficult advice whilst maintaining relationships	4.0070	4.0244	4.2684
Q19D	My supervisor encourages my team to regularly review and improve our work	4.0367	4.0406	4.3127
Q19E	My supervisor is invested in my development	3.9541	3.9398	4.1260
Q19F	My supervisor provides me with helpful feedback to improve my performance	3.9622	3.8835	4.0732
Q19G	My supervisor actively supports people from diverse backgrounds	4.1169	4.1325	4.3243
Q19H	My supervisor ensures that my workgroup delivers on what we are responsible for	4.1832	4.2005	4.4121
Q19I	My supervisor invites a range of views, including those different to their own	4.0327	4.0832	4.3066
Q33C	My immediate supervisor encourages me	4.0733	4.1115	4.2636
Q34E	I believe my immediate supervisor cares about my health and wellbeing	4.1725	4.2274	4.3839
Q48A	I believe that one of my responsibilities is to continually	4.0368	4.3581	4.6922

Average Rating: 3.7614 – 4.6998

Age: (All)

Gender (group): (All)

Agency: (All)

From the above figure, differences among the different job levels can be observed. It can be seen that SES (Senior Leadership) has a more highly positive response to the questions compared to lower levels (EL and Trainee). ANOVA test and posthoc Tukey HSD were performed to determine the difference and its significance. In both cases, the p-values obtained by performing ANOVA tests are less than the significance value ($p < 0.05$), therefore, we can say that there are differences between the job levels. Furthermore, the Post-hoc Tukey HSD specified the differences between the job levels and all resulted in less than significant value ($p < 0.05$), therefore, the differences between job levels were significant. As a result, to avoid any bias, we considered only the "Trainee/Graduate/APS" population for our further analysis.

For 2014 dataset

```
> summary(res.aov)
              Df Sum Sq Mean Sq F value             Pr(>F)
job_level      2     99   49.28   49.36 <0.0000000000000002 ***
Residuals   77838  77721    1.00
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> TukeyHSD(res.aov)
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = q20a ~ job_level, data = d2014)

$job_level
                              diff         lwr         upr     p adj
EL-Trainee/Graduate/APS  -0.03583875 -0.05414983 -0.01752766 0.0000134
SES-Trainee/Graduate/APS  0.20219471  0.14515648  0.25923295 0.0000000
SES-EL                    0.23803346  0.17990514  0.29616178 0.0000000
```

For 2021 dataset

```
> summary(res.aov)
              Df Sum Sq Mean Sq F value              Pr(>F)
Job_Level      2    131   65.67   73.13 <0.0000000000000002 ***
Residuals   97478  87540    0.90
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> TukeyHSD(res.aov)
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = q19a ~ Job_Level, data = d2021)

$Job_Level
                              diff         lwr         upr     p adj
EL-Trainee/Graduate/APS  -0.02118442 -0.03664849 -0.00572034 0.0037878
SES-Trainee/Graduate/APS  0.21777846  0.17237698  0.26317994 0.0000000
SES-EL                    0.23896288  0.19261650  0.28530925 0.0000000
```

Exploratory Factor Analysis

EFA is a multivariate statistical method that attempts to identify the hypothetical factors (also known as factors, or latent variables) that can closely explain the covariation observed among a set of measured variables (all called observed variables or effect indicators). (Watkins, 2018) To develop an adequate solution that will best explain the leadership styles adopted by the Australian Public Service, the following sequential steps were performed by the researchers:

1. Data Suitability — to determine if the data is adequate for factor analysis in terms of data size and correlation
2. Factor Extraction — methodology and criteria used to extract the number of latent factors
3. Factor Rotation — to present the factor loadings in a format that is easy to understand
4. Interpretation and labeling — to interpret the latent factors in relation to the leadership styles and employee's perceptions

Leadership Questions

Multiple rounds of EFA were performed on all the initial leadership questions that are selected (18 questions for 2014 and 12 questions for 2021) to determine the appropriate questions that can describe the leadership styles considered. In addition, rounds of EFA were also conducted for different job levels which resulted in different outcomes as expected. As a result, the succeeding findings only consist of the analysis for "Trainee/Graduate/APS" and include the highlighted questions that the researchers considered relevant to describe the selected leadership styles.

2014 Questions	
q20a	My supervisor provides me with regular and constructive feedback
q20b	My supervisor appropriately deals with employees that perform poorly
q20c	My supervisor works effectively with people from diverse backgrounds
q20d	My supervisor is committed to workplace safety
q20e	My supervisor is accepting of people from diverse backgrounds
q20f	My supervisor treats people with respect
q20g	My supervisor communicates effectively regarding the business risks that impact my workgroup
q55a	a. Achieves results
q55b	b. Cultivates productive working relationships
q55c	c. Exemplifies personal drive and integrity
q55d	d. Shapes strategic thinking
q55e	e. Communicates with influence
q55f	f. Sets direction
q55g	g. Motivates people (e.g. encourages people to understand how work fits with the strategic direction of the agency and the APS)
q55h	h. Encourages innovation (e.g. encourages people to find new ways of doing work and solving problems)
q55i	i. Develops people (e.g. encourages people to learn from work and develop new skills).
q55j	j. Is open to continued self-learning
q62f	a. My supervisor is open to new ideas

2021 Questions	
q19a	My supervisor communicates effectively
q19b	My supervisor engages with staff on how to respond to future challenges
q19c	My supervisor can deliver difficult advice whilst maintaining relationships
q19d	My supervisor encourages my team to regularly review and improve our work
q19e	My supervisor is invested in my development
q19f	My supervisor provides me with helpful feedback to improve my performance
q19g	My supervisor actively supports people from diverse backgrounds
q19h	My supervisor ensures that my workgroup delivers on what we are responsible for
q19i	My supervisor invites a range of views, including those different to their own
q33c	My immediate supervisor encourages me
q34e	My immediate supervisor encourages me for my health and wellbeing
q48b	My immediate supervisor encourages me to come up with new or better ways of doing things

Data Suitability for Factor Analysis

Two basic assumptions of factor analysis should be tested to confirm the suitability of the data for EFA - Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Barlett's test of sphericity. KMO measure of sampling adequacy measures the ratio of correlations and partial correlations between the variables. Generally, if KMO is closer to 1 means that the data is suited for factor analysis, while values above 0.5 are generally accepted as moderately adequate, and values below 0.5 mean that the sample is inadequate. (*Kaiser-Meyer-Olkin (KMO) Test for Sampling Adequacy*, n.d.) In this study, the overall KMO is 0.95, indicating good adequacy of our data for factor analysis. Bartlett's Test of Sphericity is a test to determine the redundancy between the variables and determines if the observed correlation matrix is an identity matrix. Essentially, the null hypothesis of the test is that the variables are orthogonal (not correlated) and the alternative hypothesis is that variables are not orthogonal (variables are correlated enough). (Zach, 2022)

This test is frequently performed before using a data reduction approach such as principal component analysis or factor analysis to ensure that the data can be compressed in a meaningful way.

Our dataset is appropriate for a data reduction strategy if the p-value from Bartlett's Test of Sphericity is less than our specified significance level. In this study, Bartlett's Test has a p-value less than 0.05, therefore, the variables selected have enough correlation to perform an EFA.

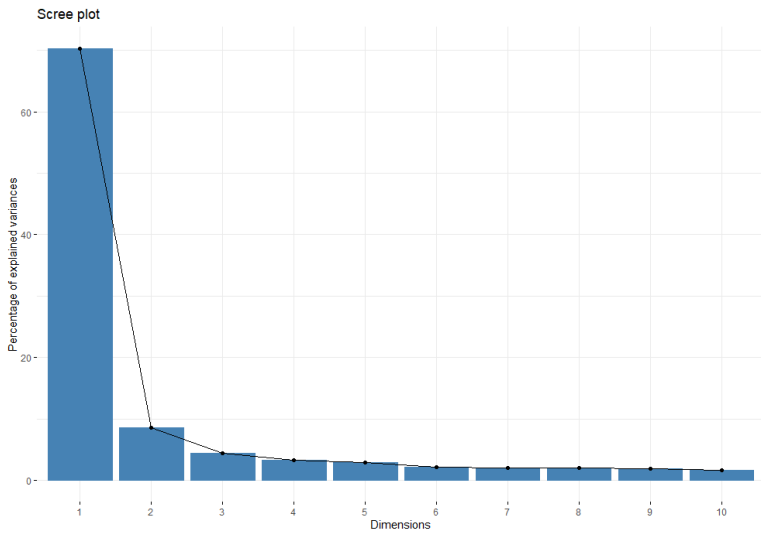
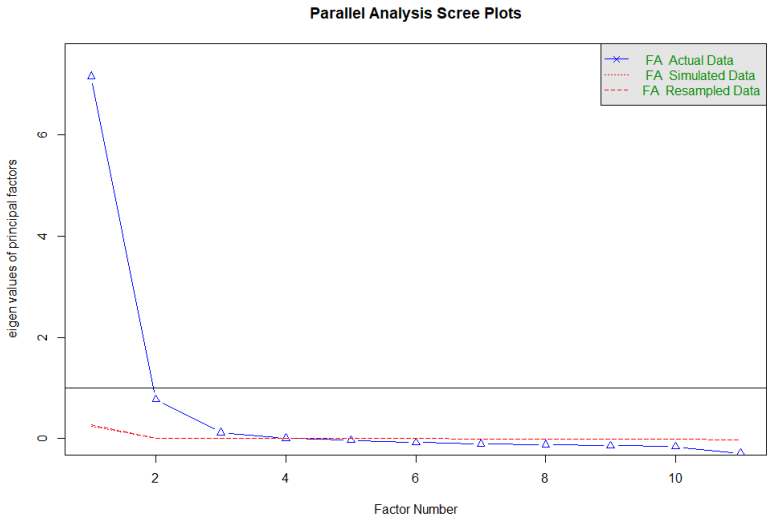
Test	2014 Data	2021 Data
KMO sampling adequacy	0.95	0.96
Barlett's Sphericity	χ2 (55) was 826784 $p < 0.001$	χ2 (36) was 840431 $p < 0.001$

Factor Extraction

The researchers performed principal component analysis (PCA) to define the number of factors needed to represent the structure of the leadership question variables. PCA's main goal is to extract the maximum variance from the data set within each component or latent factor. Thereafter, researchers considered four criteria in choosing the number of factors that best describes the leadership questions for each year, namely: 1) percentage of variance; 2) scree plot; 3) latent root criterion, eigenvalue greater than 0.7; 4) priori criterion, extent of previous knowledge.

Factor Extraction for 2014 Leadership Questions

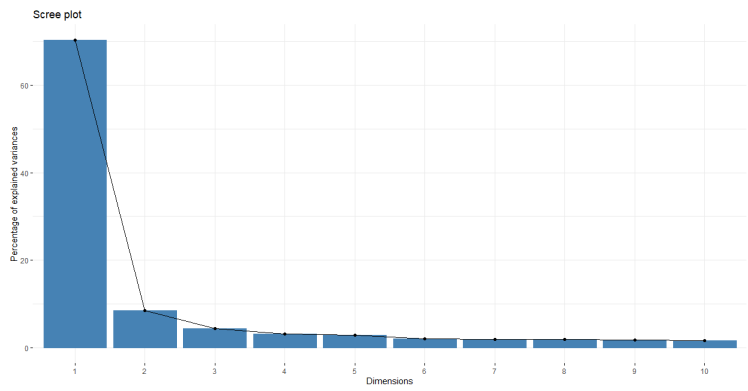
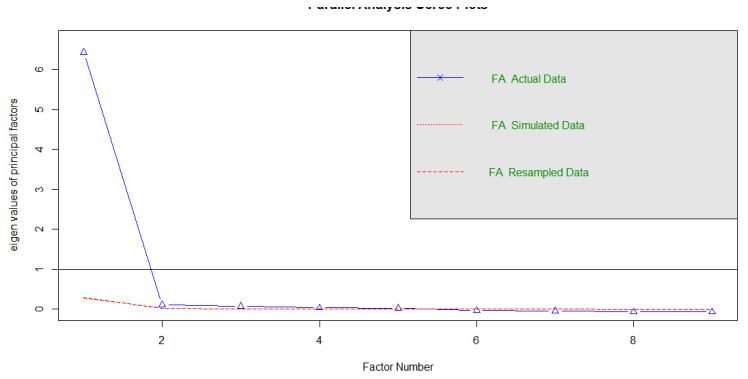
Below table specifies the results of criteria checking for PCA percentage of variance, scree plot, and latent root or eigenvalue criterion on 2014 leadership questions. The fourth criterion (priori criterion) indicates the prior knowledge of the number of factors underlying the data. In the case of the study, for 2014 survey data - 2 leadership questions are being explored namely Transformational and Consideration Leadership.

Criteria	Interpretation
	PCA scree plot indicates the individual variance explained by each component. From this, we can see that at least 3 factors are needed to have at least 80% variance.
	FA Parallel analysis using principal component analysis as a factor method indicates the number of factors as 3. However, the scree plot indicates that the number of factors that are having eigenvalue greater than 0.7 is only 2. A change in the steepness of the slope can also be observed from 2 factor going to 3

For the 2014 leadership questions, the number of factors that were used to conduct EFA was 2 factors considering the a priori criterion that the researchers have selected for the questions to two distinct components that were asked to be validated - Transformational and Consideration Leadership.

Factor Extraction for 2021 Leadership Questions

Below table specifies the results of criteria checking for PCA percentage of variance, scree plot, and latent root or eigenvalue criterion on 2021 leadership questions. The fourth criteria (priori criterion) indicates the prior knowledge of the number of factors underlying the data. In the case of the study, for 2021 survey data - 3 leadership questions are being explored namely Transformational, Interpersonal, and Entrepreneurial.

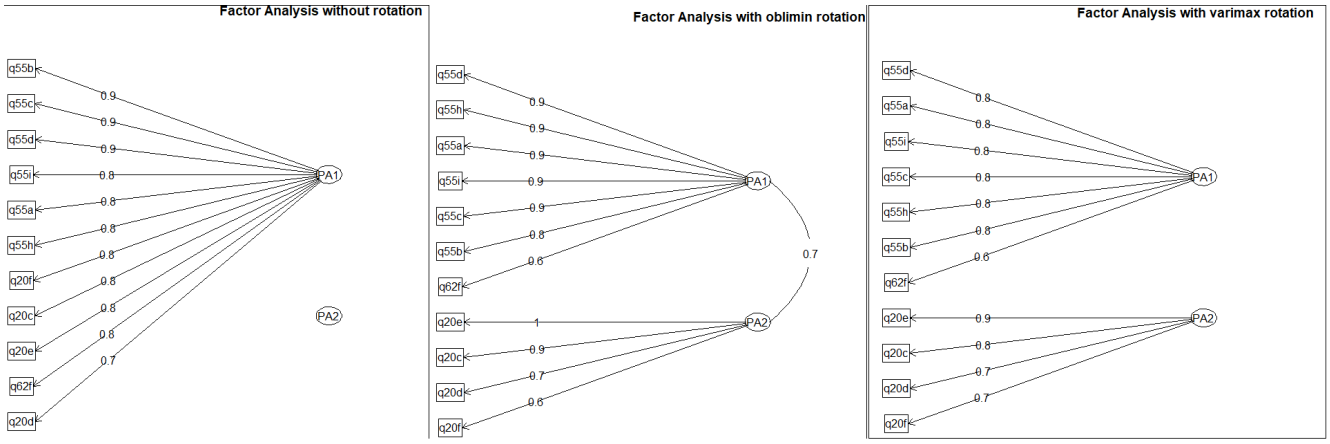
Criteria	Interpretation
	PCA scree plot indicates the individual variance explained by each component. From this, we can see that at least 3 factors are needed to have at least 85% variance.
	FA Parallel analysis using principal component analysis as a factor method indicates the number of factors as 3. However, the scree plot indicates that the number of factors that are having eigenvalue greater than 0.7 is only 2. A change in the steepness of the slope can also be observed from 2 factor going to 3

For the 2021 leadership questions, the number of factors that were used to conduct EFA was 3 factors based on – Transformational, Interpersonal and Entrepreneurial.

Factor Rotation

After the factor extraction, factor rotation is conducted to present the pattern of loadings in a format that is easy to understand. As a rule of thumb, a factor loading of 0.5 is considered a significant degree of correlation and therefore has been used as the cut-off level in this study.

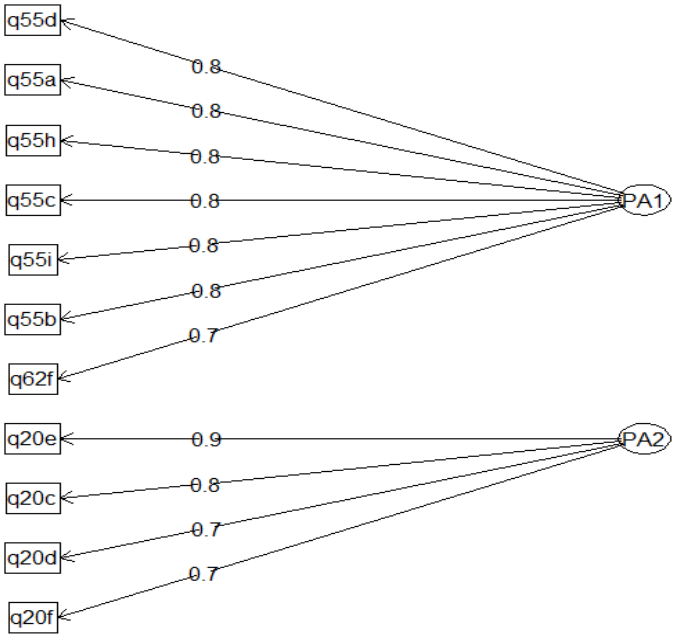
Without the rotation, the researchers have seen that the factors are loading into only one variable which might have been due to their high correlation. With an oblimin rotation, the factors have loaded into the desired number of factors, however, the loadings are too high which has presented difficulty in defining a cut-off. As a result, **varimax rotation** is employed by the researchers to maximize the variance of loadings in the factors and minimize the high loadings of the variables to each other. (Stephanie, 2018).



a. 2014 Leadership Questions

Table below represents the factor loadings and the contribution of each variable to the factors. Questions 20c, 20d, 20e, and 20f are loaded to PA2, with q20c and q20e as the highest contributors. Questions 55a, 55b, 55c, 55d, 55h, 55i, and 62f are loaded to PA1, with q55d and q55 as the highest contributors. The loadings into each of the factors range from 0.65 to 0.9 and commonalities (h2) range from 0.6 to 0.8, which we can interpret that the variables have loaded properly into the latent factors. Furthermore, the leadership factors produced a variance of 75.4% with PA1 having 45.1% and PA2 having 30.2%.

Variable	PA1	PA2	h2	u2
q20c	0.37	0.82	0.81	0.19
q20d	0.34	0.69	0.6	0.4
q20e	0.29	0.9	0.9	0.1
q20f	0.49	0.68	0.7	0.3
q55a	0.81	0.33	0.76	0.24
q55b	0.8	0.39	0.78	0.22
q55c	0.8	0.37	0.78	0.22
q55d	0.83	0.31	0.79	0.21
q55h	0.8	0.32	0.74	0.26
q55i	0.8	0.34	0.75	0.25
q62f	0.65	0.4	0.59	0.41




```
> print(fa4$loadings, digits=3, cutoff=0.5)

Loadings:
     PA1   PA2
q20c       0.822
q20d       0.700
q20e       0.900
q20f       0.691
q55a 0.812
q55b 0.805
q55c 0.811
q55d 0.838
q55h 0.810
q55i 0.812
q62f 0.645

                PA1   PA2
SS loadings    4.966 3.323
Proportion Var 0.451 0.302
Cumulative Var 0.451 0.754
```

b. 2021 Leadership Questions

Table below represents the factor loadings and the contribution of each variable to the factors. Questions 19g, 19i, 19h are loaded to PA3, with q19g and q19i as the highest contributors. Questions 19e, 19f, and 48b are loaded to PA2, with q19e and q19f as the highest contributors. Questions 19b, 19c, and 19d are loaded to PA1, with q19b as the highest contributors. With the exception of q48b, the loadings into each of the factors range from 0.6 to 0.87, and commonalities (h2) range from 0.6 to 0.8, which we can interpret that

the variables have loaded properly into the latent factors. Furthermore, the leadership factors produced a variance of 76% with PA1 having 26%, PA2 having 26%, and PA3 having 24%.

Variables	PA1	PA2	PA3	h2	u2
Q19b	0.69	0.44	0.42	0.84	0.16
Q19c	0.60	0.42	0.48	0.77	0.23
Q19d	0.61	0.47	0.43	0.77	0.23
Q19e	0.38	0.75	0.40	0.87	0.13
Q19f	0.47	0.67	0.41	0.83	0.17
Q19g	0.36	0.42	0.63	0.70	0.30
Q19h	0.50	0.37	0.55	0.69	0.31
Q19i	0.47	0.42	0.62	0.78	0.22
Q48b	0.40	0.42	0.40	0.50	0.50


```
Factor Analysis using method =  pa
Call: fa(r = t, nfactors = 3, rotate = "varimax", fm = "pa")
Standardized loadings (pattern matrix) based upon correlation matrix
      PA1  PA2  PA3   h2   u2 com
q19b 0.69 0.44 0.42 0.85 0.15 2.4
q19c 0.61 0.43 0.48 0.79 0.21 2.7
q19d 0.60 0.48 0.44 0.78 0.22 2.8
q19e 0.39 0.74 0.41 0.87 0.13 2.1
q19f 0.48 0.66 0.42 0.84 0.16 2.6
q19g 0.36 0.41 0.65 0.72 0.28 2.3
q19h 0.49 0.38 0.57 0.71 0.29 2.7
q19i 0.47 0.45 0.60 0.79 0.21 2.8
q48b 0.38 0.44 0.38 0.49 0.51 2.9

                       PA1  PA2  PA3
SS loadings           2.33 2.31 2.19
Proportion Var        0.26 0.26 0.24
Cumulative Var        0.26 0.52 0.76
Proportion Explained  0.34 0.34 0.32
Cumulative Proportion 0.34 0.68 1.00
```

Interpretation and Labeling

a. 2014 Leadership Questions

Characteristics shown by questions q20c, q20d, q20e, and q20f are those of Consideration Leadership where leaders portray importance on the personal relationships and wellbeing of the employees, while, questions q55a, q55b, q55c, q55d, q55h, q55i, and q62f portray the characteristics of Transformational Leaders in which leaders encourages and motivates employees to find new ways of doing work. As shown in the above FA results, the leadership factors produced a variance of 75.4% with PA1 (Transformational Leadership) having 45.1% and PA2 (Consideration Leadership) having 30.2%.

Variable	Description	Leadership Style
q20c	My supervisor works effectively with people from diverse backgrounds	Consideration Leadership
q20d	My supervisor is committed to workplace safety	
q20e	My supervisor is accepting of people from diverse backgrounds	
q20f	My supervisor treats people with respect	
q55a	a. Achieves results	Transformational Leadership
q55b	b. Cultivates productive working relationships	
q55c	c. Exemplifies personal drive and integrity	
q55d	d. Shapes strategic thinking	
q55h	h. Encourages innovation	
q55i	i. Develops people	
q62f	a. My supervisor is open to new ideas	

a. 2021 Leadership Questions

Characteristics shown by questions 19b, 19d, 9c are those of Entrepreneurial Leadership where leaders portray the importance of **turning problems into opportunities that create economic and social value**, while, questions 19e, 19f, 48b portray the characteristics of Transformational Leadership where **approach that causes a change in individuals and social systems**, while question 19g, 19i, 19h portray the characteristics of Interpersonal

Leadership in which leaders portray importance on **the ability to inspire and engage others to do their best work towards a shared goal.** Furthermore, the leadership factors produced a variance of 76% with PA1 (Entrepreneurial Leadership) having 26%, PA2 (Transformational Leadership) having 26%, and PA3 (Interpersonal Leadership) having 24%.

Variable	Description	Leadership Style
q19b	My supervisor engages with staff on how to respond to future challenges	Entrepreneural Leadership
q19c	My supervisor can deliver difficult advice whilst maintaining relationships	
q19d	My supervisor encourages my team to regularly review and improve our work	
q19e	My supervisor is invested in my development	Transformational Leadership
q19f	My supervisor provides me with helpful feedback to improve my performance	
q48b	My immediate supervisor encourages me to come up with new or better ways of doing things	
q19g	My supervisor actively supports people from diverse backgrounds	Interpersonal Leadership
q19h	My supervisor ensures that my workgroup delivers on what we are responsible for	
q19i	My supervisor invites a range of views, including those different to their own	

Factor Analysis Reliability

Cronbach's alpha is computed by correlating the score for each scale item with the total score for each observation (usually individual survey responses or test-takers) and then comparing that to the variance for all individual item scores. Cronbach's alpha is a function of

- the number of items in a test
- Average covariance between pairs of items
- Variance of the total score

	2014	2021
Size	77841	97481
items	11	9
alpha	0.9	0.95

For 2014 EFA, the alpha coefficient of reliability ranges from 0 to 1 in providing this overall assessment of a measure's reliability. The reliability of all questions in their respective factors ranges from 086 to 0.95 and statistics also show that if the variable is removed, the reliability will decrease. Overall assessment of this measure's reliability for both EFA of 2014 is good since the absolute value of the alpha coefficient is above 0.95.

```
Reliability analysis
Call: psych::alpha(x = d2014[, TL])

  raw_alpha std.alpha G6(smc) average_r S/N     ase mean   sd median_r
      0.95      0.95    0.95      0.74  20 0.00026  3.8 0.86     0.74

 lower alpha upper     95% confidence boundaries
0.95 0.95 0.95

 Reliability if an item is dropped:
     raw_alpha std.alpha G6(smc) average_r S/N alpha se  var.r med.r
q55a      0.94      0.94    0.94      0.73  16  0.00031 0.0032  0.74
q55b      0.94      0.94    0.94      0.73  16  0.00032 0.0037  0.73
q55c      0.94      0.94    0.94      0.73  16  0.00032 0.0032  0.74
q55d      0.94      0.94    0.94      0.73  16  0.00032 0.0035  0.73
q55h      0.94      0.94    0.94      0.73  17  0.00031 0.0043  0.75
q55i      0.94      0.94    0.94      0.73  17  0.00031 0.0040  0.74
q62f      0.95      0.95    0.95      0.77  20  0.00027 0.0011  0.76

 Item statistics
         n raw.r std.r r.cor r.drop mean   sd
q55a 77841  0.89  0.89  0.87   0.85  3.9 0.90
q55b 77841  0.90  0.90  0.88   0.86  3.8 1.01
q55c 77841  0.89  0.89  0.88   0.85  3.9 0.98
q55d 77841  0.90  0.90  0.88   0.86  3.8 0.99
q55h 77841  0.89  0.89  0.87   0.84  3.7 1.02
q55i 77841  0.89  0.89  0.87   0.85  3.7 1.05
q62f 77841  0.80  0.81  0.75   0.74  3.9 0.88
```

```
Reliability analysis
Call: psych::alpha(x = d2014[, CL])

  raw_alpha std.alpha G6(smc) average_r S/N     ase mean   sd median_r
      0.91      0.92     0.9      0.73  11 0.00051  4.1 0.69     0.73

 lower alpha upper     95% confidence boundaries
0.91 0.91 0.91

 Reliability if an item is dropped:
     raw_alpha std.alpha G6(smc) average_r  S/N alpha se  var.r med.r
q20c      0.87      0.88    0.83      0.70  7.1  0.00079 0.0036  0.73
q20d      0.91      0.91    0.88      0.78 10.4  0.00058 0.0042  0.75
q20e      0.86      0.87    0.82      0.69  6.5  0.00083 0.0024  0.69
q20f      0.90      0.90    0.87      0.76  9.3  0.00061 0.0071  0.73

 Item statistics
         n raw.r std.r r.cor r.drop mean   sd
q20c 77841  0.92  0.92  0.89   0.84  4.0 0.78
q20d 77841  0.84  0.85  0.77   0.74  4.1 0.71
q20e 77841  0.93  0.93  0.92   0.87  4.1 0.72
q20f 77841  0.88  0.87  0.80   0.77  4.1 0.87
```

For 2021 EFA, the alpha coefficient of reliability ranges from 0 to 1 in providing this overall assessment of a measure's reliability. The reliability of all questions in their respective factors ranges from 0.7 to 0.9 and statistics also show that if the variable is removed, the reliability will decrease. Overall assessment of this measure's reliability for both EFA of 2021 is good since the absolute value of the alpha coefficient is 0.88.

```
Reliability analysis
Call: psych::alpha(x = d2021[, TL])

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean   sd median_r
      0.88      0.87    0.84       0.7 6.9 7e-04  3.9 0.87      0.63

    95% confidence boundaries
         lower alpha upper
Feldt     0.87  0.88  0.88
Duhachek  0.87  0.88  0.88

 Reliability if an item is dropped:
     raw_alpha std.alpha G6(smc) average_r  S/N alpha se var.r med.r
q19e      0.76      0.77    0.62      0.62  3.3  0.00150    NA  0.62
q19f      0.77      0.77    0.63      0.63  3.4  0.00146    NA  0.63
q48b      0.91      0.91    0.84      0.84 10.6  0.00055    NA  0.84

 Item statistics
        n raw.r std.r r.cor r.drop mean   sd
q19e 97481  0.93  0.92  0.89   0.82  4.0 1.02
q19f 97481  0.92  0.92  0.89   0.82  3.9 0.99
q48b 97481  0.83  0.84  0.68   0.65  3.9 0.91

Non missing response frequency for each item
        1    2    3    4    5 miss
q19e 0.03 0.06 0.16 0.41 0.34    0
q19f 0.03 0.07 0.15 0.44 0.31    0
q48b 0.02 0.06 0.17 0.49 0.26    0
```

```
Reliability analysis
Call: psych::alpha(x = d2021[, EL])

 raw_alpha std.alpha G6(smc) average_r S/N     ase mean   sd median_r
     0.92      0.92    0.88       0.79  11 0.00045    4 0.86     0.79

    95% confidence boundaries
         lower alpha upper
Feldt     0.92  0.92  0.92
Duhachek  0.92  0.92  0.92

 Reliability if an item is dropped:
     raw_alpha std.alpha G6(smc) average_r S/N alpha se var.r med.r
q19b      0.86      0.87    0.76      0.76 6.4  0.00086    NA  0.76
q19c      0.88      0.89    0.79      0.79 7.7  0.00074    NA  0.79
q19d      0.90      0.90    0.81      0.81 8.6  0.00067    NA  0.81

 Item statistics
        n raw.r std.r r.cor r.drop mean   sd
q19b 97481  0.94  0.94  0.89   0.86    4 0.95
q19c 97481  0.93  0.93  0.87   0.83    4 0.95
q19d 97481  0.92  0.92  0.85   0.82    4 0.90

Non missing response frequency for each item
        1    2    3    4    5 miss
q19b 0.02 0.06 0.11 0.48 0.32    0
q19c 0.03 0.05 0.13 0.46 0.33    0
q19d 0.02 0.05 0.12 0.49 0.32    0
```

```
Reliability analysis
Call: psych::alpha(x = d2021[, IL])

 raw_alpha std.alpha G6(smc) average_r S/N     ase mean   sd
     0.88      0.88    0.83       0.71 7.4 0.00066  4.1 0.77

    95% confidence boundaries
         lower alpha upper
Feldt     0.88  0.88  0.88
Duhachek  0.88  0.88  0.88

 Reliability if an item is dropped:
     raw_alpha std.alpha G6(smc) average_r S/N alpha se var.r
q19g      0.83      0.84    0.72      0.72 5.2   0.0010    NA
q19i      0.82      0.82    0.69      0.69 4.4   0.0012    NA
q19h      0.84      0.84    0.73      0.73 5.3   0.0010    NA

 Item statistics
        n raw.r std.r r.cor r.drop mean   sd
q19g 97481  0.89  0.90  0.81   0.76  4.1 0.84
q19i 97481  0.92  0.91  0.84   0.79  4.1 0.93
q19h 97481  0.89  0.89  0.81   0.76  4.2 0.80

Non missing response frequency for each item
        1    2    3    4    5 miss
q19g 0.01 0.02 0.16 0.44 0.36    0
q19i 0.03 0.05 0.12 0.46 0.34    0
q19h 0.01 0.03 0.09 0.50 0.37    0
```

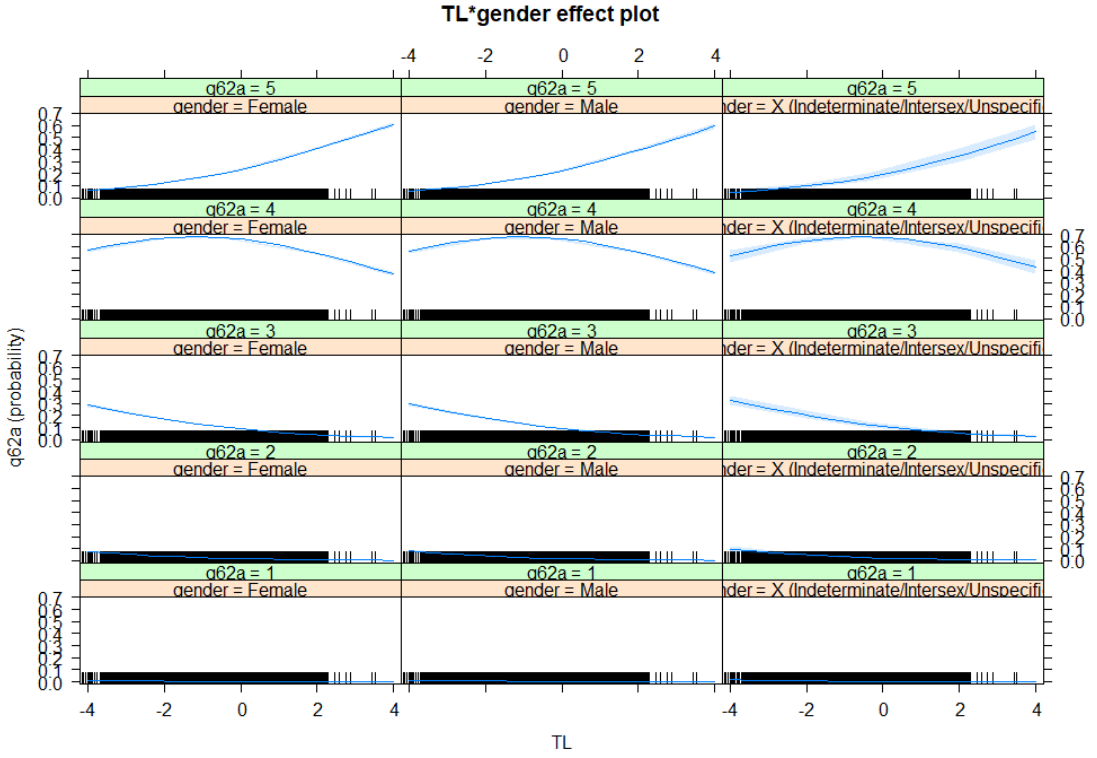
Predictive Modeling

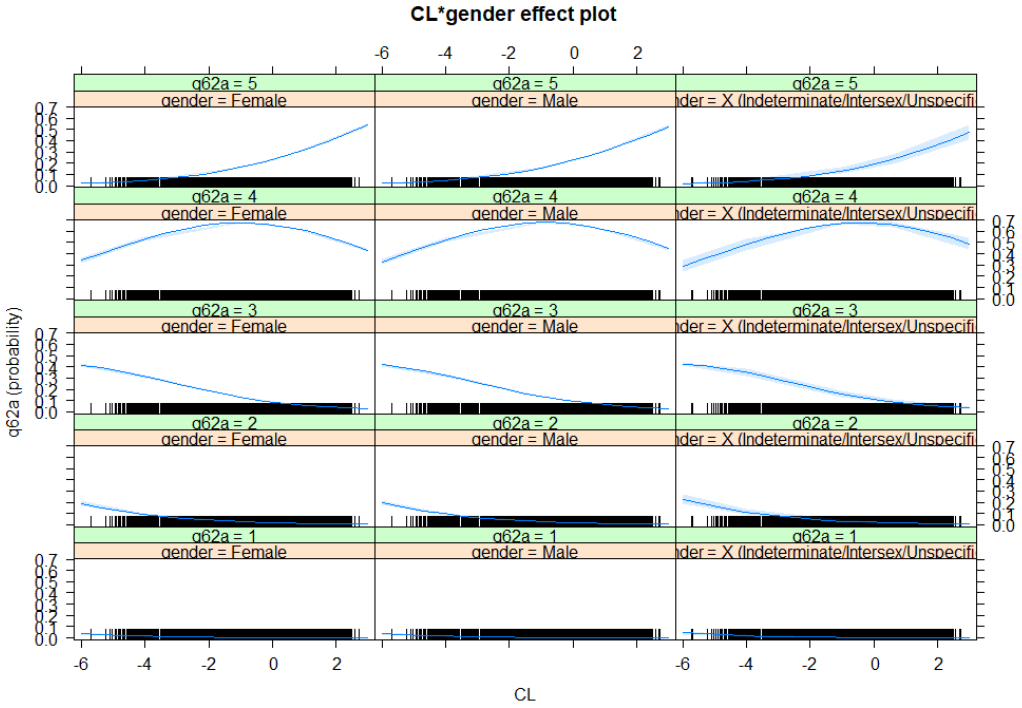
Ordered logistic regression was used to predict the level of innovation from employees and the predictors that were used are the Leadership Styles (TL and CL) that were formed from EFA, gender, and age. We can see from the below results that the TL and CL variables are significant on our model (p-value < 0.05). The coefficients are positive for the TL and CL variables which we can interpret that the odds of the innovation levels of the employees going towards highly agreed (highly innovative) is increasing with the increasing agreement on the leadership styles.

```
Call:
polr(formula = q62a ~ TL + CL + gender + age, data = train.data[train.data$job_level ==
    "Trainee/Graduate/APS", ], Hess = TRUE)

Coefficients:
                                              Value Std. Error t value
TL                                          0.40335    0.01088  37.061
CL                                          0.44627    0.01095  40.741
genderMale                                 -0.05270    0.02067  -2.550
genderX (Indeterminate/Intersex/Unspecified) -0.24791    0.12219  -2.029
age55 years or older                        0.05338    0.03042   1.755
ageUnder 40 years                           0.21821    0.02185   9.987

Intercepts:
    Value     Std. Error t value
1|2   -5.9025    0.0889   -66.4064
2|3   -3.8283    0.0354  -108.0113
3|4   -2.0195    0.0210   -96.1619
4|5    1.2813    0.0188    68.0630

Residual Deviance: 77239.53
AIC: 77259.53
```

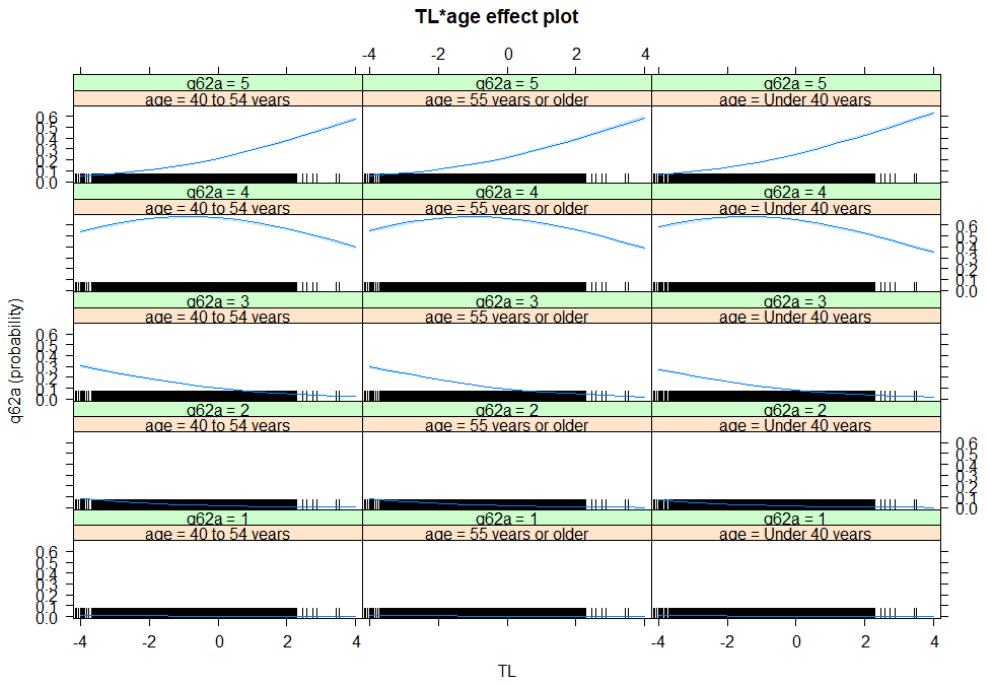
	Value	Std. Error	t value	p value
TL	0.4034	0.0109	37.06	0.0000
CL	0.4463	0.0110	40.74	0.0000
genderMale	-0.0527	0.0207	-2.55	0.0108
genderX (Indeterminate/Intersex/Unspecified)	-0.2479	0.1222	-2.03	0.0425
age55 years or older	0.0534	0.0304	1.75	0.0793
ageUnder 40 years	0.2182	0.0218	9.99	0.0000

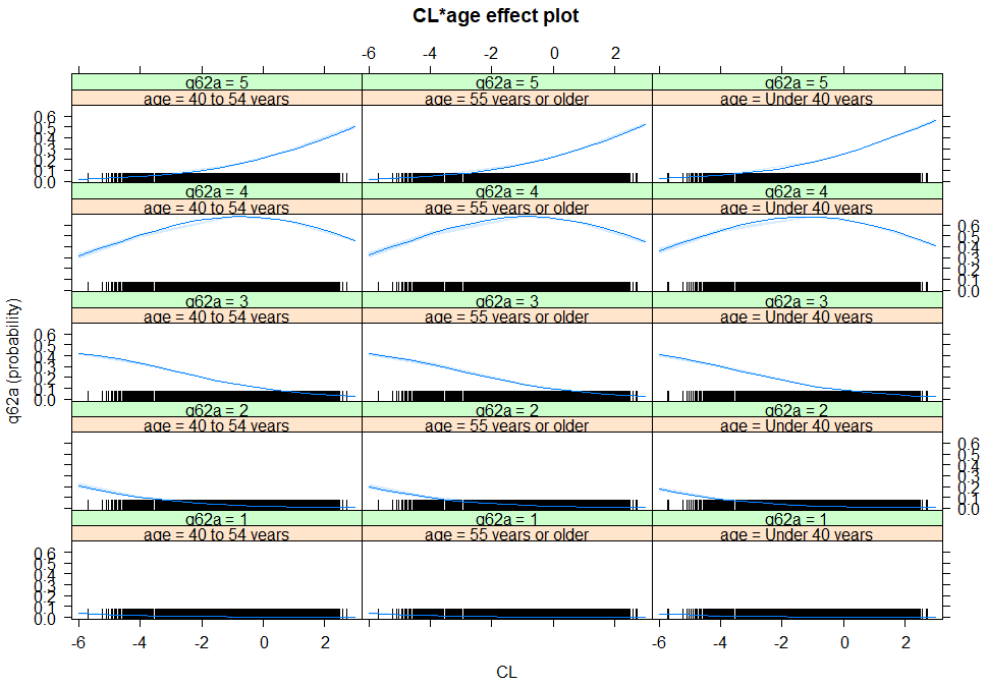
We explored the effects plot of the leadership styles with gender and we can see that for all genders, the probability of employees being highly innovative increases with the TL and CL factor scores. In addition, the probability of employees having lower innovativeness decreases with the TL and CL factors scores for all genders.



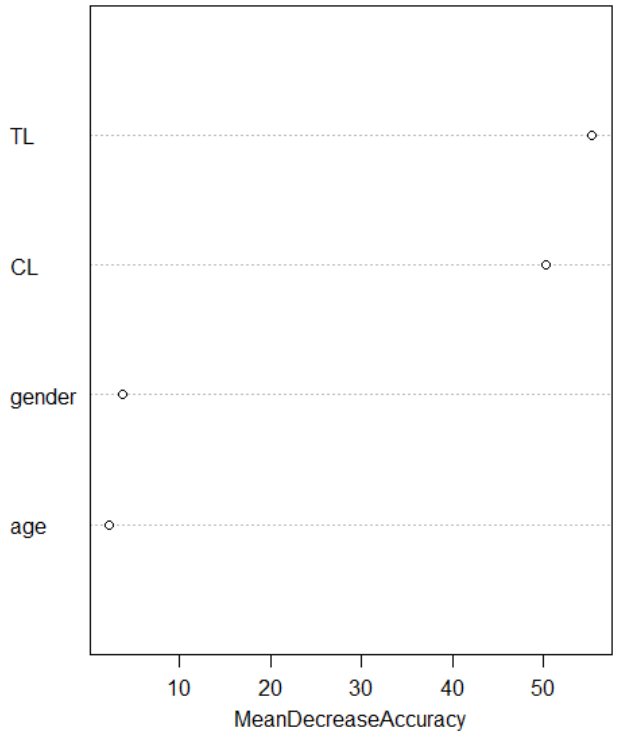


We explored the effects plot of the leadership styles with age and we can see that for all ages, the probability of employees being highly innovative increases with the TL and CL factor scores. In addition, the probability of employees having lower innovativeness decreases with the TL and CL factors scores for all ages.





Finally, we assessed the overall model which indicates that TL (Transformational Leadership) is the most important variable and presented 65.5% accuracy in detecting the level of innovation of the employees.




```
Overall Statistics

               Accuracy : 0.655
                 95% CI : (0.6458, 0.6641)
    No Information Rate : 0.6313
    P-Value [Acc > NIR] : 2.596e-07

                  Kappa : 0.1941

 Mcnemar's Test P-Value : NA
```

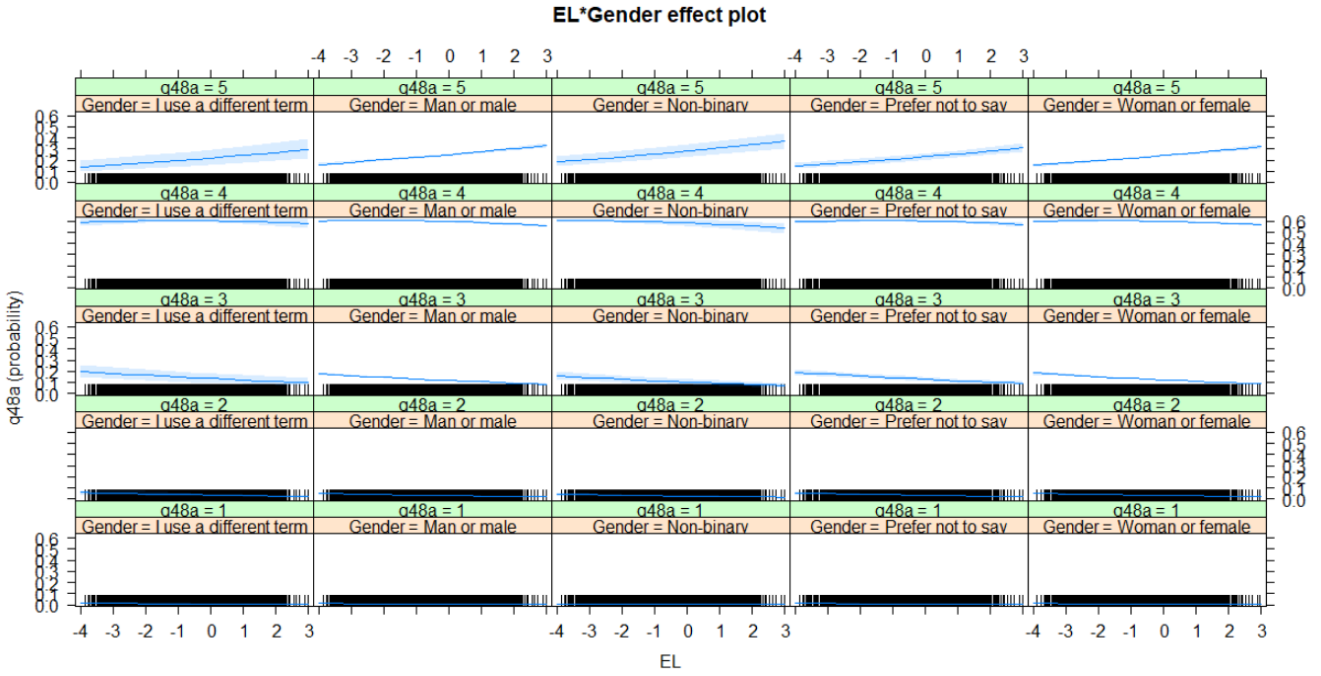
For 2021 dataset

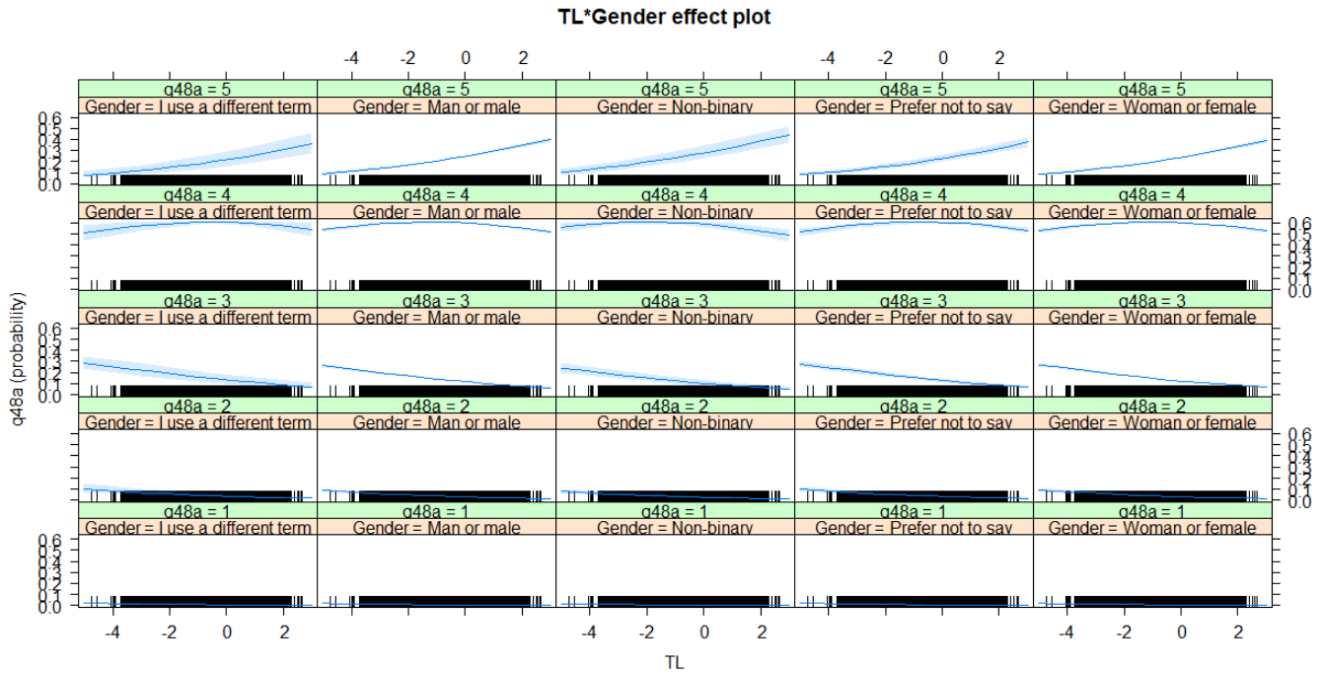
Ordered logistic regression was used to predict the level of innovation from employees and the predictors that were used are the Leadership Styles (TL, EL, and IL) that were formed from EFA, gender, and age. We can see from the below results that the TL, EL, and IL variables are significant on our model (p-value < 0.05). The coefficients are positive for the TL, EL and IL variables which we can interpret that the odds of the innovation levels of the employees going towards strongly agreeing (highly innovative) is increasing with the increasing agreement on the leadership styles.

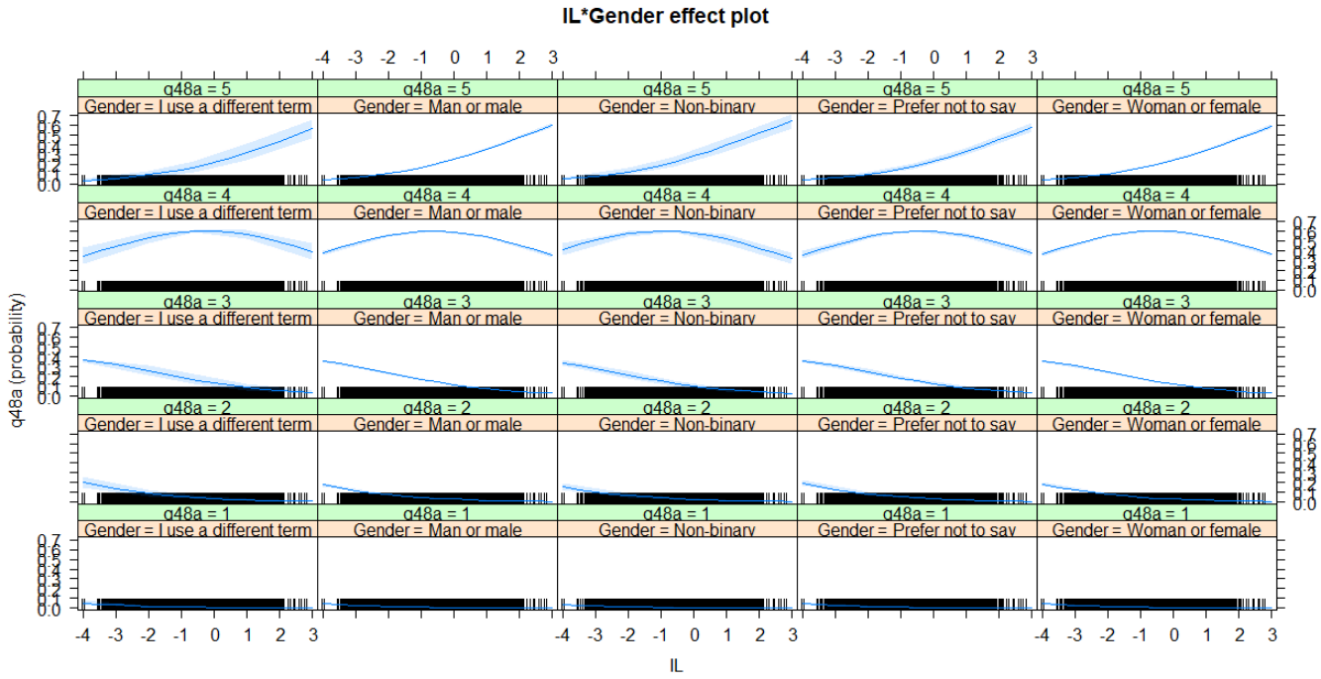
```
polr(formula = q48a ~ EL + TL + IL + Age + Gender, data = TrainSet[TrainSet$Job_Level ==
    "Trainee/Graduate/APS", ], Hess = T)

Coefficients:
                         Value Std. Error t value
EL                     0.13608    0.01300 10.4669
TL                     0.23659    0.01170 20.2289
IL                     0.50629    0.01416 35.7573
Age55 years or older  -0.15386    0.02516 -6.1151
AgeUnder 40 years     -0.10086    0.01912 -5.2739
GenderMan or male      0.16948    0.20383  0.8315
GenderNon-binary       0.33630    0.24927  1.3491
GenderPrefer not to say 0.06494   0.22040  0.2946
GenderWoman or female  0.11939    0.20360  0.5864

Intercepts:
    Value    Std. Error t value
1|2  -4.9844   0.2098   -23.7549
2|3  -3.1743   0.2046   -15.5162
3|4  -1.6093   0.2038    -7.8980
4|5   1.1968   0.2037     5.8756

Residual Deviance: 108732.76
AIC: 108758.76
```

```
> summary_table
                            Value Std. Error     t value p value
EL                     0.13608138 0.01300115  10.4668744   0.000
TL                     0.23659453 0.01169586  20.2289123   0.000
IL                     0.50628526 0.01415894  35.7572948   0.000
Age55 years or older  -0.15385648 0.02516014  -6.1150889   0.000
AgeUnder 40 years     -0.10085561 0.01912365  -5.2738670   0.000
GenderMan or male      0.16948471 0.20382642   0.8315149   0.406
GenderNon-binary       0.33629504 0.24926953   1.3491221   0.177
GenderPrefer not to say 0.06493542 0.22040458  0.2946192   0.768
GenderWoman or female  0.11939004 0.20359799   0.5864009   0.558
```

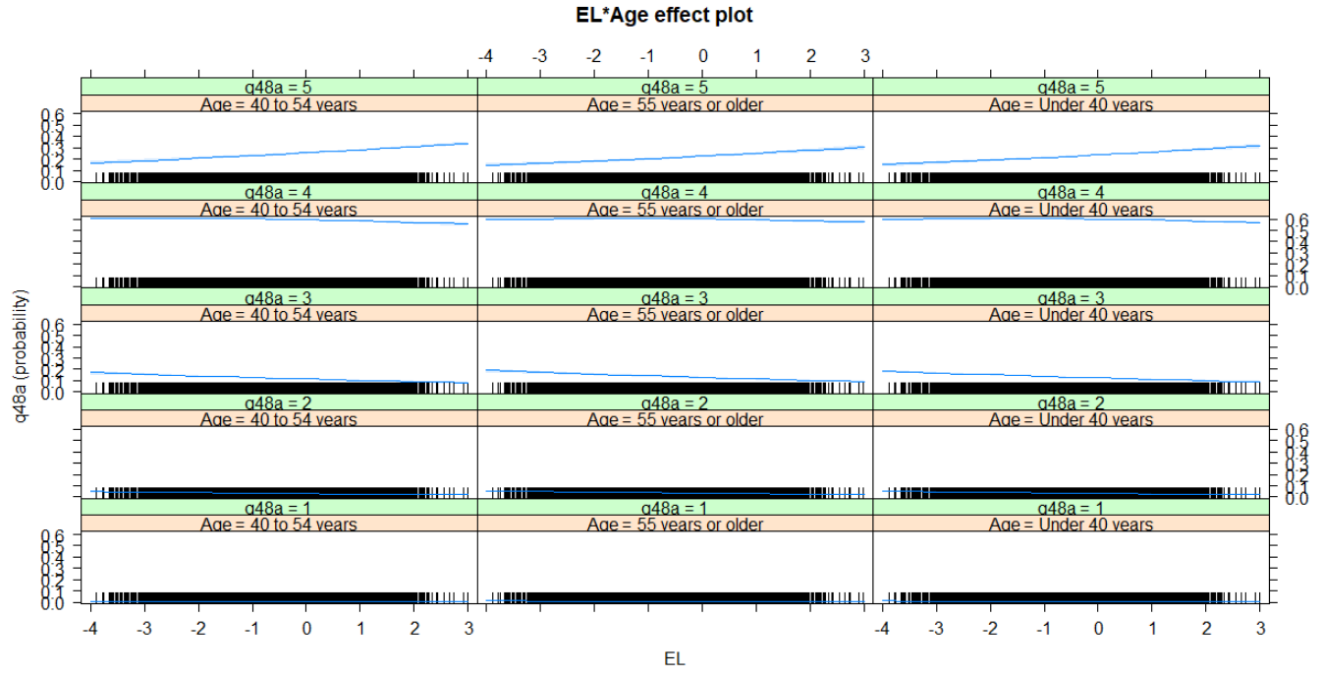
Now we can see the leadership plot with gender (joint effect of two independent variables). The probability of employees being highly innovative increases with the TL, EL, and IL factor scores. In addition, the probability of employees having lower innovativeness decreases with the TL, EL, and IL factors scores for all genders.

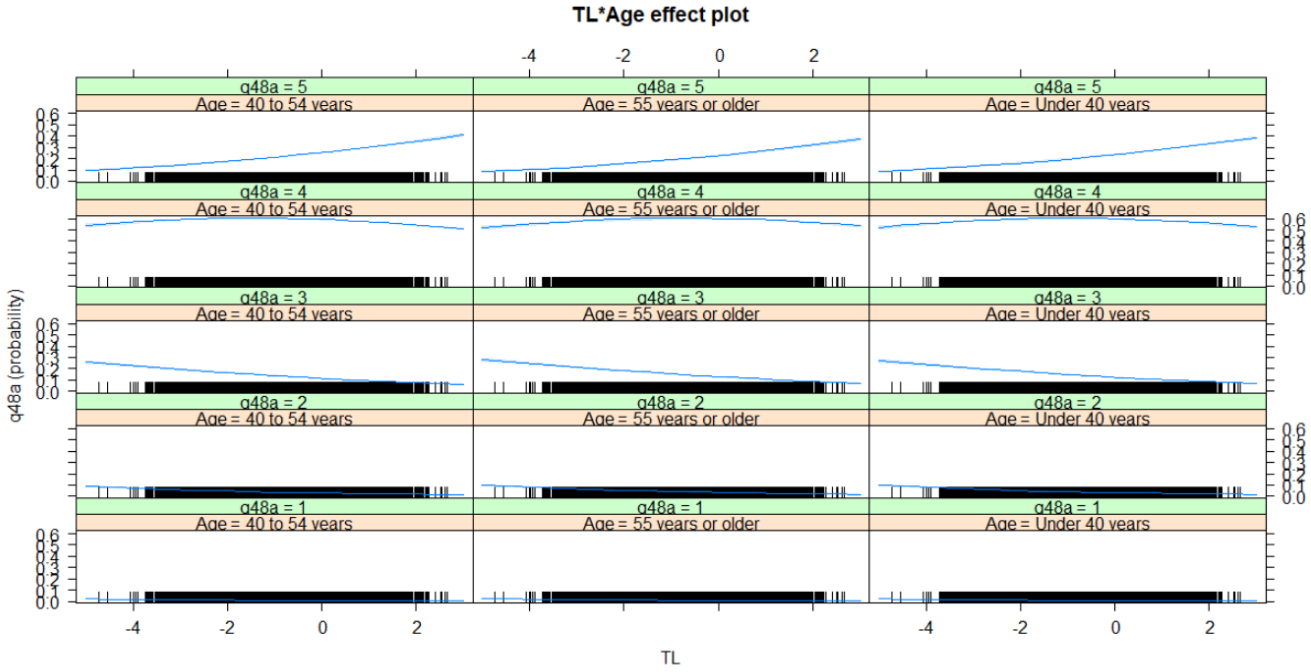


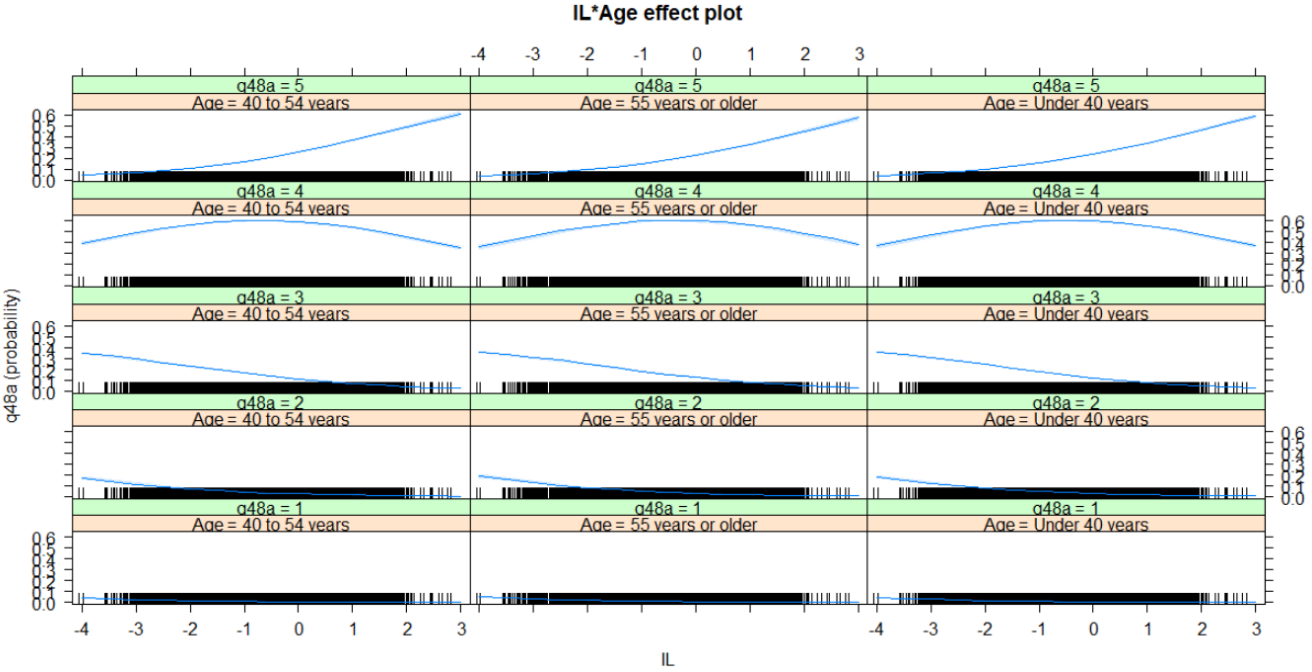




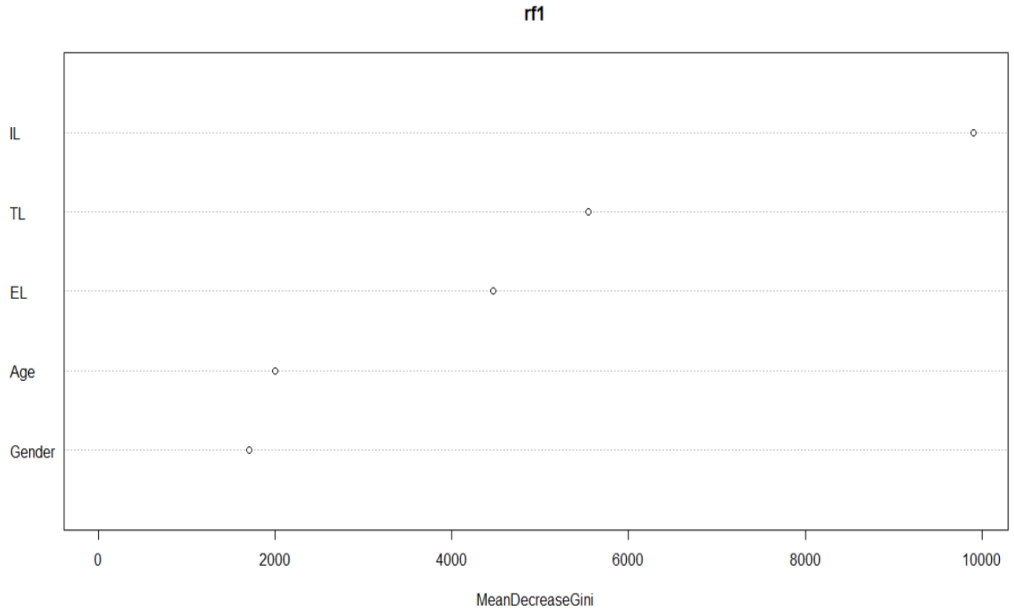
We explored the effects plot of the leadership styles with age and we can see that for all ages, the probability of employees being highly innovative increases with the TL, EL, and IL factor scores. In addition, the probability of employees having lower innovativeness decreases with the TL, EL, and IL factors scores for all ages.




TL*Age effect plot
q48a = 5
Age = 40 to 54 years
q48a = 5
Age = 55 years or older
q48a = 5
Age = Under 40 years
q48a = 4
Age = 40 to 54 years
q48a = 4
Age = 55 years or older
q48a = 4
Age = Under 40 years
q48a = 3
Age = 40 to 54 years
q48a = 3
Age = 55 years or older
q48a = 3
Age = Under 40 years
q48a = 2
Age = 40 to 54 years
q48a = 2
Age = 55 years or older
q48a = 2
Age = Under 40 years
q48a = 1
Age = 40 to 54 years
q48a = 1
Age = 55 years or older
q48a = 1
Age = Under 40 years
q48a (probability)
TL


IL*Age effect plot
q48a = 5
Age = 40 to 54 years
q48a = 5
Age = 55 years or older
q48a = 5
Age = Under 40 years
q48a = 4
Age = 40 to 54 years
q48a = 4
Age = 55 years or older
q48a = 4
Age = Under 40 years
q48a = 3
Age = 40 to 54 years
q48a = 3
Age = 55 years or older
q48a = 3
Age = Under 40 years
q48a = 2
Age = 40 to 54 years
q48a = 2
Age = 55 years or older
q48a = 2
Age = Under 40 years
q48a = 1
Age = 40 to 54 years
q48a = 1
Age = 55 years or older
q48a = 1
Age = Under 40 years
q48a (probability)
IL

Finally, we assessed the overall model which indicates that IL (Interpersonal Leadership) is the most important variable and presented 64.4% accuracy in detecting the level of innovation of the employees.




```
Overall Statistics

               Accuracy : 0.6441
                 95% CI : (0.6374, 0.6509)
    No Information Rate : 0.5568
    P-Value [Acc > NIR] : < 2.2e-16

                  Kappa : 0.3459

 Mcnemar's Test P-Value : < 2.2e-16
```

Conclusion and Recommendations

For 2014

- The characteristics such as accepting and working with people with diverse backgrounds, workplace safety, and treating people with respect correspond to a considerational leadership style that reflects employee wellbeing and relationships.
- The characteristics include achieving results, cultivating productive working relationships, shaping strategic thinking, and encouraging innovation corresponds to a transformational leadership style that reflects encouragement and motivation to be innovative and develop new skills.

For 2021

- The characteristics where leaders portray the importance of turning problems into opportunities that create economic and social value corresponds to the entrepreneurial leadership style which reflects setting goals within the organization and a futuristic vision
- The transformational leadership style this year focuses on providing feedback and encouraging employees towards better ways of doing things.
- The interpersonal leadership style reflects motivation for collaboration while accepting the diversity and opinions of employees. The leaders portray the importance of the ability to inspire and engage others to do their best work towards a shared goal.

While transformational and consideration leadership styles were dominant in 2014, we saw transformational, interpersonal, and entrepreneurial leadership styles in 2021. The difference between the results from the analysis of leadership styles for two years is, that as consideration and Interpersonal leadership styles have similar characteristics, we have an entrepreneurial leadership style in 2021 that exhibits collaboration and employees teamwork.

This study also explored ordinal logistic regression models to determine the possibility of leadership styles in detecting employee innovation. The model showed leadership styles as significant predictors to measure the response of employees' innovation. In 2014, it indicates

that *Transformational* Leadership is the most significant variable, while, in 2021, *Interpersonal* Leadership style is the most significant to predict employee innovation. The model has produced only 63% accuracy as the researchers have focused on detecting the significance of the leadership styles. In the future, it would be interesting to refine and turn the model into a more accurate model to predict the innovation response of the employees.

With the findings of exploratory factor analysis and predictive modeling, It is recommended that the leadership styles discussed in this project should be included in management training and development programs. It is also important that before adopting innovative projects, the agency should hire supervisors who have the above-discussed leadership characteristics.

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Appendix

Final Presentation Site

https://mmlespedillon.wixsite.com/dana4830

Tableau Link

https://public.tableau.com/views/APSEmployeeSatisfactionSurvey2014and2021/2014Leadership?:language=en-US&:display_count=n&:origin=viz_share_link

Datasets and R Code

https://drive.google.com/drive/folders/1bLBx0AOMRoekGPr_gWjfXjVL0kg_Oreu?usp=sharing