Markdown-HTML—final-code—CIND-820—Ibrahim-Ibrahim.R

ibrahimibrahim

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```
# CIND 820: Anlalyzing APS data set


# preparing 2018 APS data as the training set


# calling libraries
library(tidyverse)
```

```
## -- Attaching packages ---------------------------------------------------------------- tidyverse 1.3.0

## v ggplot2 3.3.2     v purrr   0.3.4
## v tibble  3.0.1     v dplyr   1.0.2
## v tidyr   1.1.2     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.5.0

## -- Conflicts ------------------------------------------------------------------- tidyverse_conflicts()
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(mgsub)
library(corrgram)
```

```
## Registered S3 method overwritten by 'seriation':
##   method         from
##   reorder.hclust gclus
```

```
library(corrplot)
```

```
## corrplot 0.84 loaded
```

```
library(likert)
```

```
## Loading required package: xtable

##
## Attaching package: 'likert'
```

```
## The following object is masked from 'package:dplyr':
##
##     recode
```

```
library(party)
```

```
## Loading required package: grid

## Loading required package: mvtnorm

## Loading required package: modeltools

## Loading required package: stats4

## Loading required package: strucchange

## Loading required package: zoo

##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric

## Loading required package: sandwich

##
## Attaching package: 'strucchange'

## The following object is masked from 'package:stringr':
##
##     boundary
```

```
library(pROC)
```

```
## Type 'citation("pROC")' for a citation.

##
## Attaching package: 'pROC'

## The following objects are masked from 'package:stats':
##
##     cov, smooth, var
```

```r
# reading 2018 aps data set
aps <- read.csv("/Users/ibrahimibrahim/Documents/Ryerson/820/data set/2018-aps-employee-census-dataset.

# when I first examined the dataset, I found out there were no NAs and all unaswered questions
# were categorized as " ", so I modified the read.csv file to regard " " as NA using na.strings=" "
# all variables are factors so I chose stringAsFators=True


# overview
#head(aps)
#tail(aps)
#str(aps)
#summary(aps)


# renaming variables and creating a new data frame with reduced number of variables

# reading new column names from a csv file
column_names_1 <- read.csv("/Users/ibrahimibrahim/Documents/Ryerson/820/data set/column_names_2018.csv"

aps_new_column_names <- aps
names(aps_new_column_names)[1:301] <- c(column_names_1$new.column.name)
aps_reduced <- select(aps_new_column_names, -contains("disregarded"))


# On page 1 of instructions on how to complete the census, employees were told:
# 1- You are then free to skip and not answer any other questions that you may not want to answer.
# 2- If you cannot answer a question, please feel free to leave it blank.

# a few questions also had the option of answering with "I do not know" which could be
# one of the motivations for skipping a question - so "I do not know" answers cannot be
# treated as unique vs. skipped questions (these answers are likely a subset of skipped questions)
# therefore after initial exploration, "I do not know" answers will be treated the same
# way as skipped questions

# Skippig questions was allowed in survey, so will check for missing values
sum(is.na(aps_reduced))
```

```
## [1] 362167
```

```r
aps_reduced$number_skipped_questions <- rowSums(is.na(aps_reduced))
table(aps_reduced$number_skipped_questions)
```

```
##
##     0     1     2     3     4     5     6     7     8     9    10    11    12
## 80389 10372  1852   651   353   535   221   386   188   107   131   109   258
##    13    14    15    16    17    18    19    20    21    22    23    24    25
##   250   108    85    78    97  1128   432   137    69    54   290   108    78
##    26    27    28    29    30    31    32    33    34    35    36    37    38
##    44    36    44    48   268   102   198    23    30    24    53    72   372
##    39    40    41    42    43    44    45    46    47    48    49    50    51
##    62    25    22    39    23    26    31    13    14   197    40    30    19
```

```
##    52    53    54    55    56    57    58    59    60    61    62    63    64
##    15    26    26   413    62    27     7    17   241    33    19    11     8
##    65    66    67    68    69    70    71    72    73    74    75    76    77
##     9    19   354    38    14    11     8    10     8    20     9    10    14
##    78    79    80    81    82    83    84    85    86    87    88    89    90
##   318    11     7     7   211    10     3     3     7     8    12     9    16
##    91    92
##    25   740
```

```
number_skipped_questions_above_0 <- aps_reduced$number_skipped_questions[aps_reduced$number_skipped_ques
table(number_skipped_questions_above_0)
```

```
## number_skipped_questions_above_0
##     1     2     3     4     5     6     7     8     9    10    11    12    13
## 10372  1852   651   353   535   221   386   188   107   131   109   258   250
##    14    15    16    17    18    19    20    21    22    23    24    25    26
##   108    85    78    97  1128   432   137    69    54   290   108    78    44
##    27    28    29    30    31    32    33    34    35    36    37    38    39
##    36    44    48   268   102   198    23    30    24    53    72   372    62
##    40    41    42    43    44    45    46    47    48    49    50    51    52
##    25    22    39    23    26    31    13    14   197    40    30    19    15
##    53    54    55    56    57    58    59    60    61    62    63    64    65
##    26    26   413    62    27     7    17   241    33    19    11     8     9
##    66    67    68    69    70    71    72    73    74    75    76    77    78
##    19   354    38    14    11     8    10     8    20     9    10    14   318
##    79    80    81    82    83    84    85    86    87    88    89    90    91
##    11     7     7   211    10     3     3     7     8    12     9    16    25
##    92
##   740
```

```
sum(table(number_skipped_questions_above_0))       # a total of 22,748 respondents who skipped question
```

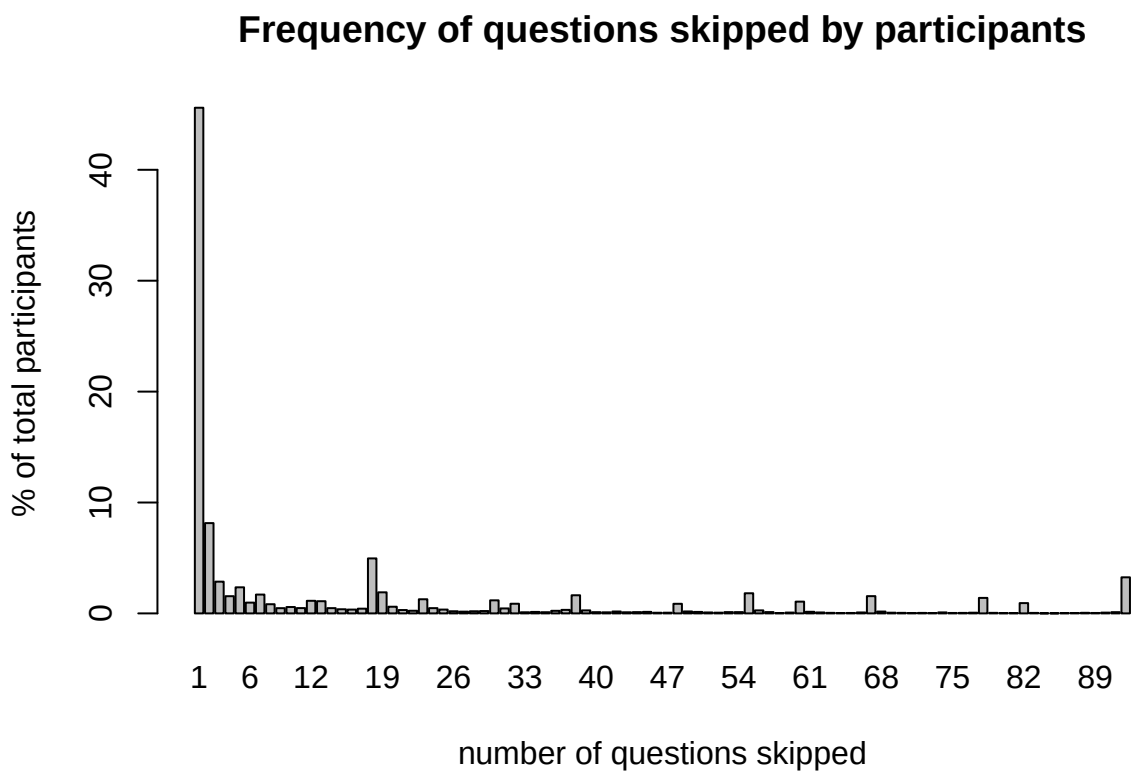
```
## [1] 22748
```

```
prop.table(table(number_skipped_questions_above_0))*100
```

```
## number_skipped_questions_above_0
##           1           2           3           4           5           6
## 45.59521716  8.14137507  2.86179005  1.55178477  2.35185511  0.97151398
##           7           8           9          10          11          12
##  1.69685247  0.82644628  0.47037102  0.57587480  0.47916300  1.13416564
##          13          14          15          16          17          18
##  1.09899771  0.47476701  0.37365922  0.34288729  0.42641111  4.95867769
##          19          20          21          22          23          24
##  1.89906805  0.60225075  0.30332337  0.23738351  1.27483735  0.47476701
##          25          26          27          28          29          30
##  0.34288729  0.19342360  0.15825567  0.19342360  0.21100756  1.17812555
##          31          32          33          34          35          36
##  0.44839107  0.87040619  0.10110779  0.13187973  0.10550378  0.23298752
##          37          38          39          40          41          42
##  0.31651134  1.63530860  0.27255143  0.10989977  0.09671180  0.17144364
##          43          44          45          46          47          48
```

```
##  0.10110779  0.11429576  0.13627572  0.05714788  0.06154387  0.86601020
##          49          50          51          52          53          54
##  0.17583963  0.13187973  0.08352383  0.06593986  0.11429576  0.11429576
##          55          56          57          58          59          60
##  1.81554422  0.27255143  0.11869175  0.03077194  0.07473184  1.05943380
##          61          62          63          64          65          66
##  0.14506770  0.08352383  0.04835590  0.03516793  0.03956392  0.08352383
##          67          68          69          70          71          72
##  1.55618076  0.16704765  0.06154387  0.04835590  0.03516793  0.04395991
##          73          74          75          76          77          78
##  0.03516793  0.08791982  0.03956392  0.04395991  0.06154387  1.39792509
##          79          80          81          82          83          84
##  0.04835590  0.03077194  0.03077194  0.92755407  0.04395991  0.01318797
##          85          86          87          88          89          90
##  0.01318797  0.03077194  0.03516793  0.05275189  0.03956392  0.07033585
##          91          92
##  0.10989977  3.25303323
```

```
barplot(prop.table(table(number_skipped_questions_above_0))*100, main = "Frequency of questions skipped
```




```
# Univariate analysis
# examining variables that will be combined to form the main scales that will be studied

# reformat_variable_group1:
# a function to change a variable to factor, re-order factor levels, rename factor levels:
```

```r
# this function will be applied to the following variables:
# job_engagement, team_engagement, supervisor_engagement, senior_manager_engagement,
# agency_engagement, wellbeing (Q9 to Q13), team_performance_support, risk_culture,
# innovation

reformat_variable_group1 <- function(variable_to_be_used){
  # re-order factor levels and rename factor levels
  variable_to_be_used <- fct_relevel(variable_to_be_used, c("Strongly disagree", "Disagree", "Neither ag

  levels(variable_to_be_used) <- list("1" = "Strongly disagree", "2" = "Disagree", "3" = "Neither agree

  return(variable_to_be_used)
}
#end reformat_variable_group1

# reformat_variable_group2:
# a function to re-order factor levels, rename factor levels:
# this function will be applied to the following variables:
# leadership_engagement

unique(aps_reduced$leadership_engagement_1)
```

```
## [1] Agree                       Neither agree nor disagree
## [3] Disagree                    Strongly disagree
## [5] Strongly agree              Do not know
## [7] <NA>
## 6 Levels: Agree Disagree Do not know ... Strongly disagree
```

```r
reformat_variable_group2 <- function(variable_to_be_used){
  # re-order factor levels and rename factor levels
  variable_to_be_used <- fct_relevel(variable_to_be_used, c("Strongly disagree", "Disagree", "Neither ag

  levels(variable_to_be_used) <- list("1" = "Strongly disagree", "2" = "Disagree", "3" = "Neither agree

  return(variable_to_be_used)
}
#end reformat_variable_group2

# reformat_variable_group3:
# a function to re-order factor levels, rename factor levels:
# this function will be applied to the following variables:
# wellbeing_1

unique(aps_reduced$wellbeing_1)
```

```
## [1] Satisfied                           Very satisfied
## [3] Neither satisfied or dissatisfied Dissatisfied
## [5] <NA>                                Very dissatisfied
## 5 Levels: Dissatisfied Neither satisfied or dissatisfied ... Very satisfied
```

```r
reformat_variable_group3 <- function(variable_to_be_used){
  # re-order factor levels and rename factor levels
```

```
  variable_to_be_used <- fct_relevel(variable_to_be_used, c("Very dissatisfied", "Dissatisfied",  "Neitl

  levels(variable_to_be_used) <- list("1" = "Very dissatisfied", "2" = "Dissatisfied",  "3" = "Neither s

  return(variable_to_be_used)
}
#end reformat_variable_group3

# reformat_variable_group4:
# a function to re-order factor levels, rename factor levels:
# this function will be applied to the following variables:
# wellbeing_2 and wellbeing_6

unique(aps_reduced$wellbeing_2)
```

```
## [1] Rarely    Sometimes Often     Always    Never     <NA>
## Levels: Always Never Often Rarely Sometimes
```

```
unique(aps_reduced$wellbeing_6)
```

```
## [1] Rarely    Sometimes Often     Never     Always    <NA>
## Levels: Always Never Often Rarely Sometimes
```

```
reformat_variable_group4 <- function(variable_to_be_used){
  # re-order factor levels and rename factor levels
  variable_to_be_used <- fct_relevel(variable_to_be_used, c("Always", "Often", "Sometimes", "Rarely", "

  levels(variable_to_be_used) <- list("1" = "Always", "2" = "Often", "3" = "Sometimes", "4" = "Rarely",

  return(variable_to_be_used)
}
#end reformat_variable_group4

# reformat_variable_group5:
# a function to re-order factor levels, rename factor levels:
# this function will be applied to the following variables:
# wellbeing_3, wellbeing_4, wellbeing_=5, wellbeing_7, wellbeing_8

unique(aps_reduced$wellbeing_3)
```

```
## [1] Often     Always    Sometimes Never     Rarely    <NA>
## Levels: Always Never Often Rarely Sometimes
```

```
reformat_variable_group5 <- function(variable_to_be_used){
  # re-order factor levels and rename factor levels
  variable_to_be_used <- fct_relevel(variable_to_be_used, c("Always", "Often", "Sometimes", "Rarely", "

  levels(variable_to_be_used) <- list("1" = "Never", "2" = "Rarely", "3" = "Sometimes", "4" = "Often",

  return(variable_to_be_used)
}
```

```
#end reformat_variable_group5


# reformat_variable_group7:
# a function to re-order factor levels, rename factor levels:
# this function will be applied to the following variables:
# values

unique(aps_reduced$values_1)
```

```
## [1] Always    Not sure  Often     <NA>      Sometimes Rarely    Never
## Levels: Always Never Not sure Often Rarely Sometimes
```

```
reformat_variable_group7 <- function(variable_to_be_used){
  # re-order factor levels and rename factor levels
  variable_to_be_used <- fct_relevel(variable_to_be_used, c("Never", "Rarely", "Sometimes", "Often", "Al

  levels(variable_to_be_used) <- list("1" = "Never", "2" = "Rarely", "3" = "Sometimes", "4" = "Often",

  return(variable_to_be_used)
}
#end reformat_variable_group7

# reformat_variable_group8:
# a function to re-order factor levels, rename factor levels:
# this function will be applied to the following variables:
# team_performance_rating

unique(aps_reduced$team_performance_rating)
```

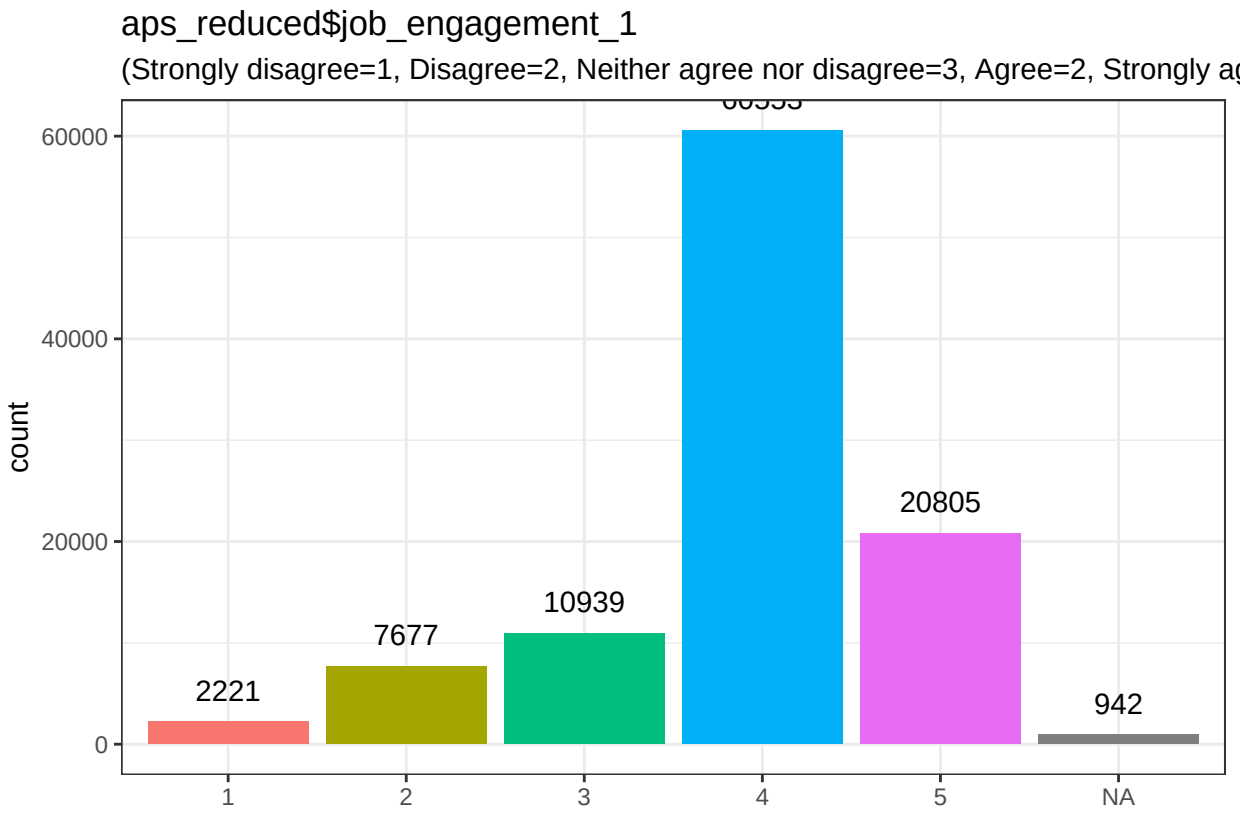
```
##  [1] 8          9          6          7          Don't know <NA>
##  [7] 2          3          5          10         4          1
## Levels: 1 10 2 3 4 5 6 7 8 9 Don't know
```

```
unique(aps_reduced$agency_performance_rating)
```

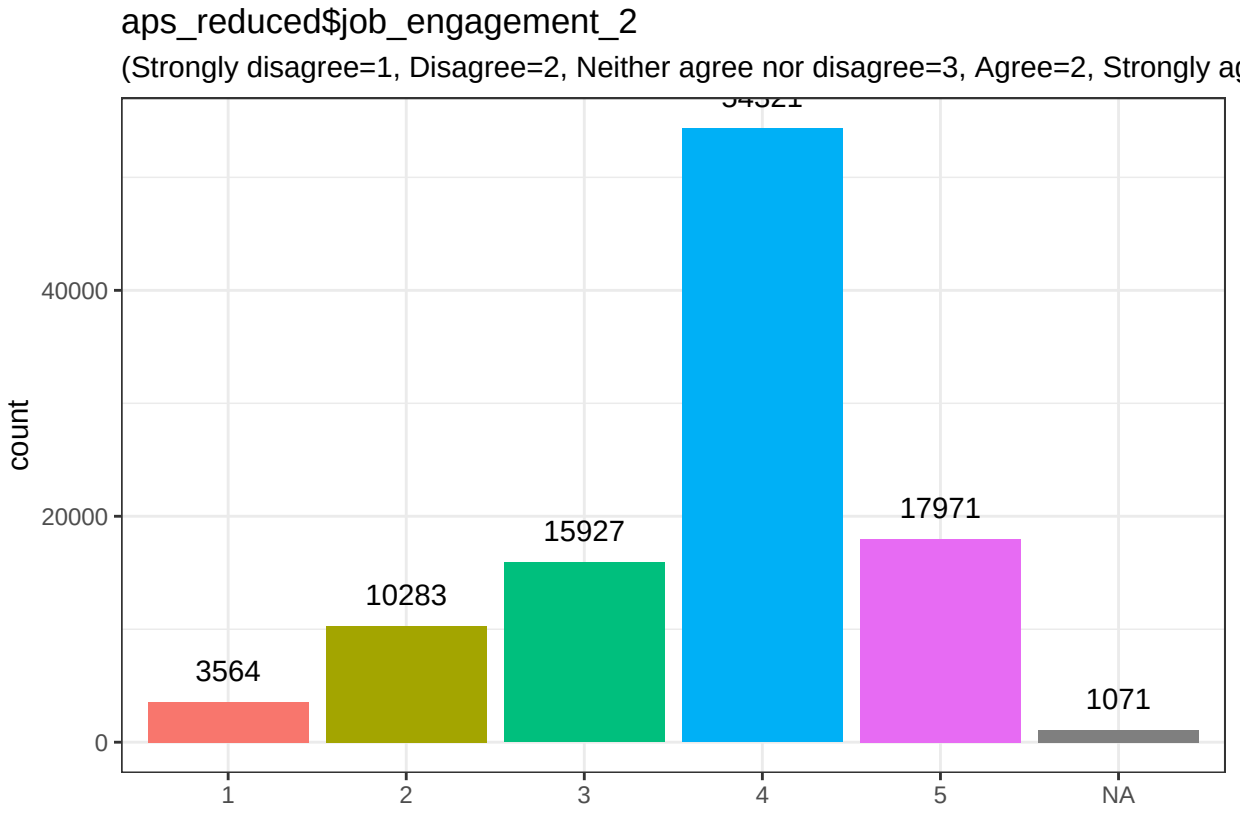
```
## NULL
```

```
reformat_variable_group8 <- function(variable_to_be_used){
  # re-order factor levels and rename factor levels
  variable_to_be_used <- fct_relevel(variable_to_be_used, c("1", "2", "3", "4", "5", "6", "7", "8", "9"

  levels(variable_to_be_used) <- list("1" = "1", "2" = "2", "3" = "3", "4" = "4", "5" = "5", "6" = "6",

  return(variable_to_be_used)
}
#end reformat_variable_group8

# function to generate a barplot for each variable - except dependent variable

generate_barplot <- function(variable_to_be_used){
```

```
  name_to_display <- deparse(substitute(variable_to_be_used))

  barplot_1 <- ggplot(aps_reduced, aes(x = variable_to_be_used, fill=variable_to_be_used)) +
    geom_bar(show.legend = FALSE) +
    labs(title = name_to_display,
         subtitle = "(Strongly disagree=1, Disagree=2, Neither agree nor disagree=3, Agree=2, Strongly a
         x = "") +
    theme_bw() +
    geom_text(stat='count', aes(label=..count..), vjust=-1)

  return(barplot_1)
}

# function to generate a barplot for dependent variable

generate_barplot_dep_var <- function(variable_to_be_used){
  name_to_display <- deparse(substitute(variable_to_be_used))

  barplot_1 <- ggplot(aps_reduced, aes(x = variable_to_be_used, fill=variable_to_be_used)) +
    geom_bar(show.legend = FALSE) +
    labs(title = name_to_display,
         subtitle = "(1=workgroup's worst performance, 5=average workgroup performance, 10=the best you
         x = "") +
    theme_bw() +
    geom_text(stat='count', aes(label=..count..), vjust=-1)

  return(barplot_1)
}


# job_engagement reformatting

aps_reduced$job_engagement_1 <- reformat_variable_group1(aps_reduced$job_engagement_1)
generate_barplot(aps_reduced$job_engagement_1)
```




```
aps_reduced$job_engagement_2 <- reformat_variable_group1(aps_reduced$job_engagement_2)
generate_barplot(aps_reduced$job_engagement_2)
```




```
# code to check that outputs of function reformat_variable_group1 are correct compared to outputs
# I got earlier on job_engagement_1 and job_engagement_2 not using the function
str(aps_reduced$job_engagement_1)
```

```
##  Factor w/ 5 levels "1","2","3","4",..: 2 5 4 4 5 4 2 4 5 4 ...
```

```
levels(aps_reduced$job_engagement_1)
```

```
## [1] "1" "2" "3" "4" "5"
```

```
summary(aps_reduced$job_engagement_1)
```

```
##     1     2     3     4     5  NA's
##  2221  7677 10939 60553 20805   942
```

```
sum(is.na(aps_reduced$job_engagement_1))
```

```
## [1] 942
```

```
str(aps_reduced$job_engagement_2)
```

```
##  Factor w/ 5 levels "1","2","3","4",..: 2 4 5 4 4 3 2 4 5 4 ...
```

```r
levels(aps_reduced$job_engagement_2)
```

```
## [1] "1" "2" "3" "4" "5"
```

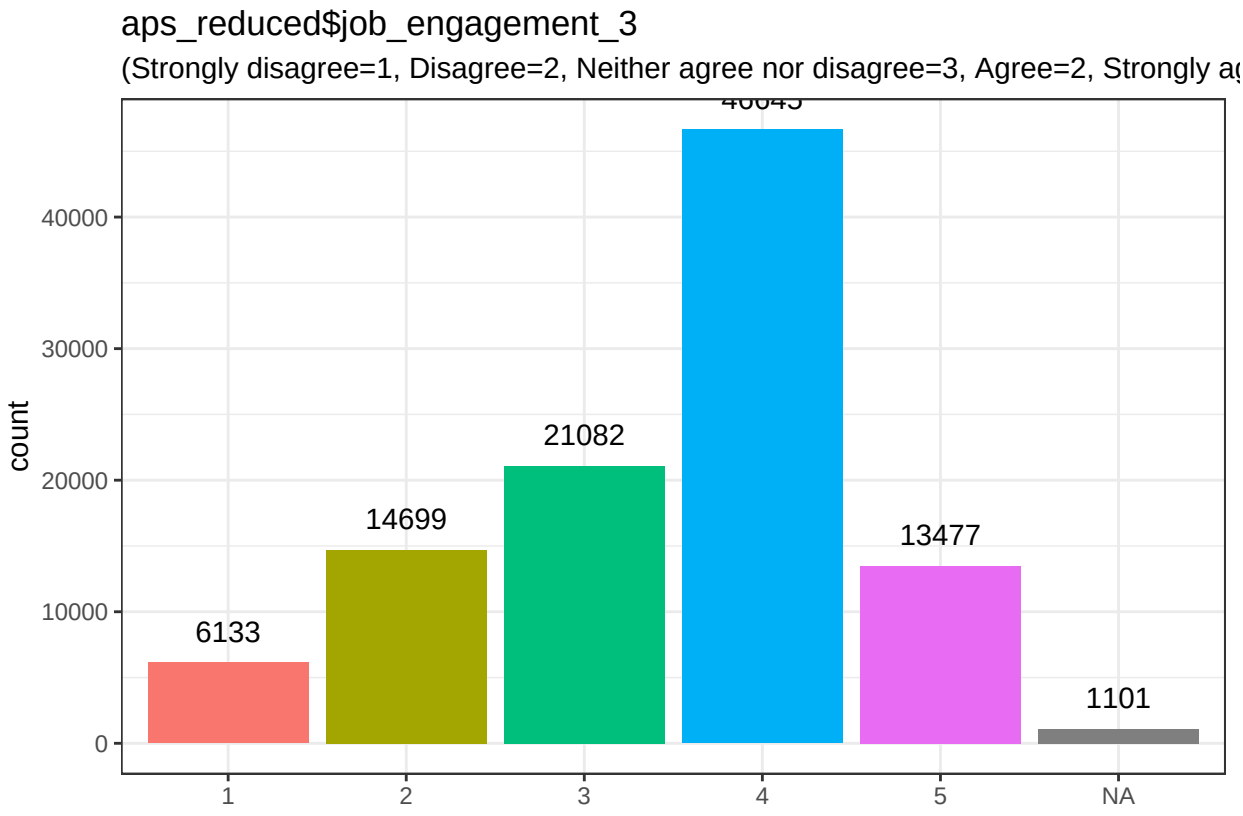
```r
summary(aps_reduced$job_engagement_2)
```

```
##     1     2     3     4     5  NA's
##  3564 10283 15927 54321 17971  1071
```

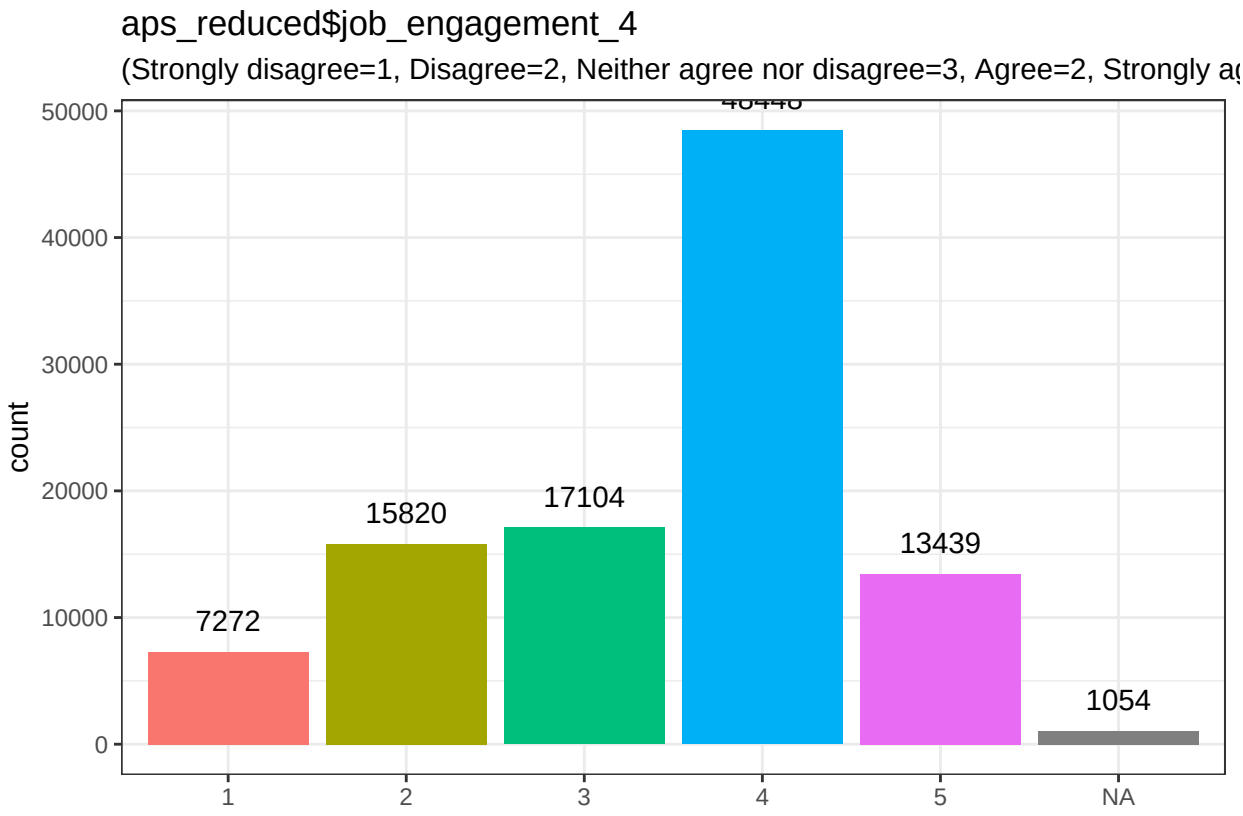
```r
sum(is.na(aps_reduced$job_engagement_2))
```

```
## [1] 1071
```

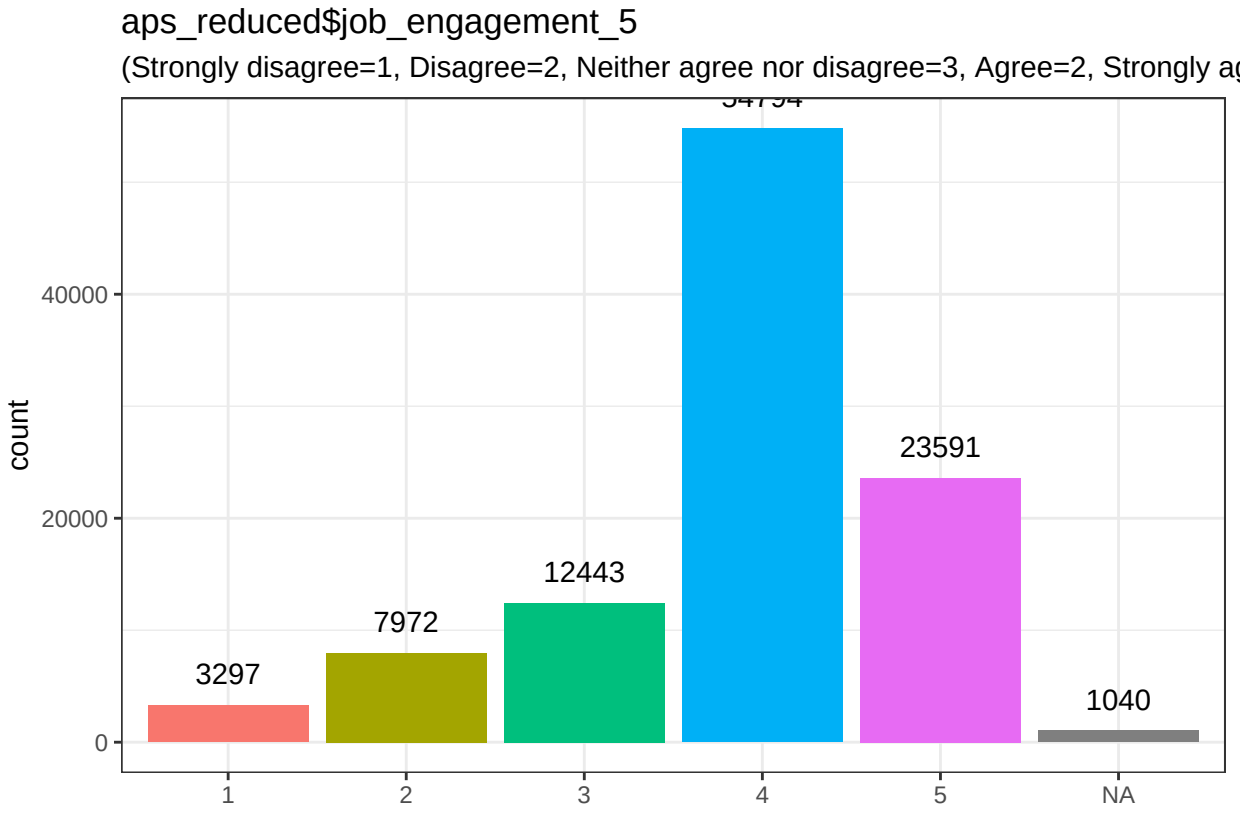
```r
aps_reduced$job_engagement_3 <- reformat_variable_group1(aps_reduced$job_engagement_3)
generate_barplot(aps_reduced$job_engagement_3)
```



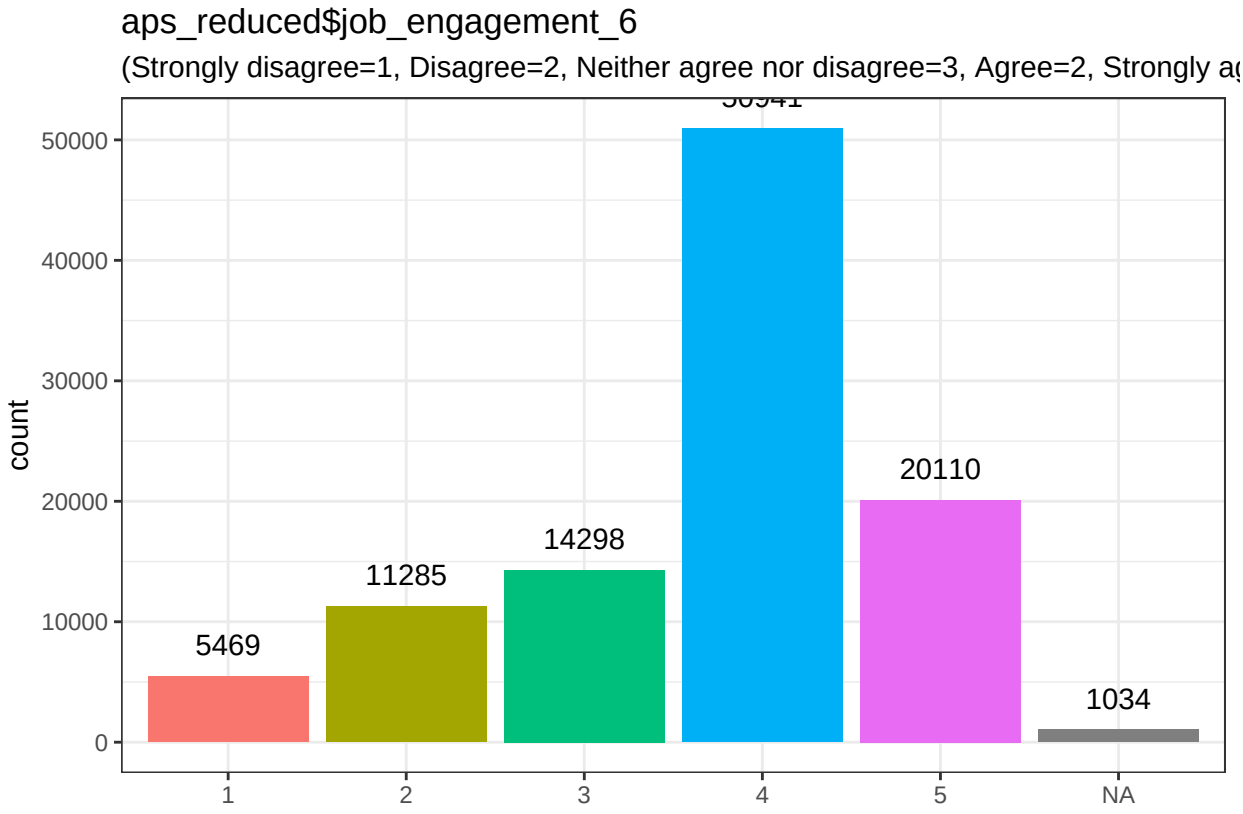

```r
aps_reduced$job_engagement_4 <- reformat_variable_group1(aps_reduced$job_engagement_4)
generate_barplot(aps_reduced$job_engagement_4)
```



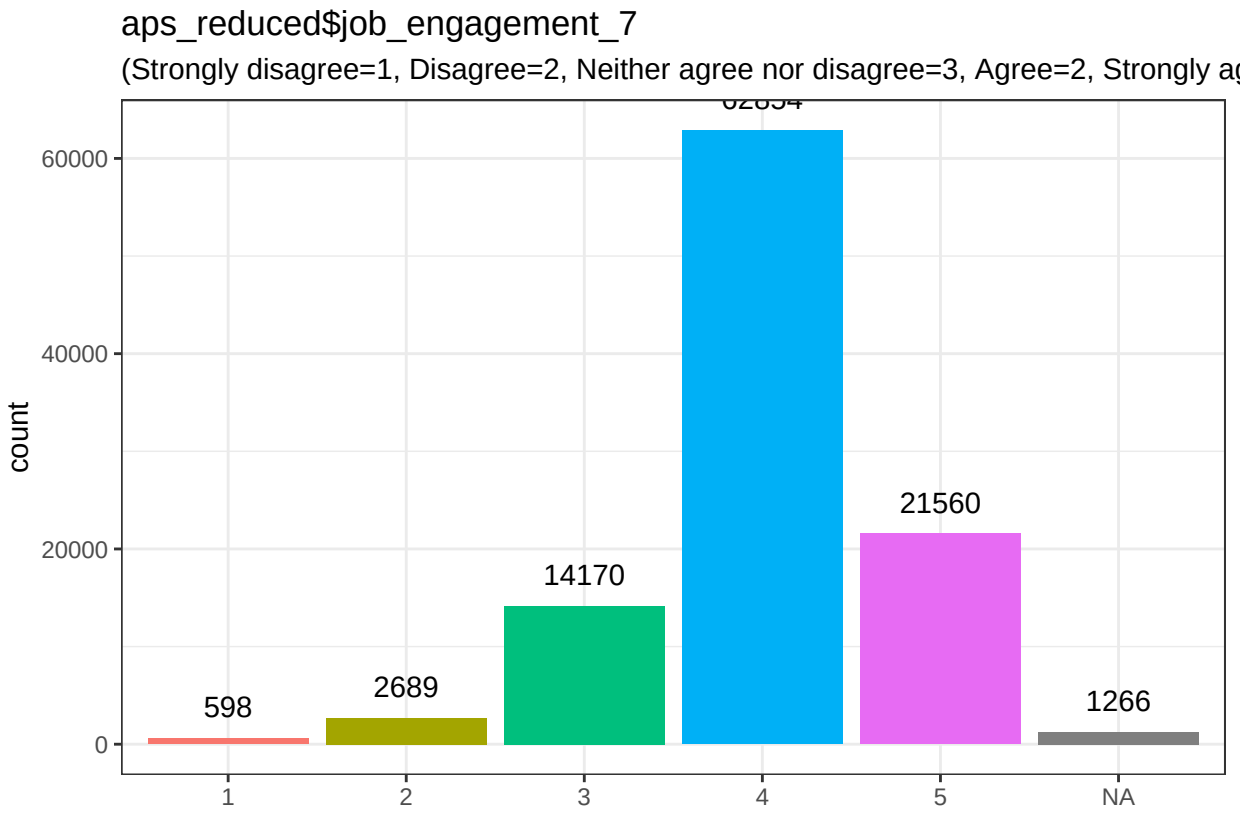

```
aps_reduced$job_engagement_5 <- reformat_variable_group1(aps_reduced$job_engagement_5)
generate_barplot(aps_reduced$job_engagement_5)
```



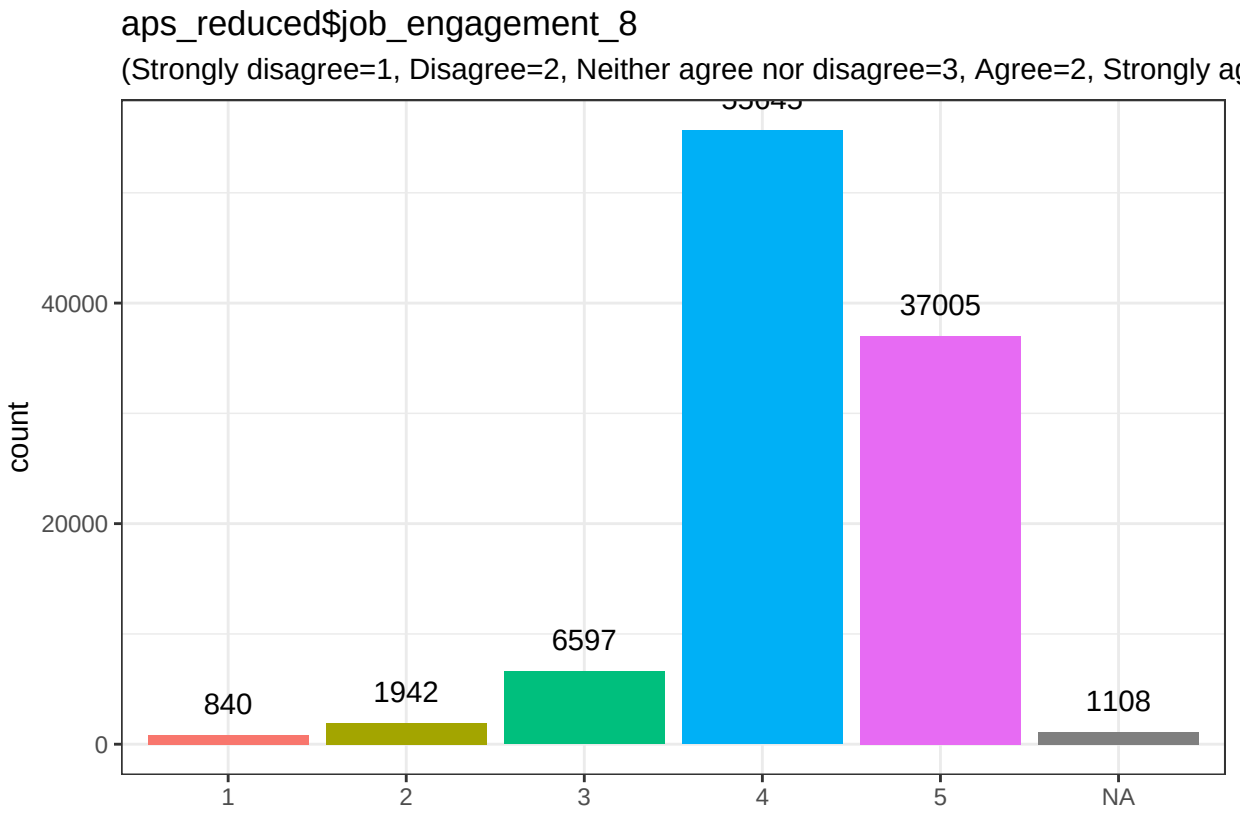

```
aps_reduced$job_engagement_6 <- reformat_variable_group1(aps_reduced$job_engagement_6)
generate_barplot(aps_reduced$job_engagement_6)
```



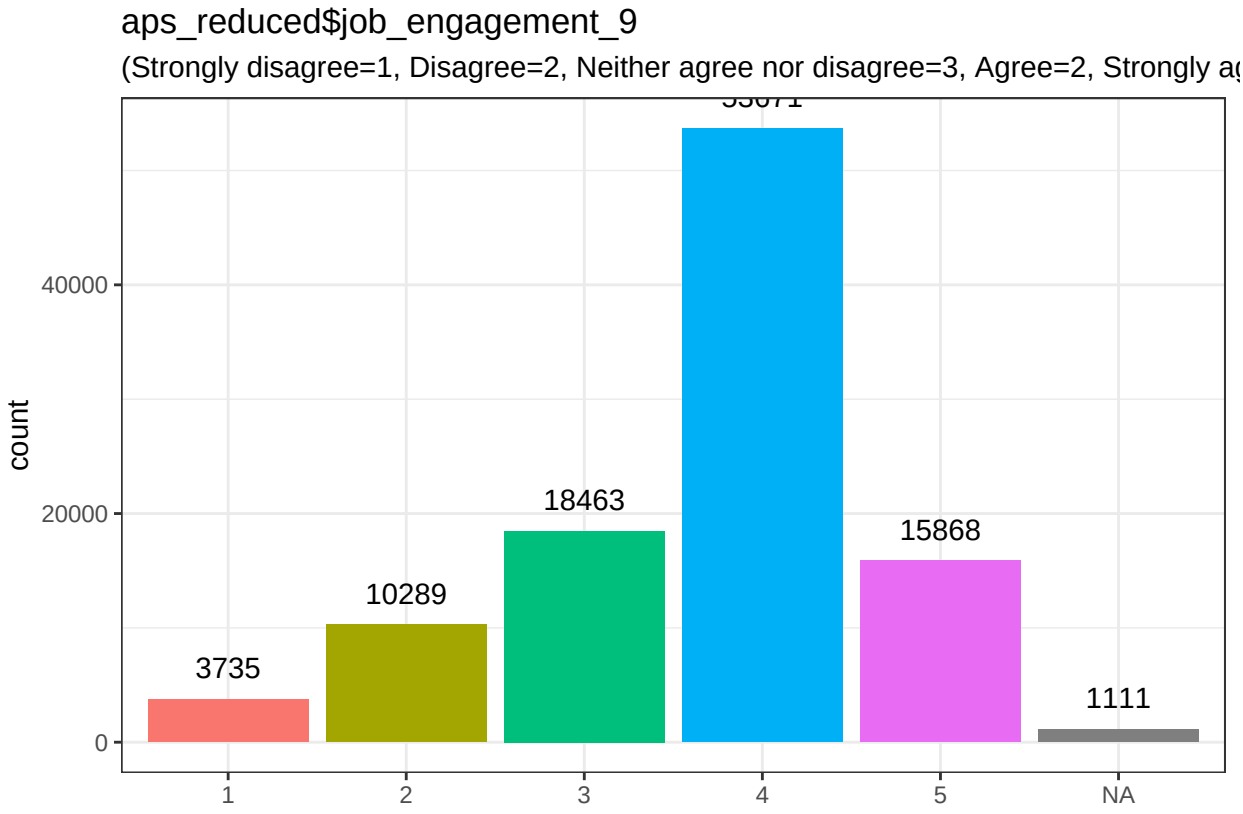

```
aps_reduced$job_engagement_7 <- reformat_variable_group1(aps_reduced$job_engagement_7)
generate_barplot(aps_reduced$job_engagement_7)
```



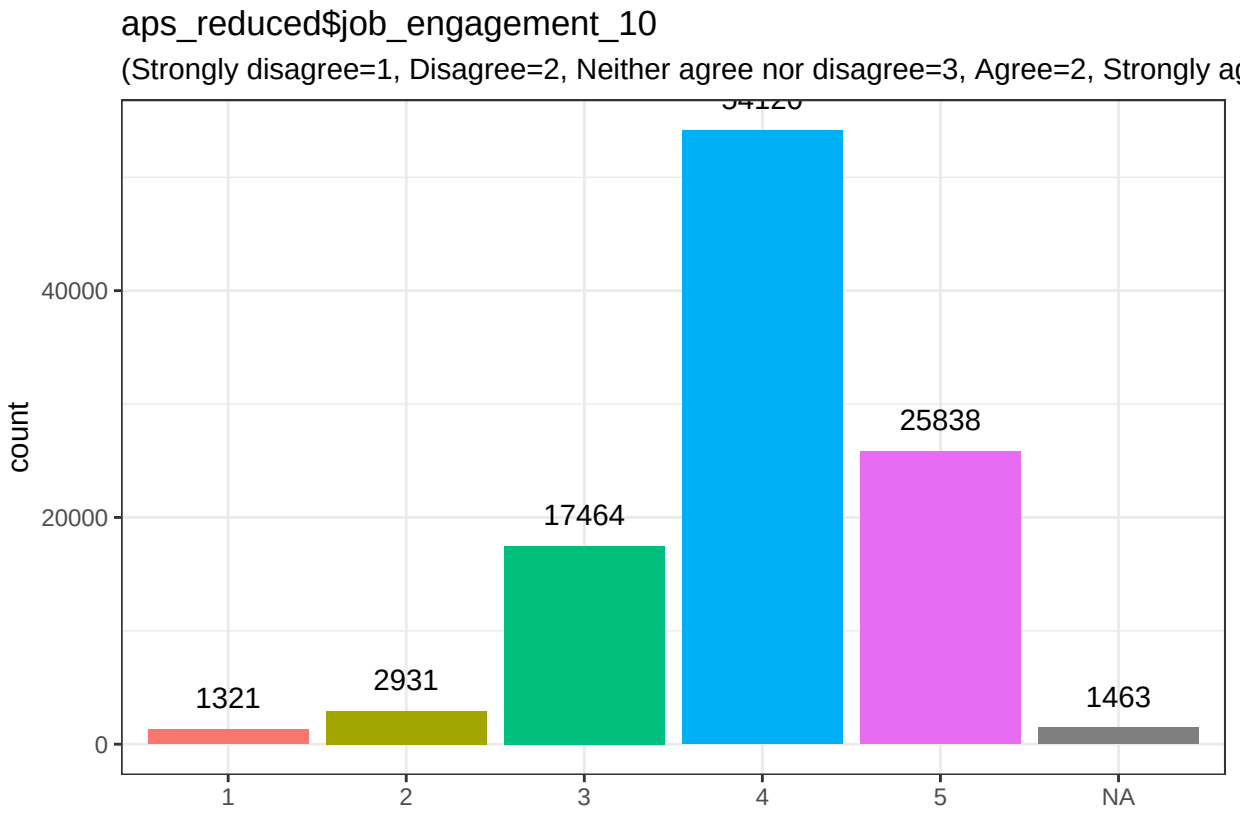

```
aps_reduced$job_engagement_8 <- reformat_variable_group1(aps_reduced$job_engagement_8)
generate_barplot(aps_reduced$job_engagement_8)
```



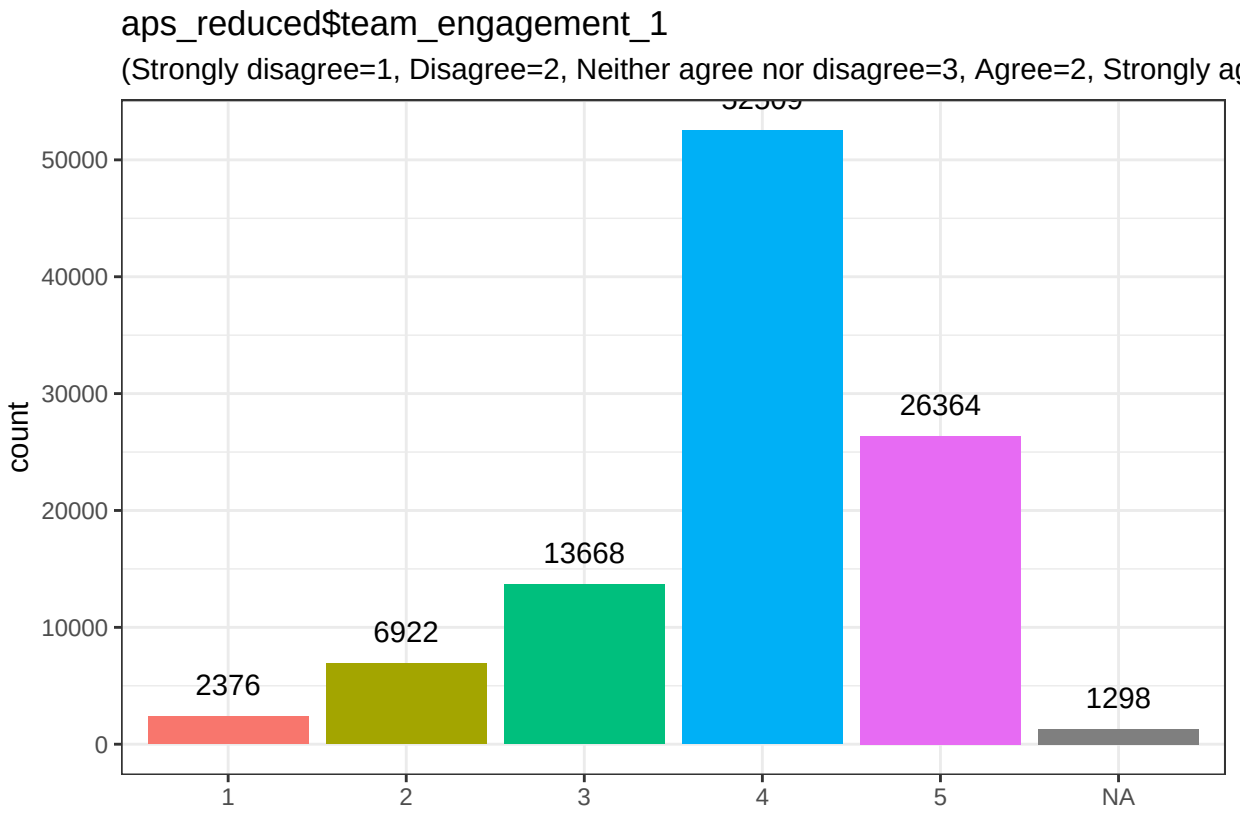

```
aps_reduced$job_engagement_9 <- reformat_variable_group1(aps_reduced$job_engagement_9)
generate_barplot(aps_reduced$job_engagement_9)
```



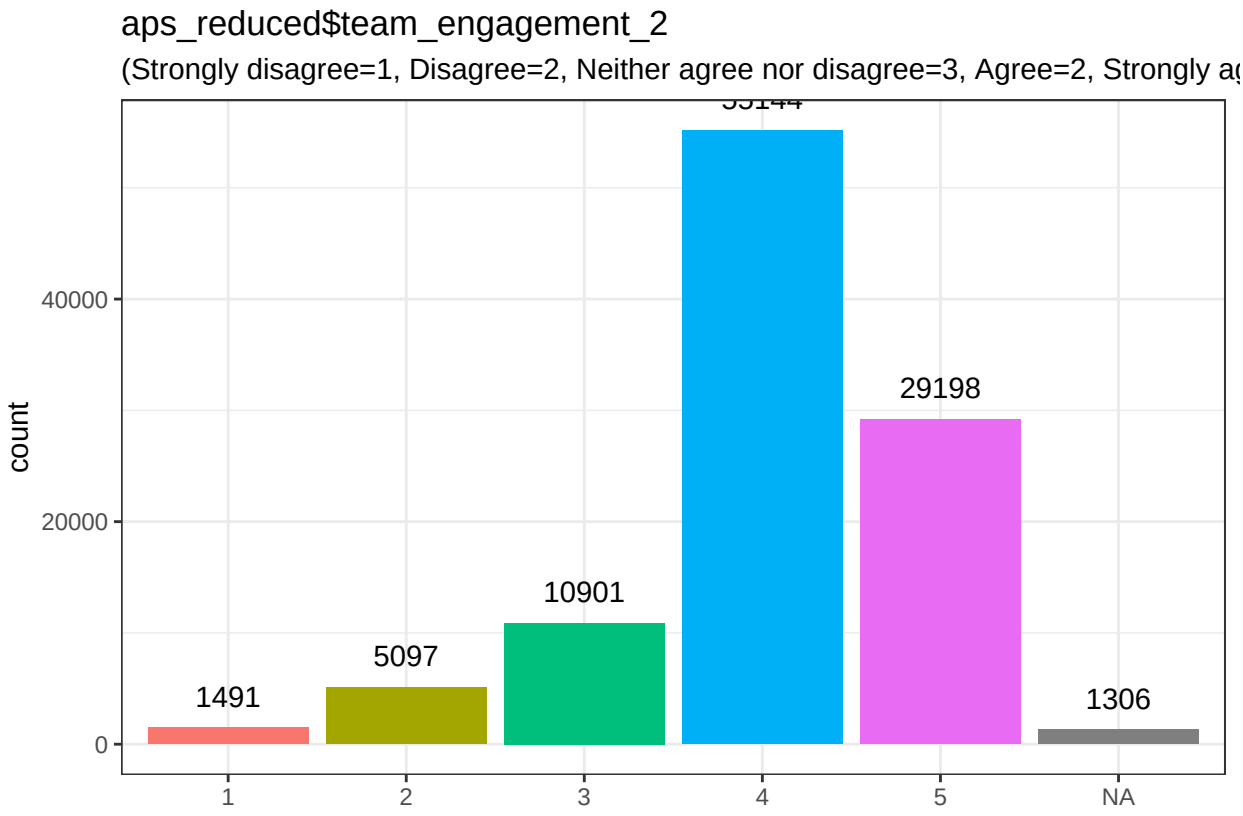

```
aps_reduced$job_engagement_10 <- reformat_variable_group1(aps_reduced$job_engagement_10)
generate_barplot(aps_reduced$job_engagement_10)
```



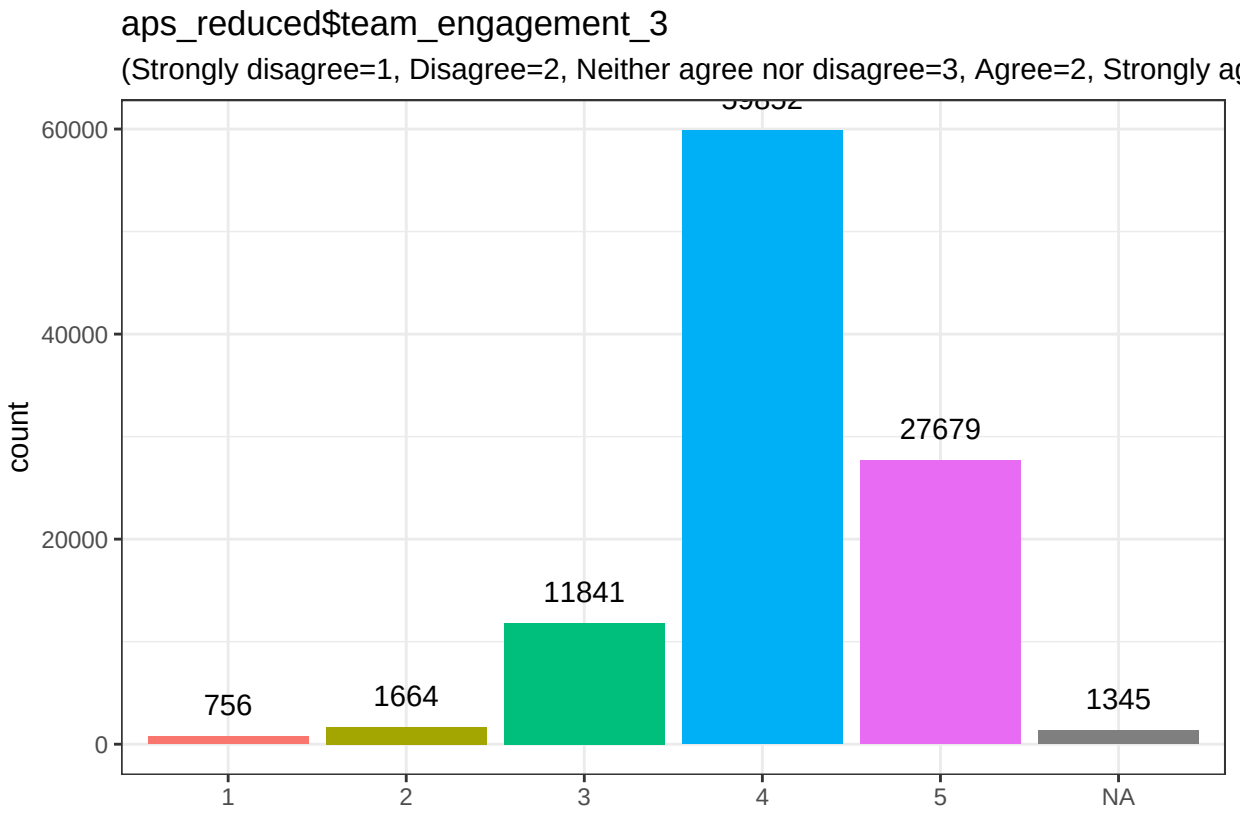

```
# team_engagement reformatting

aps_reduced$team_engagement_1 <- reformat_variable_group1(aps_reduced$team_engagement_1)
generate_barplot(aps_reduced$team_engagement_1)
```



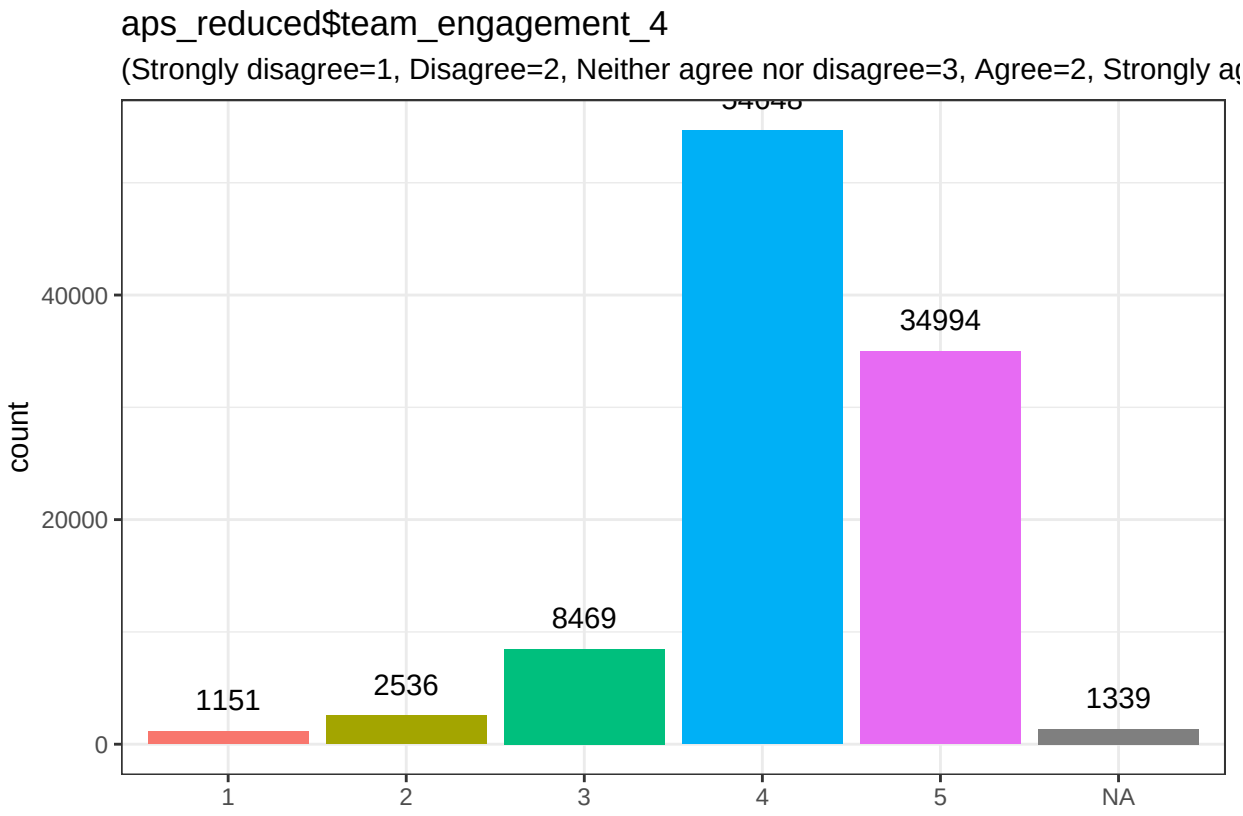

```
aps_reduced$team_engagement_2 <- reformat_variable_group1(aps_reduced$team_engagement_2)
generate_barplot(aps_reduced$team_engagement_2)
```



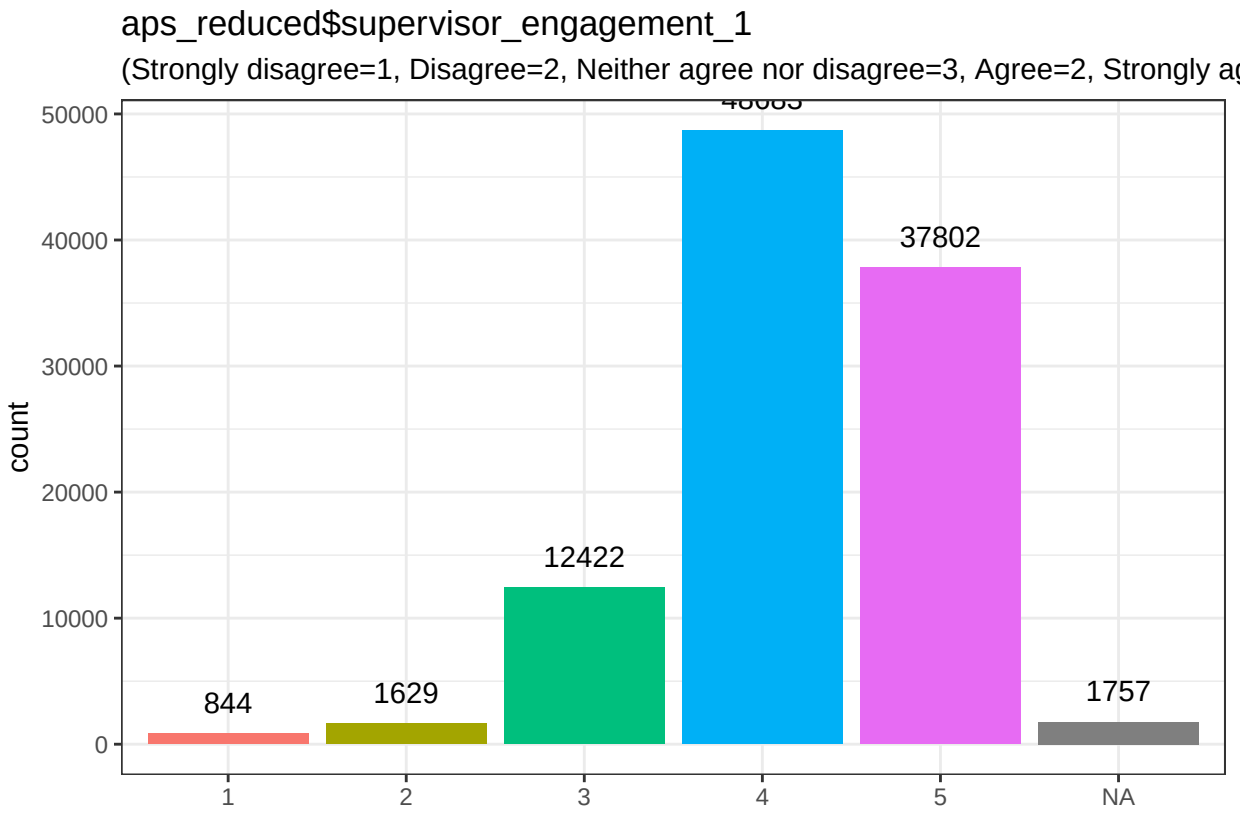

```
aps_reduced$team_engagement_3 <- reformat_variable_group1(aps_reduced$team_engagement_3)
generate_barplot(aps_reduced$team_engagement_3)
```



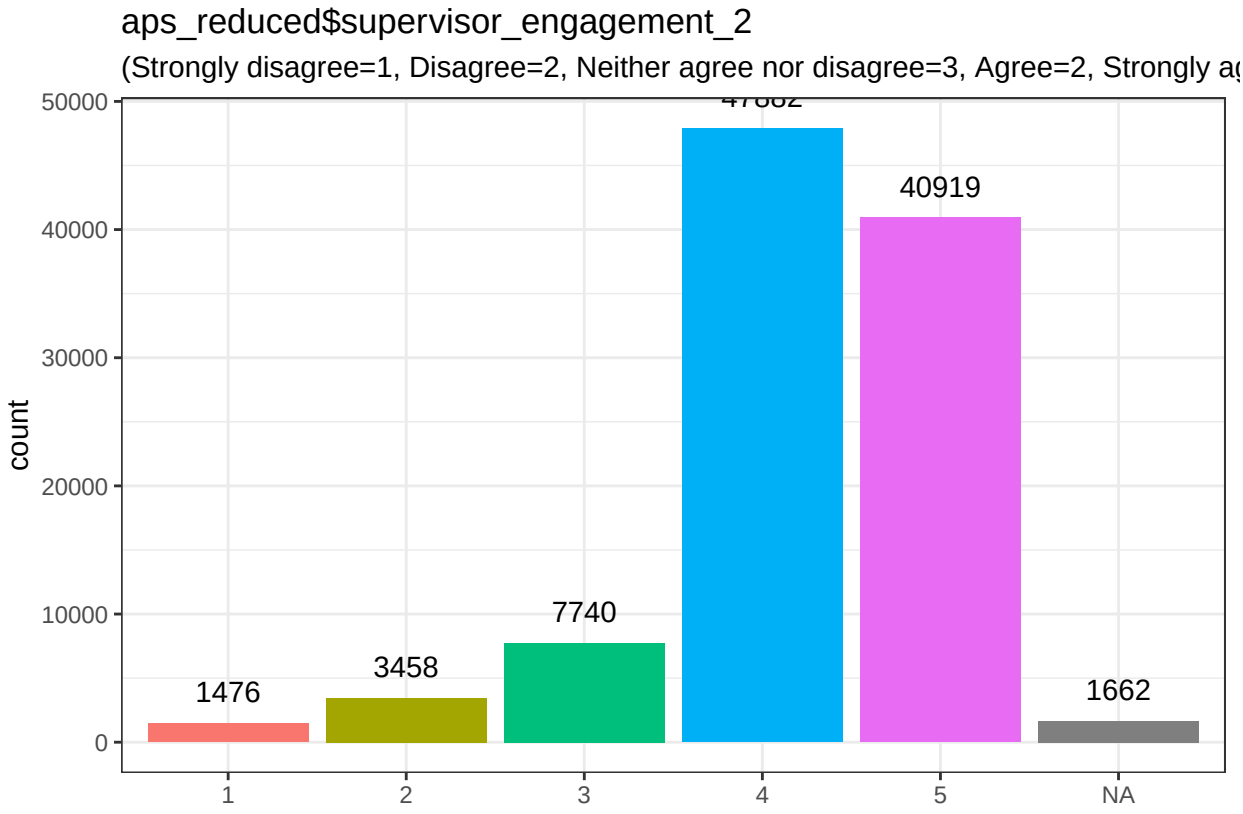

```
aps_reduced$team_engagement_4 <- reformat_variable_group1(aps_reduced$team_engagement_4)
generate_barplot(aps_reduced$team_engagement_4)
```




```
# supervisor_engagement reformatting

aps_reduced$supervisor_engagement_1 <- reformat_variable_group1(aps_reduced$supervisor_engagement_1)
generate_barplot(aps_reduced$supervisor_engagement_1)
```



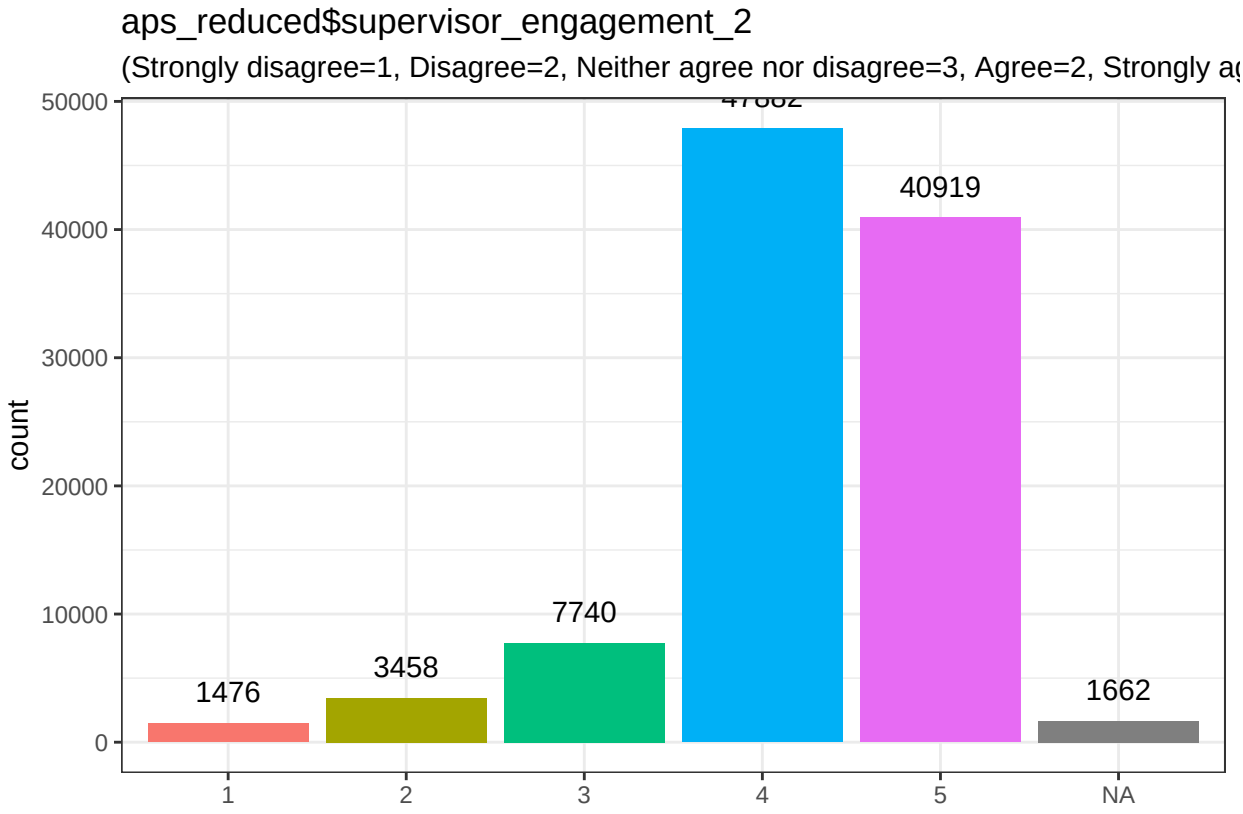

```
aps_reduced$supervisor_engagement_2 <- reformat_variable_group1(aps_reduced$supervisor_engagement_2)
generate_barplot(aps_reduced$supervisor_engagement_2)
```



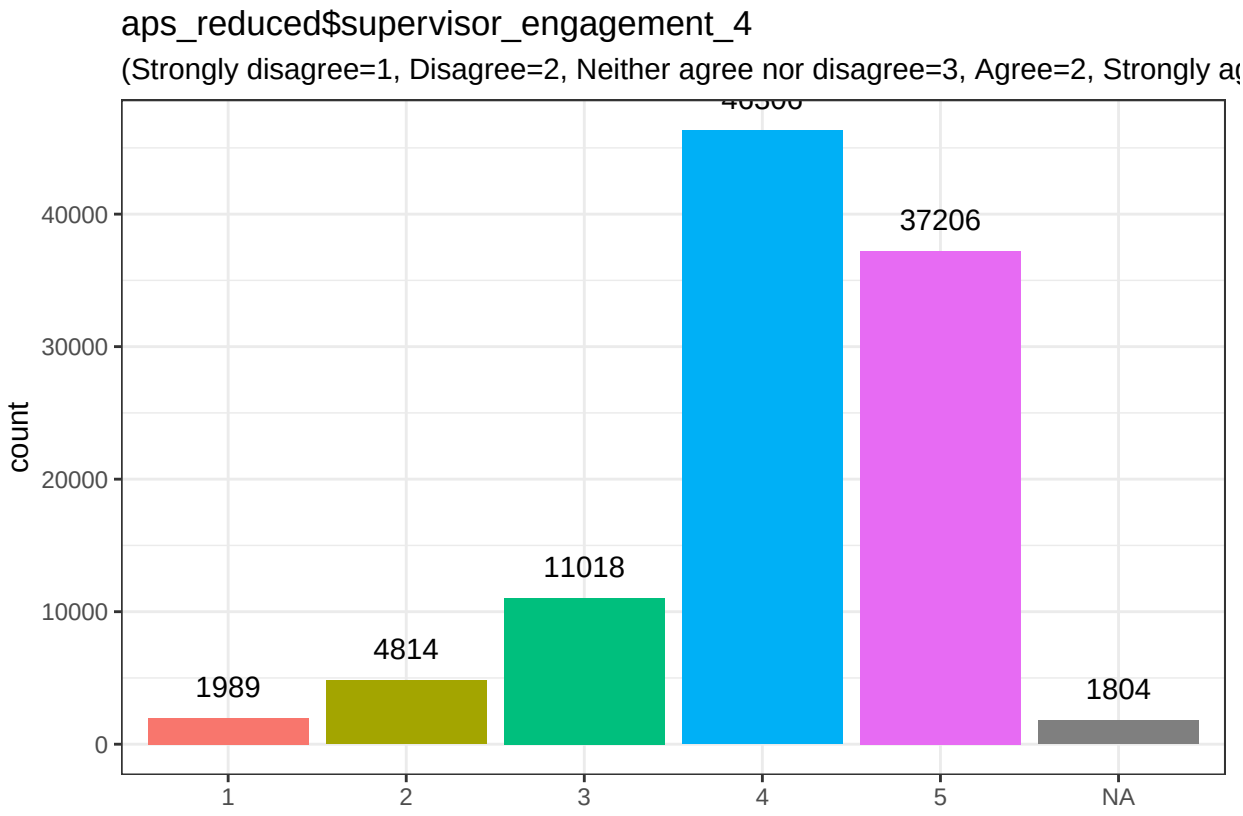

```
aps_reduced$supervisor_engagement_3 <- reformat_variable_group1(aps_reduced$supervisor_engagement_2)
```

```
## Warning: Unknown levels in `f`: Strongly disagree, Disagree, Neither agree nor
## disagree, Agree, Strongly agree
```

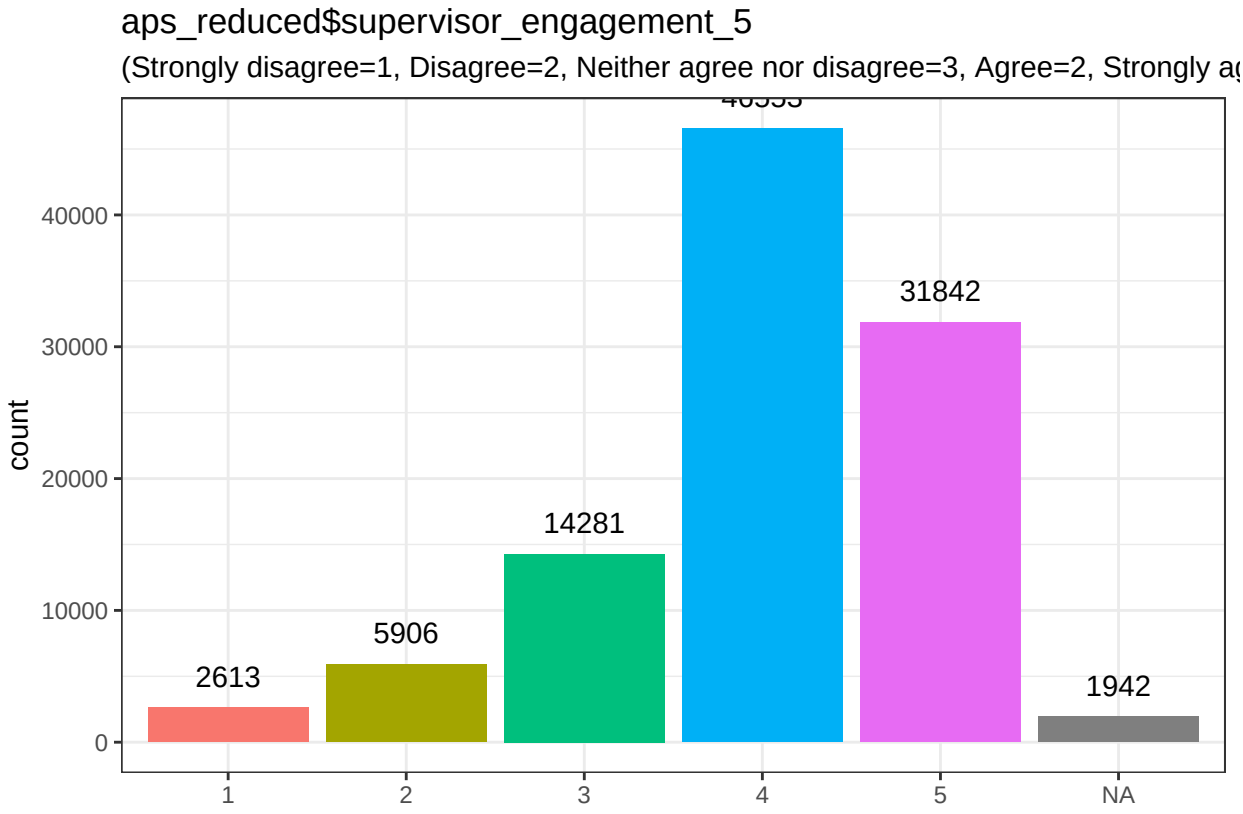
```
generate_barplot(aps_reduced$supervisor_engagement_2)
```



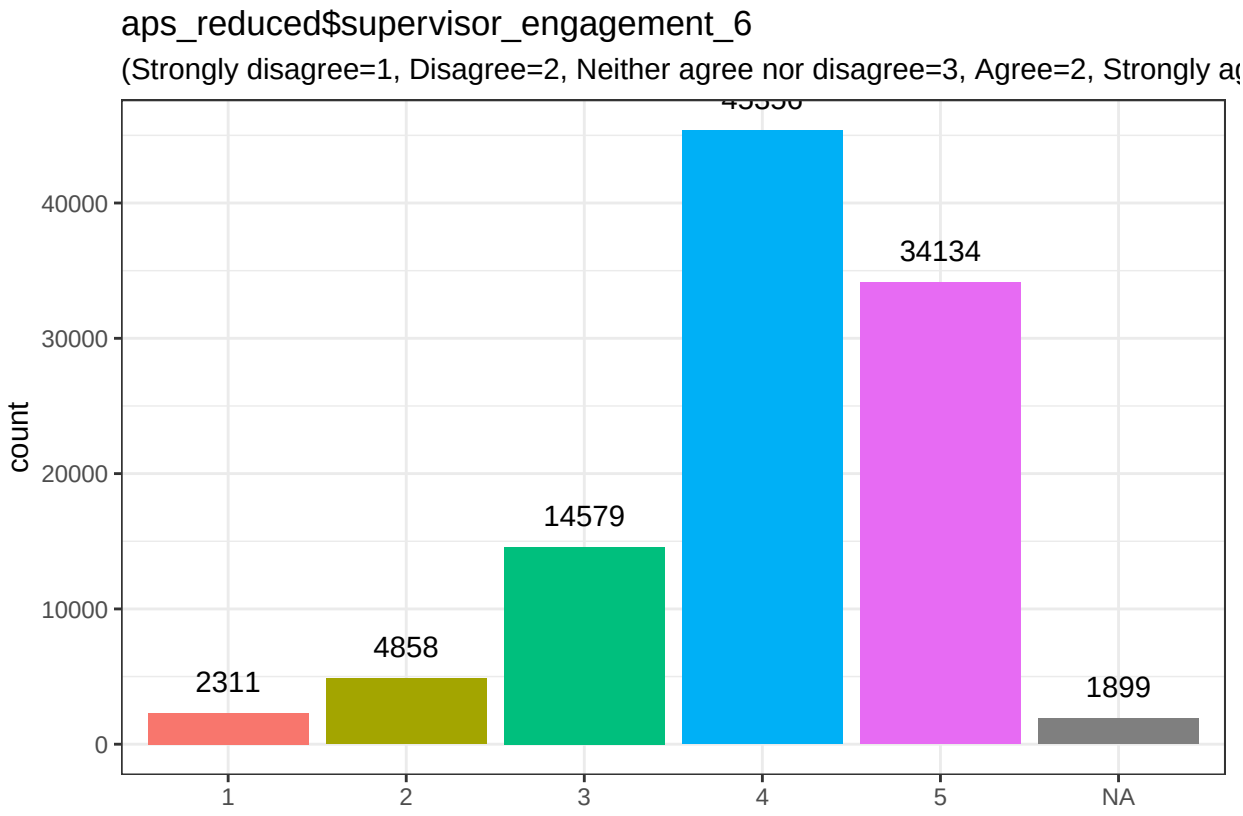

```
aps_reduced$supervisor_engagement_4 <- reformat_variable_group1(aps_reduced$supervisor_engagement_4)
generate_barplot(aps_reduced$supervisor_engagement_4)
```



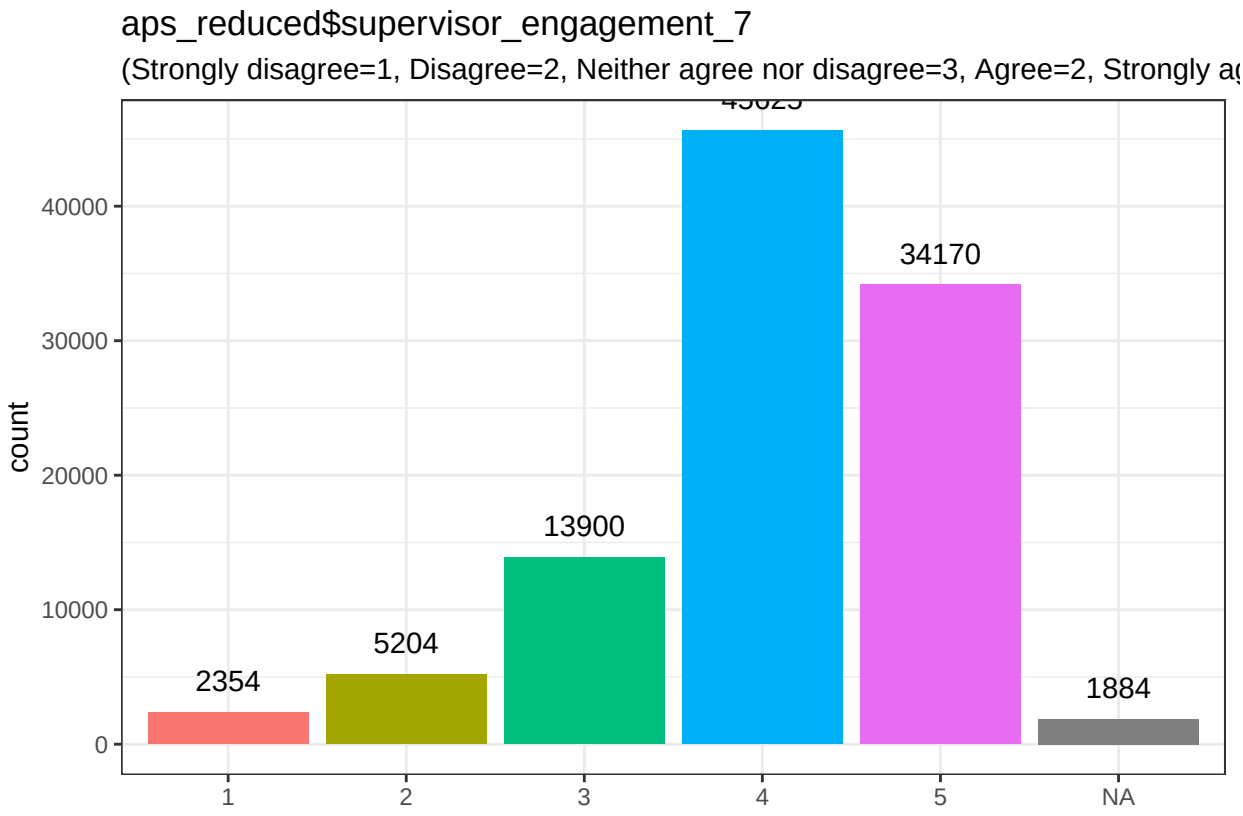

```
aps_reduced$supervisor_engagement_5 <- reformat_variable_group1(aps_reduced$supervisor_engagement_5)
generate_barplot(aps_reduced$supervisor_engagement_5)
```



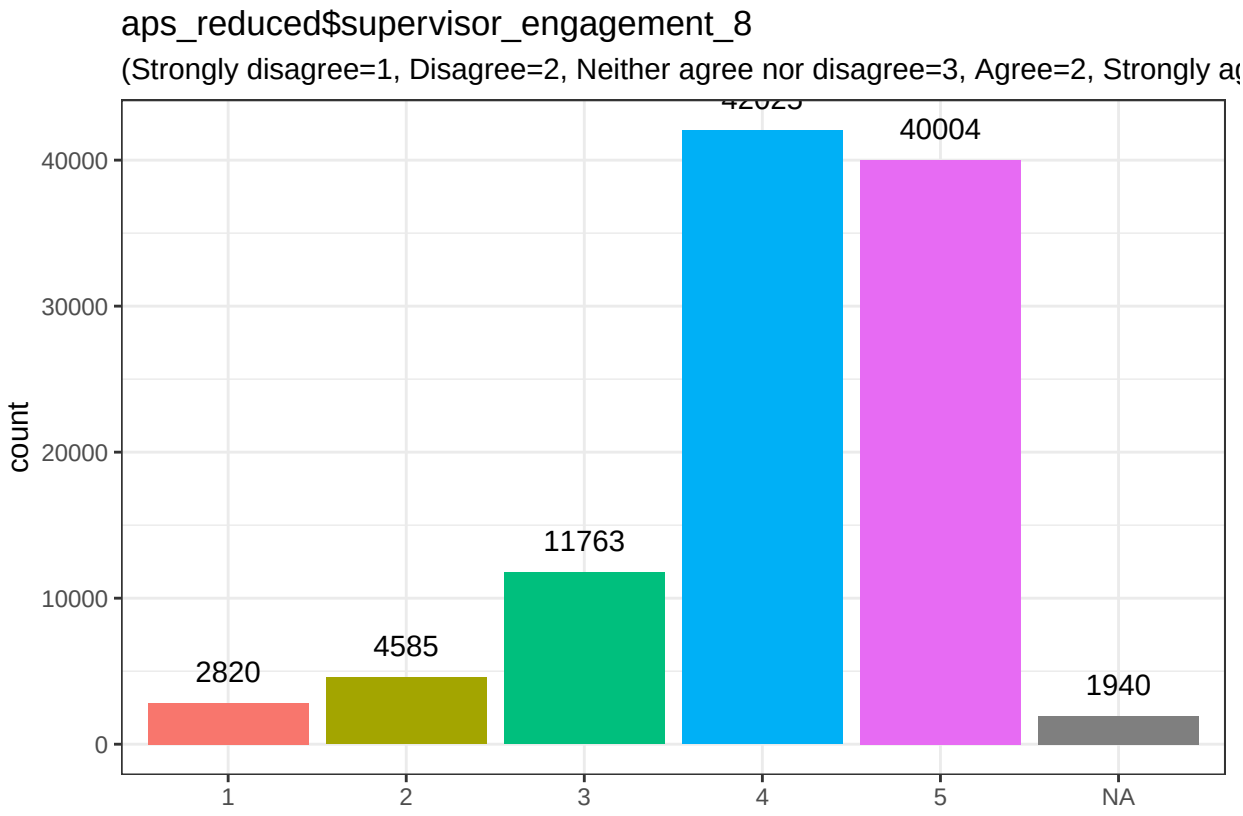

```
aps_reduced$supervisor_engagement_6 <- reformat_variable_group1(aps_reduced$supervisor_engagement_6)
generate_barplot(aps_reduced$supervisor_engagement_6)
```



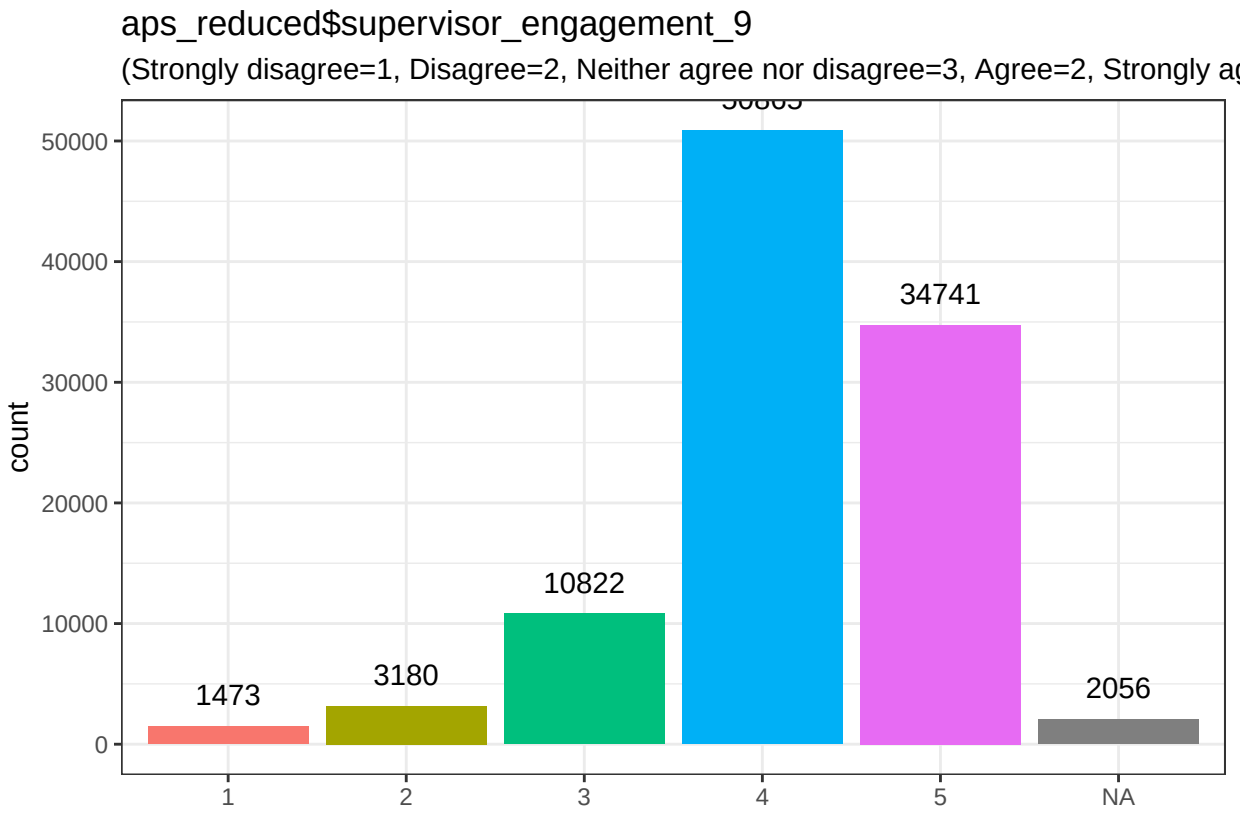

```
aps_reduced$supervisor_engagement_7 <- reformat_variable_group1(aps_reduced$supervisor_engagement_7)
generate_barplot(aps_reduced$supervisor_engagement_7)
```



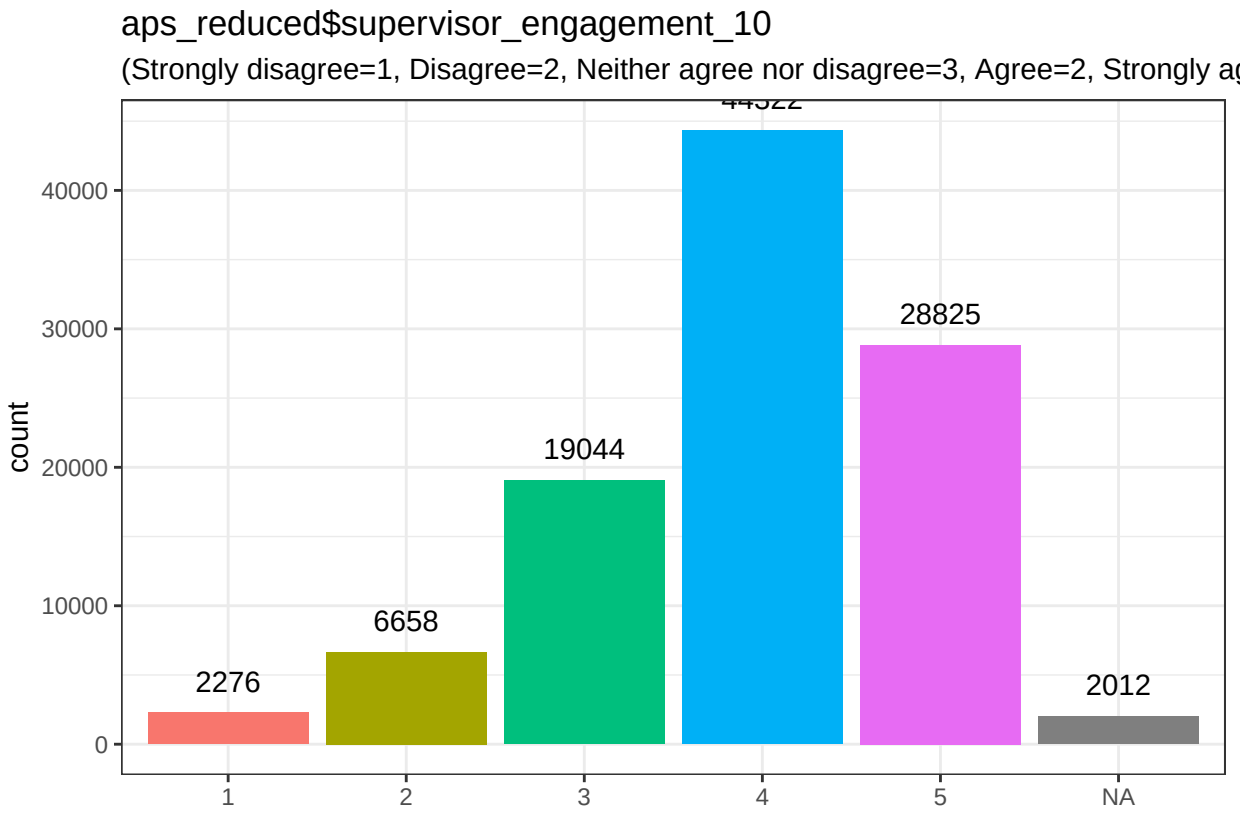

```
aps_reduced$supervisor_engagement_8 <- reformat_variable_group1(aps_reduced$supervisor_engagement_8)
generate_barplot(aps_reduced$supervisor_engagement_8)
```



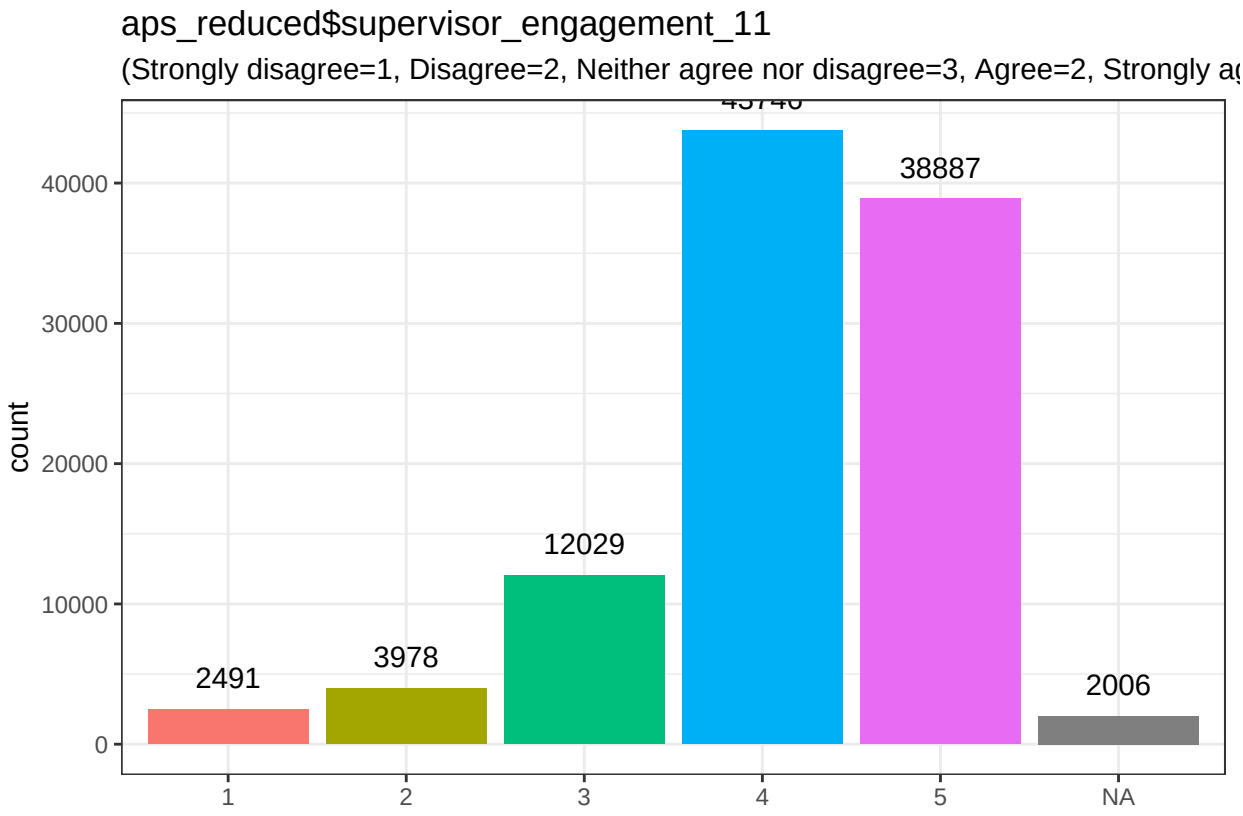

```
aps_reduced$supervisor_engagement_9 <- reformat_variable_group1(aps_reduced$supervisor_engagement_9)
generate_barplot(aps_reduced$supervisor_engagement_9)
```



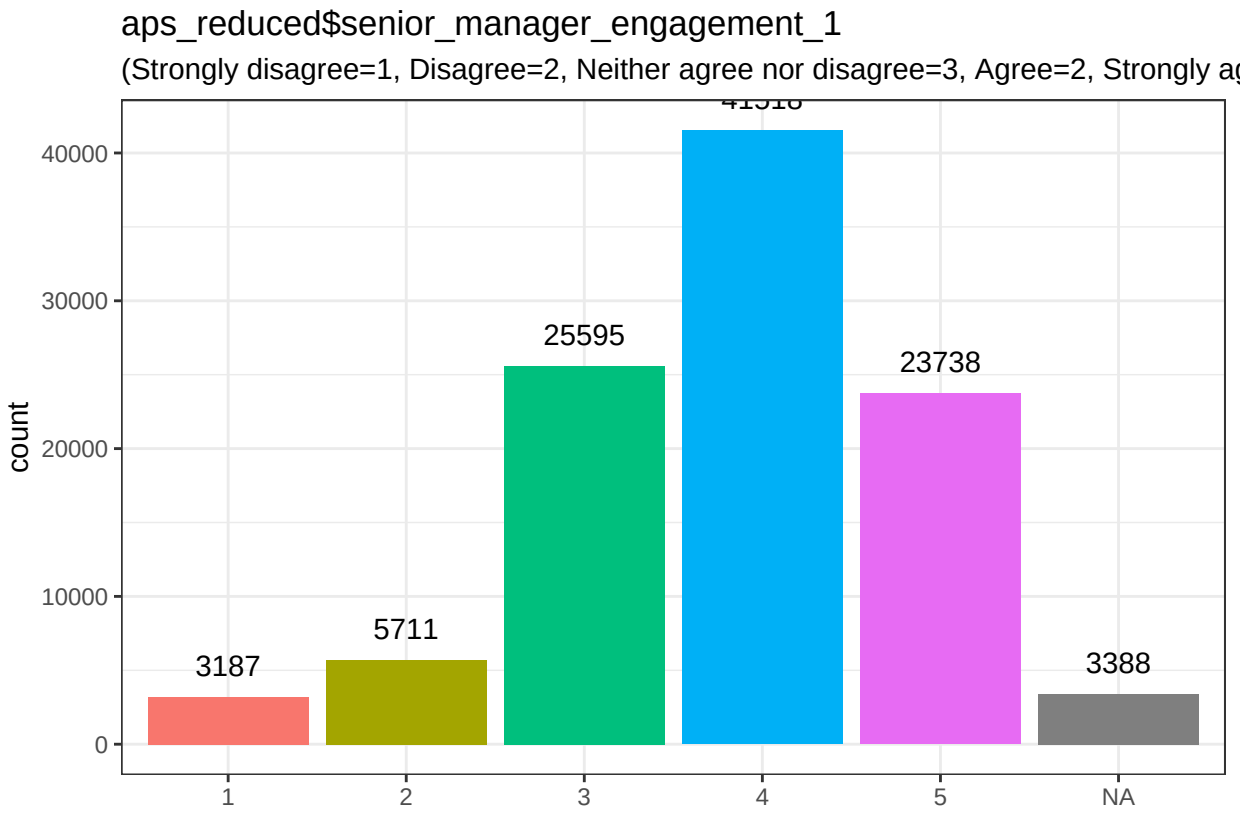

```
aps_reduced$supervisor_engagement_10 <- reformat_variable_group1(aps_reduced$supervisor_engagement_10)
generate_barplot(aps_reduced$supervisor_engagement_10)
```



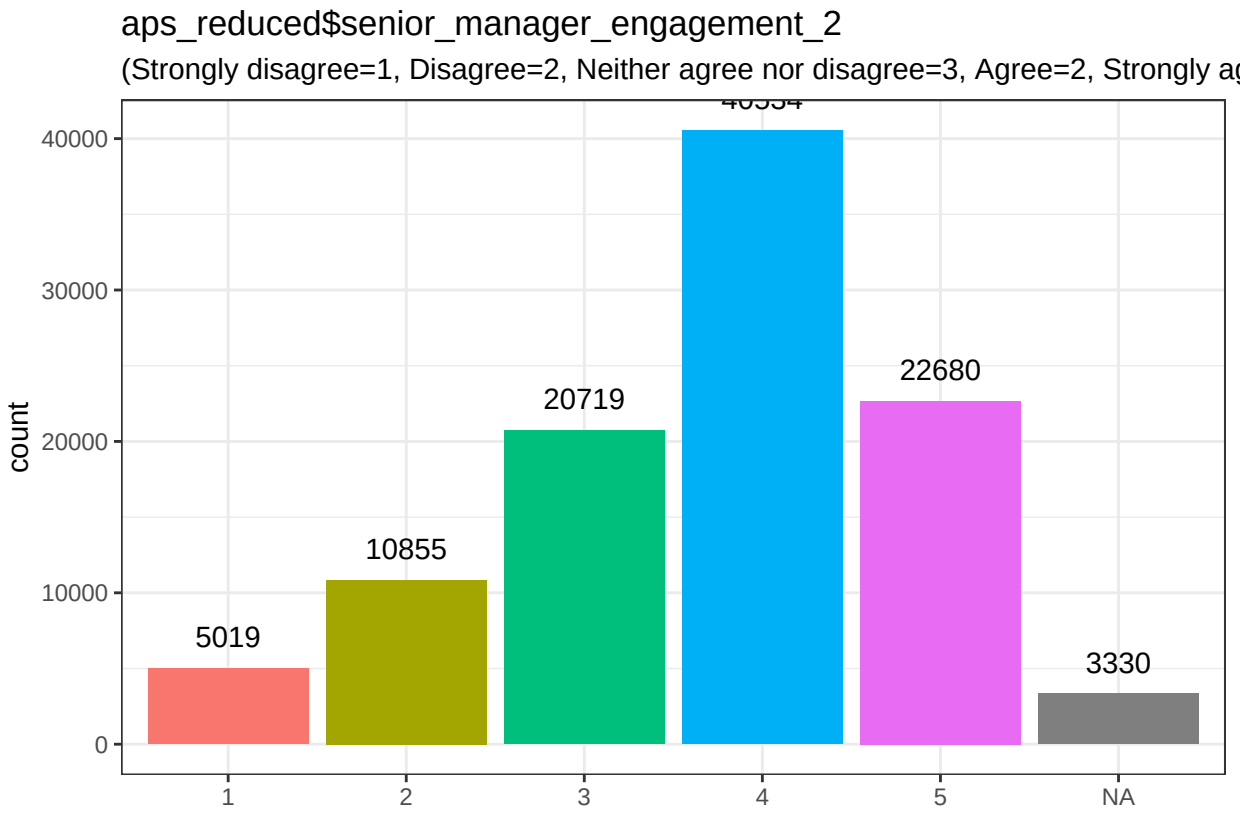

```
aps_reduced$supervisor_engagement_11 <- reformat_variable_group1(aps_reduced$supervisor_engagement_11)
generate_barplot(aps_reduced$supervisor_engagement_11)
```



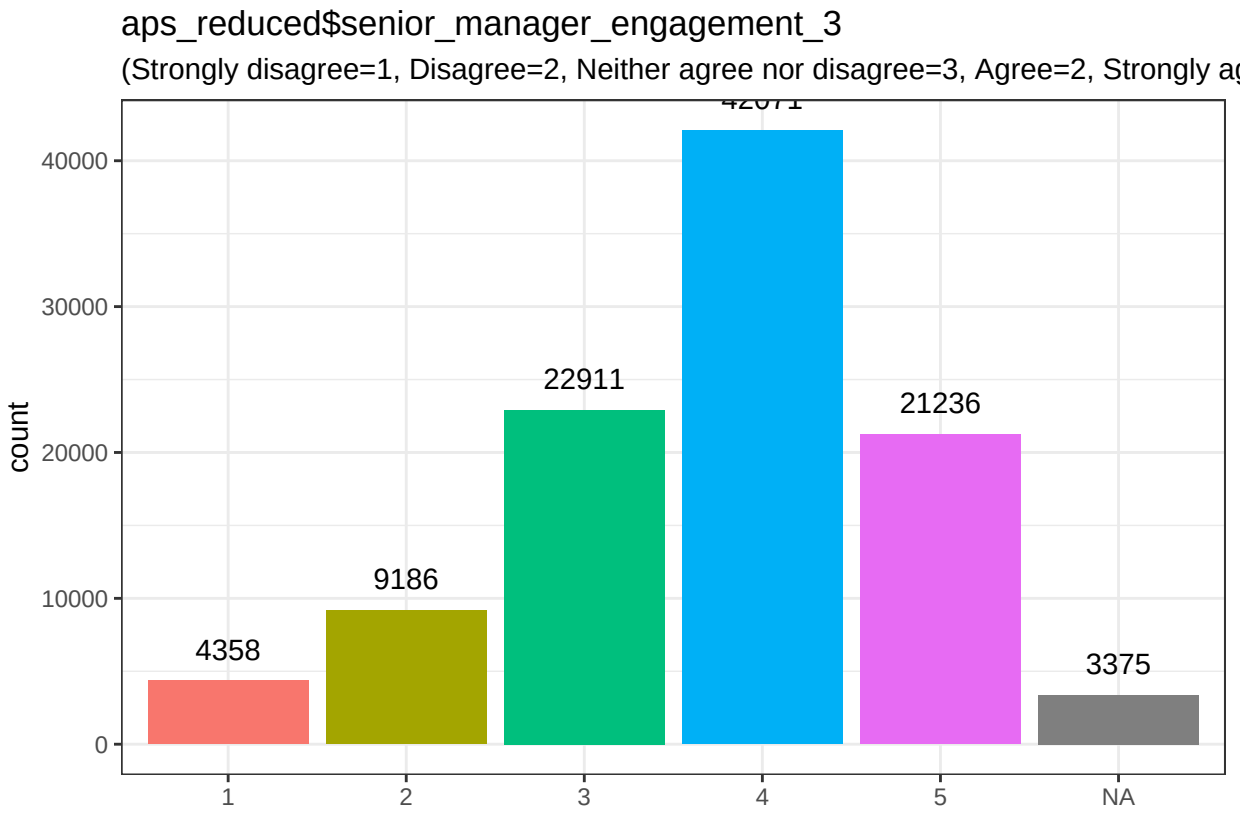

```
# senior_manager_engagement reformatting

aps_reduced$senior_manager_engagement_1 <- reformat_variable_group1(aps_reduced$senior_manager_engagemer
generate_barplot(aps_reduced$senior_manager_engagement_1)
```



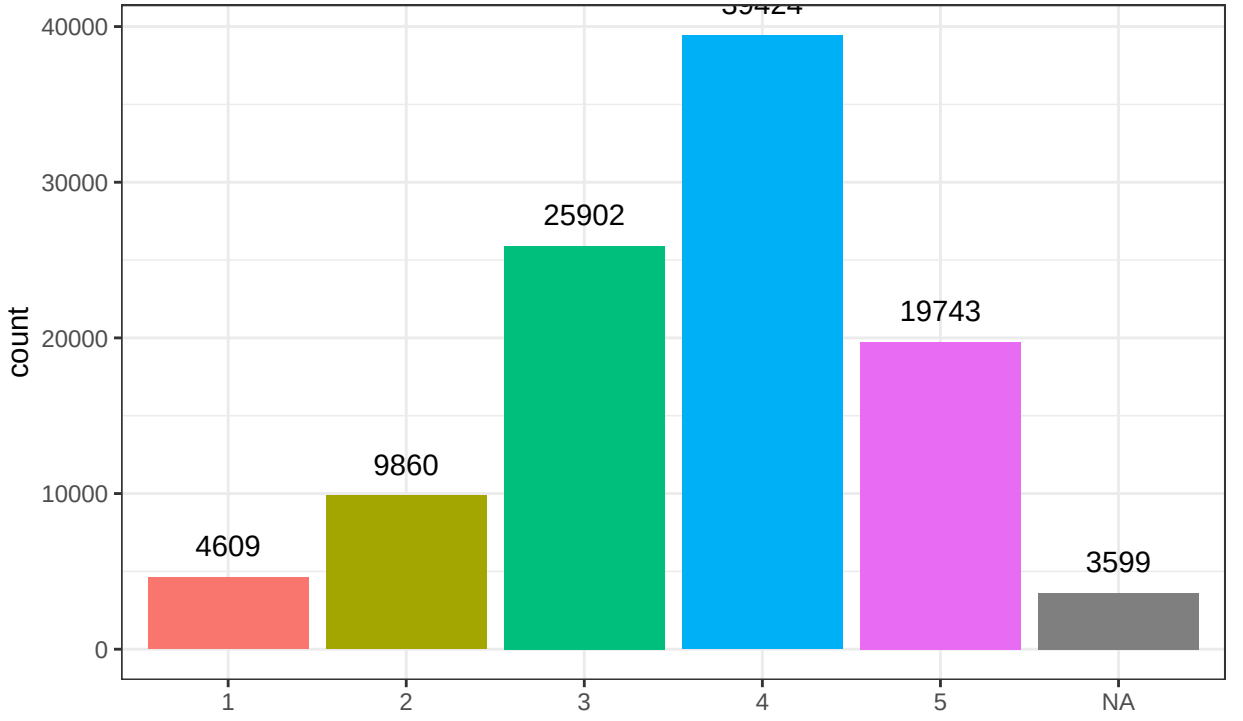

```
aps_reduced$senior_manager_engagement_2 <- reformat_variable_group1(aps_reduced$senior_manager_engagemer
generate_barplot(aps_reduced$senior_manager_engagement_2)
```



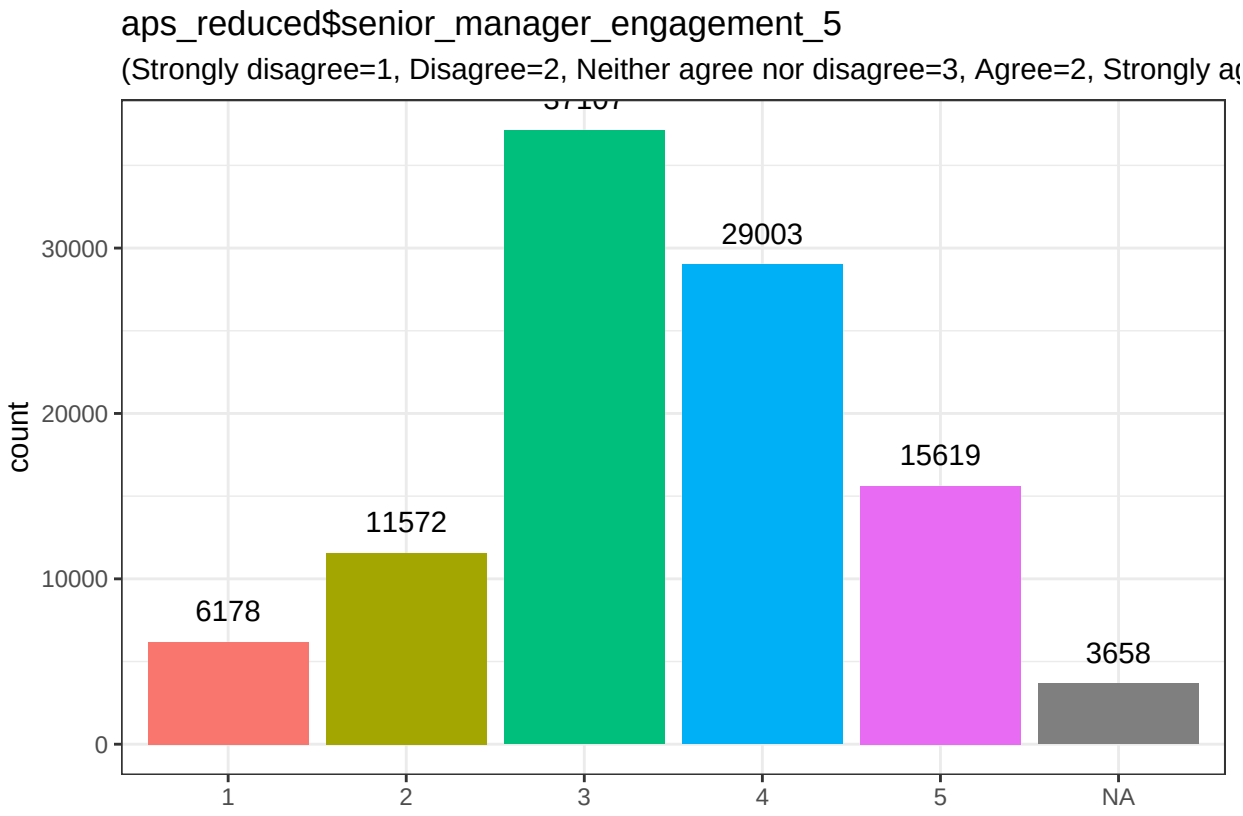

```
aps_reduced$senior_manager_engagement_3 <- reformat_variable_group1(aps_reduced$senior_manager_engagemer
generate_barplot(aps_reduced$senior_manager_engagement_3)
```



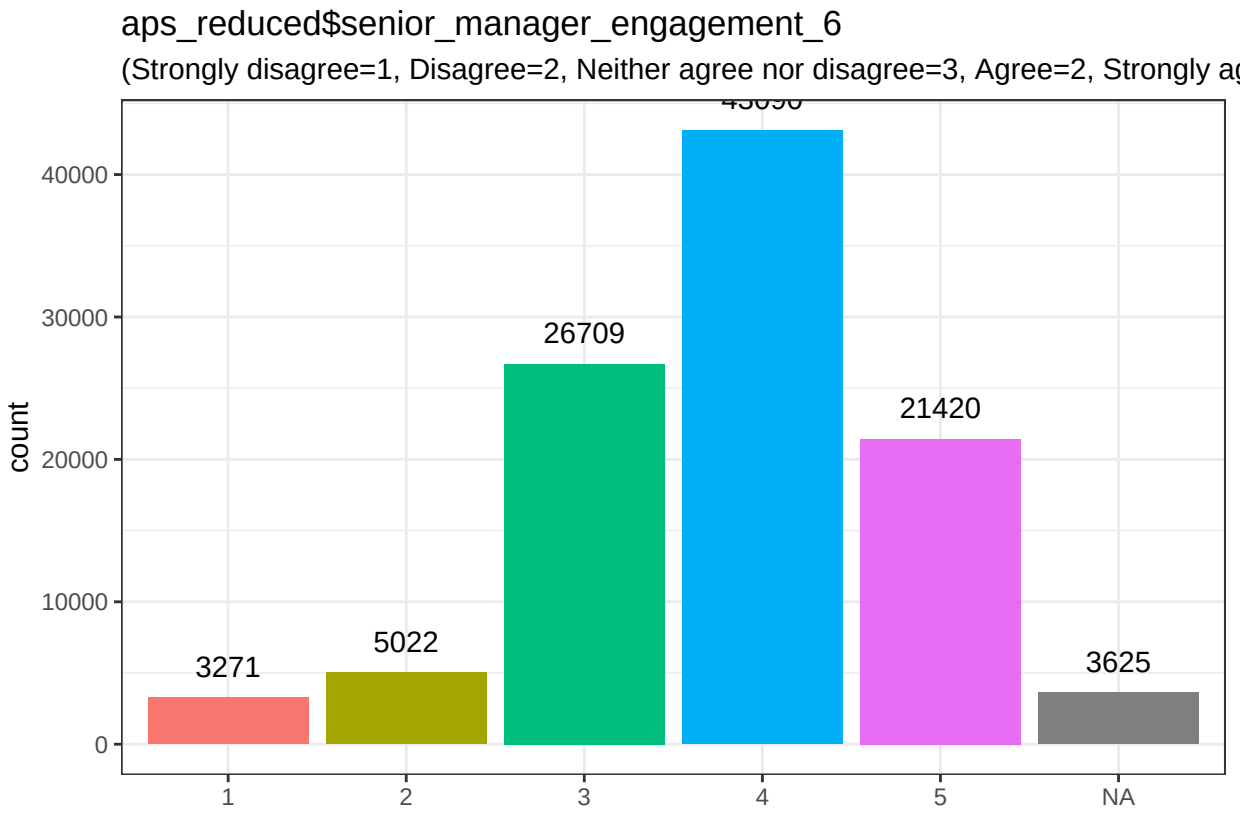

```
aps_reduced$senior_manager_engagement_4 <- reformat_variable_group1(aps_reduced$senior_manager_engagemer
generate_barplot(aps_reduced$senior_manager_engagement_4)
```



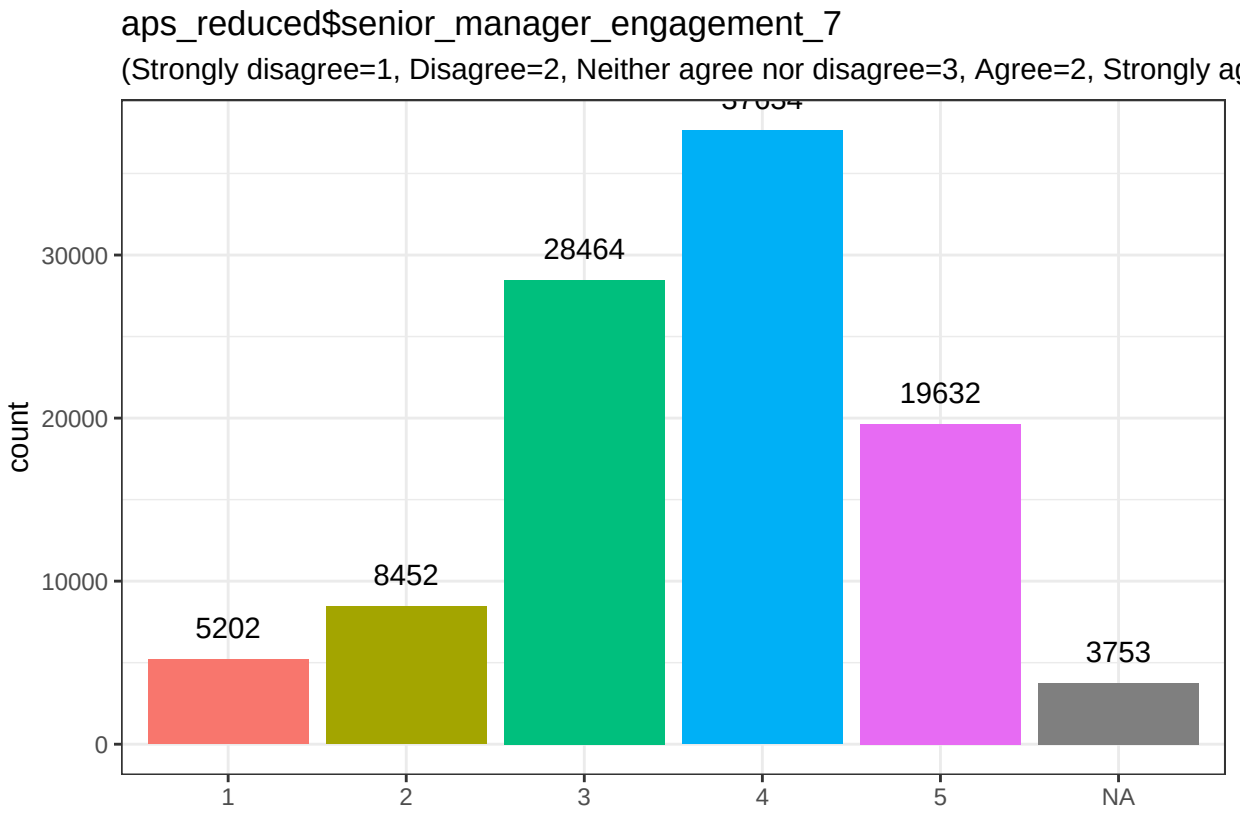

```
aps_reduced$senior_manager_engagement_5 <- reformat_variable_group1(aps_reduced$senior_manager_engagemer
generate_barplot(aps_reduced$senior_manager_engagement_5)
```



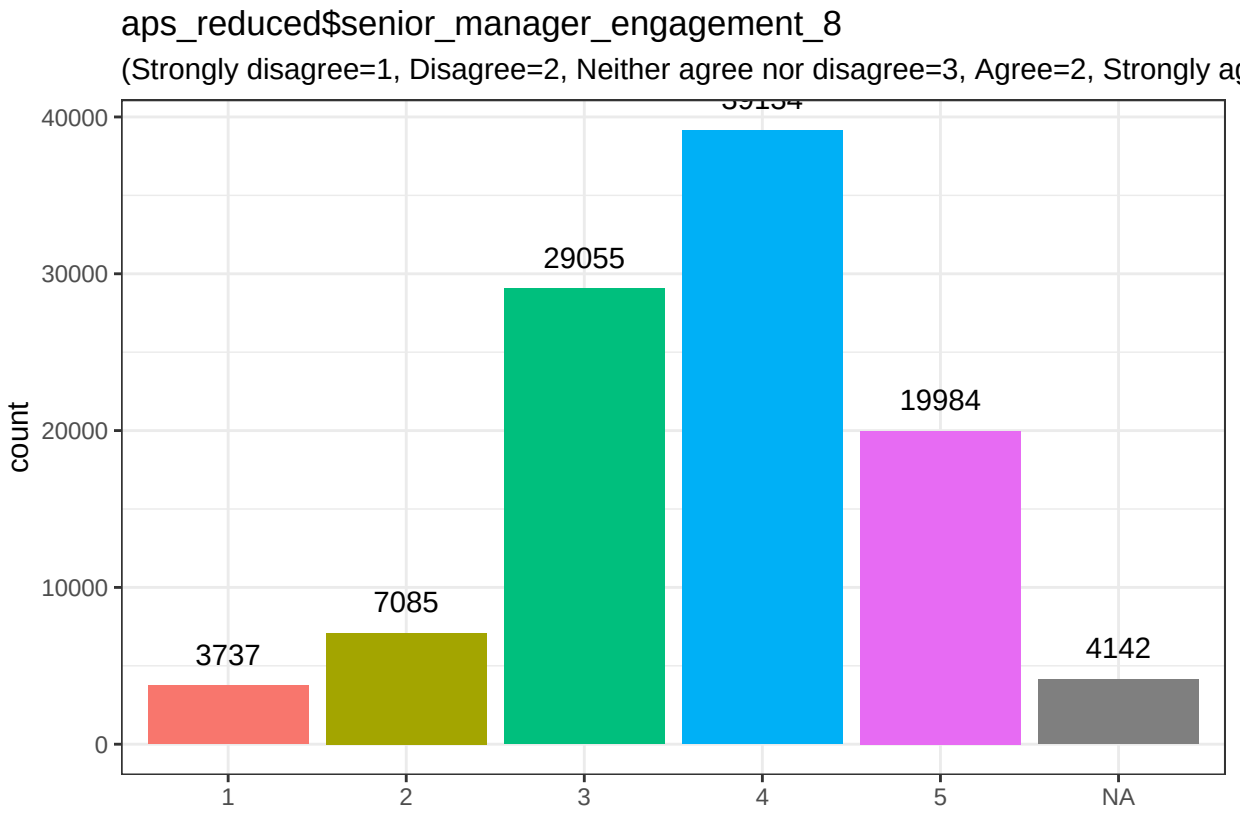

```
aps_reduced$senior_manager_engagement_6 <- reformat_variable_group1(aps_reduced$senior_manager_engagemer
generate_barplot(aps_reduced$senior_manager_engagement_6)
```



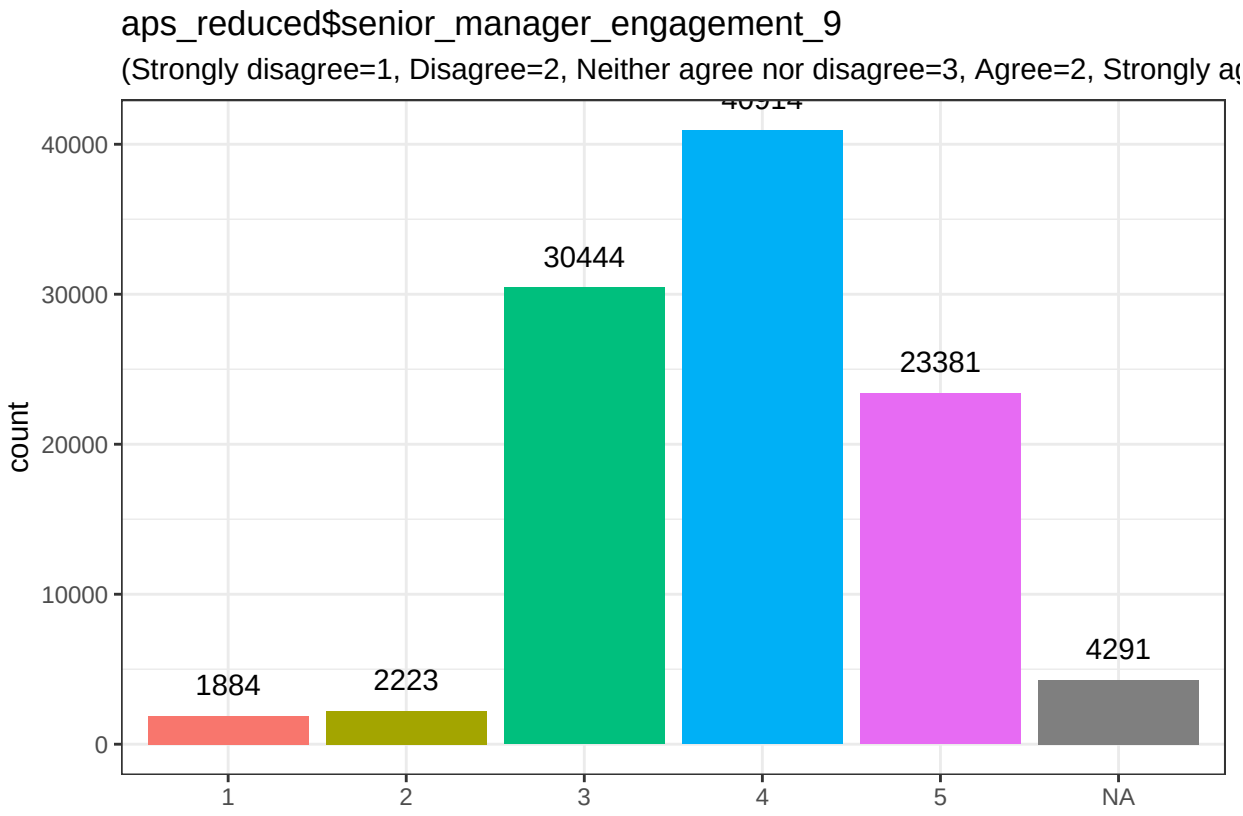

```
aps_reduced$senior_manager_engagement_7 <- reformat_variable_group1(aps_reduced$senior_manager_engagemer
generate_barplot(aps_reduced$senior_manager_engagement_7)
```



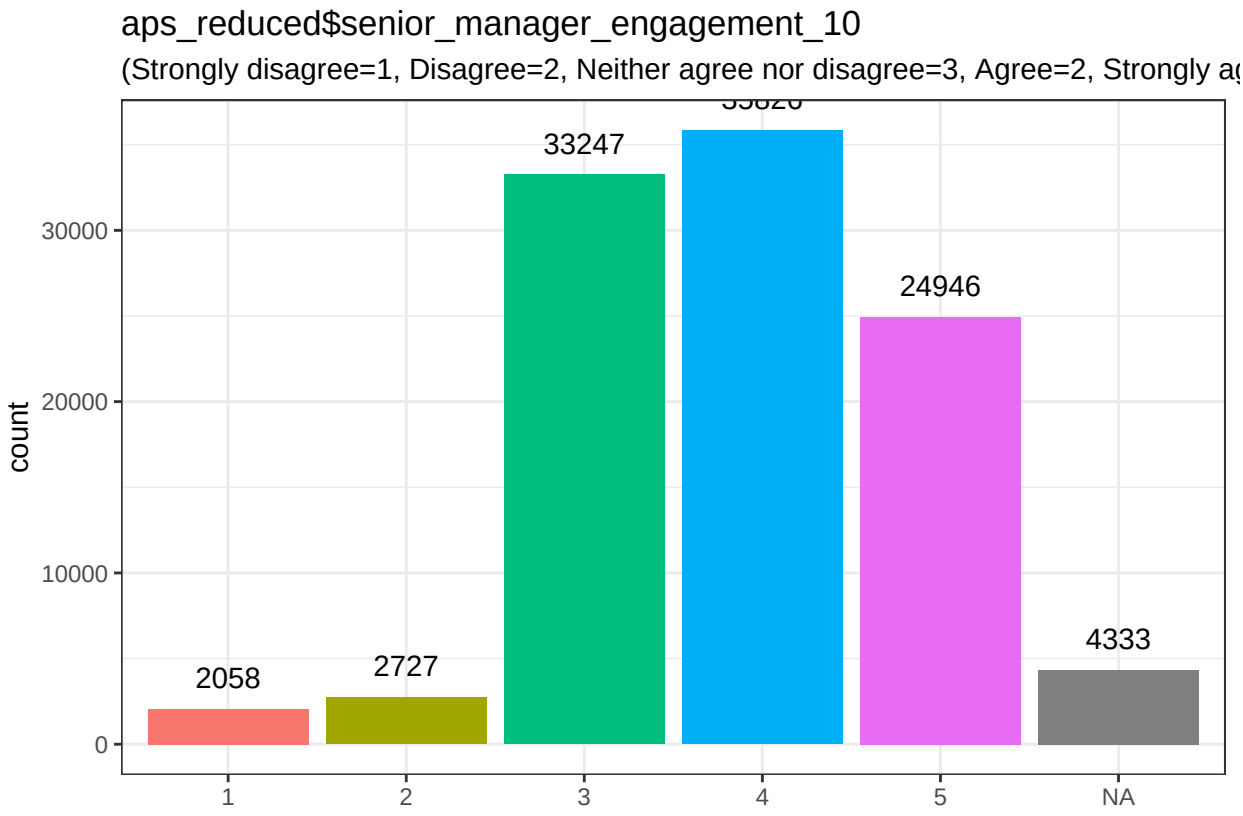

```
aps_reduced$senior_manager_engagement_8 <- reformat_variable_group1(aps_reduced$senior_manager_engagemer
generate_barplot(aps_reduced$senior_manager_engagement_8)
```



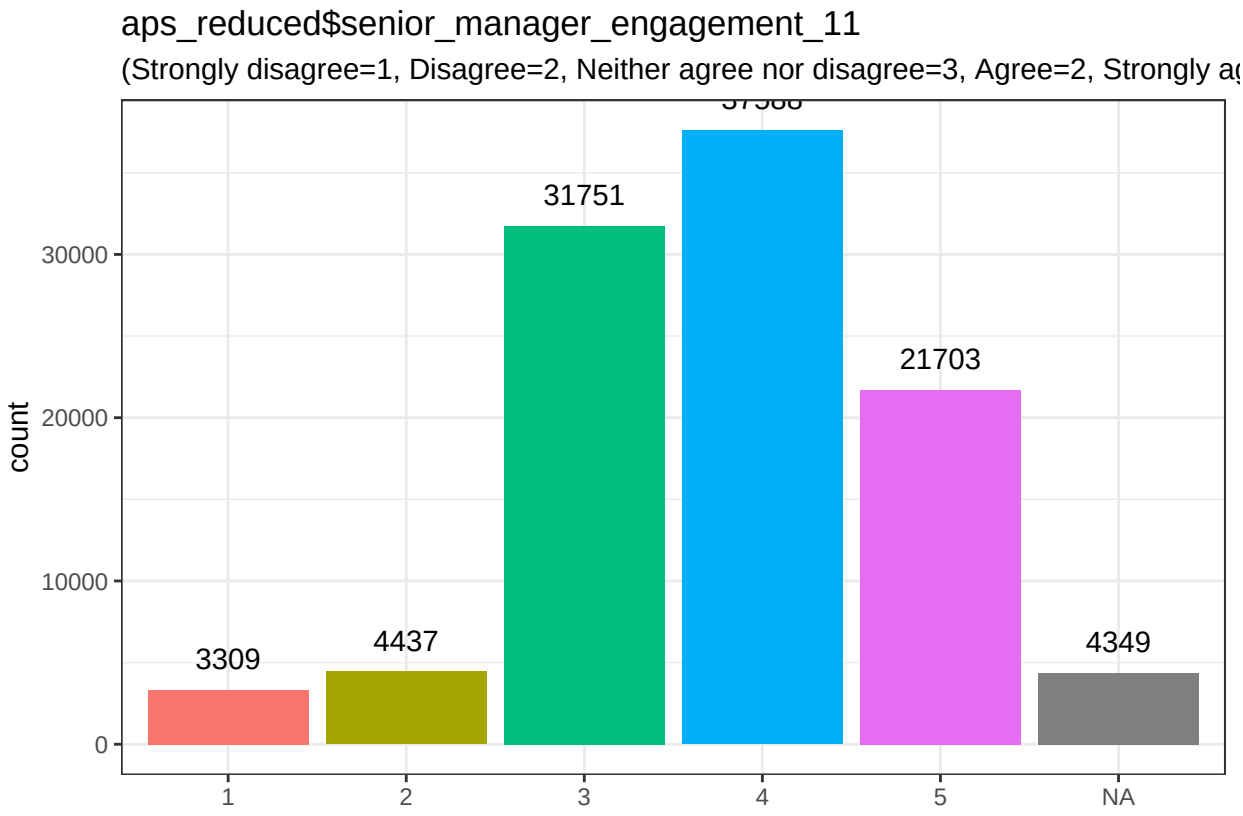

```
aps_reduced$senior_manager_engagement_9 <- reformat_variable_group1(aps_reduced$senior_manager_engagemer
generate_barplot(aps_reduced$senior_manager_engagement_9)
```



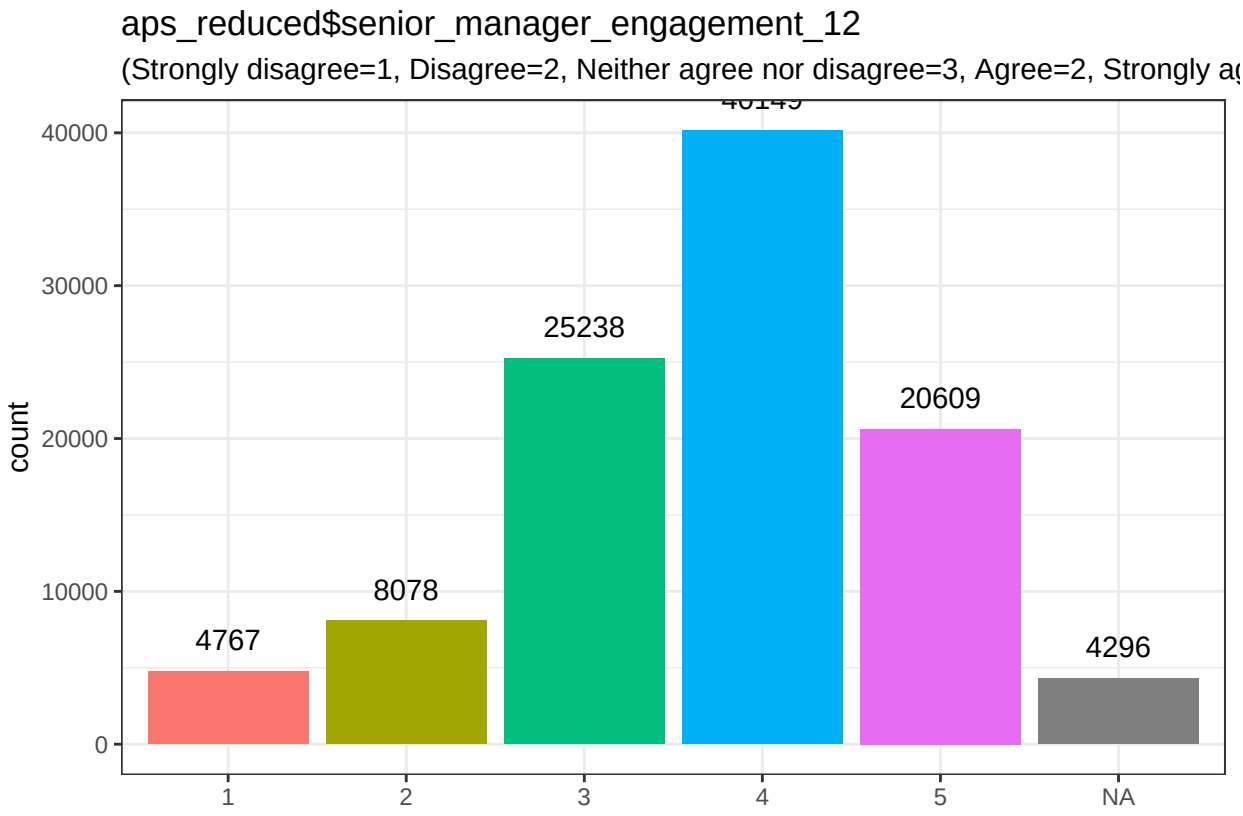

```
aps_reduced$senior_manager_engagement_10 <- reformat_variable_group1(aps_reduced$senior_manager_engageme
generate_barplot(aps_reduced$senior_manager_engagement_10)
```



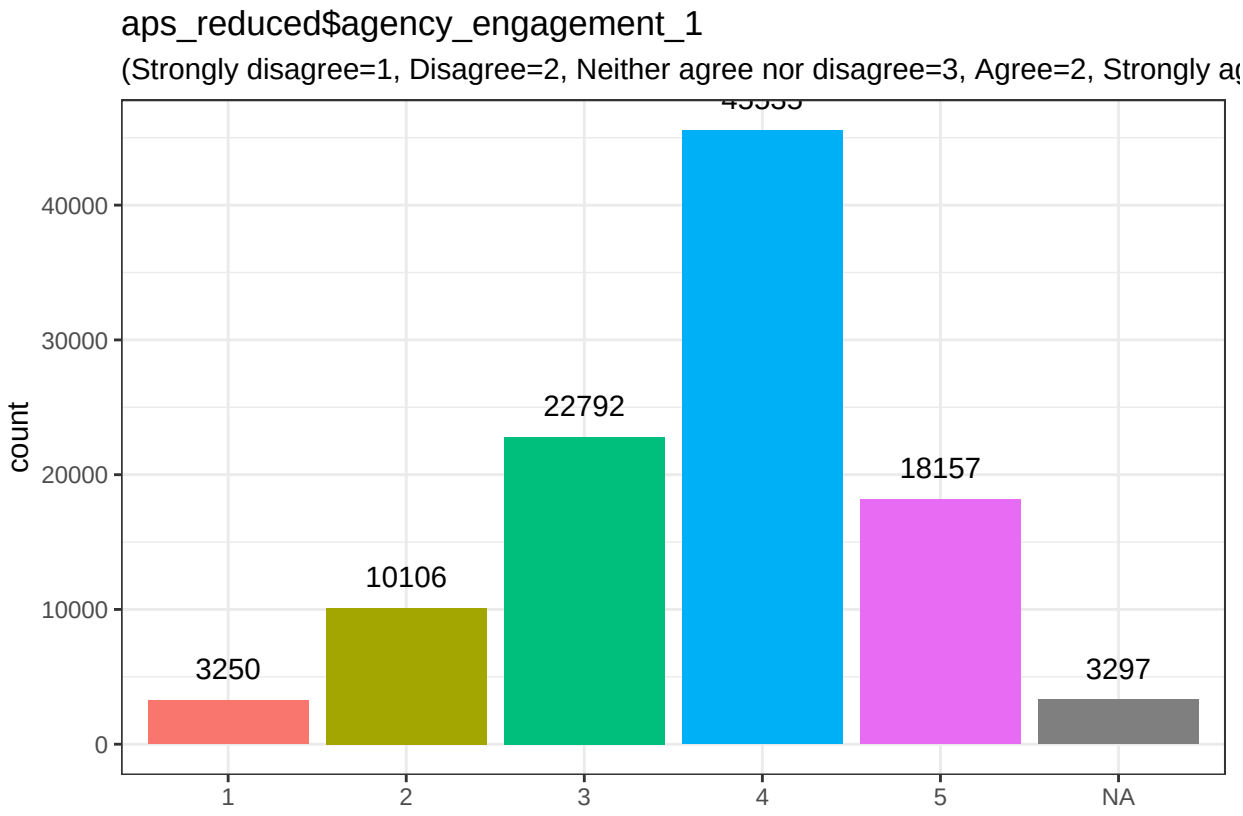

```
aps_reduced$senior_manager_engagement_11 <- reformat_variable_group1(aps_reduced$senior_manager_engageme
generate_barplot(aps_reduced$senior_manager_engagement_11)
```



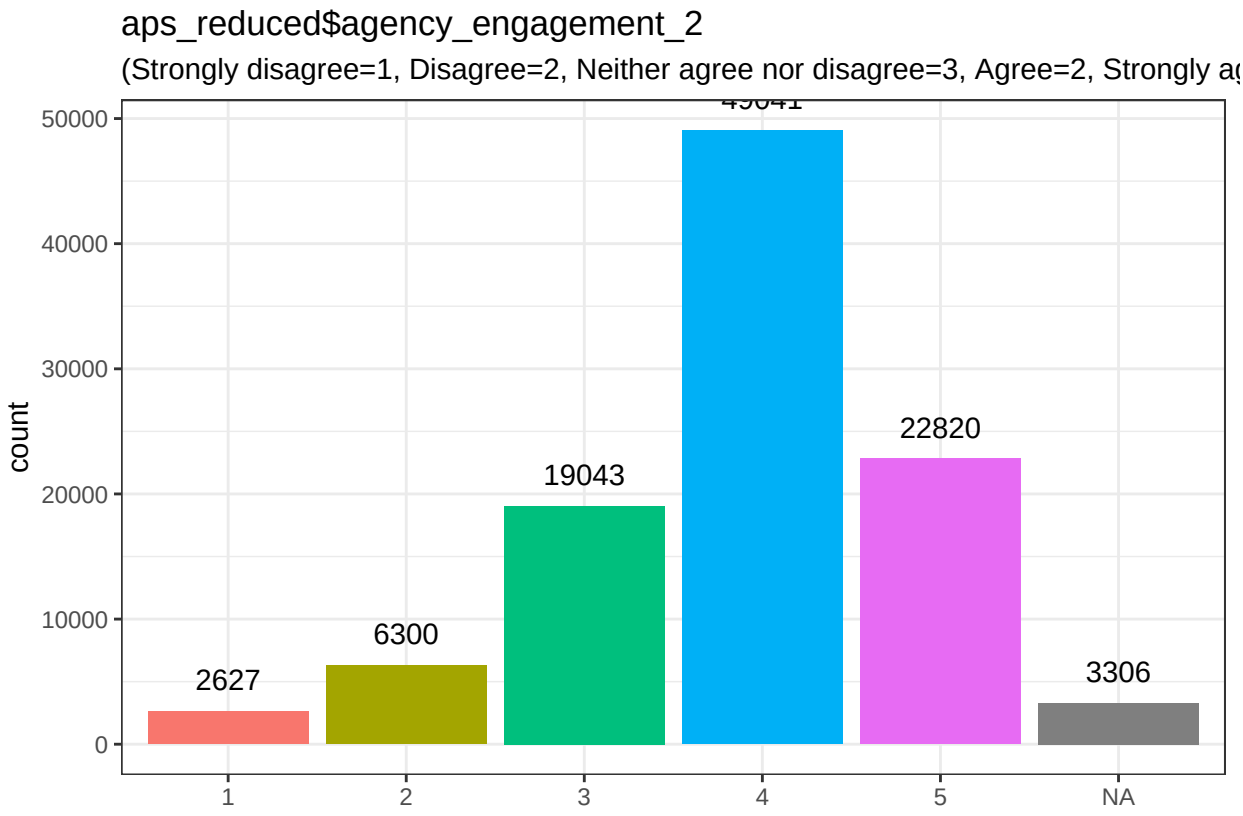

```
aps_reduced$senior_manager_engagement_12 <- reformat_variable_group1(aps_reduced$senior_manager_engagem
generate_barplot(aps_reduced$senior_manager_engagement_12)
```



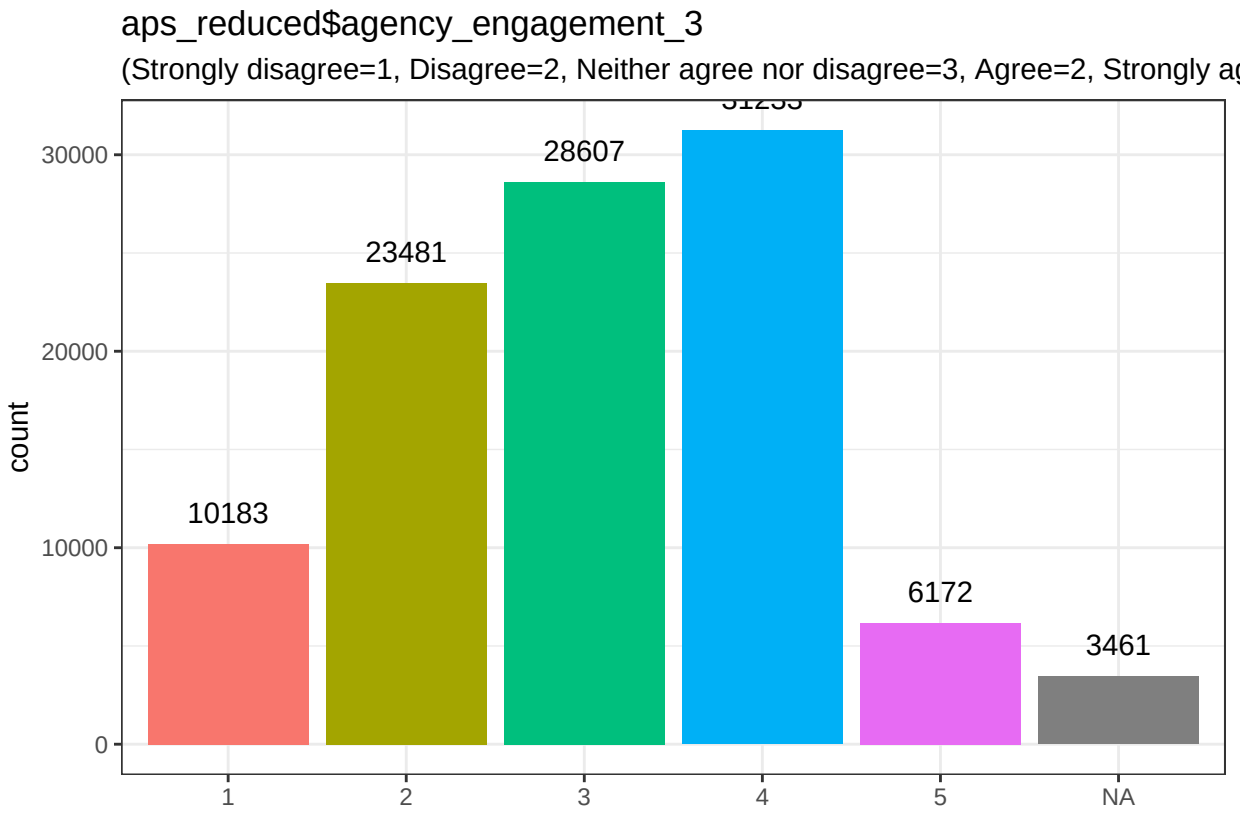

```
# agency_engagement reformatting

aps_reduced$agency_engagement_1 <- reformat_variable_group1(aps_reduced$agency_engagement_1)
generate_barplot(aps_reduced$agency_engagement_1)
```



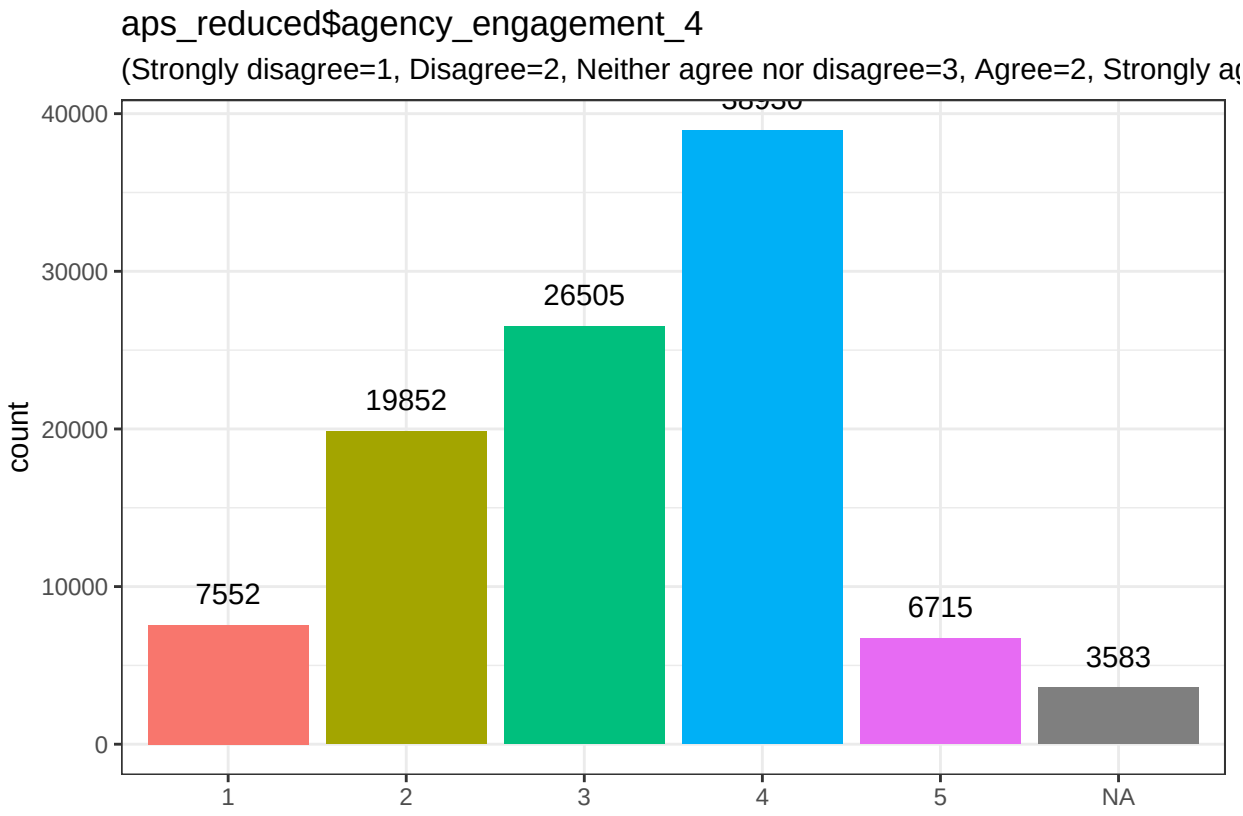

```
aps_reduced$agency_engagement_2 <- reformat_variable_group1(aps_reduced$agency_engagement_2)
generate_barplot(aps_reduced$agency_engagement_2)
```



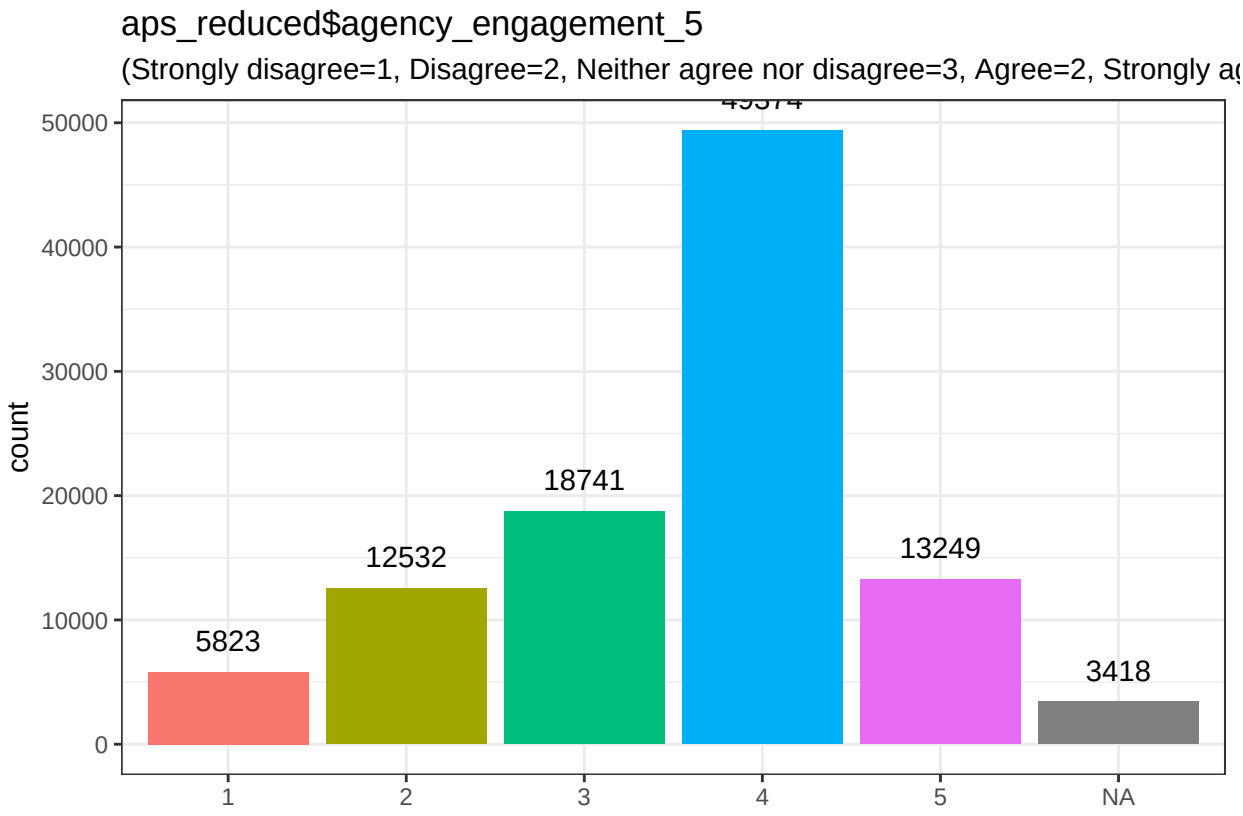

```
aps_reduced$agency_engagement_3 <- reformat_variable_group1(aps_reduced$agency_engagement_3)
generate_barplot(aps_reduced$agency_engagement_3)
```



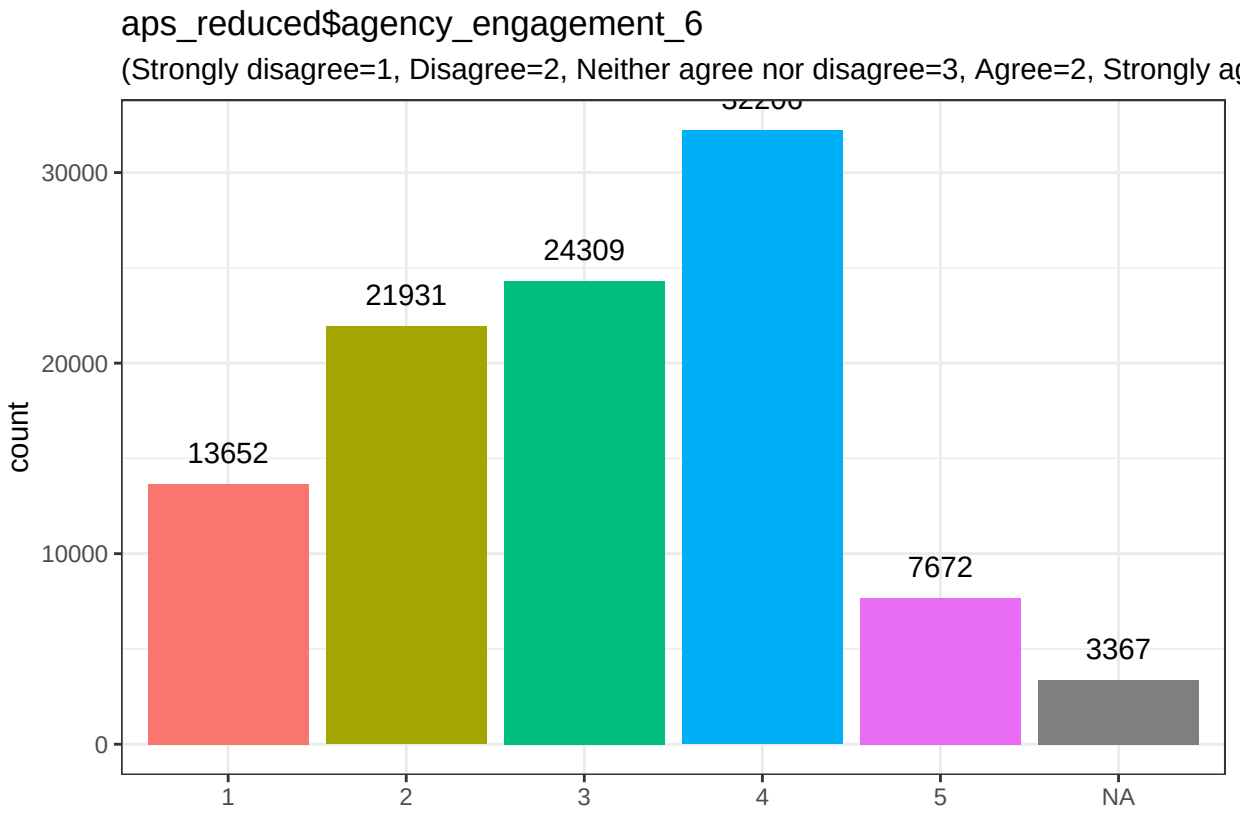

```
aps_reduced$agency_engagement_4 <- reformat_variable_group1(aps_reduced$agency_engagement_4)
generate_barplot(aps_reduced$agency_engagement_4)
```



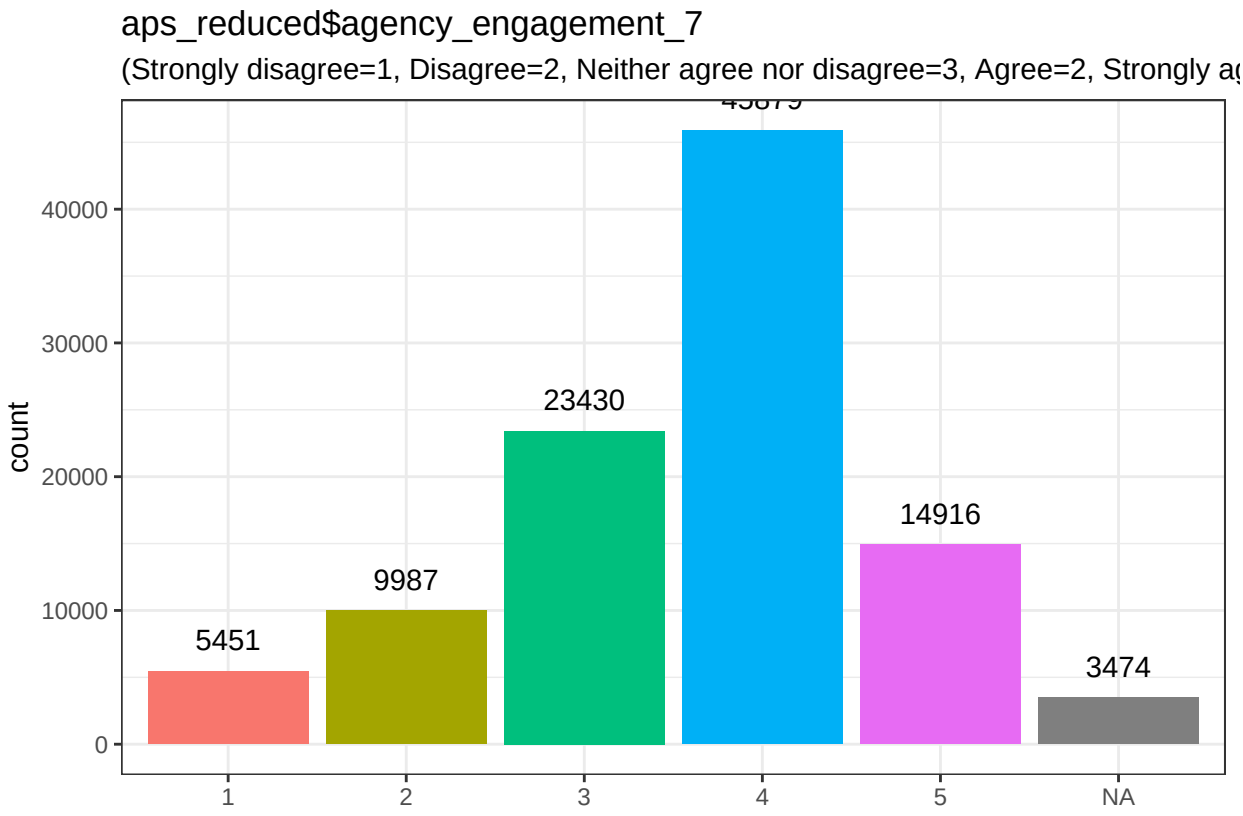

```
aps_reduced$agency_engagement_5 <- reformat_variable_group1(aps_reduced$agency_engagement_5)
generate_barplot(aps_reduced$agency_engagement_5)
```



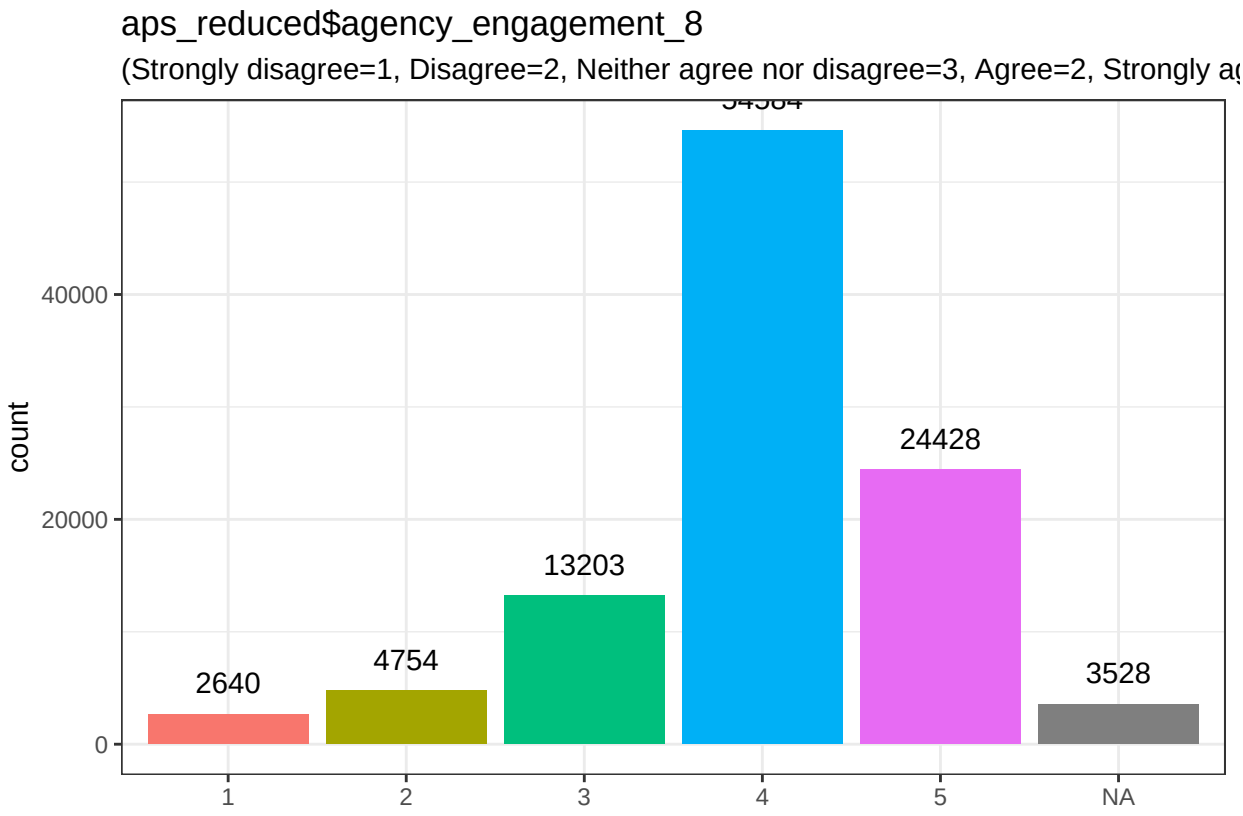

```
aps_reduced$agency_engagement_6 <- reformat_variable_group1(aps_reduced$agency_engagement_6)
generate_barplot(aps_reduced$agency_engagement_6)
```



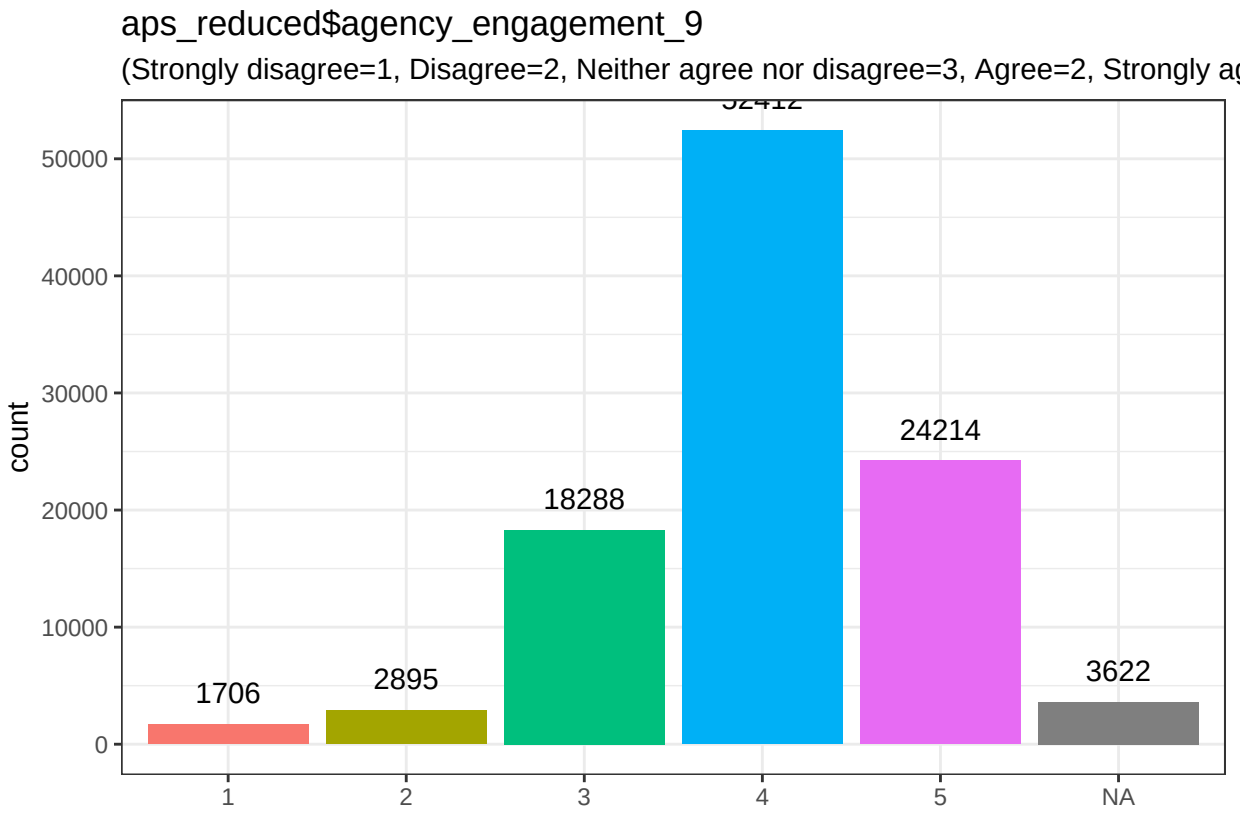

```
aps_reduced$agency_engagement_7 <- reformat_variable_group1(aps_reduced$agency_engagement_7)
generate_barplot(aps_reduced$agency_engagement_7)
```



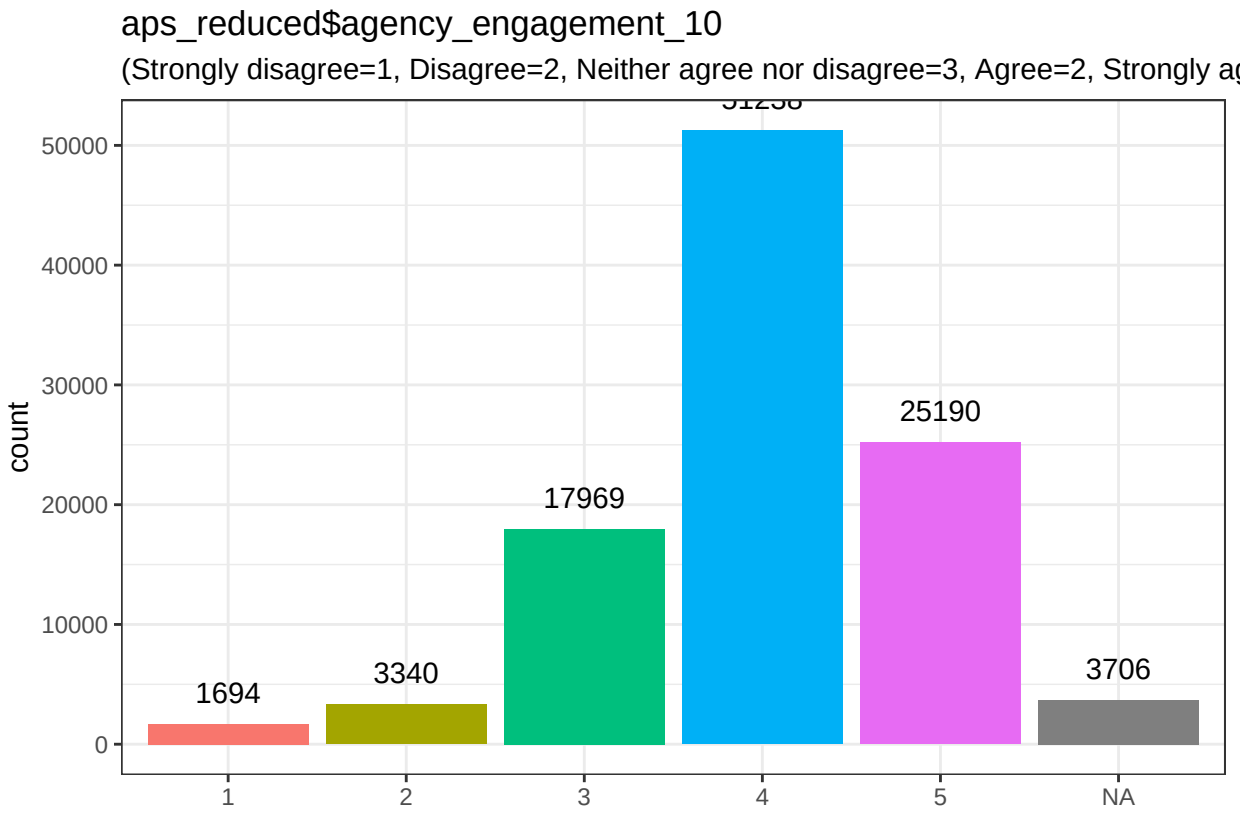

```
aps_reduced$agency_engagement_8 <- reformat_variable_group1(aps_reduced$agency_engagement_8)
generate_barplot(aps_reduced$agency_engagement_8)
```



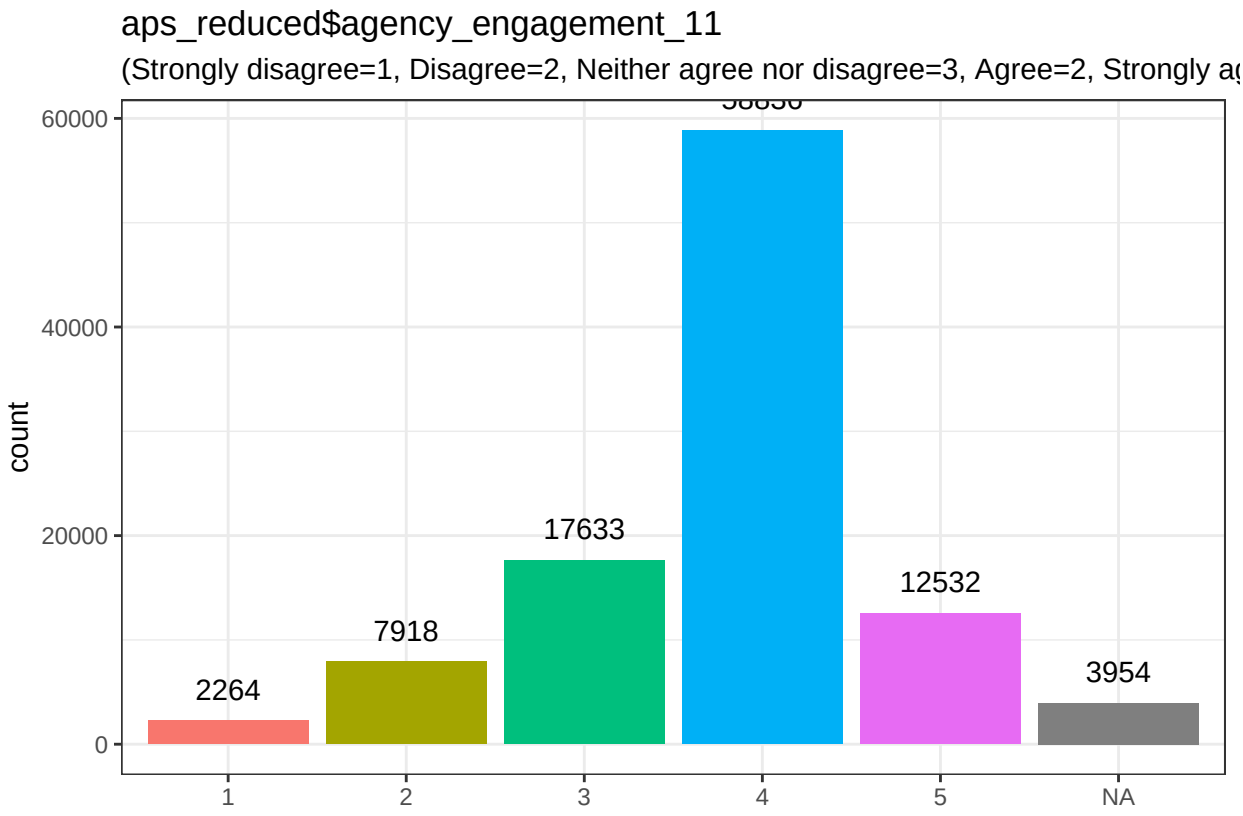

```
aps_reduced$agency_engagement_9 <- reformat_variable_group1(aps_reduced$agency_engagement_9)
generate_barplot(aps_reduced$agency_engagement_9)
```



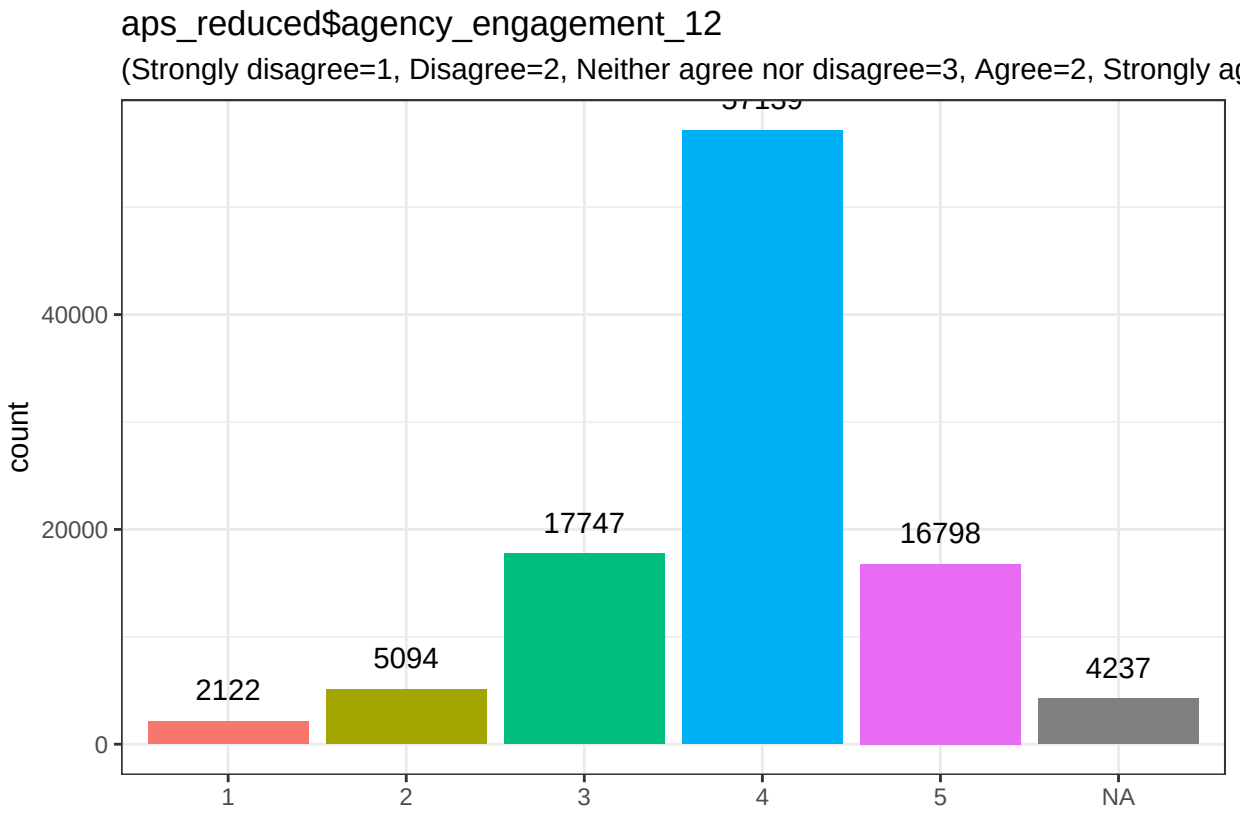

```
aps_reduced$agency_engagement_10 <- reformat_variable_group1(aps_reduced$agency_engagement_10)
generate_barplot(aps_reduced$agency_engagement_10)
```



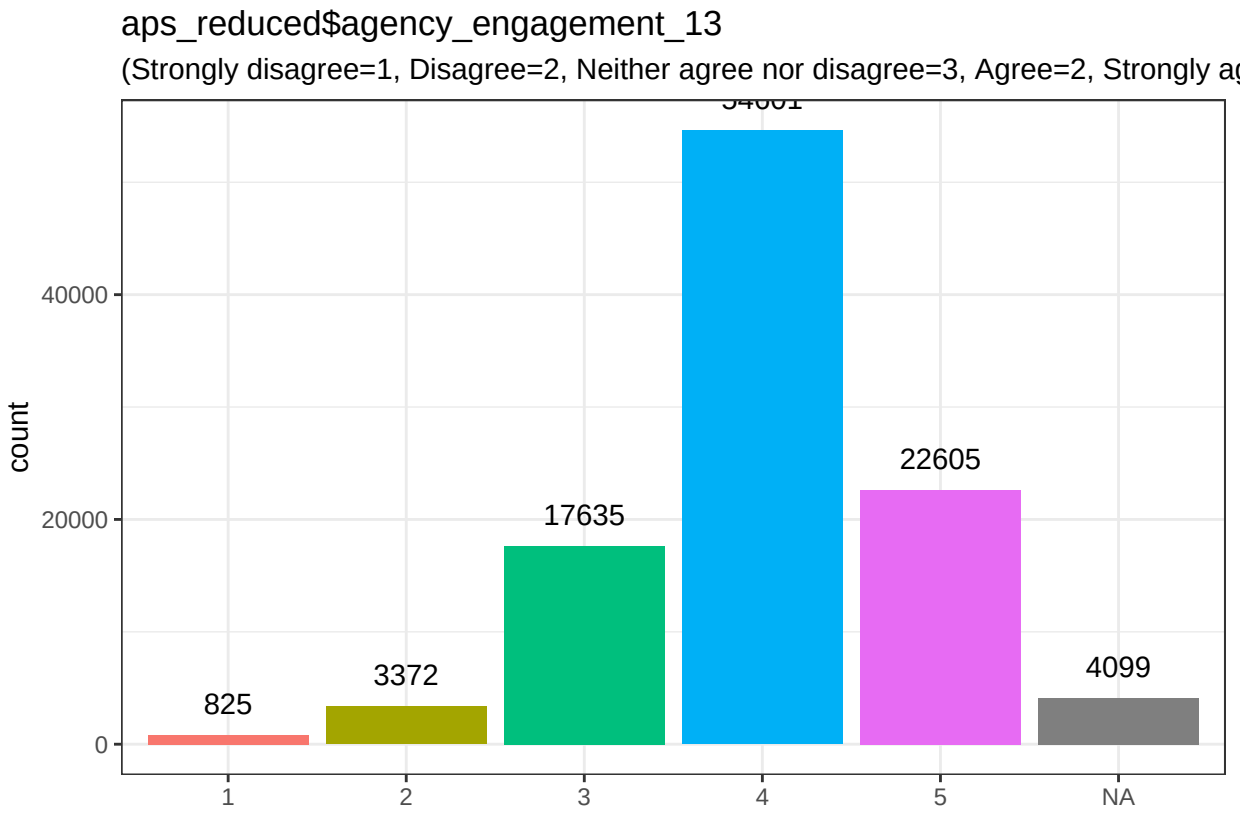

```
aps_reduced$agency_engagement_11 <- reformat_variable_group1(aps_reduced$agency_engagement_11)
generate_barplot(aps_reduced$agency_engagement_11)
```



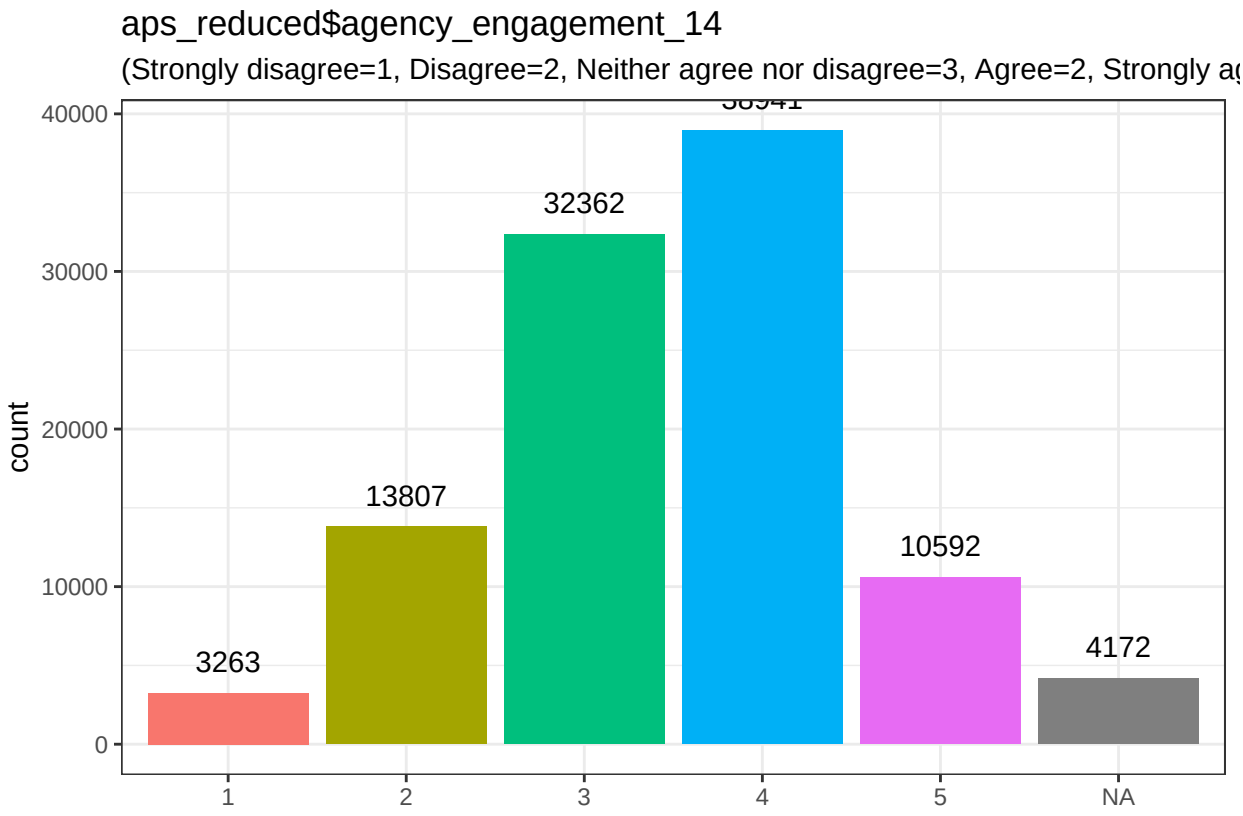

```
aps_reduced$agency_engagement_12 <- reformat_variable_group1(aps_reduced$agency_engagement_12)
generate_barplot(aps_reduced$agency_engagement_12)
```



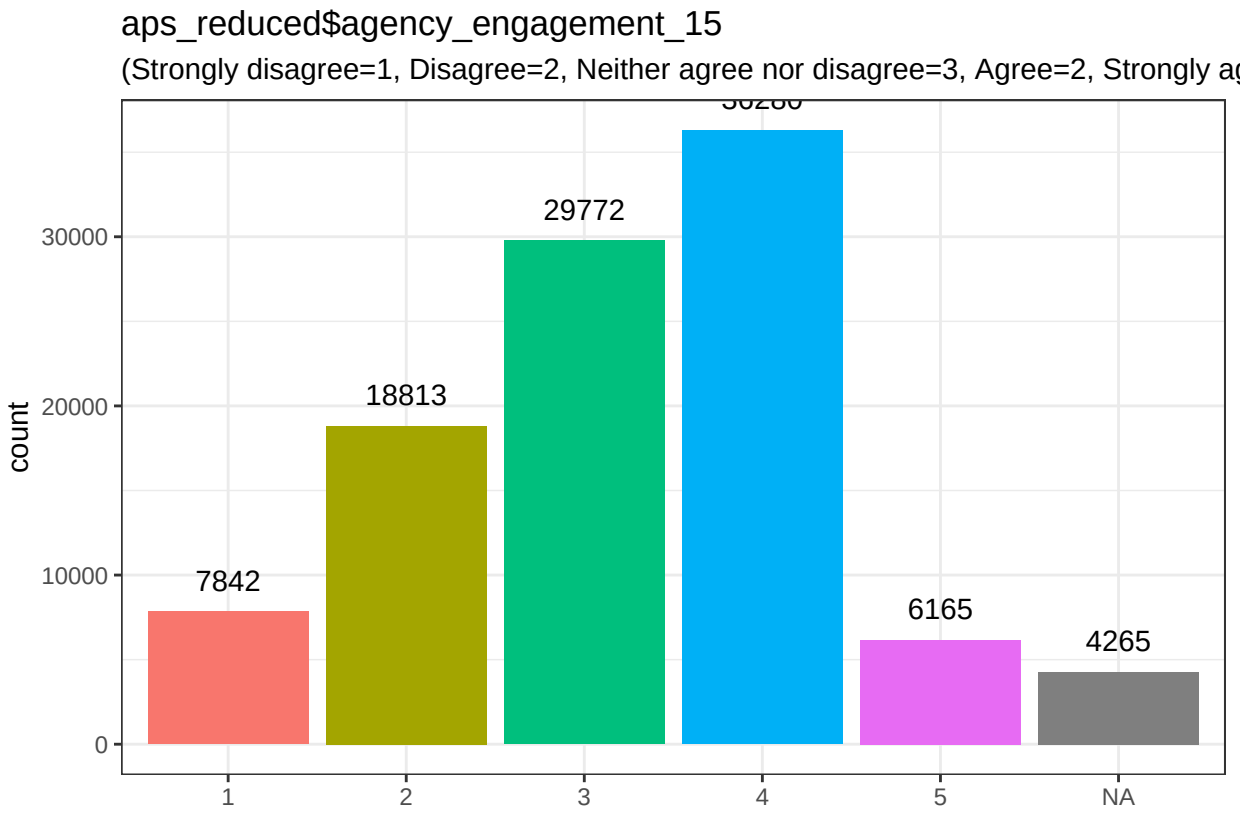

```
aps_reduced$agency_engagement_13 <- reformat_variable_group1(aps_reduced$agency_engagement_13)
generate_barplot(aps_reduced$agency_engagement_13)
```



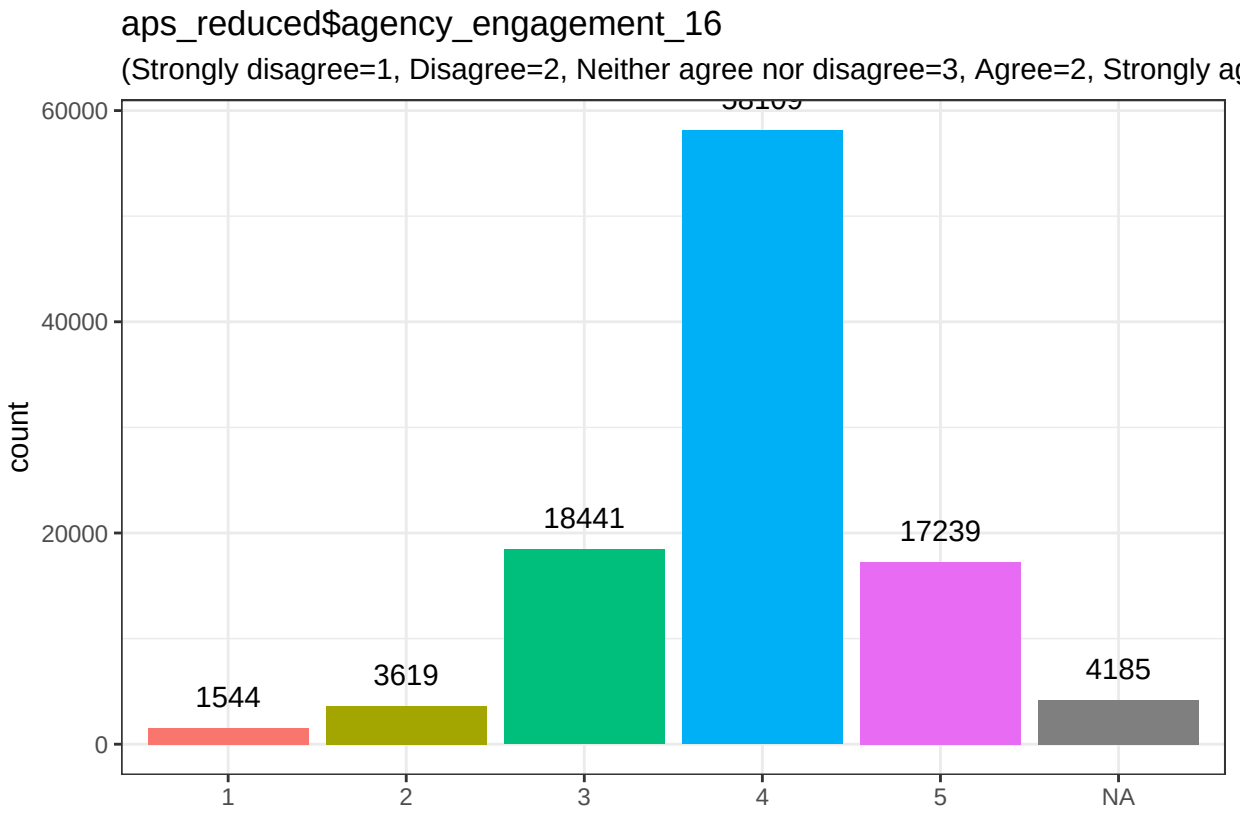

```
aps_reduced$agency_engagement_14 <- reformat_variable_group1(aps_reduced$agency_engagement_14)
generate_barplot(aps_reduced$agency_engagement_14)
```



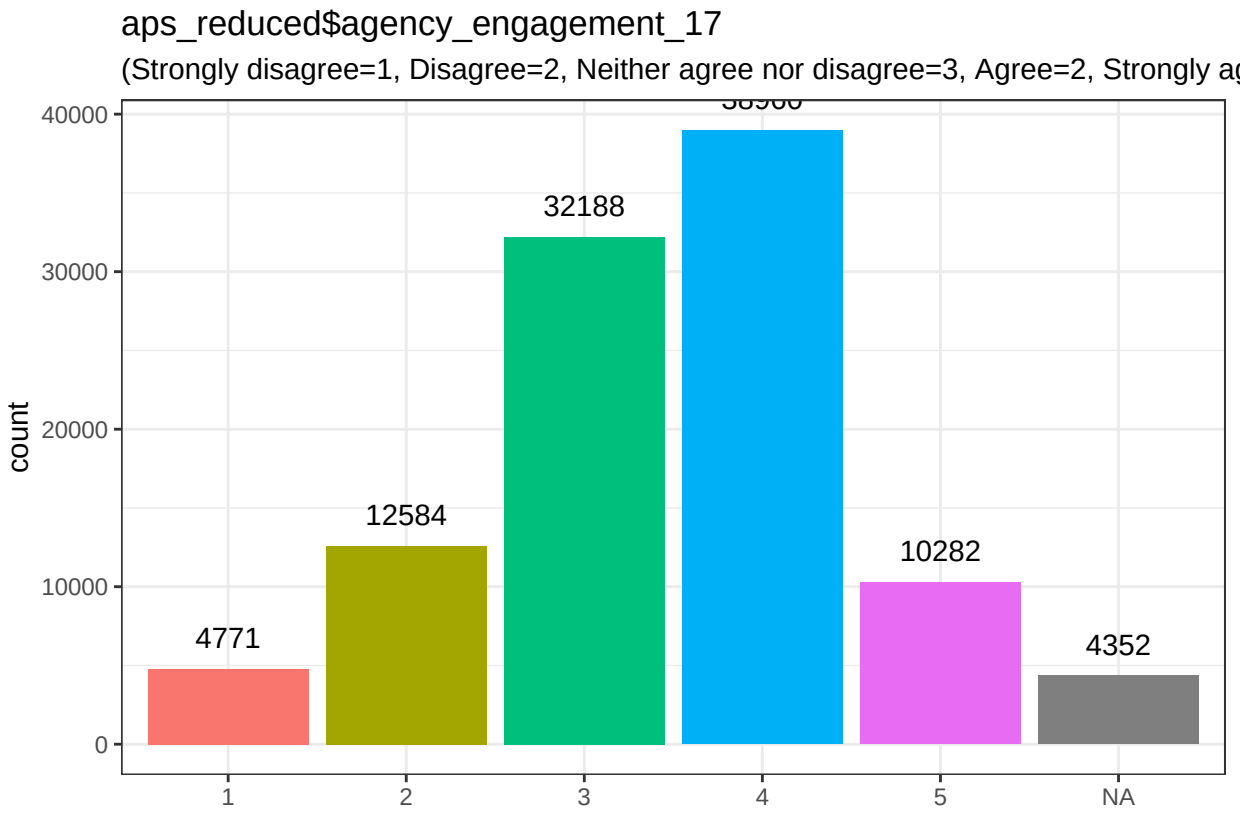

```
aps_reduced$agency_engagement_15 <- reformat_variable_group1(aps_reduced$agency_engagement_15)
generate_barplot(aps_reduced$agency_engagement_15)
```



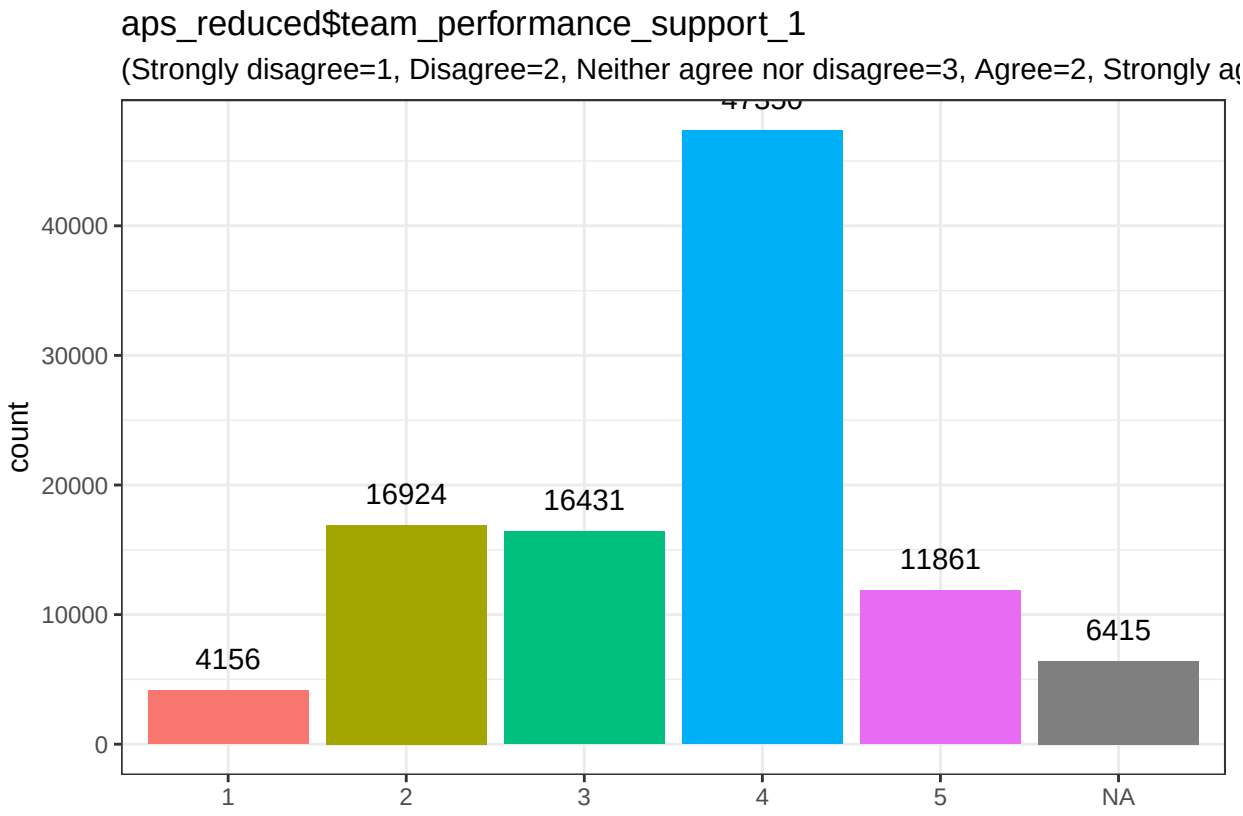

```
aps_reduced$agency_engagement_16 <- reformat_variable_group1(aps_reduced$agency_engagement_16)
generate_barplot(aps_reduced$agency_engagement_16)
```



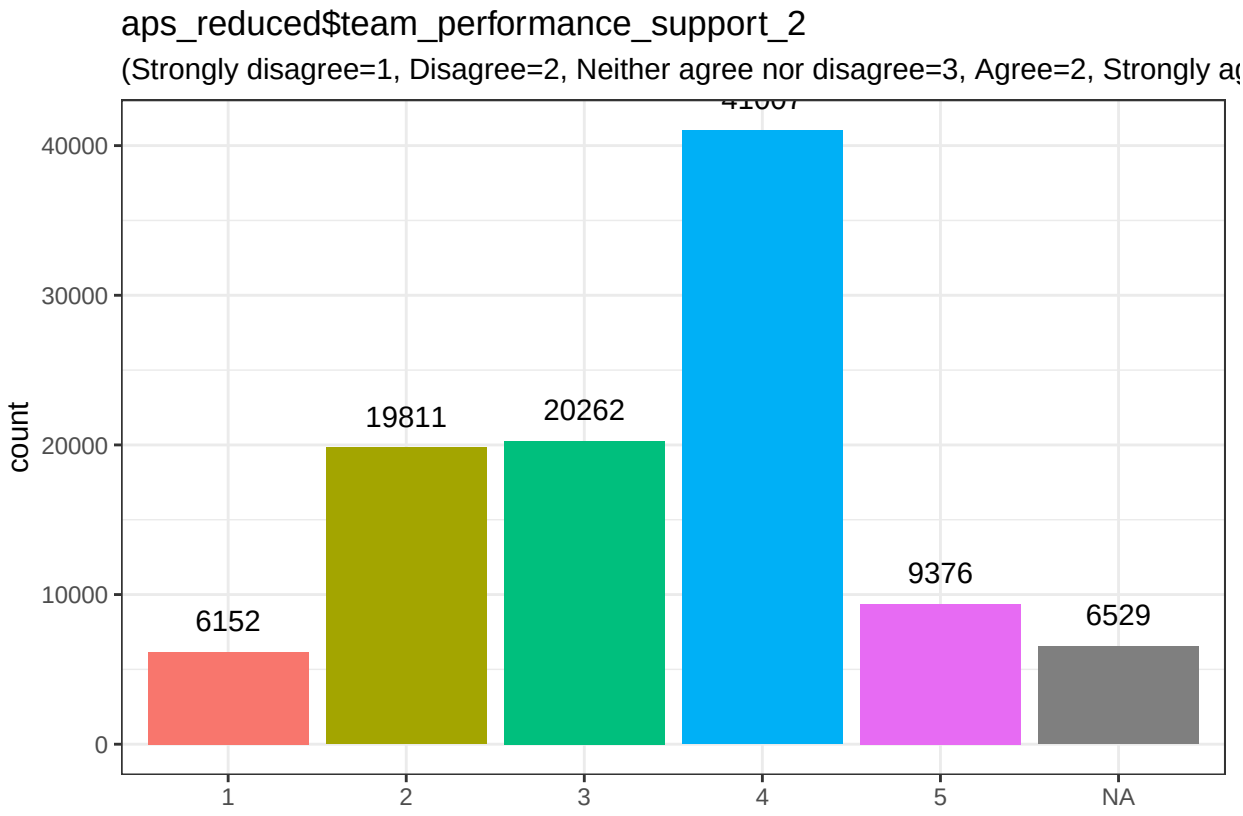

```
aps_reduced$agency_engagement_17 <- reformat_variable_group1(aps_reduced$agency_engagement_17)
generate_barplot(aps_reduced$agency_engagement_17)
```



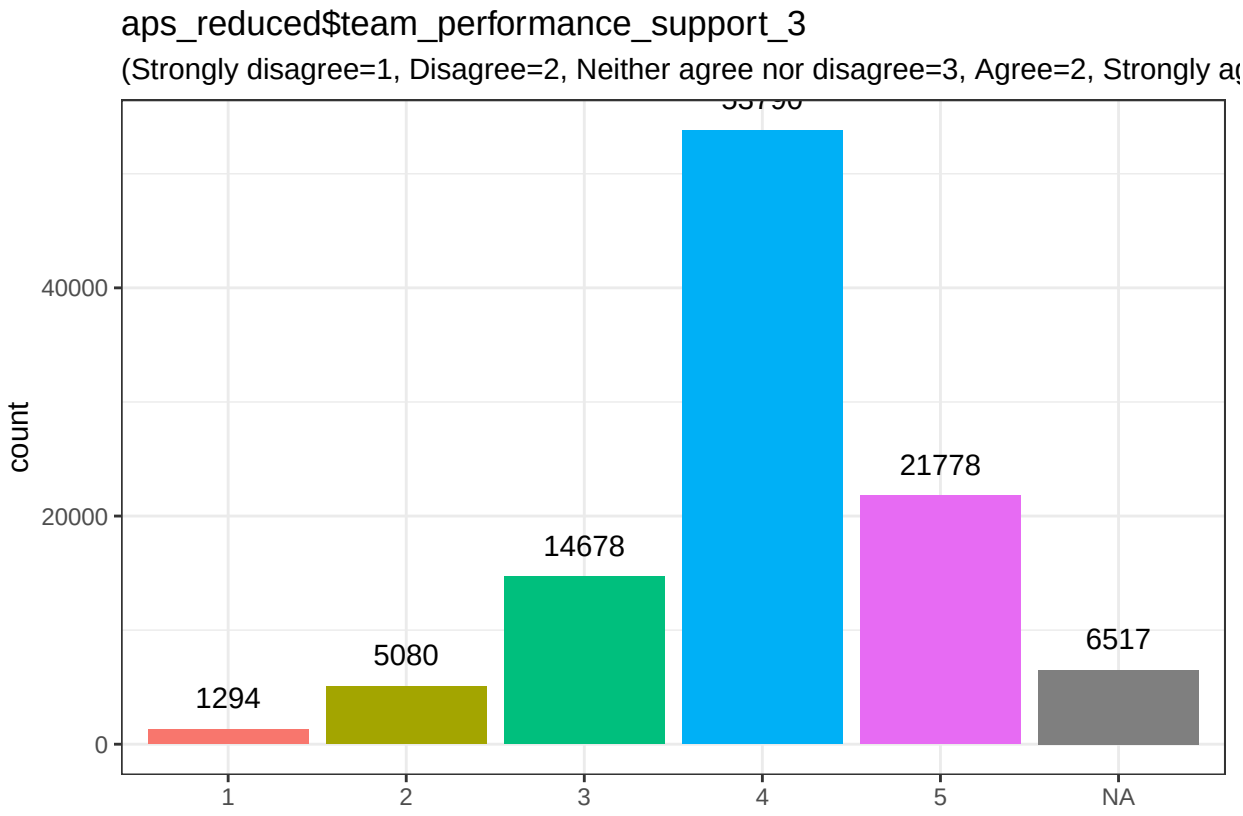

```
# team_performance_support reformatting

aps_reduced$team_performance_support_1 <- reformat_variable_group1(aps_reduced$team_performance_support
generate_barplot(aps_reduced$team_performance_support_1)
```



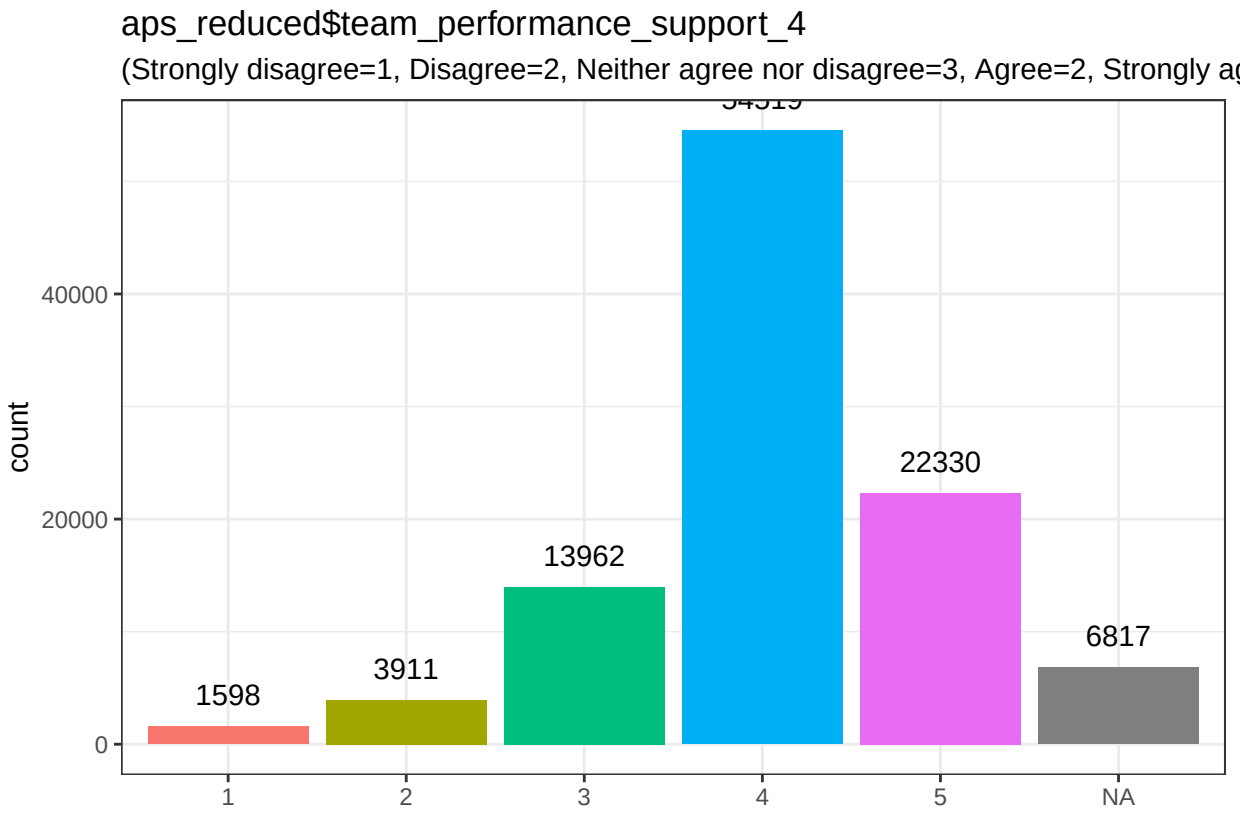

```
aps_reduced$team_performance_support_2 <- reformat_variable_group1(aps_reduced$team_performance_support_
generate_barplot(aps_reduced$team_performance_support_2)
```



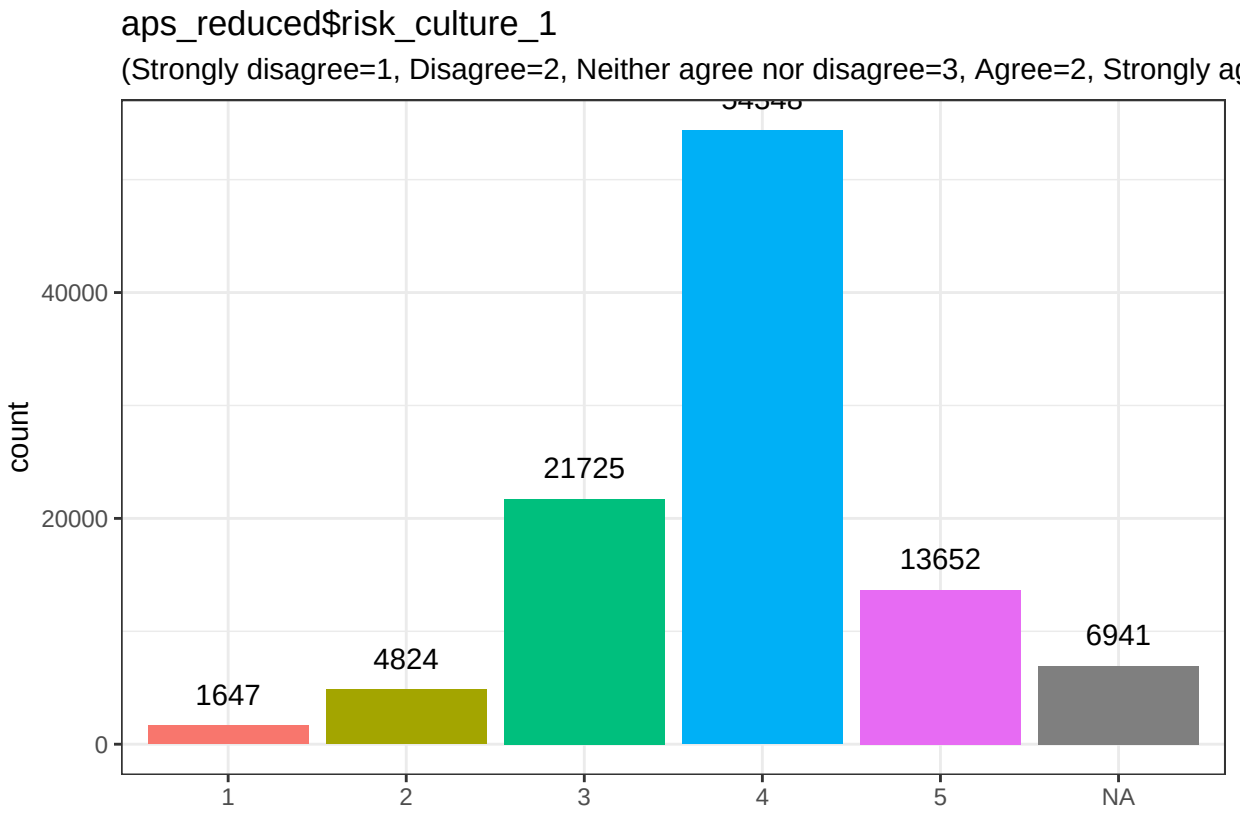

```
aps_reduced$team_performance_support_3 <- reformat_variable_group1(aps_reduced$team_performance_support_
generate_barplot(aps_reduced$team_performance_support_3)
```



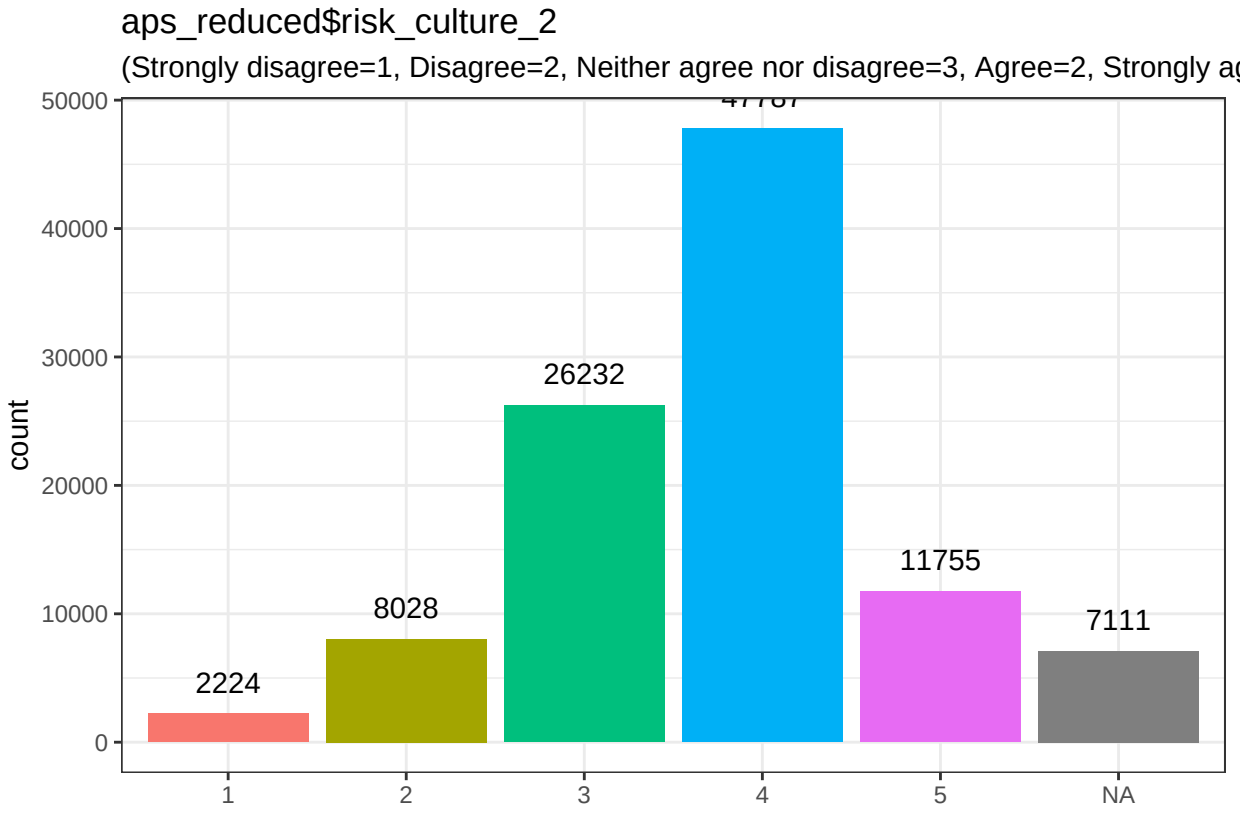

```
aps_reduced$team_performance_support_4 <- reformat_variable_group1(aps_reduced$team_performance_support_
generate_barplot(aps_reduced$team_performance_support_4)
```



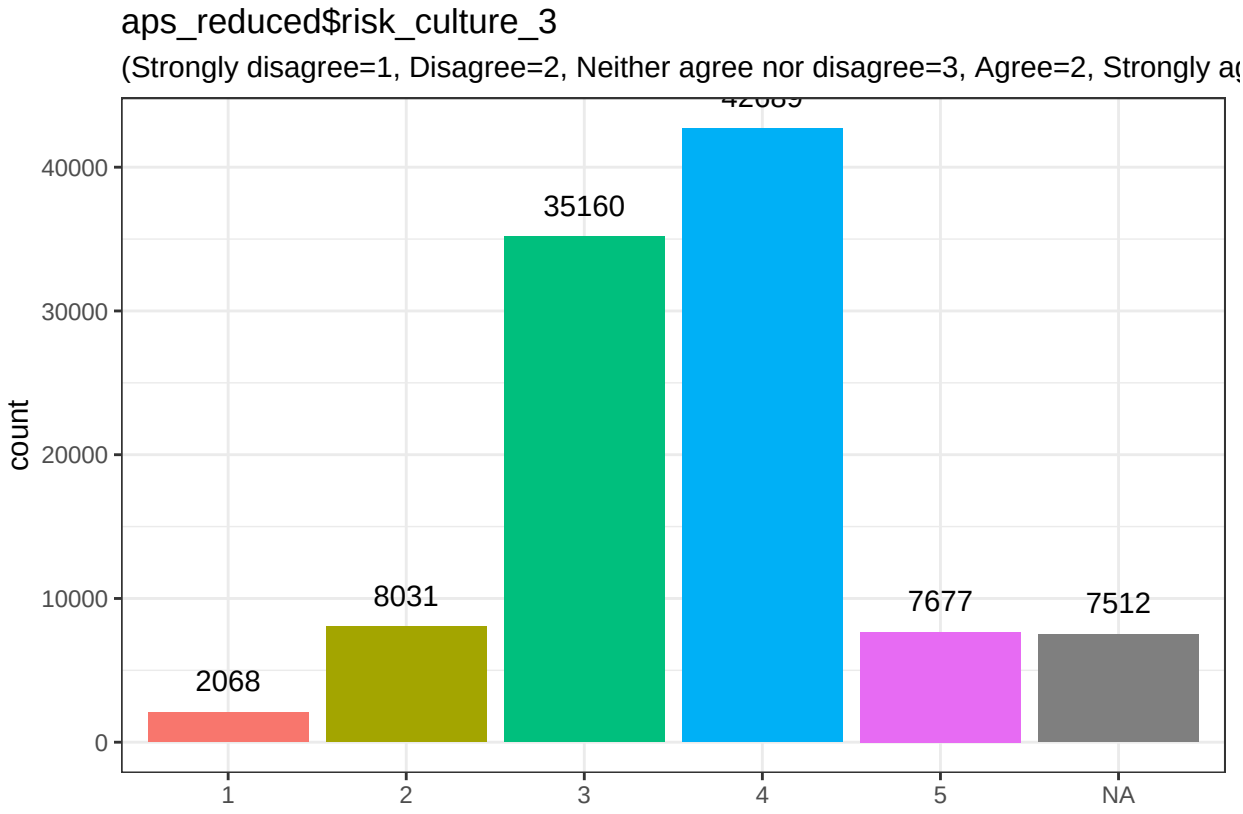

```
# risk culture reformatting

aps_reduced$risk_culture_1 <- reformat_variable_group1(aps_reduced$risk_culture_1)
generate_barplot(aps_reduced$risk_culture_1)
```



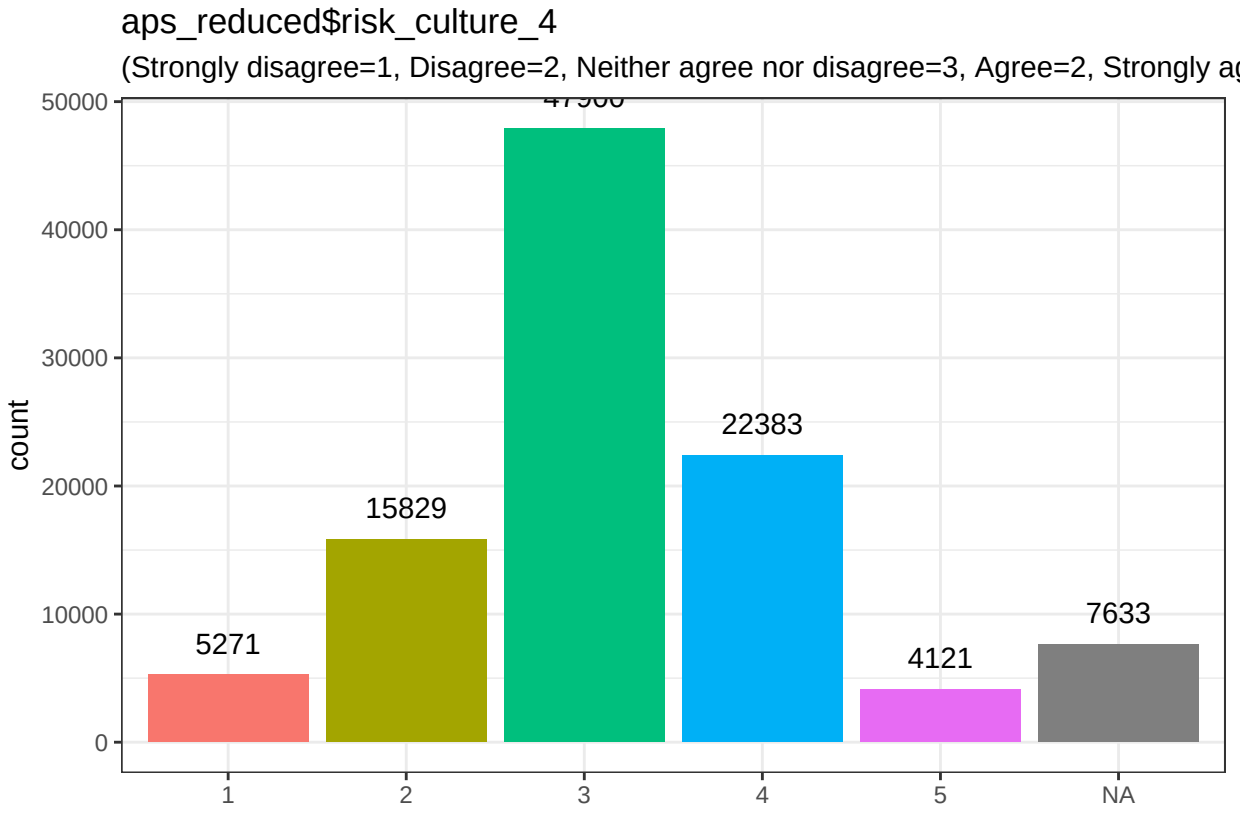

```
aps_reduced$risk_culture_2 <- reformat_variable_group1(aps_reduced$risk_culture_2)
generate_barplot(aps_reduced$risk_culture_2)
```



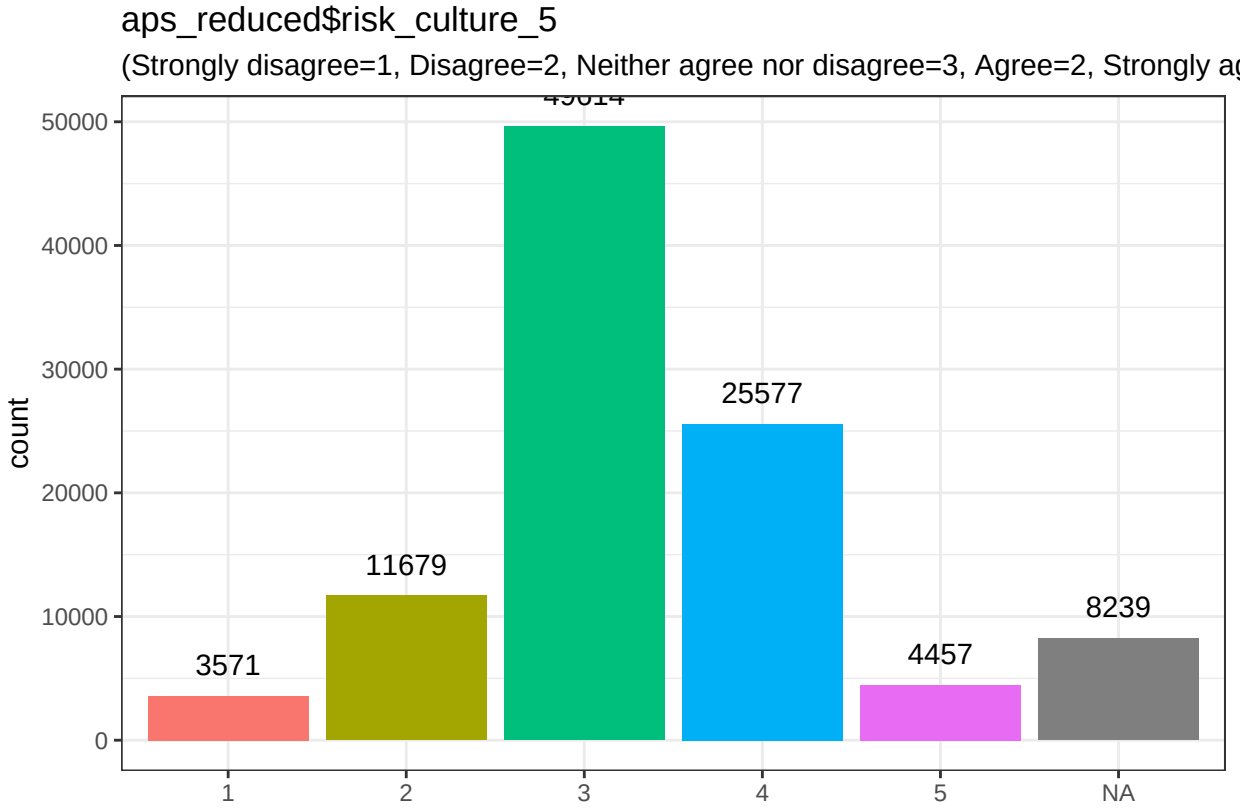

```
aps_reduced$risk_culture_3 <- reformat_variable_group1(aps_reduced$risk_culture_3)
generate_barplot(aps_reduced$risk_culture_3)
```



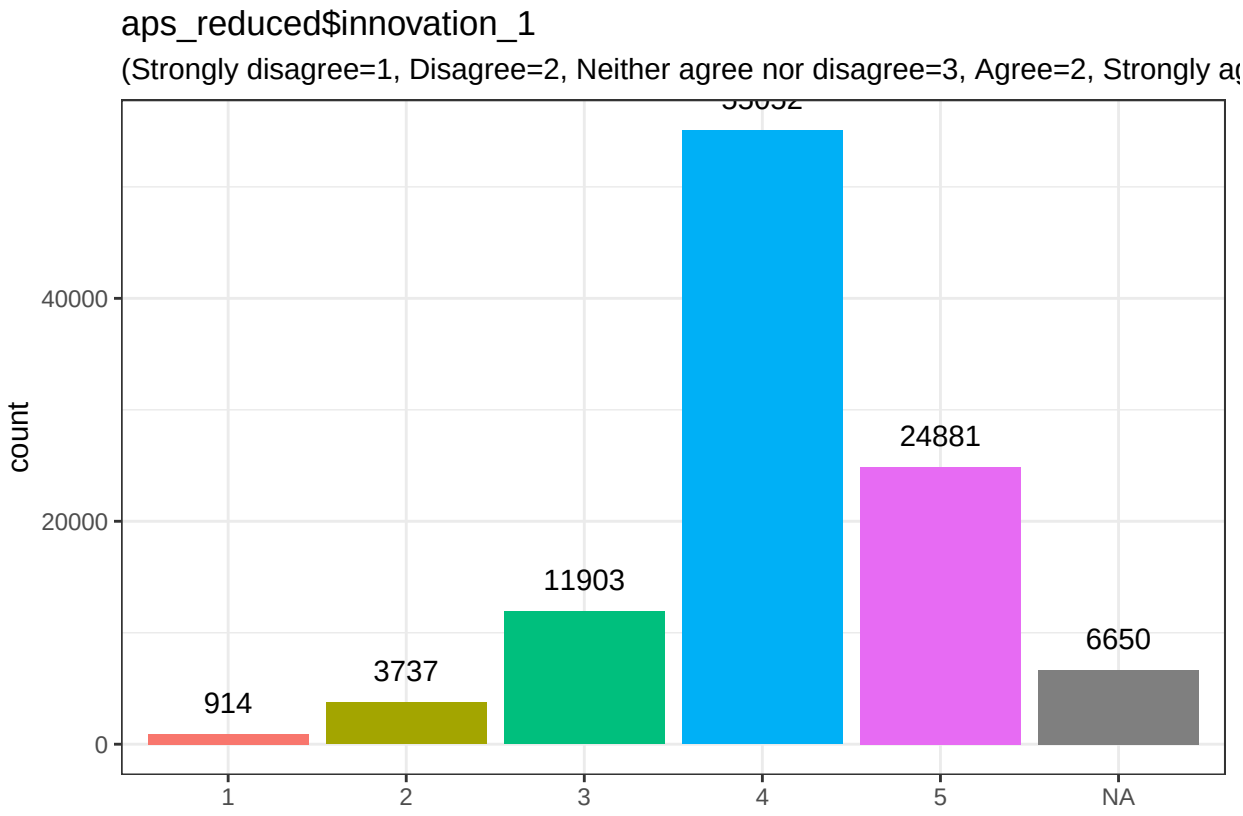

```
aps_reduced$risk_culture_4 <- reformat_variable_group1(aps_reduced$risk_culture_4)
generate_barplot(aps_reduced$risk_culture_4)
```



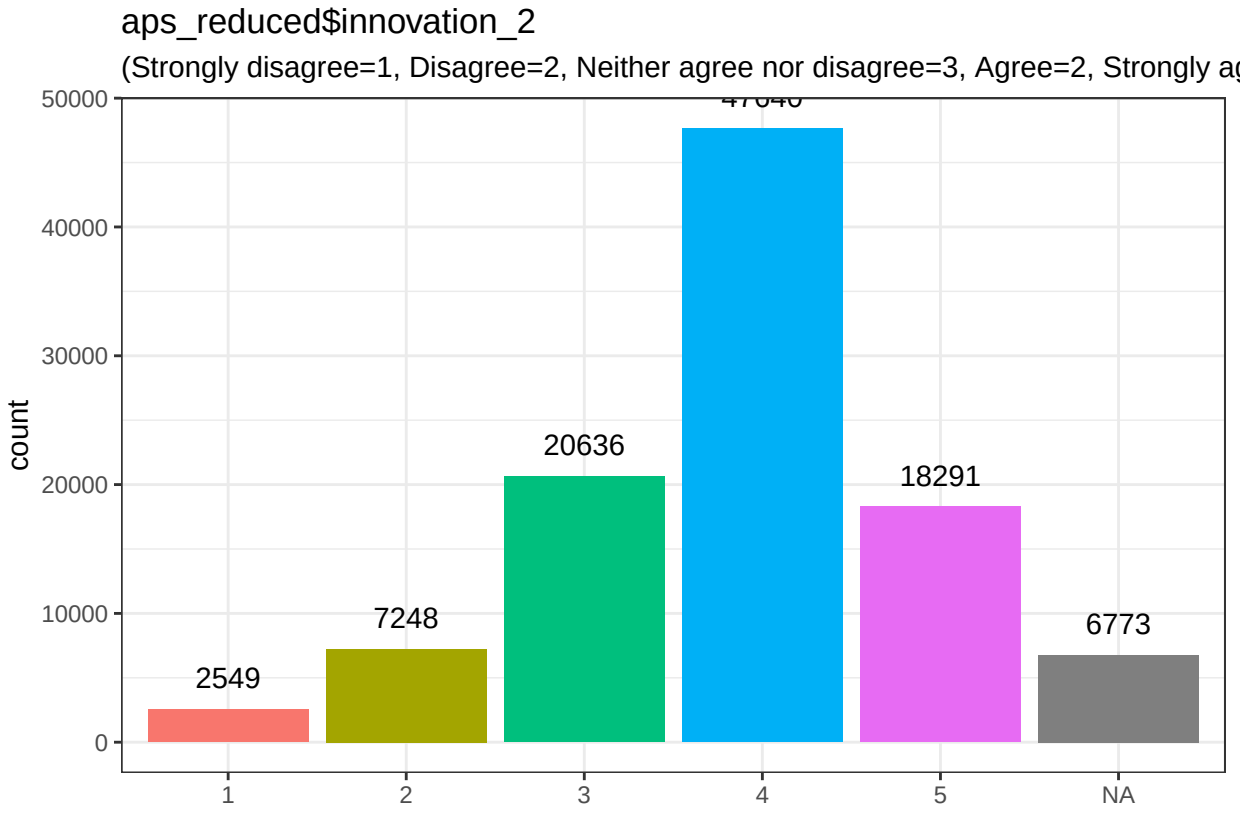

```
aps_reduced$risk_culture_5 <- reformat_variable_group1(aps_reduced$risk_culture_5)
generate_barplot(aps_reduced$risk_culture_5)
```



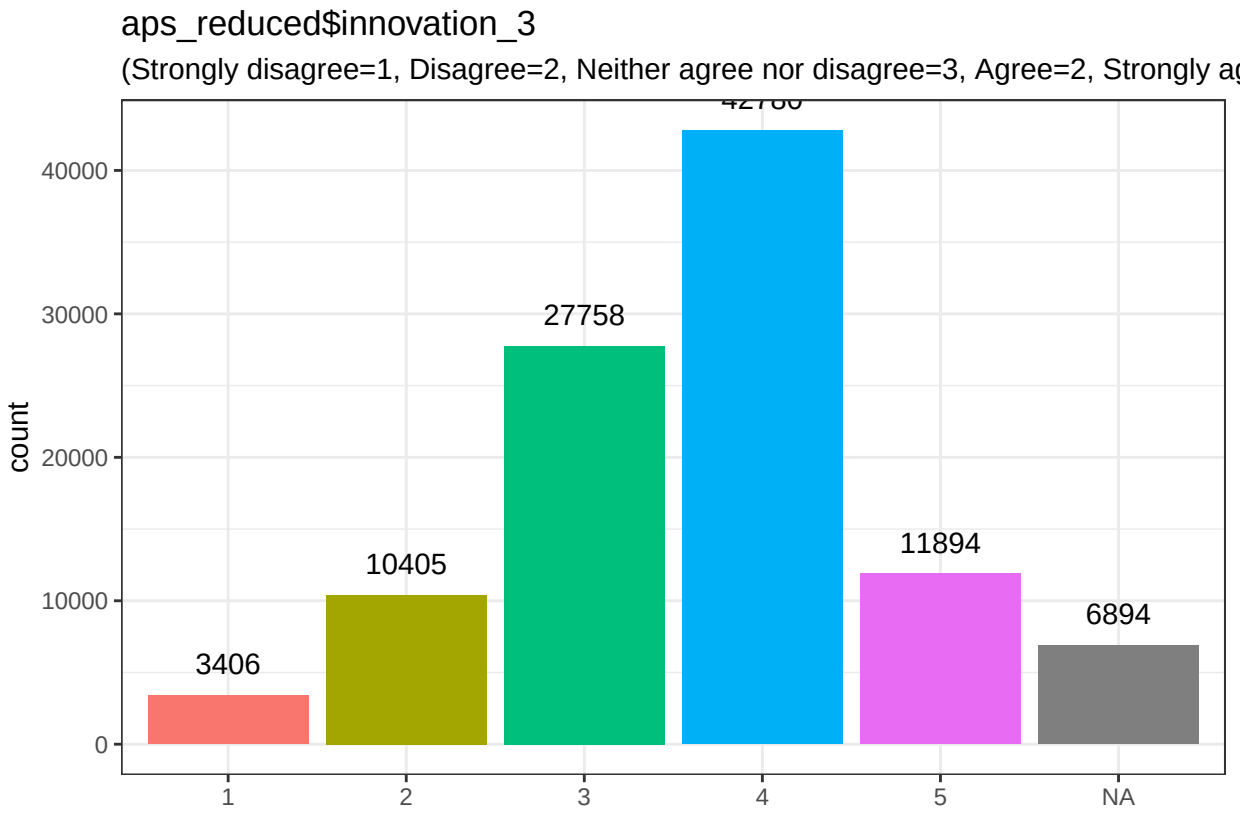

```
# reformatting innovation

aps_reduced$innovation_1 <- reformat_variable_group1(aps_reduced$innovation_1)
generate_barplot(aps_reduced$innovation_1)
```



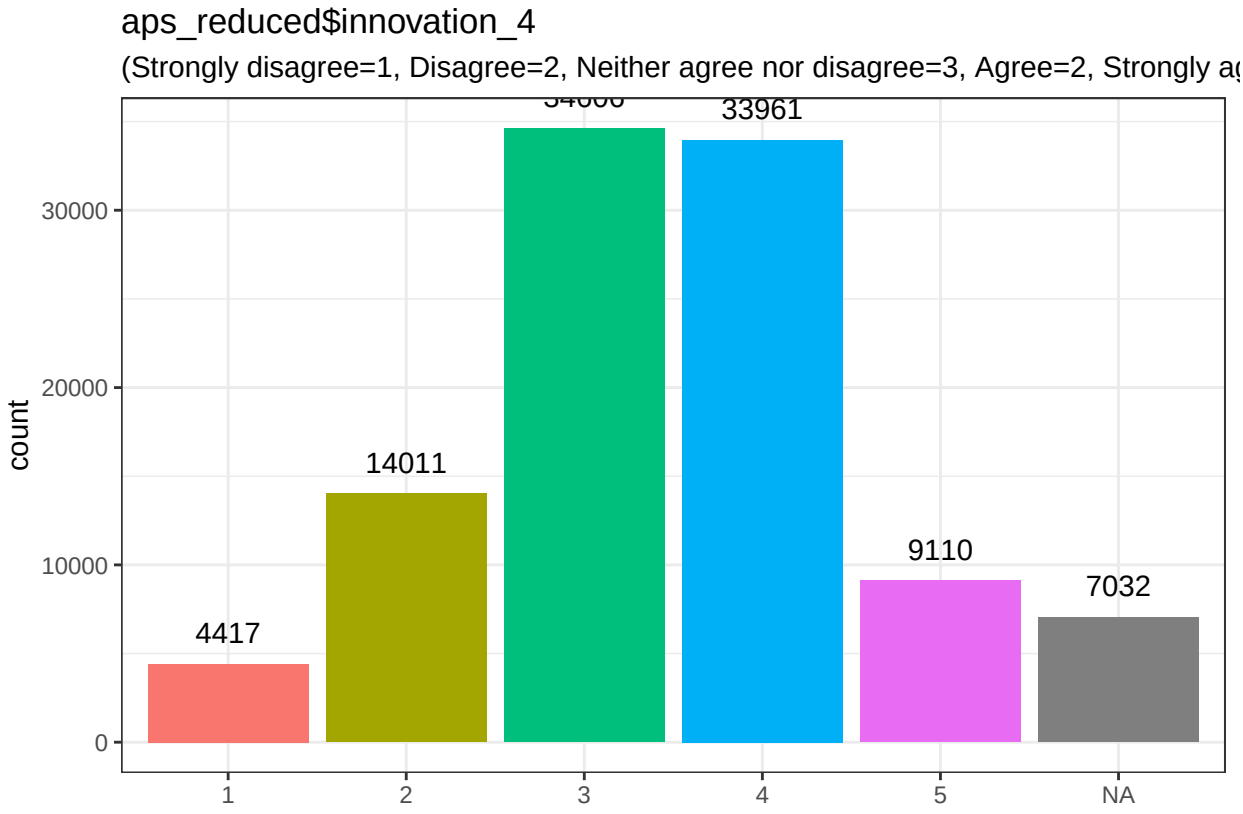

```
aps_reduced$innovation_2 <- reformat_variable_group1(aps_reduced$innovation_2)
generate_barplot(aps_reduced$innovation_2)
```



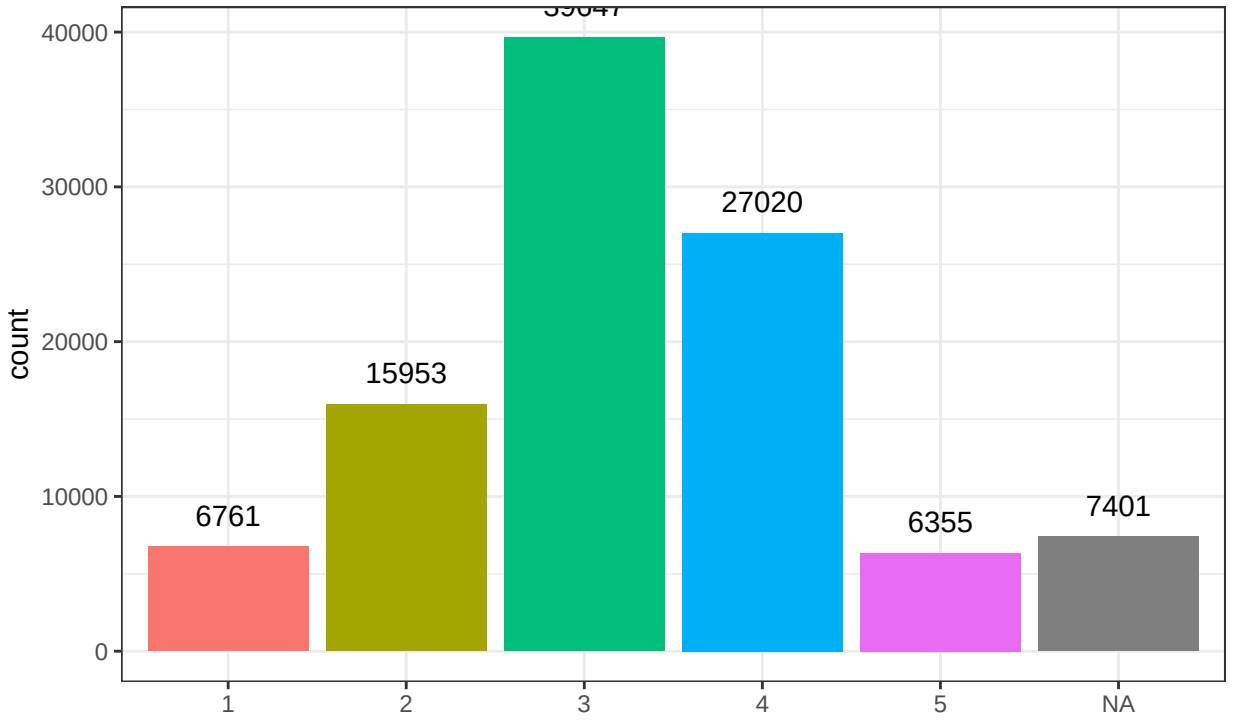

```
aps_reduced$innovation_3 <- reformat_variable_group1(aps_reduced$innovation_3)
generate_barplot(aps_reduced$innovation_3)
```



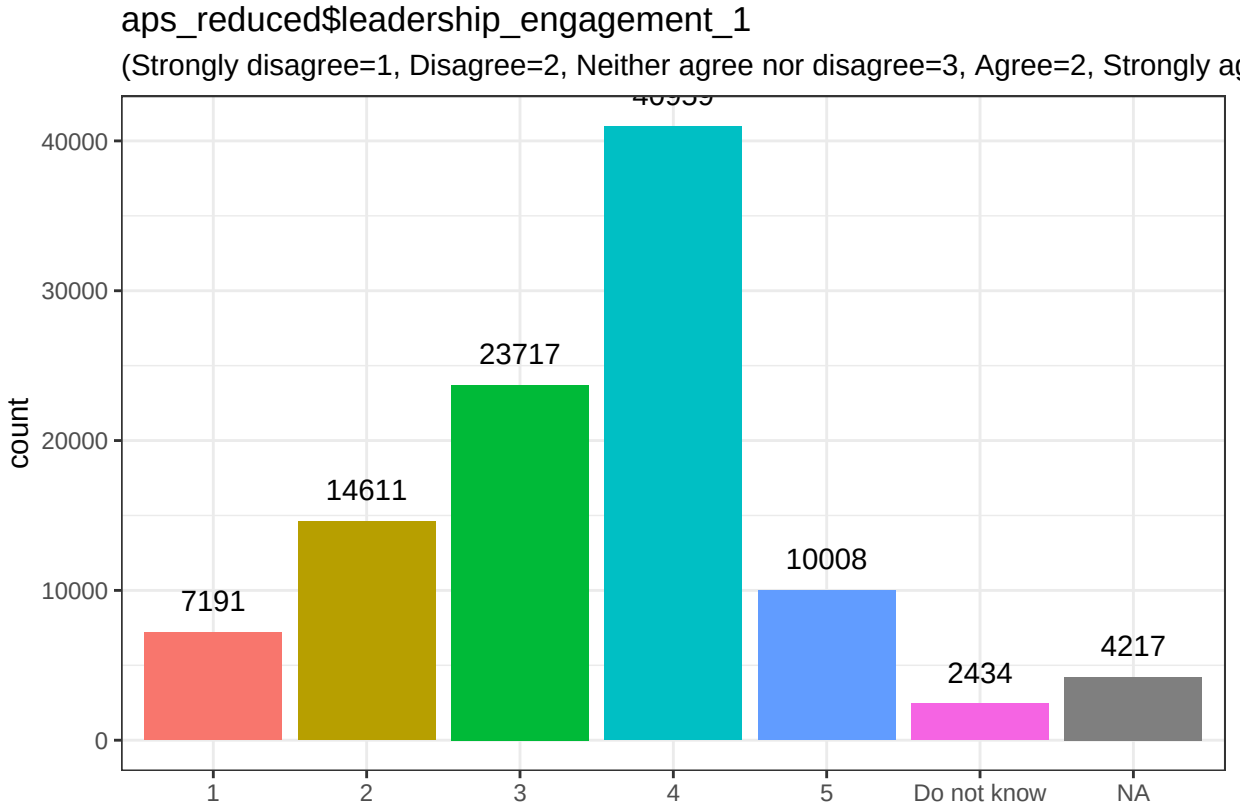

```
aps_reduced$innovation_4 <- reformat_variable_group1(aps_reduced$innovation_4)
generate_barplot(aps_reduced$innovation_4)
```




```
aps_reduced$innovation_5 <- reformat_variable_group1(aps_reduced$innovation_5)
generate_barplot(aps_reduced$innovation_5)
```




```
# leadership engagement reformatting - group2

aps_reduced$leadership_engagement_1 <- reformat_variable_group2(aps_reduced$leadership_engagement_1)
generate_barplot(aps_reduced$leadership_engagement_1)
```




```
# checking that function for reformartting variable worked
str(aps_reduced$leadership_engagement_1)
```

```
##  Factor w/ 6 levels "1","2","3","4",..: 4 3 4 3 4 4 4 4 4 2 ...
```

```
levels(aps_reduced$leadership_engagement_1)
```

```
## [1] "1"           "2"           "3"           "4"           "5"
## [6] "Do not know"
```

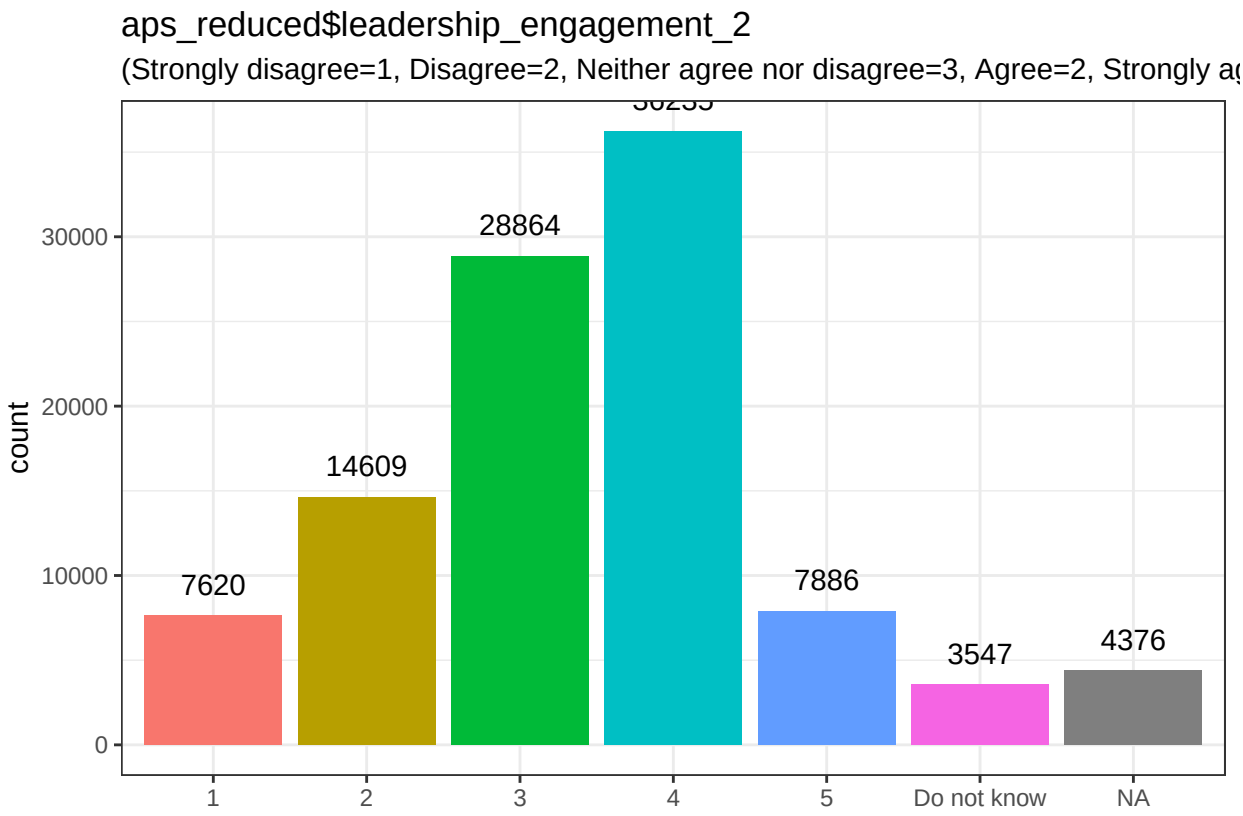
```
summary(aps_reduced$leadership_engagement_1)
```

```
##           1           2           3           4           5 Do not know
##        7191       14611       23717       40959       10008        2434
##        NA's
##        4217
```

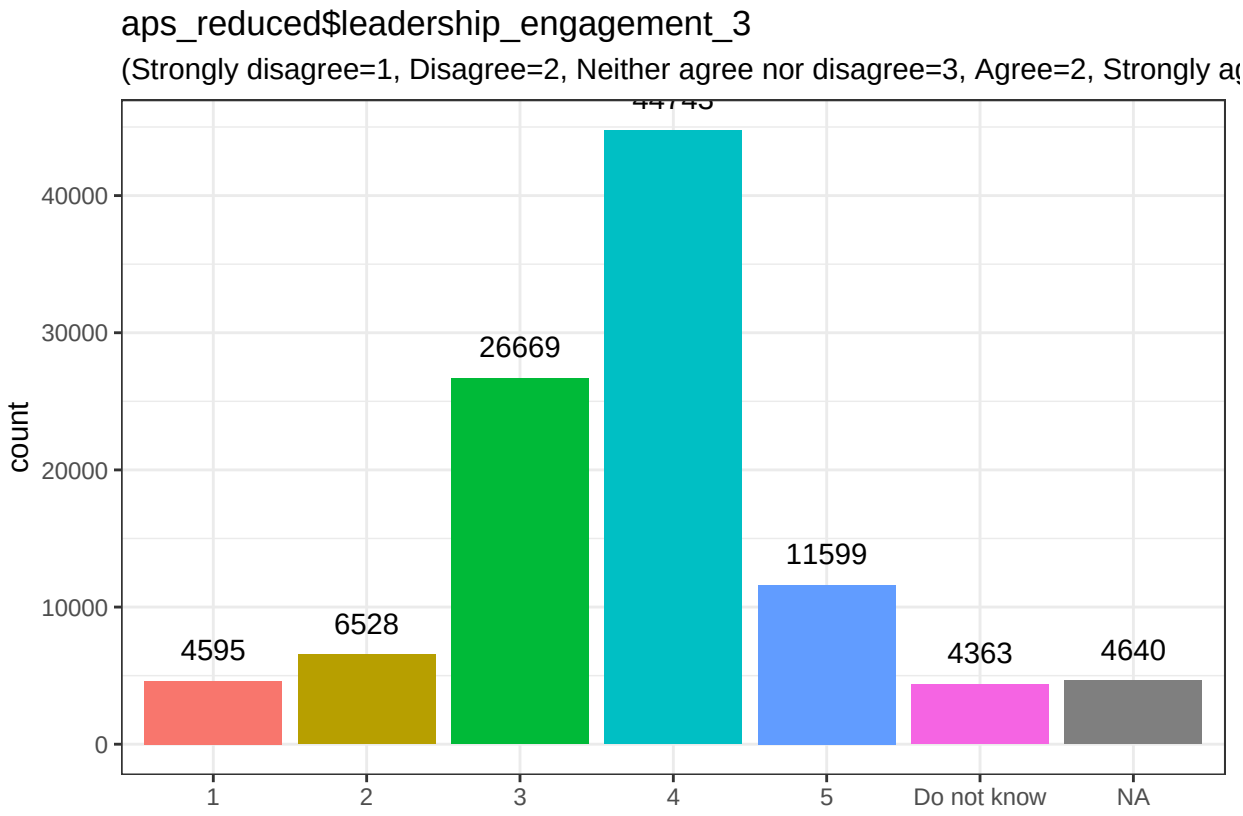
```
sum(is.na(aps_reduced$leadership_engagement_1))
```

```
## [1] 4217
```

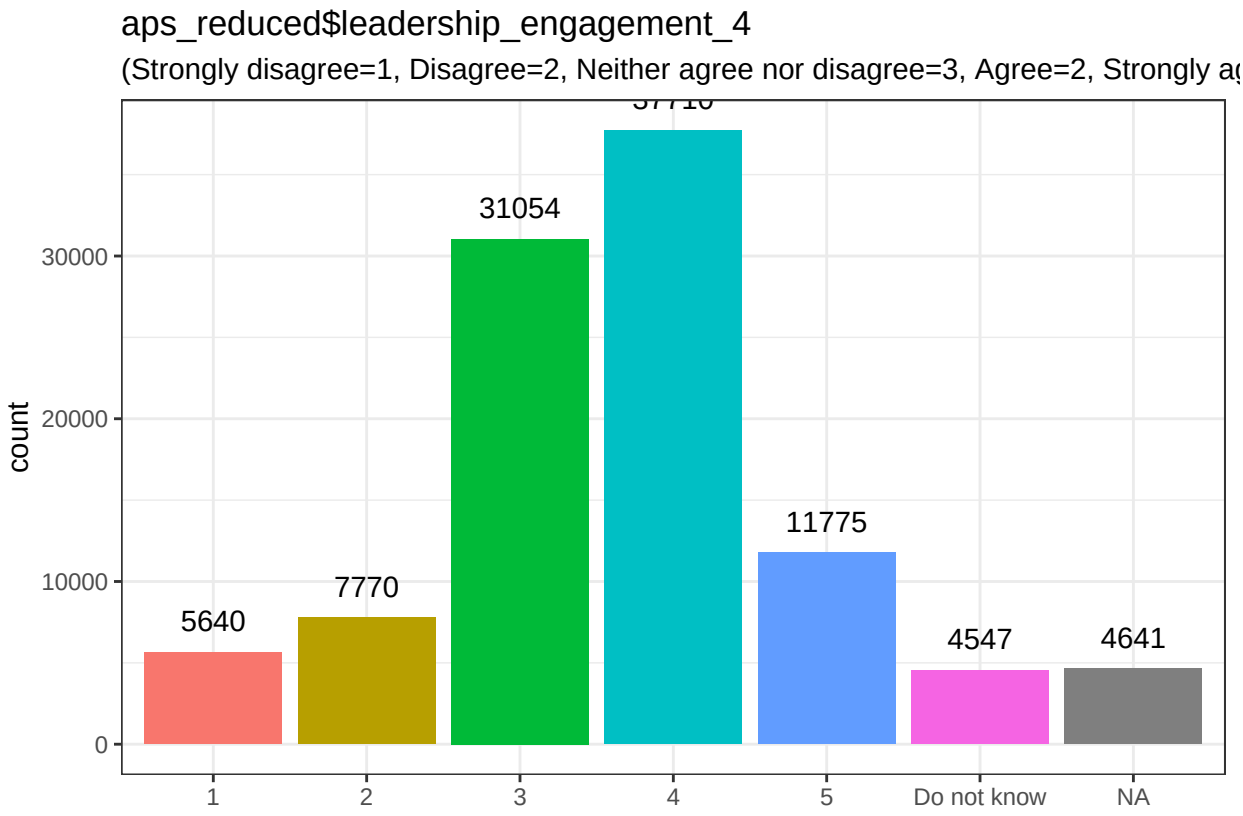
```
aps_reduced$leadership_engagement_2 <- reformat_variable_group2(aps_reduced$leadership_engagement_2)
generate_barplot(aps_reduced$leadership_engagement_2)
```



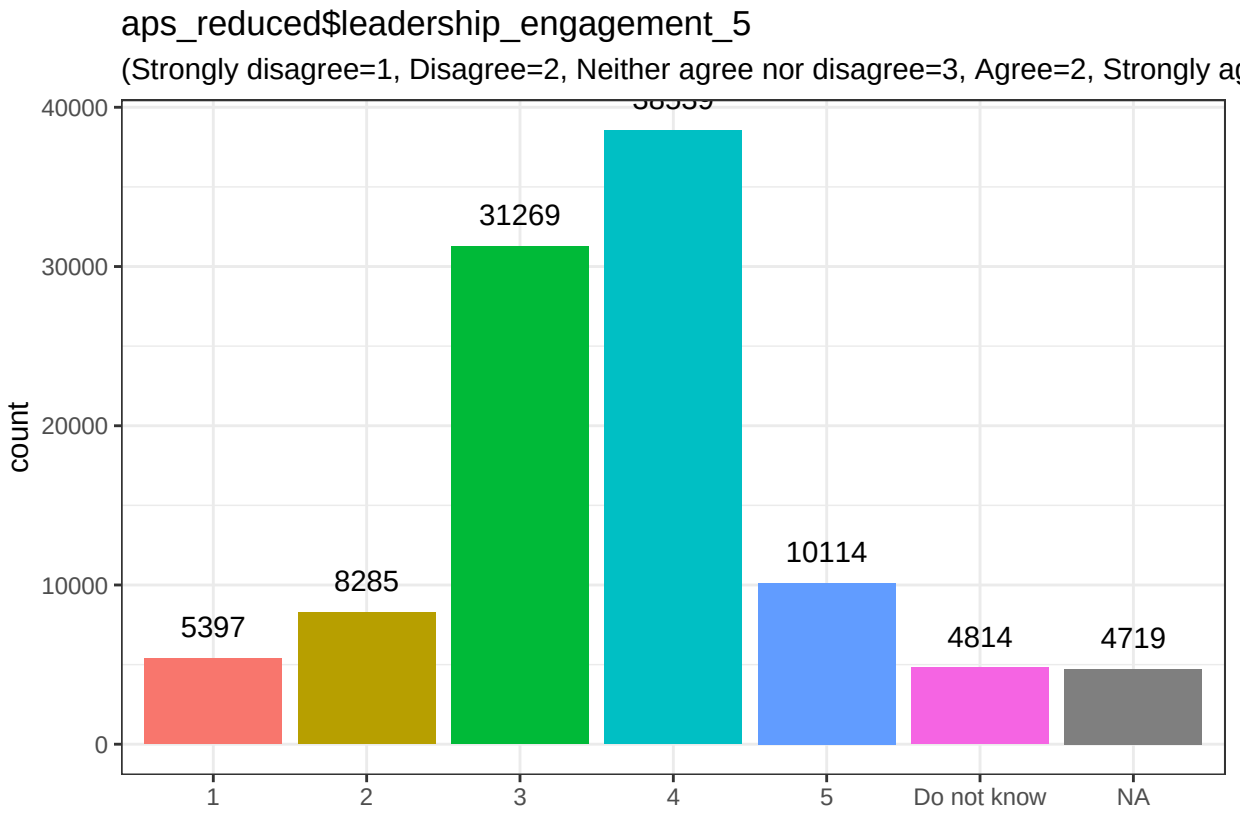

```
aps_reduced$leadership_engagement_3 <- reformat_variable_group2(aps_reduced$leadership_engagement_3)
generate_barplot(aps_reduced$leadership_engagement_3)
```



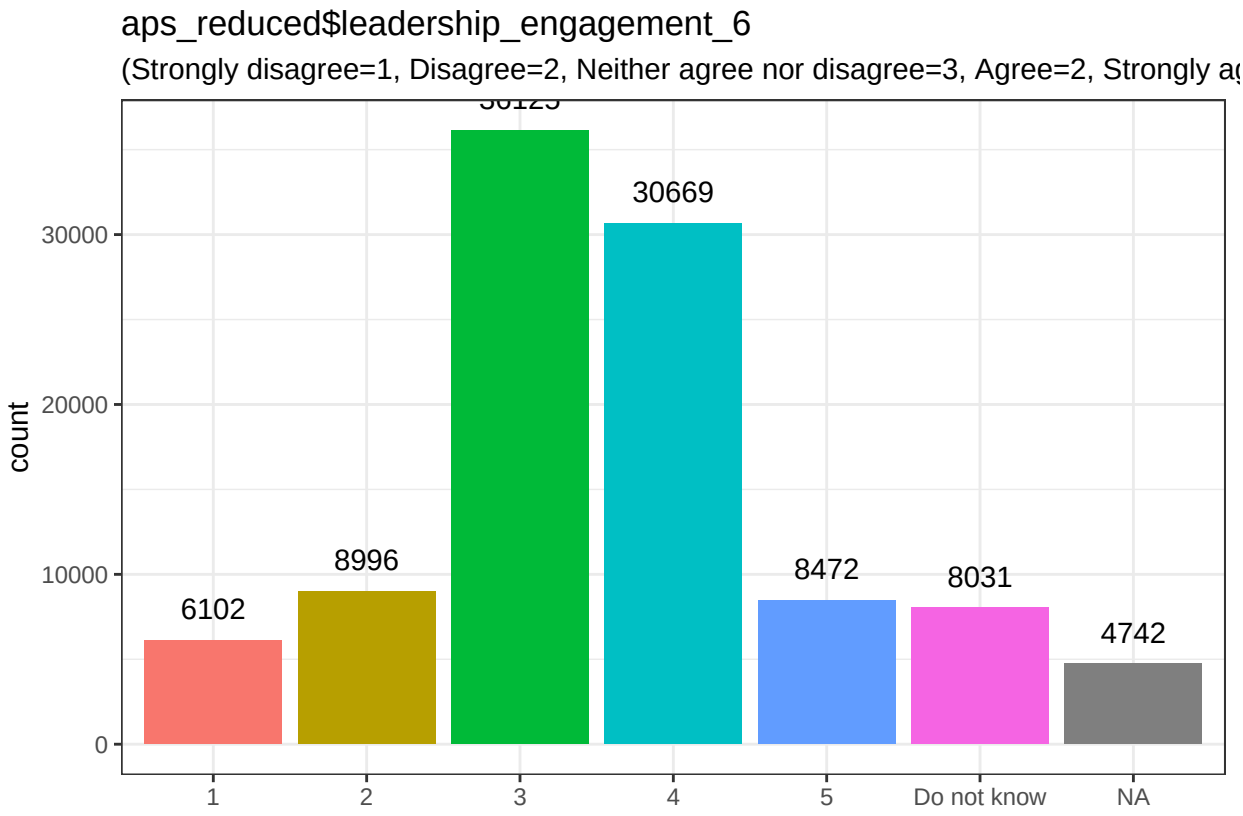

```
aps_reduced$leadership_engagement_4 <- reformat_variable_group2(aps_reduced$leadership_engagement_4)
generate_barplot(aps_reduced$leadership_engagement_4)
```



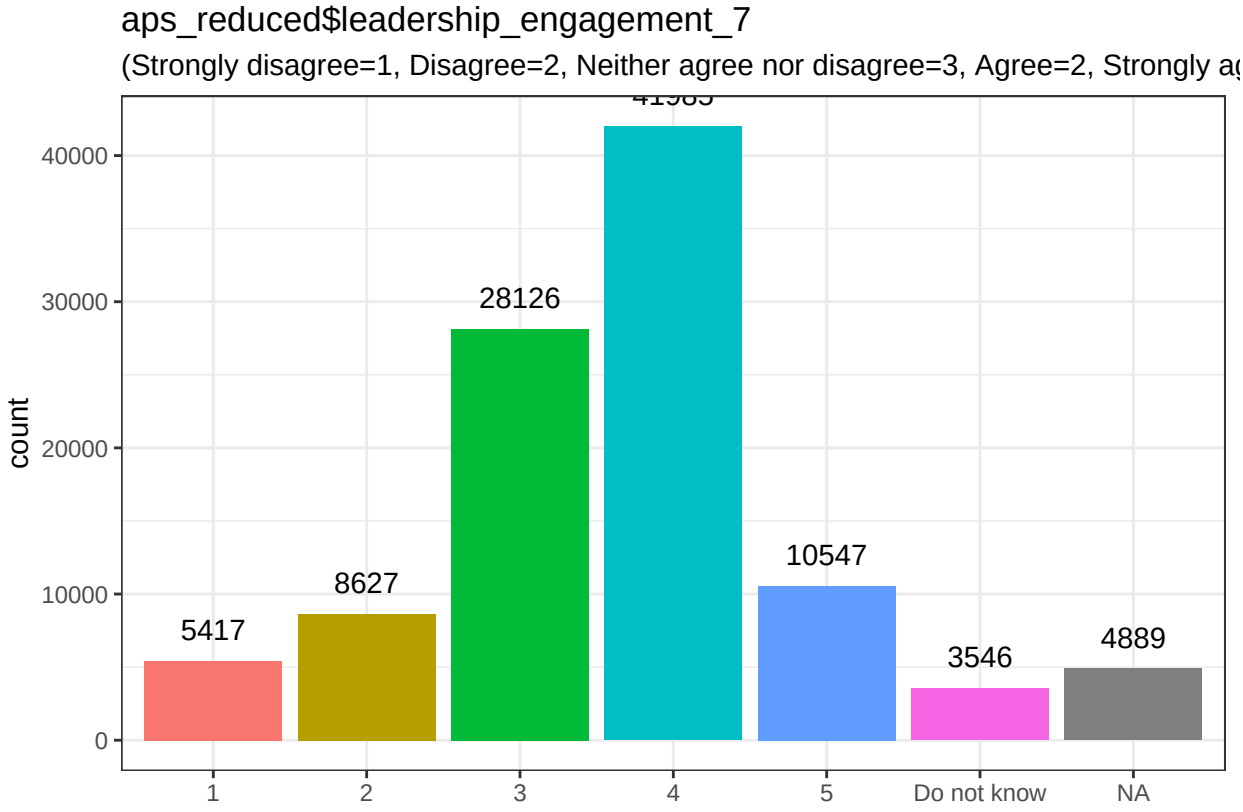

```
aps_reduced$leadership_engagement_5 <- reformat_variable_group2(aps_reduced$leadership_engagement_5)
generate_barplot(aps_reduced$leadership_engagement_5)
```



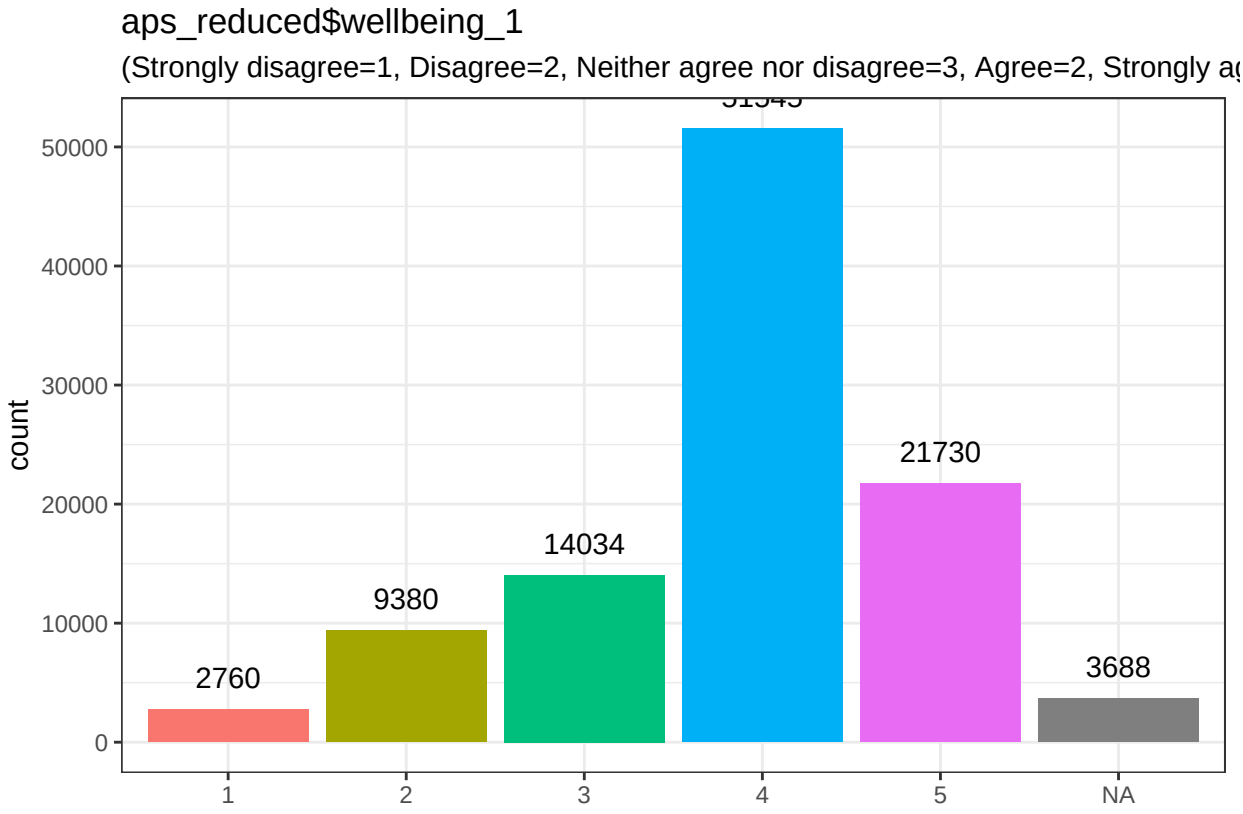

```
aps_reduced$leadership_engagement_6 <- reformat_variable_group2(aps_reduced$leadership_engagement_6)
generate_barplot(aps_reduced$leadership_engagement_6)
```




```
aps_reduced$leadership_engagement_7 <- reformat_variable_group2(aps_reduced$leadership_engagement_7)
generate_barplot(aps_reduced$leadership_engagement_7)
```




```
# wellbeing_1 reformatting - group3

aps_reduced$wellbeing_1 <- reformat_variable_group3(aps_reduced$wellbeing_1)
generate_barplot(aps_reduced$wellbeing_1)
```




```
# checking that function for reformartting variable worked
str(aps_reduced$wellbeing_1)
```

```
##  Factor w/ 5 levels "1","2","3","4",..: 4 5 5 4 4 5 4 3 5 2 ...
```

```
levels(aps_reduced$wellbeing_1)
```

```
## [1] "1" "2" "3" "4" "5"
```

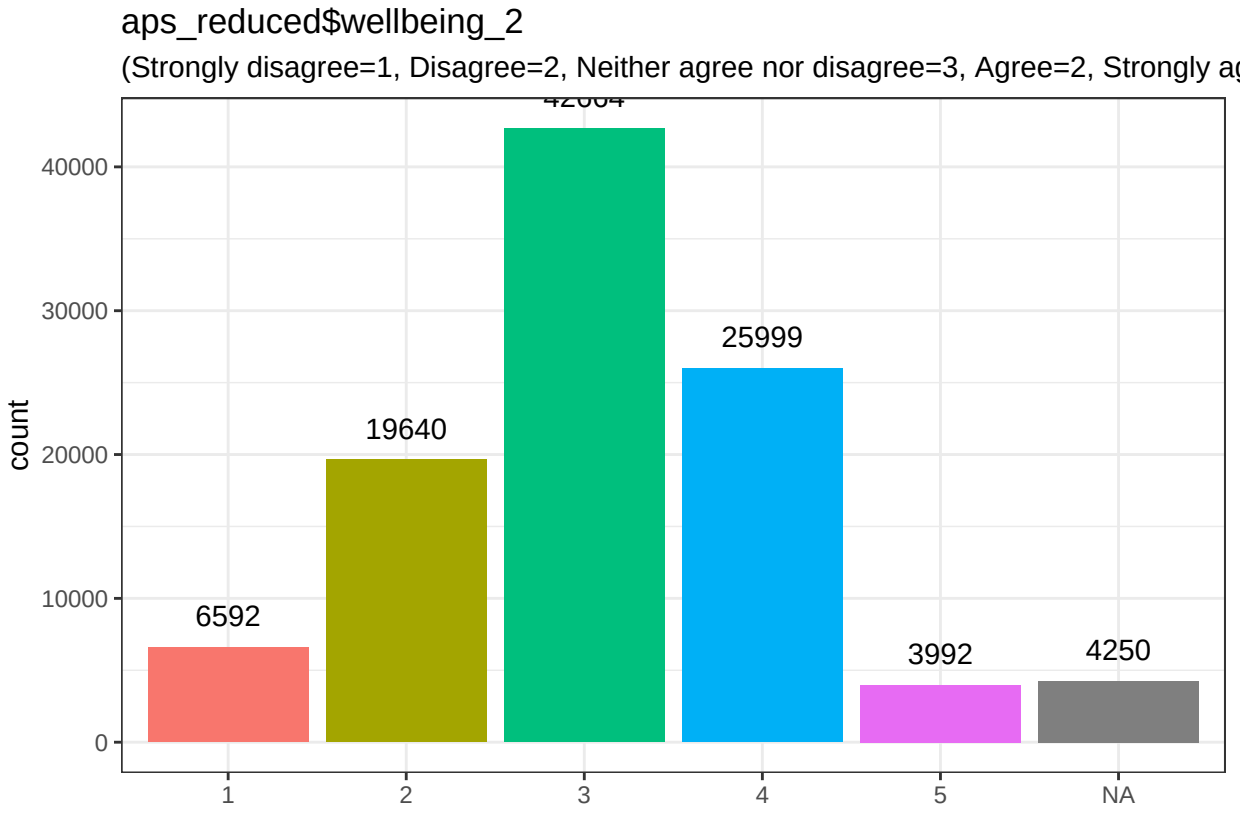
```
summary(aps_reduced$wellbeing_1)
```

```
##     1     2     3     4     5  NA's
##  2760  9380 14034 51545 21730  3688
```

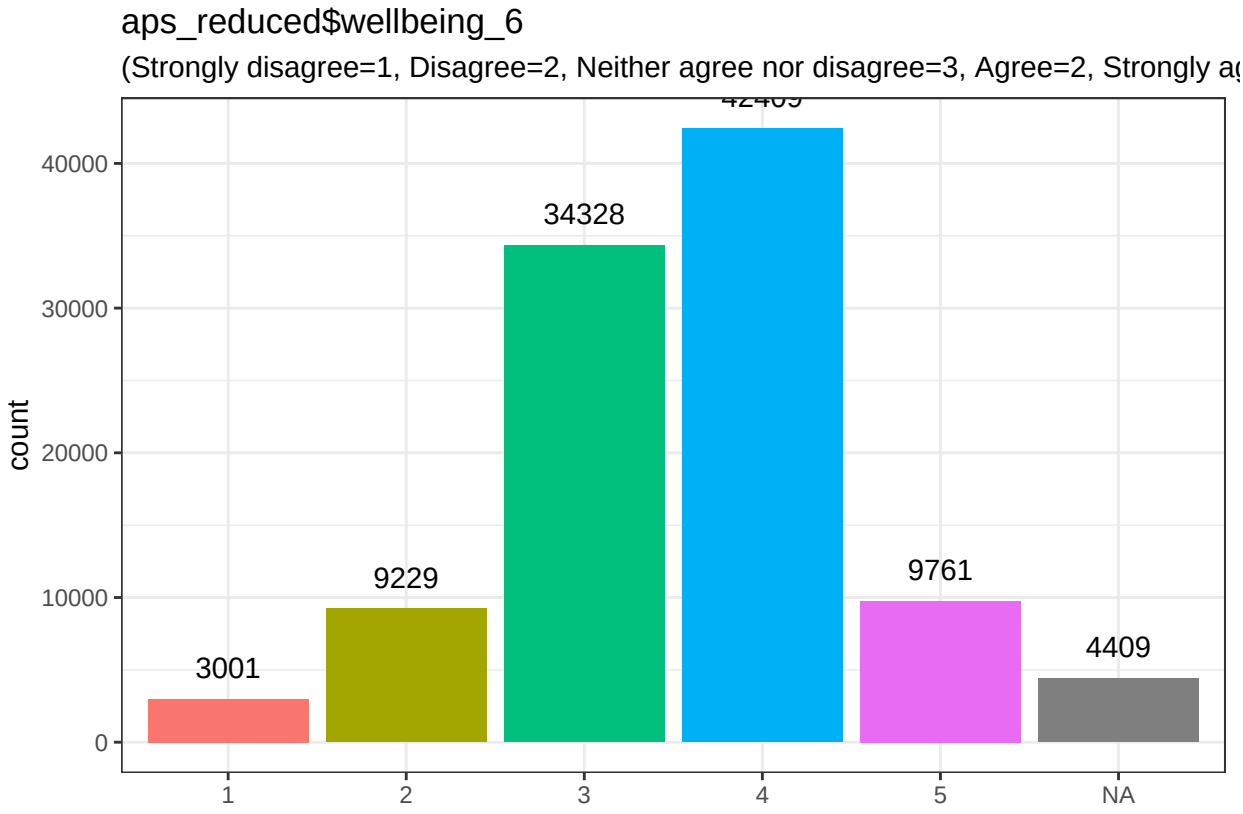
```
sum(is.na(aps_reduced$wellbeing_1))
```

```
## [1] 3688
```

```
# wellbeing_2 and wellbeing_6 reformatting - group4

aps_reduced$wellbeing_2 <- reformat_variable_group4(aps_reduced$wellbeing_2)
generate_barplot(aps_reduced$wellbeing_2)
```




```
aps_reduced$wellbeing_6 <- reformat_variable_group4(aps_reduced$wellbeing_6)
generate_barplot(aps_reduced$wellbeing_6)
```




```
# checking that function for reformartting variable worked
str(aps_reduced$wellbeing_2)
```

```
##  Factor w/ 5 levels "1","2","3","4",..: 4 4 3 4 3 4 2 3 4 1 ...
```

```
levels(aps_reduced$wellbeing_2)
```

```
## [1] "1" "2" "3" "4" "5"
```

```
summary(aps_reduced$wellbeing_2)
```

```
##     1     2     3     4     5  NA's
##  6592 19640 42664 25999  3992  4250
```

```
sum(is.na(aps_reduced$wellbeing_2))
```

```
## [1] 4250
```

```
str(aps_reduced$wellbeing_6)
```

```
##  Factor w/ 5 levels "1","2","3","4",..: 4 3 4 4 4 4 3 2 4 3 ...
```

```r
levels(aps_reduced$wellbeing_6)
```

```
## [1] "1" "2" "3" "4" "5"
```

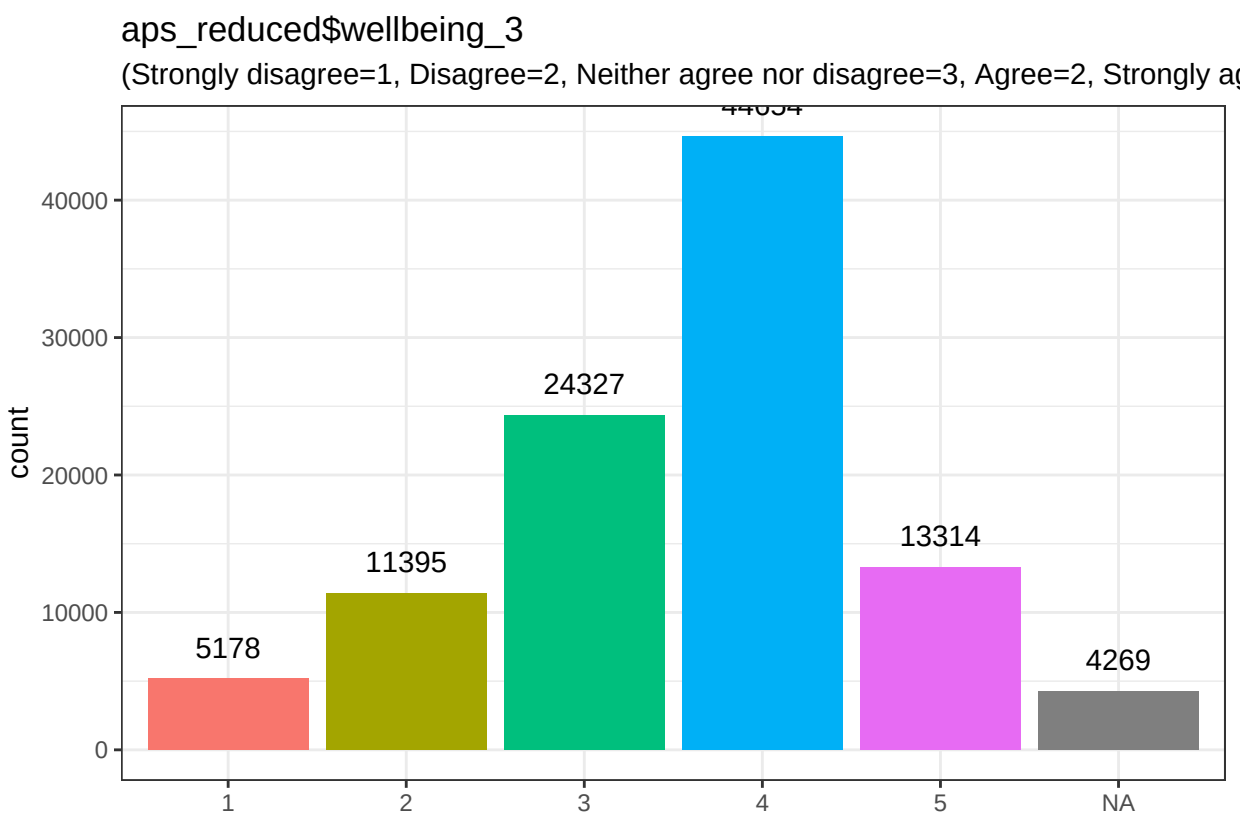
```r
summary(aps_reduced$wellbeing_6)
```

```
##     1     2     3     4     5  NA's
##  3001  9229 34328 42409  9761  4409
```

```r
sum(is.na(aps_reduced$wellbeing_6))
```

```
## [1] 4409
```

```r
# wellbeing_3, wellbeing_4, wellbeing_=5, wellbeing_7, wellbeing_8 reformating - group5

aps_reduced$wellbeing_3 <- reformat_variable_group5(aps_reduced$wellbeing_3)
generate_barplot(aps_reduced$wellbeing_3)
```




```r
str(aps_reduced$wellbeing_3)
```

```
##  Factor w/ 5 levels "1","2","3","4",..: 4 4 5 5 4 5 3 1 4 4 ...
```

```r
levels(aps_reduced$wellbeing_3)
```

```
## [1] "1" "2" "3" "4" "5"
```

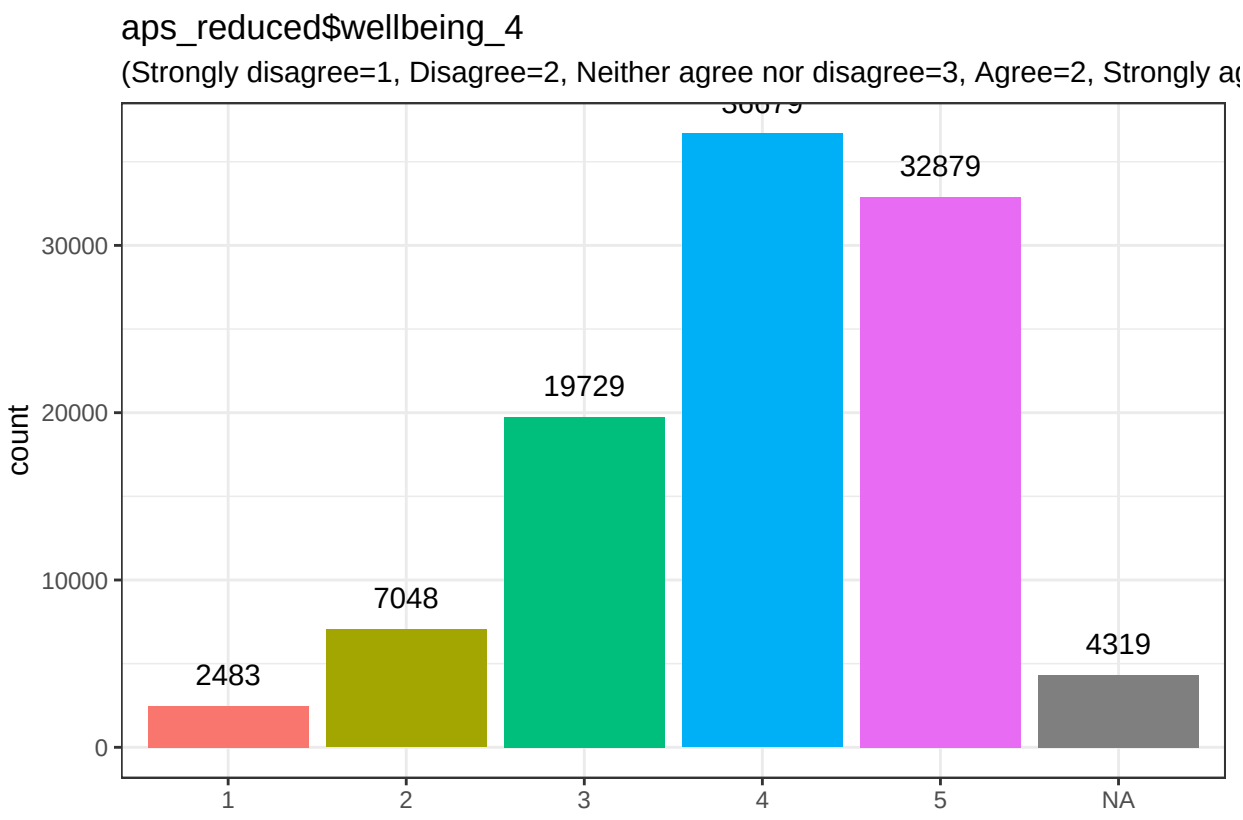
```r
summary(aps_reduced$wellbeing_3)
```

```
##     1     2     3     4     5  NA's
##  5178 11395 24327 44654 13314  4269
```

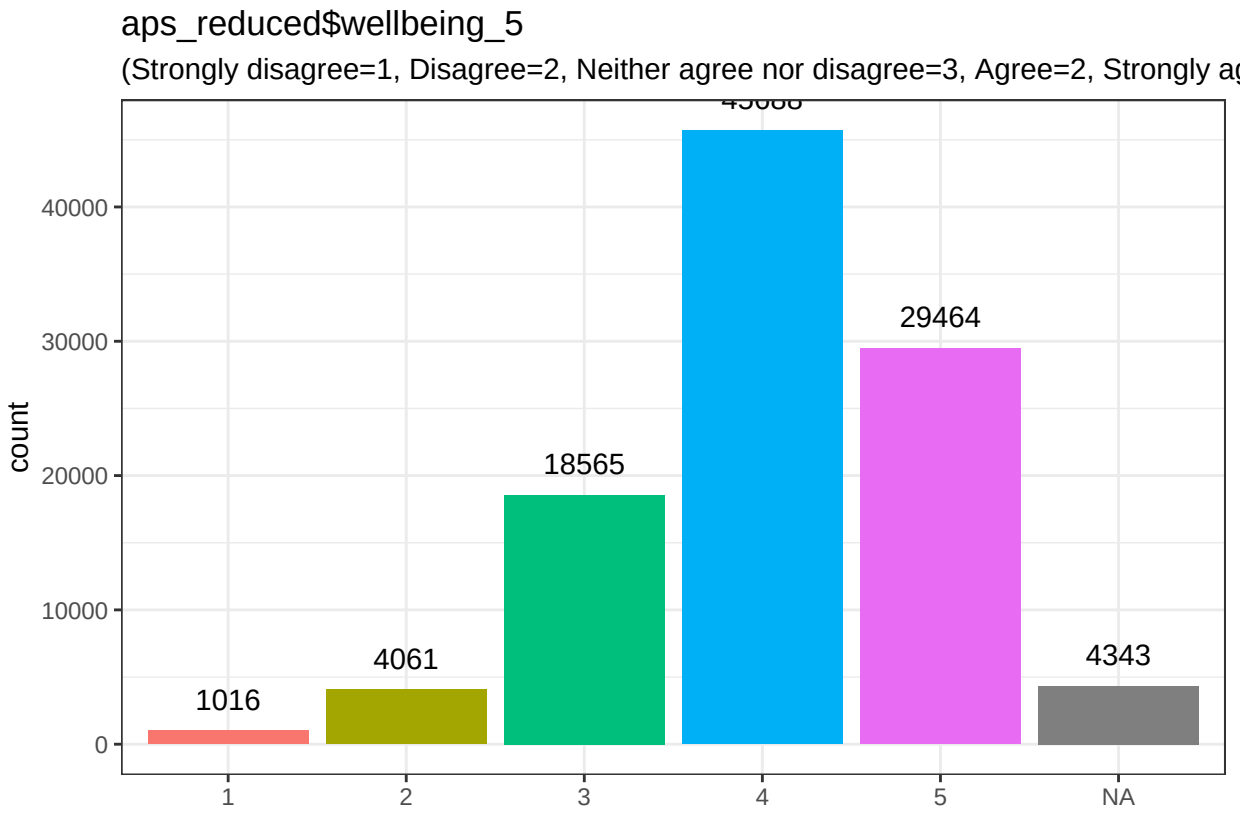
```r
sum(is.na(aps_reduced$wellbeing_3))
```

```
## [1] 4269
```

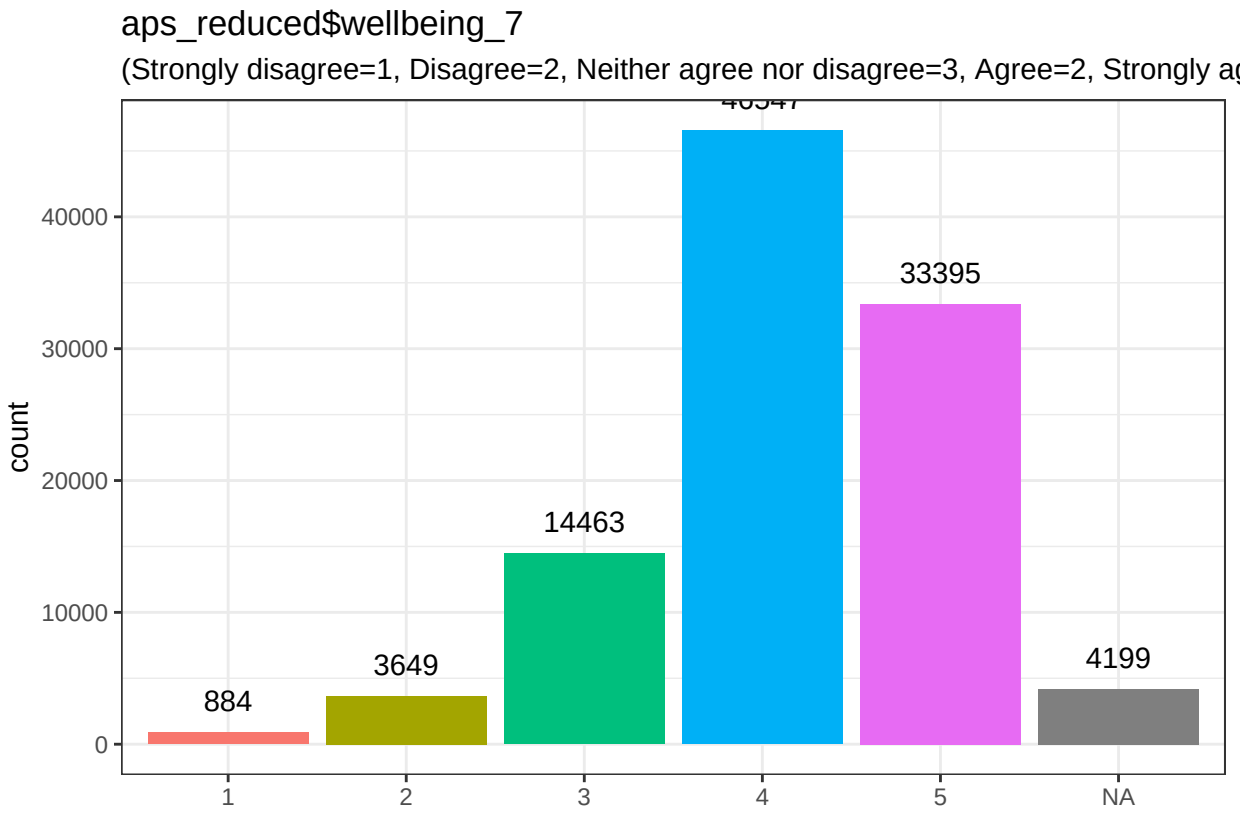
```r
aps_reduced$wellbeing_4 <- reformat_variable_group5(aps_reduced$wellbeing_4)
generate_barplot(aps_reduced$wellbeing_4)
```



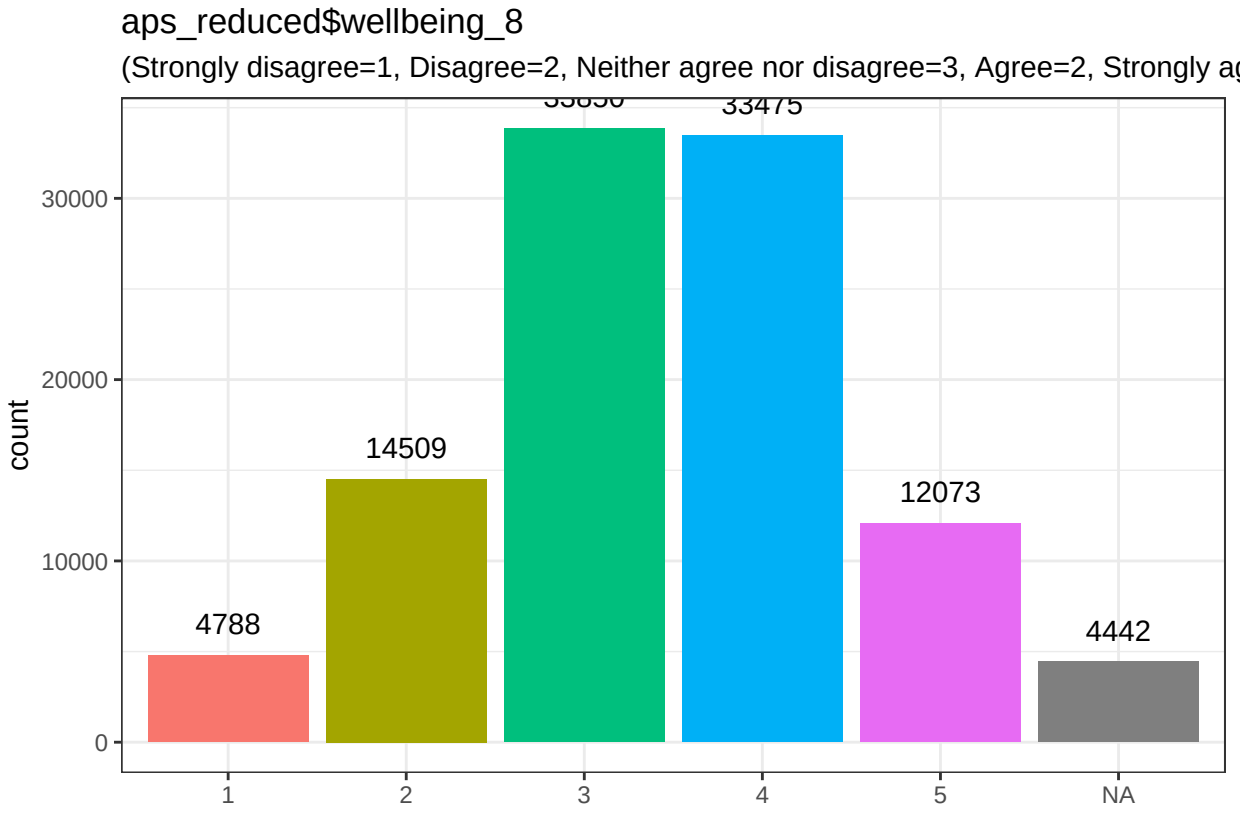

```r
aps_reduced$wellbeing_5 <- reformat_variable_group5(aps_reduced$wellbeing_5)
generate_barplot(aps_reduced$wellbeing_5)
```



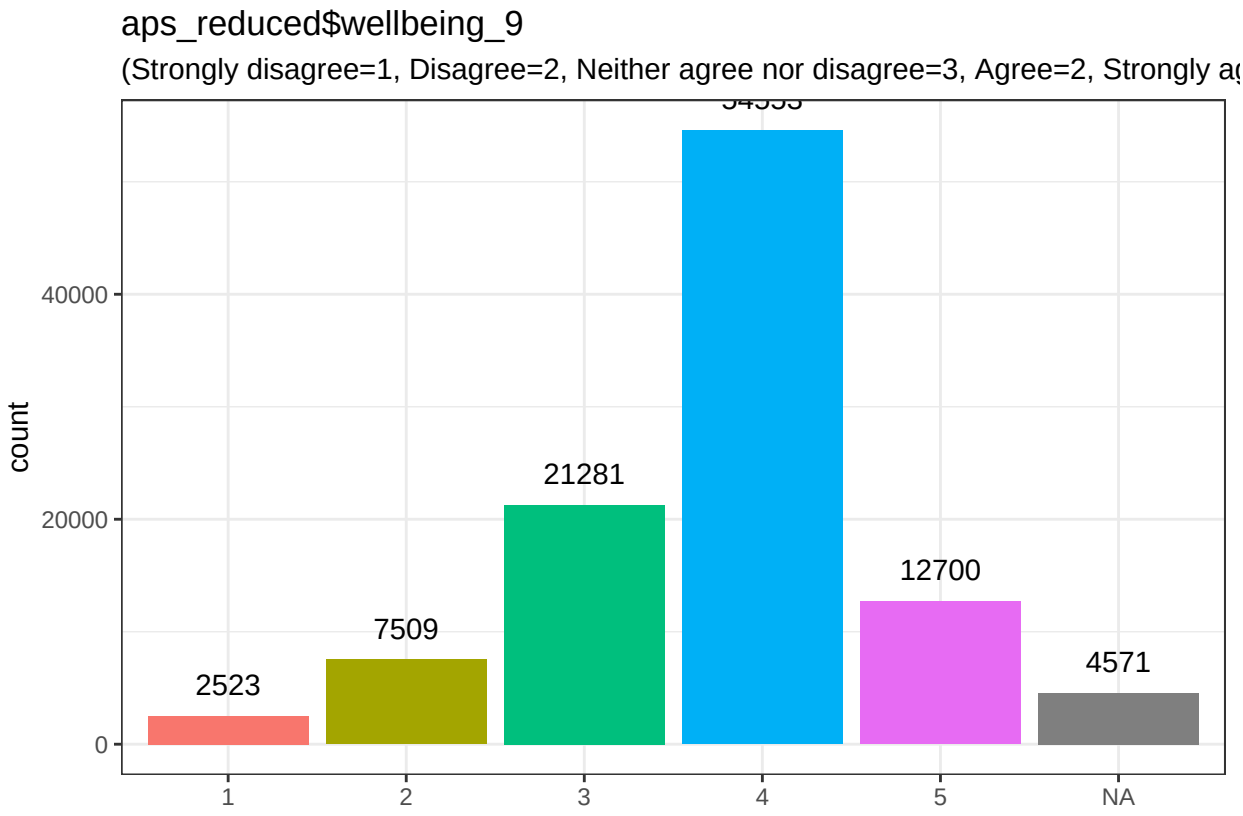

```
aps_reduced$wellbeing_7 <- reformat_variable_group5(aps_reduced$wellbeing_7)
generate_barplot(aps_reduced$wellbeing_7)
```



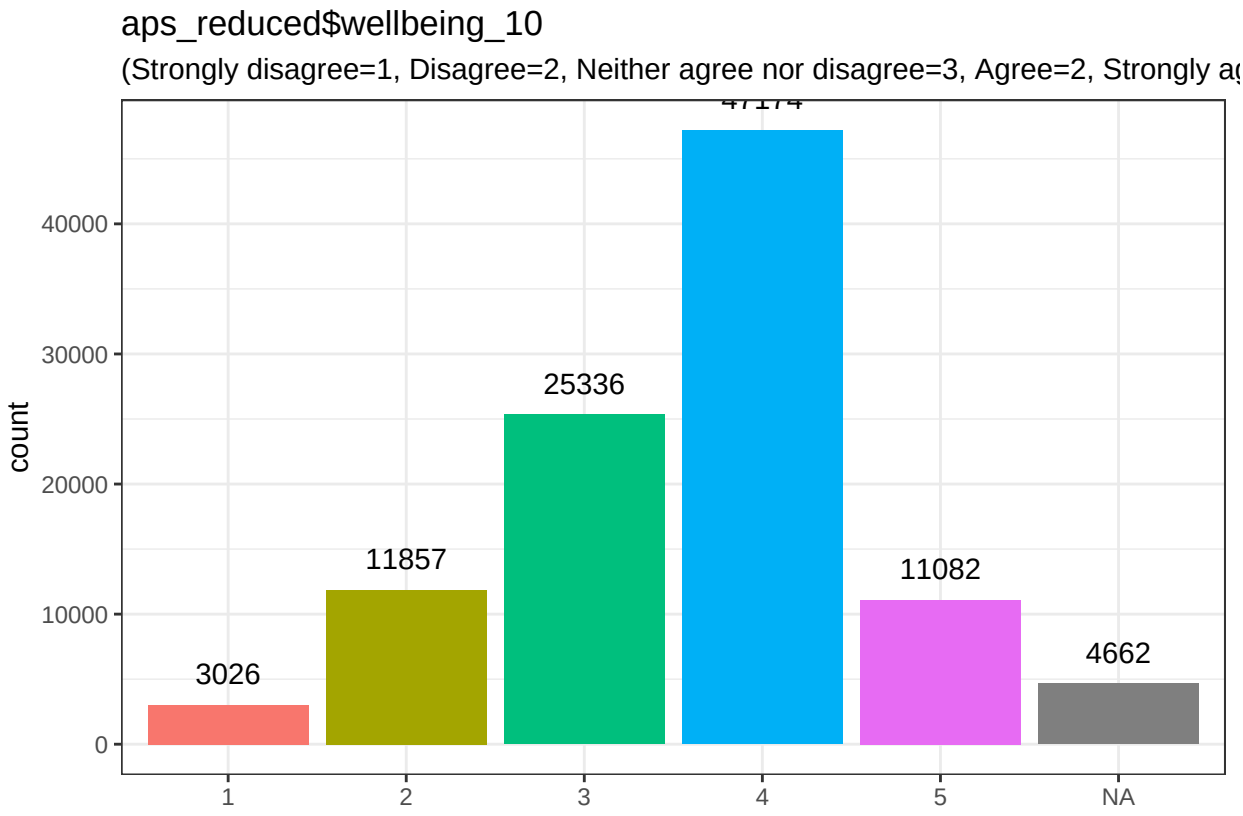

```
aps_reduced$wellbeing_8 <- reformat_variable_group5(aps_reduced$wellbeing_8)
generate_barplot(aps_reduced$wellbeing_8)
```



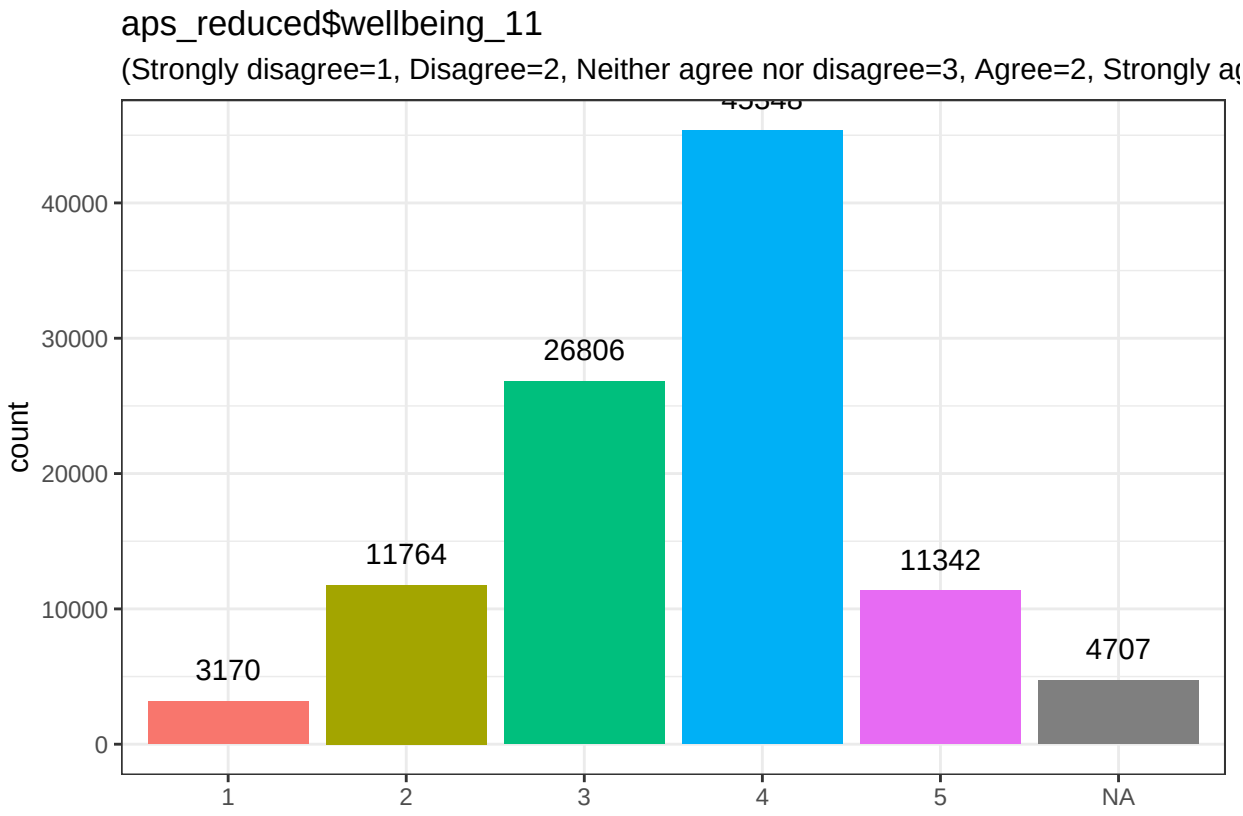

```
# wellbeing_9,  wellbeing_10, wellbeing_11, wellbeing_12, wellbeing_13 reformatting - group1

aps_reduced$wellbeing_9 <- reformat_variable_group1(aps_reduced$wellbeing_9)
generate_barplot(aps_reduced$wellbeing_9)
```



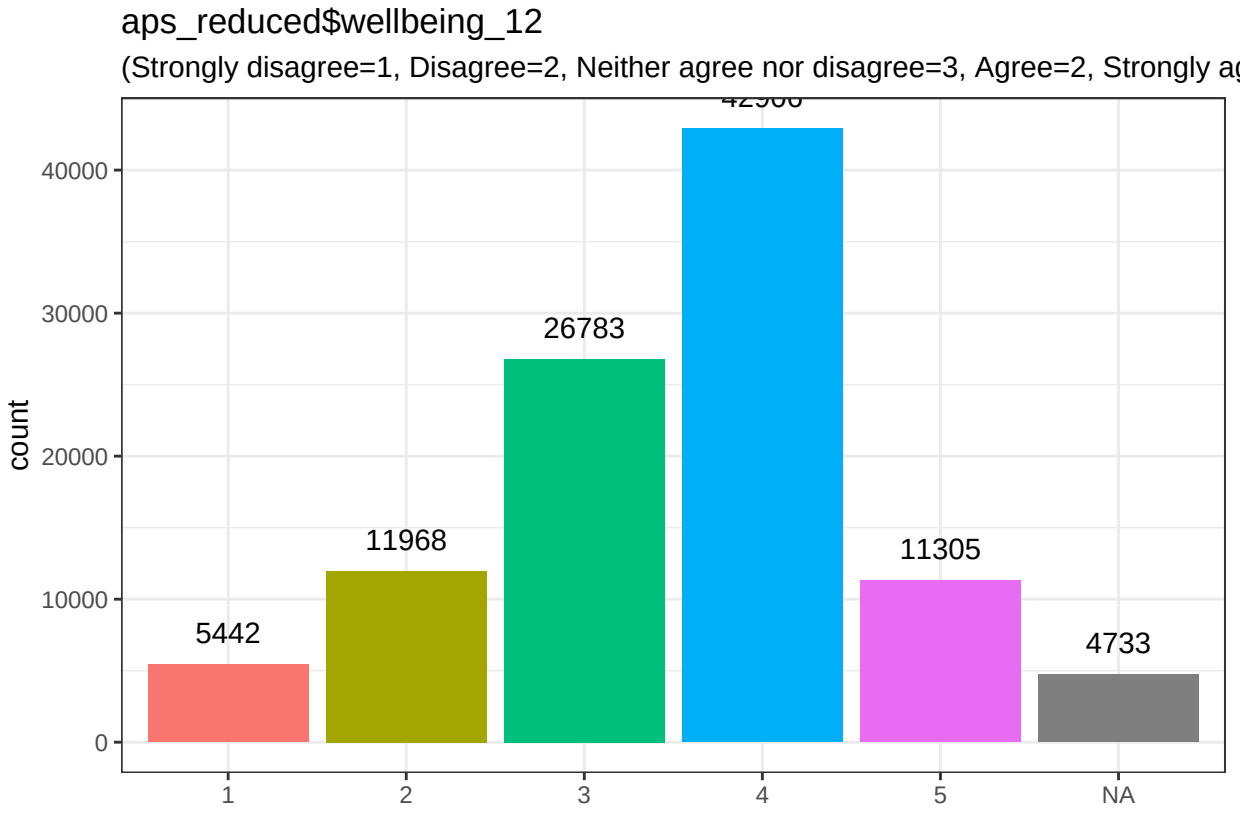

```
aps_reduced$wellbeing_10 <- reformat_variable_group1(aps_reduced$wellbeing_10)
generate_barplot(aps_reduced$wellbeing_10)
```



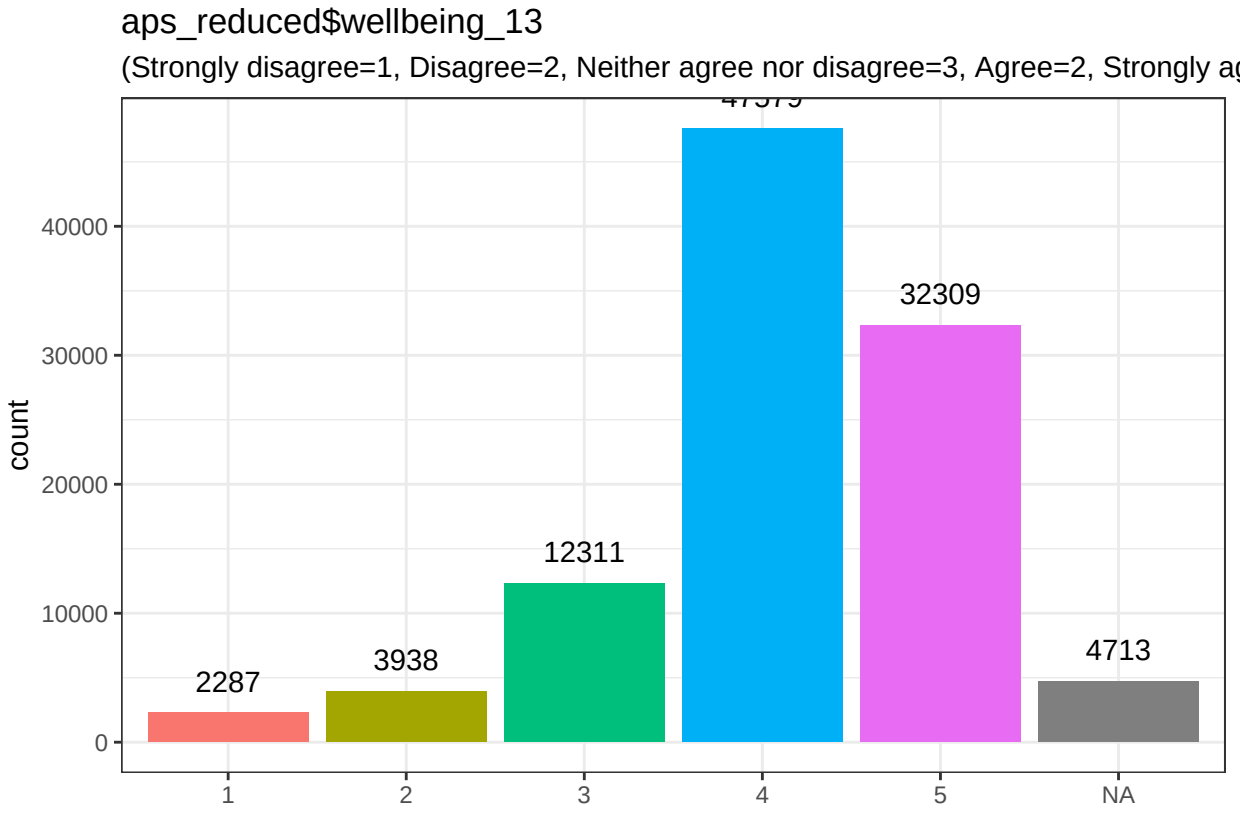

```
aps_reduced$wellbeing_11 <- reformat_variable_group1(aps_reduced$wellbeing_11)
generate_barplot(aps_reduced$wellbeing_11)
```



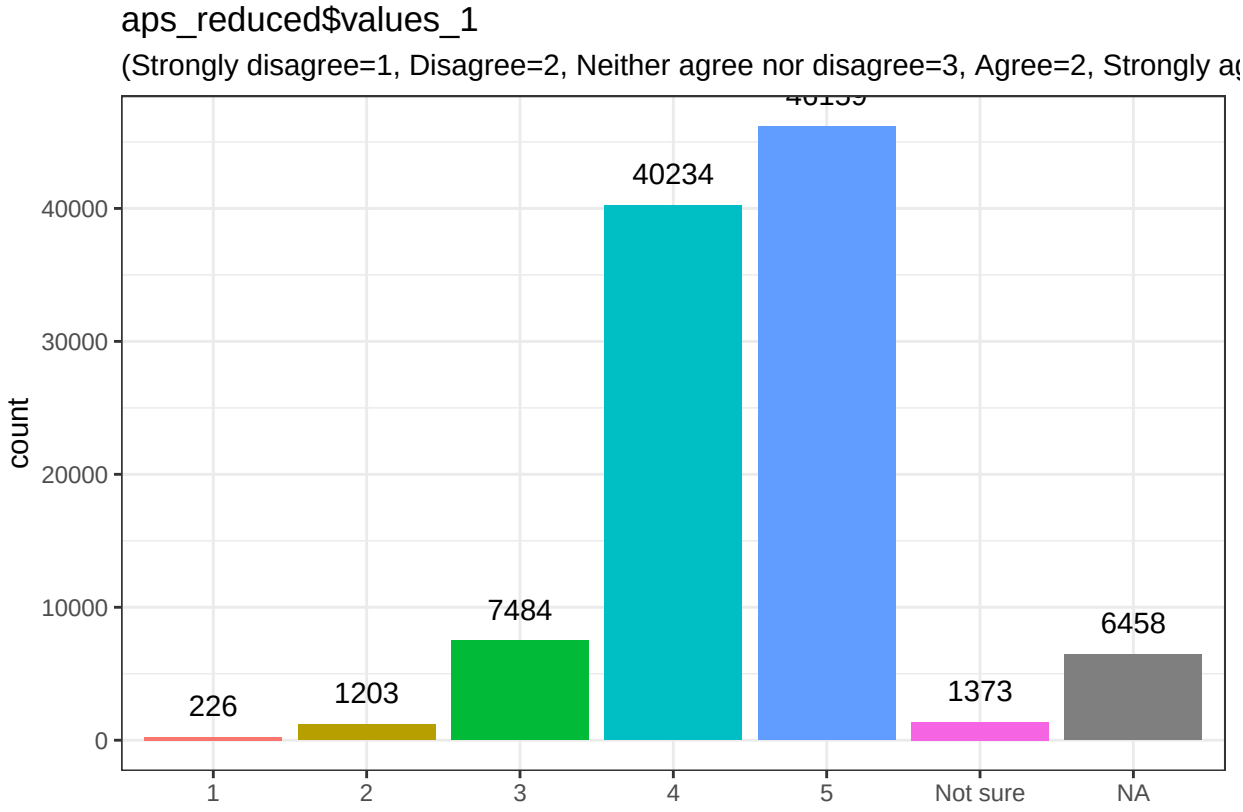

```
aps_reduced$wellbeing_12 <- reformat_variable_group1(aps_reduced$wellbeing_12)
generate_barplot(aps_reduced$wellbeing_12)
```




```
aps_reduced$wellbeing_13 <- reformat_variable_group1(aps_reduced$wellbeing_13)
generate_barplot(aps_reduced$wellbeing_13)
```




```
# values reformatting - group7

aps_reduced$values_1 <- reformat_variable_group7(aps_reduced$values_1)
generate_barplot(aps_reduced$values_1)
```




```
str(aps_reduced$values_1)
```

```
##  Factor w/ 6 levels "1","2","3","4",..: 5 5 6 5 5 5 5 6 4 NA ...
```

```
levels(aps_reduced$values_1)
```

```
## [1] "1"        "2"        "3"        "4"        "5"        "Not sure"
```

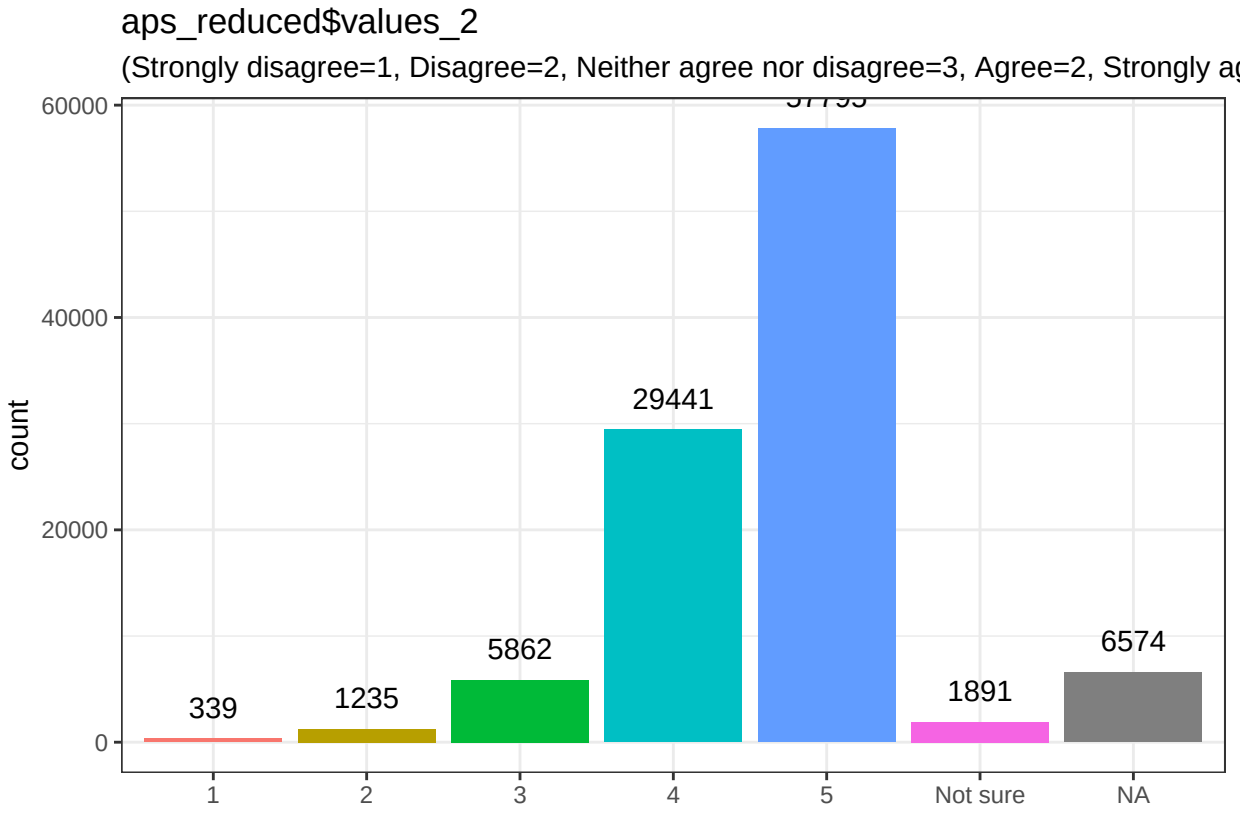
```
summary(aps_reduced$values_1)
```

```
##        1        2        3        4        5 Not sure     NA's
##      226     1203     7484    40234    46159     1373     6458
```

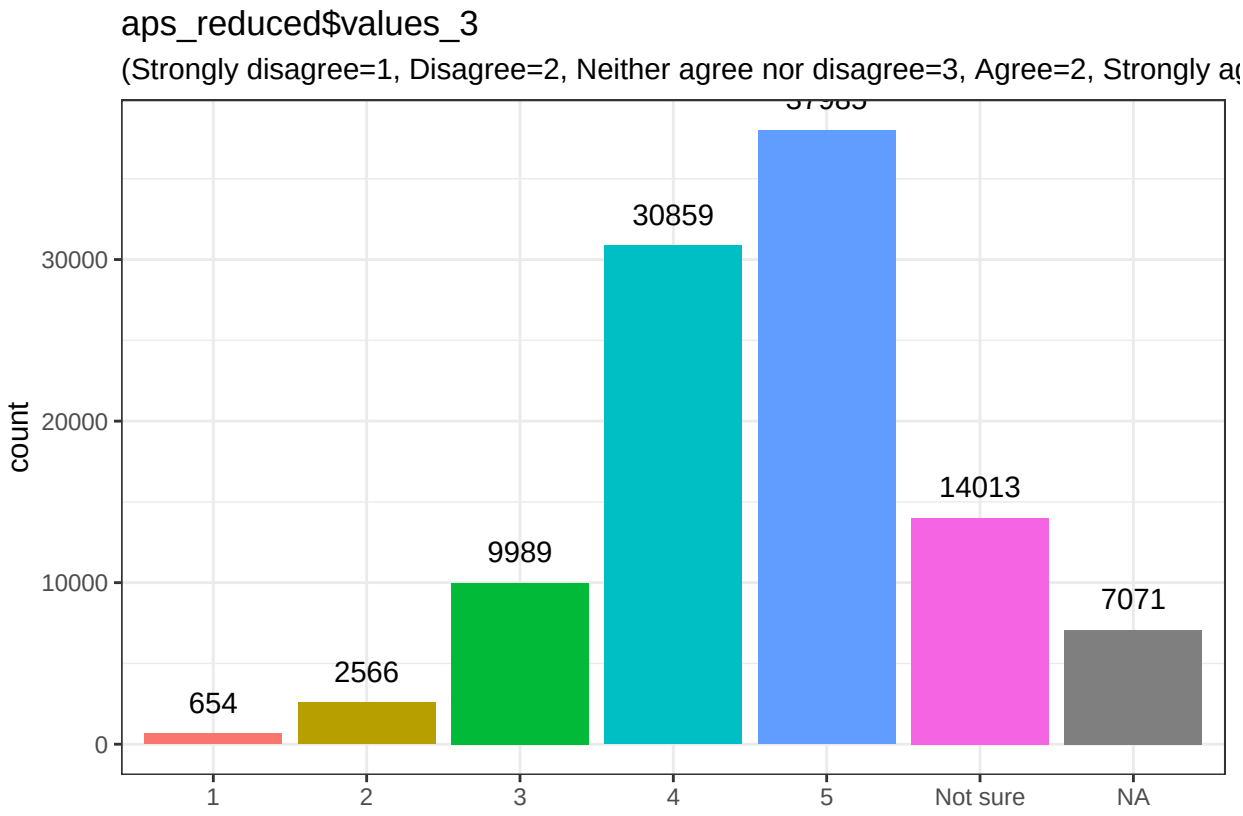
```
sum(is.na(aps_reduced$values_1))
```

```
## [1] 6458
```

```
aps_reduced$values_2 <- reformat_variable_group7(aps_reduced$values_2)
generate_barplot(aps_reduced$values_2)
```




```
aps_reduced$values_3 <- reformat_variable_group7(aps_reduced$values_3)
generate_barplot(aps_reduced$values_3)
```

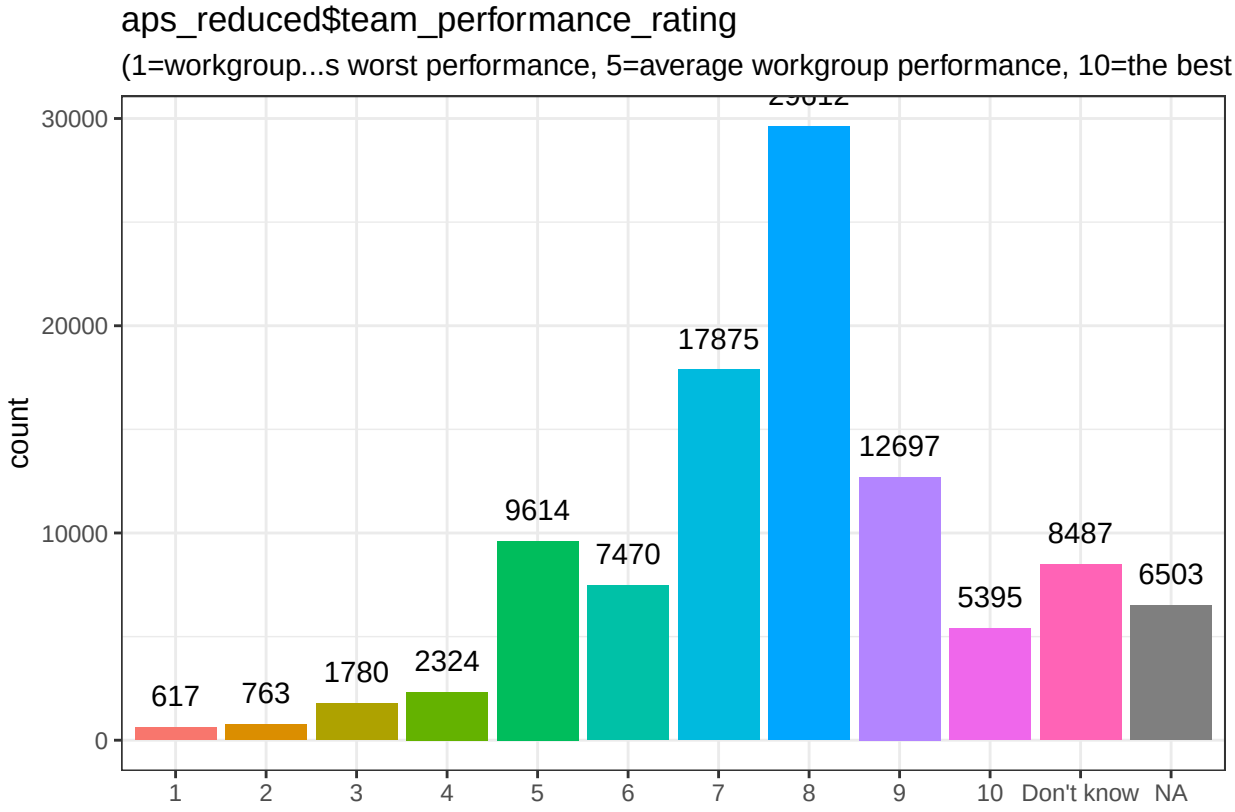



```
# team_performance_rating reformatting - dependent variable - group8

aps_reduced$team_performance_rating <- reformat_variable_group8(aps_reduced$team_performance_rating)
generate_barplot_dep_var(aps_reduced$team_performance_rating)
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <e2>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <99>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <99>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on '(1=workgroup's worst performance, 5=average workgroup
## performance, 10=the best your workgroup has ever worked, NA=Skipped question)'
## in 'mbcsToSbcs': dot substituted for <99>
```




```
str(aps_reduced$team_performance_rating)
```

```
##  Factor w/ 11 levels "1","2","3","4",..: 8 8 8 9 6 7 9 11 7 NA ...
```

```
levels(aps_reduced$team_performance_rating)
```

```
##  [1] "1"          "2"          "3"          "4"          "5"
##  [6] "6"          "7"          "8"          "9"          "10"
## [11] "Don't know"
```

```
summary(aps_reduced$team_performance_rating)
```

```
##          1          2          3          4          5          6          7
##        617        763       1780       2324       9614       7470      17875
##          8          9         10 Don't know       NA's
##      29612      12697       5395       8487       6503
```

```
sum(is.na(aps_reduced$team_performance_rating))
```

```
## [1] 6503
```

```r
# handling no response and I do not know / Not sure

# total number of skipped questions
sum(is.na(aps_reduced))         #362,030 skipped questions in 2018 vs. 355,416 in 2019
```

```
## [1] 362030
```

```r
table(rowSums((is.na(aps_reduced))>0)>0)  # 22,646 respondents in 2018 vs. 23,037 in 2019
```

```
##
## FALSE  TRUE
## 80491 22646
```

```r
# out of 129 variables, only the following have "I do not know" as an option for answers:
# leadership_engagement 1:7
length(which(aps_reduced=="Do not know"))   #31,282 responses in 2018 vs.31,247 in 2019
```

```
## [1] 31282
```

```r
table(rowSums(aps_reduced=="Do not know")>0)  #8,092 respondents in 2018 vs.7,990 in 2019
```

```
##
## FALSE  TRUE
## 72399  8092
```

```r
# team_performance_rating
length(which(aps_reduced=="Don't know"))    #8,487 responses in 2018 vs. 8,726 in 2019
```

```
## [1] 8487
```

```r
table(rowSums(aps_reduced=="Don't know")>0) #6,572 respondents in 2018 vs.6,629 in 2019
```

```
##
## FALSE  TRUE
## 73919  6572
```

```r
# one variable had a "not sure" option": values 1:3
length(which(aps_reduced=="Not sure"))    #17,277 responses in 2018 vs. 15,786 in 2019
```

```
## [1] 17277
```

```r
table(rowSums(aps_reduced=="Not sure")>0) #11,764 respondents in 2018 vs. 15,786 in 2019
```

```
##
## FALSE  TRUE
## 68727 11764
```

```r
# Handling of skipped questions and non standard answer options
# a) removing all respondents with more than 13 skipped questions
# b) removing all respondents who answered the team performance question with either
# don't know or who skipped
# c) replacing all "Do not know" for leadership_engagement 1 to 7 with "3" of each variable
# d) replacing all re "not sure" for values 1 to 3 with "3" for each variable
# e) replacing all remaining skipped questions with "3" for each variable

# a) removing all respondents with more than 13 skipped questions

number_skipped_questions_above_0 <- aps_reduced$number_skipped_questions[aps_reduced$number_skipped_ques
#data[data[, "Var"]<=13, ]
question_threshold <- 3
aps_reduced <- aps_reduced[aps_reduced[ , "number_skipped_questions"]<=question_threshold, ]

# b) removing all respondents who answered the team performance question with either
# Don't know or who skipped

aps_reduced <- aps_reduced[aps_reduced[ , "team_performance_rating"]!="Don't know", ]
aps_reduced <- aps_reduced[!is.na(aps_reduced$team_performance_rating) , ]
levels(aps_reduced$team_performance_rating)
```

```
##  [1] "1"          "2"          "3"          "4"          "5"
##  [6] "6"          "7"          "8"          "9"          "10"
## [11] "Don't know"
```

```r
# c) replacing all "Do not know" for leadership_engagement 1 to 7 with "3"

replacement_for_Do_not_know <- "3"

aps_reduced$leadership_engagement_1 <- replace(aps_reduced$leadership_engagement_1, aps_reduced$leadersh
aps_reduced$leadership_engagement_2 <- replace(aps_reduced$leadership_engagement_2, aps_reduced$leadersh
aps_reduced$leadership_engagement_3 <- replace(aps_reduced$leadership_engagement_3, aps_reduced$leadersh
aps_reduced$leadership_engagement_4 <- replace(aps_reduced$leadership_engagement_4, aps_reduced$leadersh
aps_reduced$leadership_engagement_5 <- replace(aps_reduced$leadership_engagement_5, aps_reduced$leadersh
aps_reduced$leadership_engagement_6 <- replace(aps_reduced$leadership_engagement_6, aps_reduced$leadersh
aps_reduced$leadership_engagement_7 <- replace(aps_reduced$leadership_engagement_7, aps_reduced$leadersh


# d) replacing all re "Not sure" for values 1 to 3 with "3"

replacement_for_Not_sure <- "3"

aps_reduced$values_1 <- replace(aps_reduced$values_1, aps_reduced$values_1 == "Not sure", replacement_fo
aps_reduced$values_2 <- replace(aps_reduced$values_2, aps_reduced$values_2 == "Not sure", replacement_fo
aps_reduced$values_3 <- replace(aps_reduced$values_3, aps_reduced$values_3 == "Not sure", replacement_fo

# e) replacing all remaining skipped questions with "3"

replacement_for_NAs <- "3"


aps_reduced$org_size[which(is.na(aps_reduced$org_size))] = replacement_for_NAs
```

```
## Warning in `[<-.factor`(`*tmp*`, which(is.na(aps_reduced$org_size)), value =
## structure(c(3L, : invalid factor level, NA generated
```

```
aps_reduced$employee_level[which(is.na(aps_reduced$employee_level))] = replacement_for_NAs
```

```
## Warning in `[<-.factor`(`*tmp*`, which(is.na(aps_reduced$employee_level)), :
## invalid factor level, NA generated
```

```
aps_reduced$job_engagement_1[which(is.na(aps_reduced$job_engagement_1))] = replacement_for_NAs
aps_reduced$job_engagement_2[which(is.na(aps_reduced$job_engagement_2))] = replacement_for_NAs
aps_reduced$job_engagement_3[which(is.na(aps_reduced$job_engagement_3))] = replacement_for_NAs
aps_reduced$job_engagement_4[which(is.na(aps_reduced$job_engagement_4))] = replacement_for_NAs
aps_reduced$job_engagement_5[which(is.na(aps_reduced$job_engagement_5))] = replacement_for_NAs
aps_reduced$job_engagement_6[which(is.na(aps_reduced$job_engagement_6))] = replacement_for_NAs
aps_reduced$job_engagement_7[which(is.na(aps_reduced$job_engagement_7))] = replacement_for_NAs
aps_reduced$job_engagement_8[which(is.na(aps_reduced$job_engagement_8))] = replacement_for_NAs
aps_reduced$job_engagement_9[which(is.na(aps_reduced$job_engagement_9))] = replacement_for_NAs
aps_reduced$job_engagement_10[which(is.na(aps_reduced$job_engagement_10))] = replacement_for_NAs

aps_reduced$team_engagement_1[which(is.na(aps_reduced$team_engagement_1))] = replacement_for_NAs
aps_reduced$team_engagement_2[which(is.na(aps_reduced$team_engagement_2))] = replacement_for_NAs
aps_reduced$team_engagement_3[which(is.na(aps_reduced$team_engagement_3))] = replacement_for_NAs
aps_reduced$team_engagement_4[which(is.na(aps_reduced$team_engagement_4))] = replacement_for_NAs

aps_reduced$supervisor_engagement_1[which(is.na(aps_reduced$supervisor_engagement_1))] = replacement_fo
aps_reduced$supervisor_engagement_2[which(is.na(aps_reduced$supervisor_engagement_2))] = replacement_fo
aps_reduced$supervisor_engagement_3[which(is.na(aps_reduced$supervisor_engagement_3))] = replacement_fo
aps_reduced$supervisor_engagement_4[which(is.na(aps_reduced$supervisor_engagement_4))] = replacement_fo
aps_reduced$supervisor_engagement_5[which(is.na(aps_reduced$supervisor_engagement_5))] = replacement_fo
aps_reduced$supervisor_engagement_6[which(is.na(aps_reduced$supervisor_engagement_6))] = replacement_fo
aps_reduced$supervisor_engagement_7[which(is.na(aps_reduced$supervisor_engagement_7))] = replacement_fo
aps_reduced$supervisor_engagement_8[which(is.na(aps_reduced$supervisor_engagement_8))] = replacement_fo
aps_reduced$supervisor_engagement_9[which(is.na(aps_reduced$supervisor_engagement_9))] = replacement_fo
aps_reduced$supervisor_engagement_10[which(is.na(aps_reduced$supervisor_engagement_10))] = replacement_
aps_reduced$supervisor_engagement_11[which(is.na(aps_reduced$supervisor_engagement_11))] = replacement_

aps_reduced$senior_manager_engagement_1[which(is.na(aps_reduced$senior_manager_engagement_1))] = replac
aps_reduced$senior_manager_engagement_2[which(is.na(aps_reduced$senior_manager_engagement_2))] = replac
aps_reduced$senior_manager_engagement_3[which(is.na(aps_reduced$senior_manager_engagement_3))] = replac
aps_reduced$senior_manager_engagement_4[which(is.na(aps_reduced$senior_manager_engagement_4))] = replac
aps_reduced$senior_manager_engagement_5[which(is.na(aps_reduced$senior_manager_engagement_5))] = replac
aps_reduced$senior_manager_engagement_6[which(is.na(aps_reduced$senior_manager_engagement_6))] = replac
aps_reduced$senior_manager_engagement_7[which(is.na(aps_reduced$senior_manager_engagement_7))] = replac
aps_reduced$senior_manager_engagement_8[which(is.na(aps_reduced$senior_manager_engagement_8))] = replac
aps_reduced$senior_manager_engagement_9[which(is.na(aps_reduced$senior_manager_engagement_9))] = replac
aps_reduced$senior_manager_engagement_10[which(is.na(aps_reduced$senior_manager_engagement_10))] = repla
aps_reduced$senior_manager_engagement_11[which(is.na(aps_reduced$senior_manager_engagement_11))] = repla
aps_reduced$senior_manager_engagement_12[which(is.na(aps_reduced$senior_manager_engagement_12))] = repla

aps_reduced$agency_engagement_1[which(is.na(aps_reduced$agency_engagement_1))] = replacement_for_NAs
aps_reduced$agency_engagement_2[which(is.na(aps_reduced$agency_engagement_2))] = replacement_for_NAs
aps_reduced$agency_engagement_3[which(is.na(aps_reduced$agency_engagement_3))] = replacement_for_NAs
aps_reduced$agency_engagement_4[which(is.na(aps_reduced$agency_engagement_4))] = replacement_for_NAs
```

```
aps_reduced$agency_engagement_5[which(is.na(aps_reduced$agency_engagement_5))] = replacement_for_NAs
aps_reduced$agency_engagement_6[which(is.na(aps_reduced$agency_engagement_6))] = replacement_for_NAs
aps_reduced$agency_engagement_7[which(is.na(aps_reduced$agency_engagement_7))] = replacement_for_NAs
aps_reduced$agency_engagement_8[which(is.na(aps_reduced$agency_engagement_8))] = replacement_for_NAs
aps_reduced$agency_engagement_9[which(is.na(aps_reduced$agency_engagement_9))] = replacement_for_NAs
aps_reduced$agency_engagement_10[which(is.na(aps_reduced$agency_engagement_10))] = replacement_for_NAs
aps_reduced$agency_engagement_11[which(is.na(aps_reduced$agency_engagement_11))] = replacement_for_NAs
aps_reduced$agency_engagement_12[which(is.na(aps_reduced$agency_engagement_12))] = replacement_for_NAs
aps_reduced$agency_engagement_13[which(is.na(aps_reduced$agency_engagement_13))] = replacement_for_NAs
aps_reduced$agency_engagement_14[which(is.na(aps_reduced$agency_engagement_14))] = replacement_for_NAs
aps_reduced$agency_engagement_15[which(is.na(aps_reduced$agency_engagement_15))] = replacement_for_NAs
aps_reduced$agency_engagement_16[which(is.na(aps_reduced$agency_engagement_16))] = replacement_for_NAs
aps_reduced$agency_engagement_17[which(is.na(aps_reduced$agency_engagement_17))] = replacement_for_NAs

aps_reduced$team_performance_support_1[which(is.na(aps_reduced$team_performance_support_1))] = replaceme
aps_reduced$team_performance_support_2[which(is.na(aps_reduced$team_performance_support_2))] = replaceme
aps_reduced$team_performance_support_3[which(is.na(aps_reduced$team_performance_support_3))] = replaceme
aps_reduced$team_performance_support_4[which(is.na(aps_reduced$team_performance_support_4))] = replaceme

aps_reduced$risk_culture_1[which(is.na(aps_reduced$risk_culture_1))] = replacement_for_NAs
aps_reduced$risk_culture_2[which(is.na(aps_reduced$risk_culture_2))] = replacement_for_NAs
aps_reduced$risk_culture_3[which(is.na(aps_reduced$risk_culture_3))] = replacement_for_NAs
aps_reduced$risk_culture_4[which(is.na(aps_reduced$risk_culture_4))] = replacement_for_NAs
aps_reduced$risk_culture_5[which(is.na(aps_reduced$risk_culture_5))] = replacement_for_NAs

aps_reduced$innovation_1[which(is.na(aps_reduced$innovation_1))] = replacement_for_NAs
aps_reduced$innovation_2[which(is.na(aps_reduced$innovation_2))] = replacement_for_NAs
aps_reduced$innovation_3[which(is.na(aps_reduced$innovation_3))] = replacement_for_NAs
aps_reduced$innovation_4[which(is.na(aps_reduced$innovation_4))] = replacement_for_NAs
aps_reduced$innovation_5[which(is.na(aps_reduced$innovation_5))] = replacement_for_NAs

aps_reduced$leadership_engagement_1[which(is.na(aps_reduced$leadership_engagement_1))] = replacement_fo
aps_reduced$leadership_engagement_2[which(is.na(aps_reduced$leadership_engagement_2))] = replacement_fo
aps_reduced$leadership_engagement_3[which(is.na(aps_reduced$leadership_engagement_3))] = replacement_fo
aps_reduced$leadership_engagement_4[which(is.na(aps_reduced$leadership_engagement_4))] = replacement_fo
aps_reduced$leadership_engagement_5[which(is.na(aps_reduced$leadership_engagement_5))] = replacement_fo
aps_reduced$leadership_engagement_6[which(is.na(aps_reduced$leadership_engagement_6))] = replacement_fo
aps_reduced$leadership_engagement_7[which(is.na(aps_reduced$leadership_engagement_7))] = replacement_fo

aps_reduced$wellbeing_1[which(is.na(aps_reduced$wellbeing_1))] = replacement_for_NAs
aps_reduced$wellbeing_2[which(is.na(aps_reduced$wellbeing_2))] = replacement_for_NAs
aps_reduced$wellbeing_3[which(is.na(aps_reduced$wellbeing_3))] = replacement_for_NAs
aps_reduced$wellbeing_4[which(is.na(aps_reduced$wellbeing_4))] = replacement_for_NAs
aps_reduced$wellbeing_5[which(is.na(aps_reduced$wellbeing_5))] = replacement_for_NAs
aps_reduced$wellbeing_6[which(is.na(aps_reduced$wellbeing_6))] = replacement_for_NAs
aps_reduced$wellbeing_7[which(is.na(aps_reduced$wellbeing_7))] = replacement_for_NAs
aps_reduced$wellbeing_8[which(is.na(aps_reduced$wellbeing_8))] = replacement_for_NAs
aps_reduced$wellbeing_9[which(is.na(aps_reduced$wellbeing_9))] = replacement_for_NAs
aps_reduced$wellbeing_10[which(is.na(aps_reduced$wellbeing_10))] = replacement_for_NAs
aps_reduced$wellbeing_11[which(is.na(aps_reduced$wellbeing_11))] = replacement_for_NAs
aps_reduced$wellbeing_12[which(is.na(aps_reduced$wellbeing_12))] = replacement_for_NAs
aps_reduced$wellbeing_13[which(is.na(aps_reduced$wellbeing_13))] = replacement_for_NAs
```

```r
aps_reduced$values_1[which(is.na(aps_reduced$values_1))] = replacement_for_NAs
aps_reduced$values_2[which(is.na(aps_reduced$values_2))] = replacement_for_NAs
aps_reduced$values_3[which(is.na(aps_reduced$values_3))] = replacement_for_NAs

# double checking data has no missing values and no answers other than 1-5

sum(is.na(aps_reduced))
```

```
## [1] 1
```

```r
length(which(aps_reduced=="Do not know"))
```

```
## [1] 0
```

```r
length(which(aps_reduced=="Don't know"))
```

```
## [1] 0
```

```r
length(which(aps_reduced=="Not sure"))
```

```
## [1] 0
```

```r
# developing 11 data frames grouping questions as per census

job_engagement_df <- data.frame(aps_reduced$job_engagement_1, aps_reduced$job_engagement_2, aps_reduced$
team_engagement_df <- data.frame(aps_reduced$team_engagement_1, aps_reduced$team_engagement_2, aps_redu
supervisor_engagement_df <- data.frame(aps_reduced$supervisor_engagement_1, aps_reduced$supervisor_enga
senior_manager_engagement_df <- data.frame(aps_reduced$senior_manager_engagement_1, aps_reduced$senior_
agency_engagement_df <- data.frame(aps_reduced$agency_engagement_1, aps_reduced$agency_engagement_2, aps
team_performance_support_df <- data.frame(aps_reduced$team_performance_support_1, aps_reduced$team_perf
risk_culture_df <- data.frame(aps_reduced$risk_culture_1, aps_reduced$risk_culture_2, aps_reduced$risk_
innovation_df <- data.frame(aps_reduced$innovation_1, aps_reduced$innovation_2, aps_reduced$innovation_
leadership_engagement_df <- data.frame(aps_reduced$leadership_engagement_1, aps_reduced$leadership_enga
wellbeing_df <- data.frame(aps_reduced$wellbeing_1, aps_reduced$wellbeing_2, aps_reduced$wellbeing_3, a
values_df <- data.frame(aps_reduced$values_1, aps_reduced$values_2, aps_reduced$values_3)


# descriptive statistics for questions within each scale

# Descriptive statistics step 1: entering descriptive names for columns

names(job_engagement_df) <- c(
  job_engagement_1 = column_names_1$full.question[5],
  job_engagement_2 = column_names_1$full.question[6],
  job_engagement_3 = column_names_1$full.question[7],
  job_engagement_4 = column_names_1$full.question[8],
  job_engagement_5 = column_names_1$full.question[9],
  job_engagement_6 = column_names_1$full.question[10],
  job_engagement_7 = column_names_1$full.question[11],
  job_engagement_8 = column_names_1$full.question[12],
```

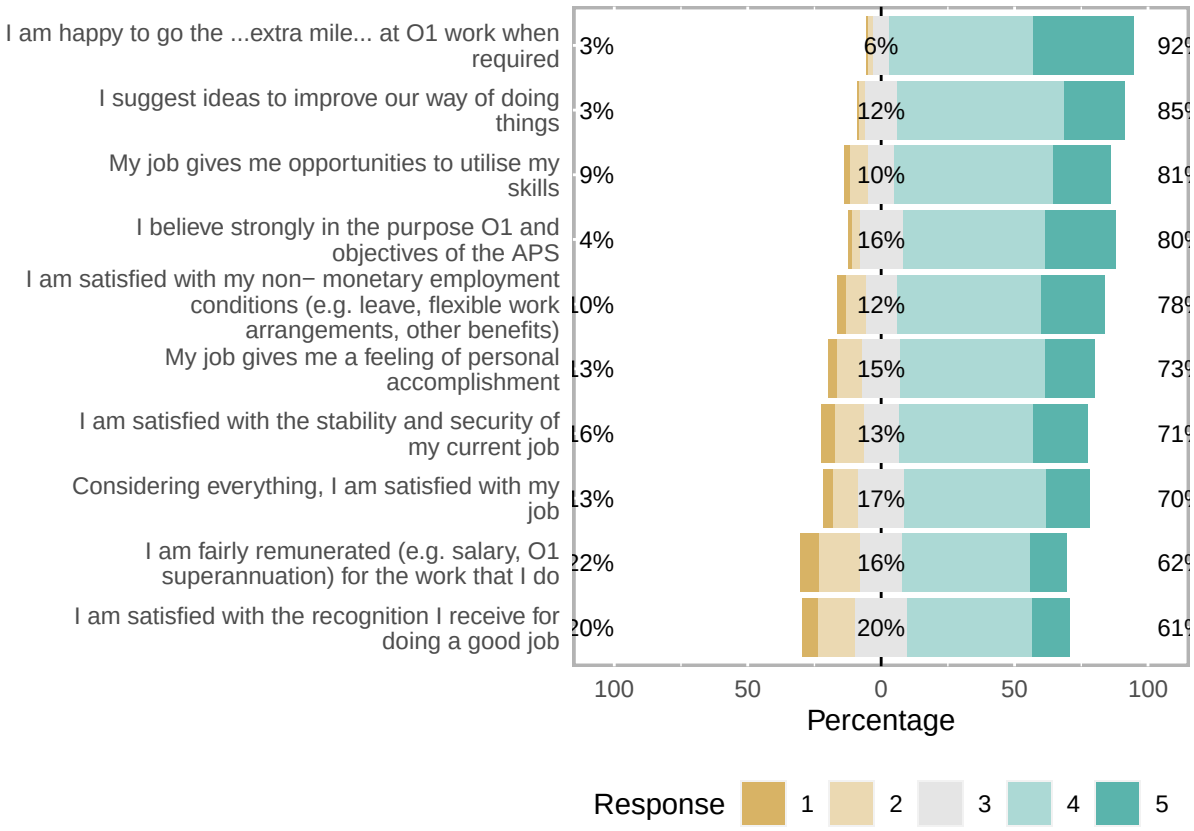
```
  job_engagement_9 = column_names_1$full.question[13],
  job_engagement_10 = column_names_1$full.question[14]
)

names(team_engagement_df) <- c(
  team_engagement_1 = column_names_1$full.question[16],
  team_engagement_2 = column_names_1$full.question[17],
  team_engagement_3 = column_names_1$full.question[18],
  team_engagement_4 = column_names_1$full.question[19]
)

names(supervisor_engagement_df) <- c(
  supervisor_engagement_1 = column_names_1$full.question[21],
  supervisor_engagement_2 = column_names_1$full.question[22],
  supervisor_engagement_3 = column_names_1$full.question[23],
  supervisor_engagement_4 = column_names_1$full.question[24],
  supervisor_engagement_5 = column_names_1$full.question[26],
  supervisor_engagement_6 = column_names_1$full.question[27],
  supervisor_engagement_7 = column_names_1$full.question[28],
  supervisor_engagement_8 = column_names_1$full.question[29],
  supervisor_engagement_9 = column_names_1$full.question[30],
  supervisor_engagement_10 = column_names_1$full.question[31],
  supervisor_engagement_11 = column_names_1$full.question[32]
)

names(senior_manager_engagement_df) <- c(
  senior_manager_engagement_1 = column_names_1$full.question[33],
  senior_manager_engagement_2 = column_names_1$full.question[34],
  senior_manager_engagement_3 = column_names_1$full.question[35],
  senior_manager_engagement_4 = column_names_1$full.question[36],
  senior_manager_engagement_5 = column_names_1$full.question[37],
  senior_manager_engagement_6 = column_names_1$full.question[38],
  senior_manager_engagement_7 = column_names_1$full.question[39],
  senior_manager_engagement_8 = column_names_1$full.question[41],
  senior_manager_engagement_9 = column_names_1$full.question[42],
  senior_manager_engagement_10 = column_names_1$full.question[43],
  senior_manager_engagement_11 = column_names_1$full.question[44],
  senior_manager_engagement_12 = column_names_1$full.question[46]
)

names(agency_engagement_df) <- c(
  agency_engagement_1 = column_names_1$full.question[55],
  agency_engagement_2 = column_names_1$full.question[56],
  agency_engagement_3 = column_names_1$full.question[57],
  agency_engagement_4 = column_names_1$full.question[58],
  agency_engagement_5 = column_names_1$full.question[59],
  agency_engagement_6 = column_names_1$full.question[60],
  agency_engagement_7 = column_names_1$full.question[61],
  agency_engagement_8 = column_names_1$full.question[62],
  agency_engagement_9 = column_names_1$full.question[63],
  agency_engagement_10 = column_names_1$full.question[64],
  agency_engagement_11 = column_names_1$full.question[65],
  agency_engagement_12 = column_names_1$full.question[66],
```

```
  agency_engagement_13 = column_names_1$full.question[68],
  agency_engagement_14 = column_names_1$full.question[69],
  agency_engagement_15 = column_names_1$full.question[70],
  agency_engagement_16 = column_names_1$full.question[71],
  agency_engagement_17 = column_names_1$full.question[72]
)

names(team_performance_support_df) <- c(
  team_performance_support_1 = column_names_1$full.question[229],
  team_performance_support_1 = column_names_1$full.question[230],
  team_performance_support_1 = column_names_1$full.question[231],
  team_performance_support_1 = column_names_1$full.question[232]
)

names(risk_culture_df) <- c(
  risk_culture_1 = column_names_1$full.question[200],
  risk_culture_1 = column_names_1$full.question[201],
  risk_culture_1 = column_names_1$full.question[203],
  risk_culture_1 = column_names_1$full.question[204],
  risk_culture_1 = column_names_1$full.question[205]
)

names(innovation_df) <- c(
  innovation_1 = column_names_1$full.question[221],
  innovation_1 = column_names_1$full.question[222],
  innovation_1 = column_names_1$full.question[223],
  innovation_1 = column_names_1$full.question[224],
  innovation_1 = column_names_1$full.question[225]
)

names(leadership_engagement_df) <- c(
  leadership_engagement_1 = column_names_1$full.question[47],
  leadership_engagement_2 = column_names_1$full.question[48],
  leadership_engagement_3 = column_names_1$full.question[50],
  leadership_engagement_4 = column_names_1$full.question[51],
  leadership_engagement_5 = column_names_1$full.question[52],
  leadership_engagement_6 = column_names_1$full.question[53],
  leadership_engagement_7 = column_names_1$full.question[54]
)

names(wellbeing_df) <- c(
  wellbeing_1 = column_names_1$full.question[74],
  wellbeing_2 = column_names_1$full.question[87],
  wellbeing_3 = column_names_1$full.question[88],
  wellbeing_4 = column_names_1$full.question[89],
  wellbeing_5 = column_names_1$full.question[90],
  wellbeing_6 = column_names_1$full.question[91],
  wellbeing_7 = column_names_1$full.question[92],
  wellbeing_8 = column_names_1$full.question[93],
  wellbeing_9 = column_names_1$full.question[94],
  wellbeing_10 = column_names_1$full.question[95],
  wellbeing_11 = column_names_1$full.question[96],
  wellbeing_12 = column_names_1$full.question[97],
```

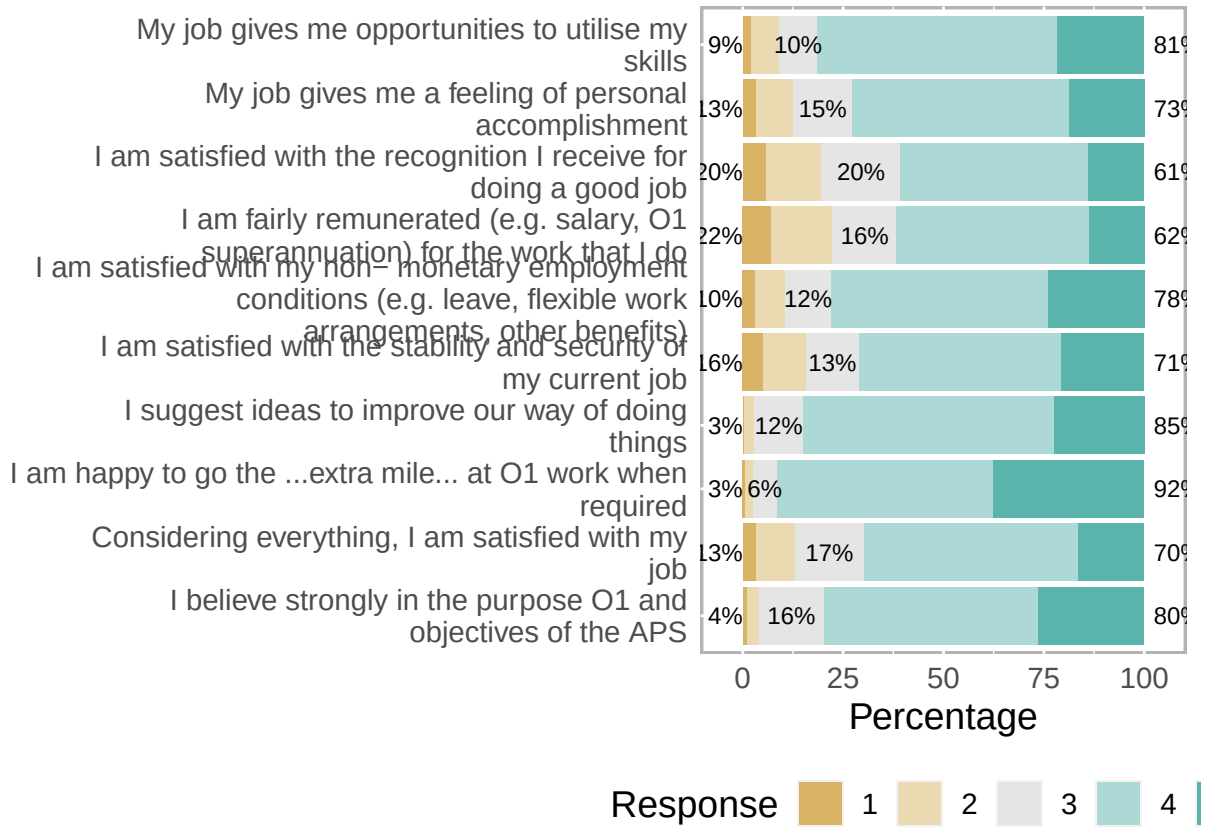
```
  wellbeing_13 = column_names_1$full.question[98]
)


names(values_df) <- c(
  values_1 = column_names_1$full.question[236],
  values_1 = column_names_1$full.question[237],
  values_1 = column_names_1$full.question[238]
)

names(aps_reduced$org_size) <- c(org_size = column_names_1$full.question[1])

names(aps_reduced$employee_level) <- c(org_size = column_names_1$full.question[4])

names(aps_reduced$team_performance_rating) <- c(org_size = column_names_1$full.question[226])


# Descriptive statistics step 2: descriptive statistics for questions within each scale (for 11 scales)

# Descriptive statistics step 2
#scale 1: job_engagement analysis

# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
job_engagement_likert <- likert(job_engagement_df)
summary(job_engagement_likert)
```

```
##
## 8                                                                I am happy to go the 'extra mile' at O1 w
## 7                                                                       I suggest ideas to improve our wa
## 1                                                                       My job gives me opportunities to
## 10                                                            I believe strongly in the purpose O1 and obje
## 5  I am satisfied with my non- monetary employment conditions (e.g. leave, flexible work arrangements
## 2                                                                  My job gives me a feeling of perso
## 6                                                          I am satisfied with the stability and security
## 9                                                                       Considering everything, I am sati
## 4                                          I am fairly remunerated (e.g. salary, O1 superannuation) for t
## 3                                                   I am satisfied with the recognition I receive for
##          low   neutral     high     mean        sd
## 8   2.561455  5.884424 91.55412 4.258011 0.7126078
## 7   2.786741 12.330889 84.88237 4.040903 0.6949163
## 1   8.945732  9.655617 81.39865 3.921244 0.8735624
## 10  4.003520 16.330889 79.66559 4.007322 0.8042136
## 5  10.495747 11.610443 77.89381 3.882957 0.9564676
## 2  12.628923 14.638897 72.73218 3.756503 0.9688846
## 6  15.704312 13.361103 70.93458 3.707820 1.0643842
## 9  13.065415 17.152244 69.78234 3.696756 0.9676607
## 4  22.406571 15.975359 61.61807 3.459572 1.1195283
## 3  19.599883 19.746553 60.65356 3.492801 1.0721082
```

```
# centered bar plot showing the percent responses for each question (order from most to least agreement)
plot(job_engagement_likert, type="bar")
```




```
# bar plot ordered by question (not centered)
plot(job_engagement_likert, group.order = names(job_engagement_df), centered = FALSE) + theme(text = el
```




```
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(job_engagement_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at O1 work when' in
## 'mbcsToSbcs': dot substituted for <e2>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at O1 work when' in
## 'mbcsToSbcs': dot substituted for <80>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at O1 work when' in
## 'mbcsToSbcs': dot substituted for <98>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at O1 work when' in
## 'mbcsToSbcs': dot substituted for <e2>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <98>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <98>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <80>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <98>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at 01 work when' in
## 'mbcsToSbcs': dot substituted for <e2>

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```
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at O1 work when' in
## 'mbcsToSbcs': dot substituted for <99>
```


```
# density plot (treating Likert data like numeric data)
plot(job_engagement_likert,
     type="density",
     facet = TRUE,
     bw = 0.5)
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at O1 work when
## required' in 'mbcsToSbcs': dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I am happy to go the 'extra mile' at O1 work when
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## conversion failure on 'I am happy to go the 'extra mile' at 01 work when
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## conversion failure on 'I am happy to go the 'extra mile' at 01 work when
## required' in 'mbcsToSbcs': dot substituted for <99>
```


```
# descriptive statistics (mean, sd, median, skewness)
psych::describe(job_engagement_df)
```

```
##
## My job gives me opportunities to utilise my skills*
## My job gives me a feeling of personal accomplishment*
## I am satisfied with the recognition I receive for doing a good job*
## I am fairly remunerated (e.g. salary, O1 superannuation) for the work that I do*
## I am satisfied with my non- monetary employment conditions (e.g. leave, flexible work arrangements, o
## I am satisfied with the stability and security of my current job*
## I suggest ideas to improve our way of doing things*
## I am happy to go the 'extra mile' at O1 work when required*
## Considering everything, I am satisfied with my job*
## I believe strongly in the purpose O1 and objectives of the APS*
##
## My job gives me opportunities to utilise my skills*
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```

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## I am happy to go the ‘extra mile’ at 01 work when required*
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## I am satisfied with the recognition I receive for doing a good job*
## I am fairly remunerated (e.g. salary, 01 superannuation) for the work that I do*
## I am satisfied with my non- monetary employment conditions (e.g. leave, flexible work arrangements,
## I am satisfied with the stability and security of my current job*
## I suggest ideas to improve our way of doing things*
## I am happy to go the ‘extra mile’ at 01 work when required*
## Considering everything, I am satisfied with my job*
## I believe strongly in the purpose 01 and objectives of the APS*
##
## My job gives me opportunities to utilise my skills*
## My job gives me a feeling of personal accomplishment*
## I am satisfied with the recognition I receive for doing a good job*
## I am fairly remunerated (e.g. salary, 01 superannuation) for the work that I do*
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## I am fairly remunerated (e.g. salary, 01 superannuation) for the work that I do*
## I am satisfied with my non- monetary employment conditions (e.g. leave, flexible work arrangements,
## I am satisfied with the stability and security of my current job*
## I suggest ideas to improve our way of doing things*
## I am happy to go the ‘extra mile’ at 01 work when required*
## Considering everything, I am satisfied with my job*
## I believe strongly in the purpose 01 and objectives of the APS*
##
## My job gives me opportunities to utilise my skills*
## My job gives me a feeling of personal accomplishment*
## I am satisfied with the recognition I receive for doing a good job*
## I am fairly remunerated (e.g. salary, 01 superannuation) for the work that I do*
## I am satisfied with my non- monetary employment conditions (e.g. leave, flexible work arrangements,
## I am satisfied with the stability and security of my current job*
## I suggest ideas to improve our way of doing things*
## I am happy to go the ‘extra mile’ at 01 work when required*
```
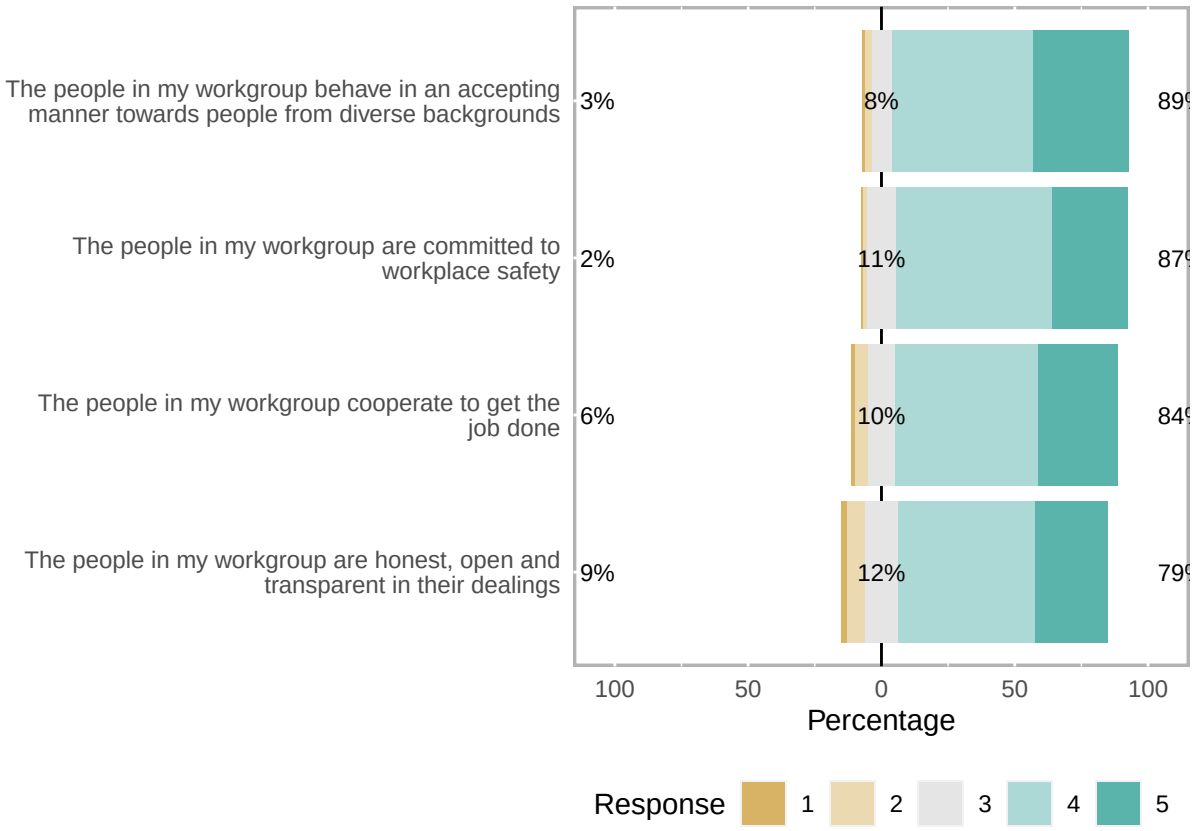

```
## Considering everything, I am satisfied with my job*
## I believe strongly in the purpose O1 and objectives of the APS*
##
## My job gives me opportunities to utilise my skills*
## My job gives me a feeling of personal accomplishment*
## I am satisfied with the recognition I receive for doing a good job*
## I am fairly remunerated (e.g. salary, O1 superannuation) for the work that I do*
## I am satisfied with my non- monetary employment conditions (e.g. leave, flexible work arrangements, c
## I am satisfied with the stability and security of my current job*
## I suggest ideas to improve our way of doing things*
## I am happy to go the 'extra mile' at O1 work when required*
## Considering everything, I am satisfied with my job*
## I believe strongly in the purpose O1 and objectives of the APS*
```

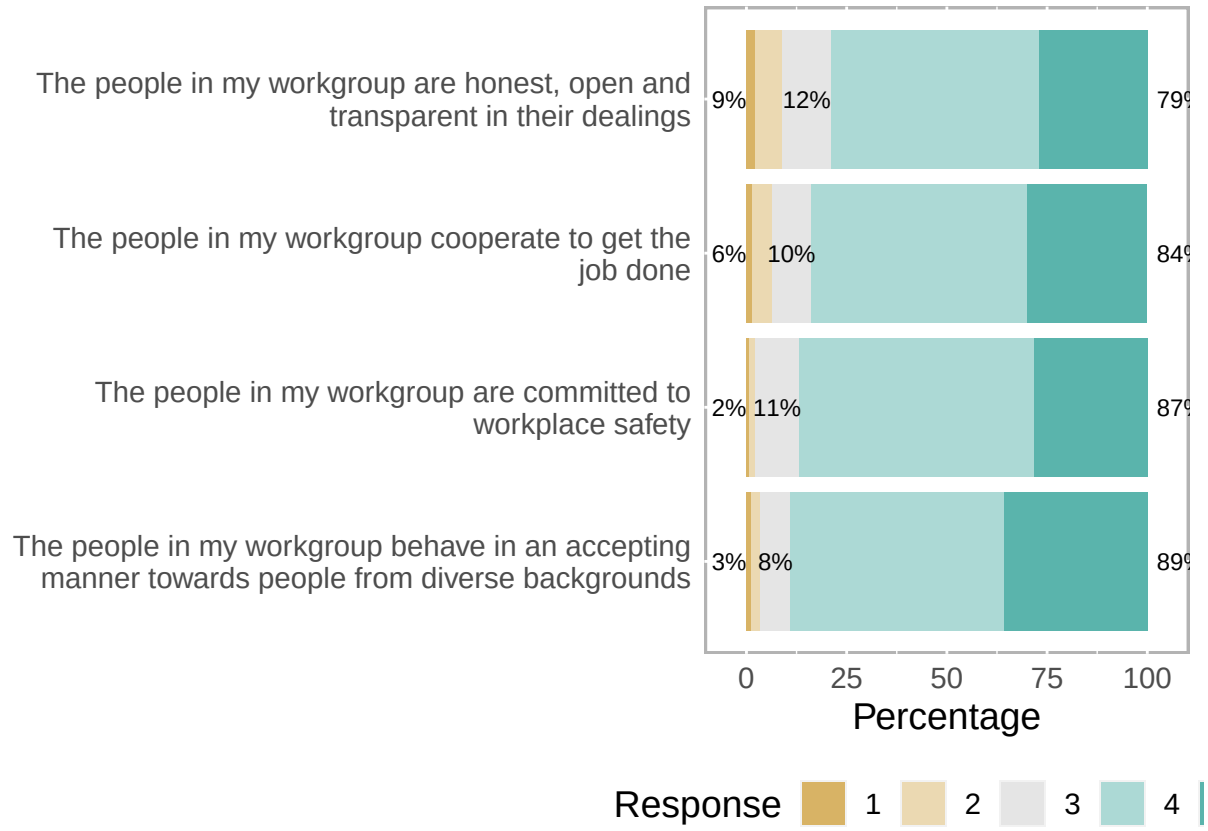
```
# Descriptive statistics step 2
#scale 2: team_engagement analysis

# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
team_engagement_likert <- likert(team_engagement_df)
summary(team_engagement_likert)
```

```
##                                                                                                  Item
## 4 The people in my workgroup behave in an accepting manner towards people from diverse backgrounds
## 3                                    The people in my workgroup are committed to workplace safety
## 2                                        The people in my workgroup cooperate to get the job done
## 1                      The people in my workgroup are honest, open and transparent in their dealings
##        low   neutral     high     mean        sd
## 4 3.470813  7.585802 88.94339 4.201162 0.7645863
## 3 2.291581 10.806688 86.90173 4.121830 0.7093272
## 2 6.299795  9.898504 83.80170 4.059407 0.8473169
## 1 8.800235 12.463479 78.73629 3.947609 0.9250462
```

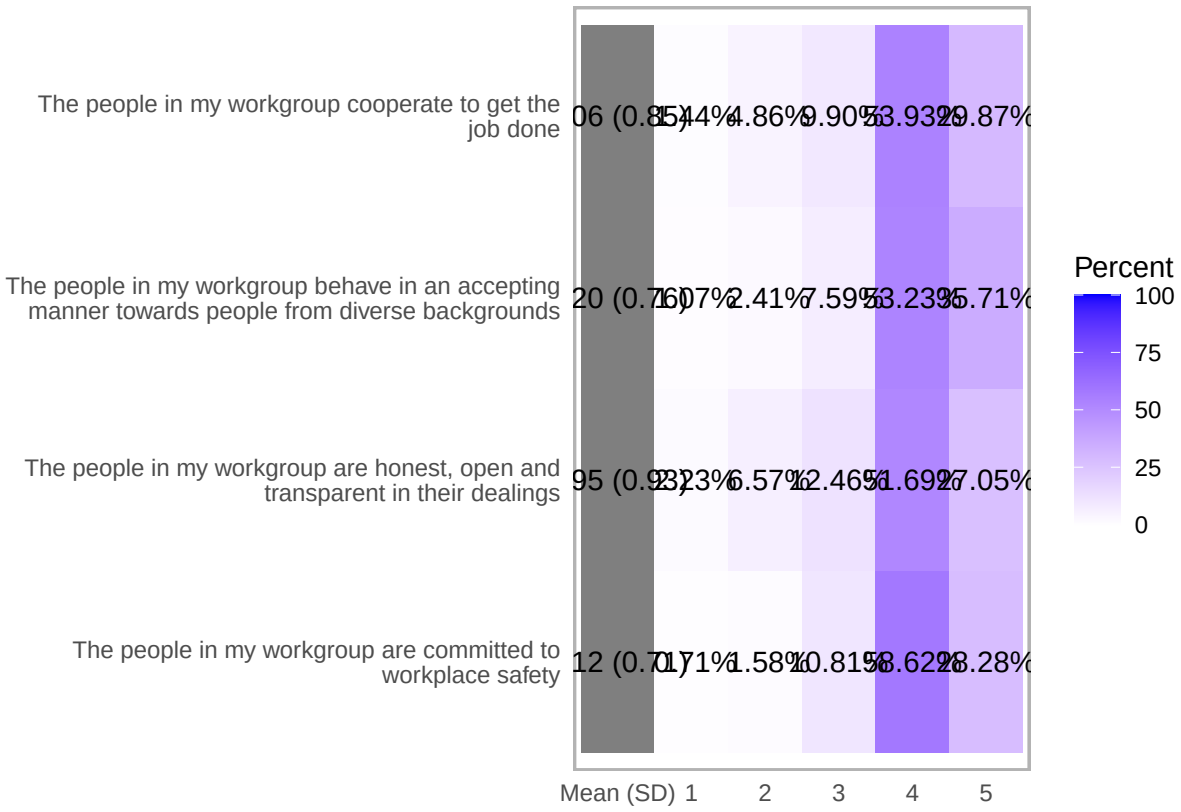
```
# centered bar plot showing the percent responses for each question (order from most to least agreement
plot(team_engagement_likert, type="bar")
```



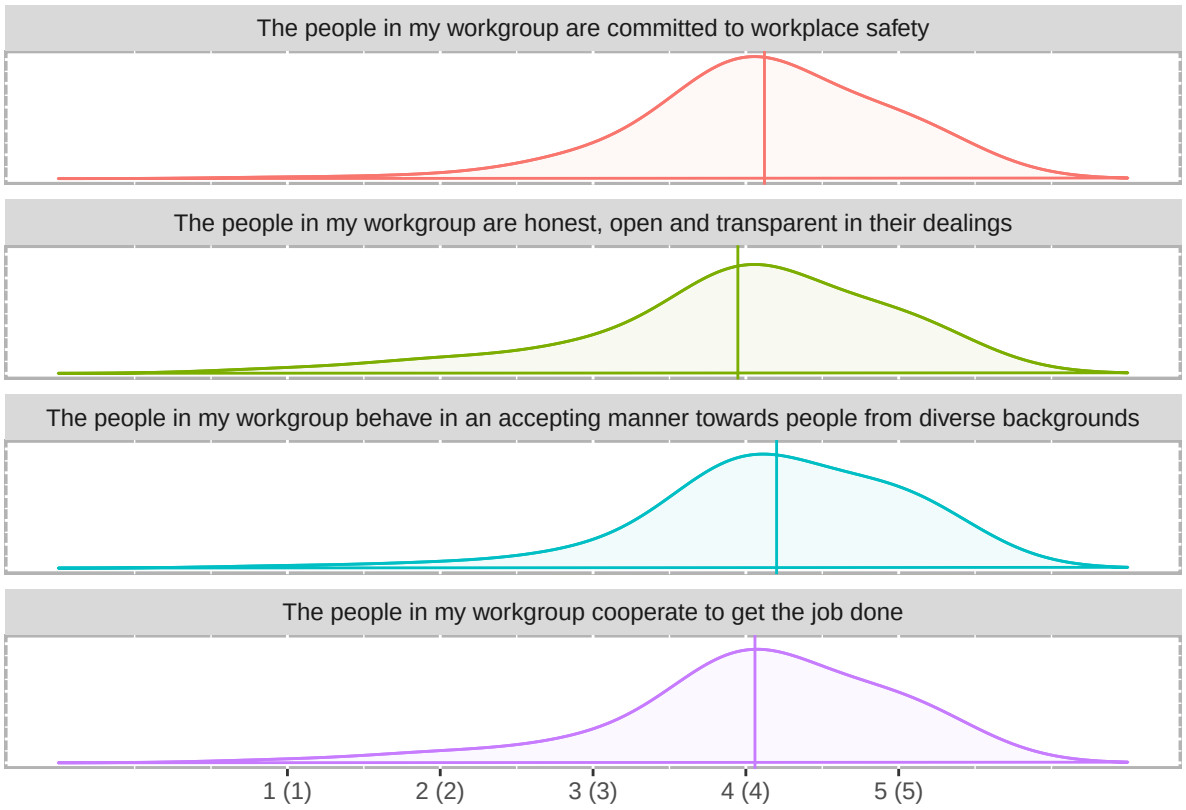

```
# bar plot ordered by question (not centered)
plot(team_engagement_likert, group.order = names(team_engagement_df), centered = FALSE) + theme(text = e
```




```
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(team_engagement_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```




```
# density plot (treating Likert data like numeric data)
plot(team_engagement_likert,
     type="density",
     facet = TRUE,
     bw = 0.5)
```




```
# descriptive statistics (mean, sd, median, skewness)
psych::describe(team_engagement_df)
```

```
##                                                                                                  va
## The people in my workgroup are honest, open and transparent in their dealings*
## The people in my workgroup cooperate to get the job done*
## The people in my workgroup are committed to workplace safety*
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds*
##
## The people in my workgroup are honest, open and transparent in their dealings*                  85
## The people in my workgroup cooperate to get the job done*                                       85
## The people in my workgroup are committed to workplace safety*                                   85
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds* 85
##                                                                                                  me
## The people in my workgroup are honest, open and transparent in their dealings*                  3.
## The people in my workgroup cooperate to get the job done*                                       4.
## The people in my workgroup are committed to workplace safety*                                   4.
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds* 4.
##                                                                                                   s
## The people in my workgroup are honest, open and transparent in their dealings*                  0.
## The people in my workgroup cooperate to get the job done*                                       0.
## The people in my workgroup are committed to workplace safety*                                   0.
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds* 0.
##                                                                                                  me
## The people in my workgroup are honest, open and transparent in their dealings*
```

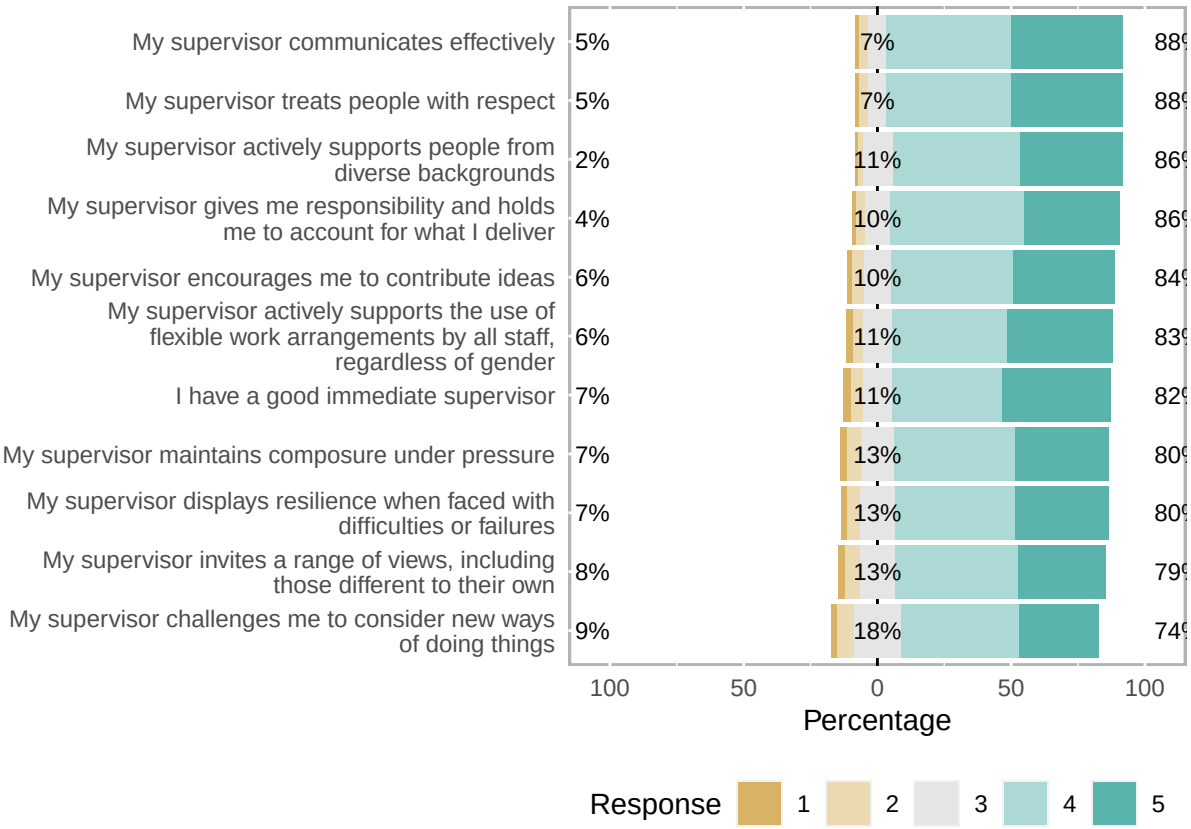
```
## The people in my workgroup cooperate to get the job done*
## The people in my workgroup are committed to workplace safety*
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds*
##                                                                                                  tri
## The people in my workgroup are honest, open and transparent in their dealings*
## The people in my workgroup cooperate to get the job done*
## The people in my workgroup are committed to workplace safety*
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds*
##                                                                                                  mac
## The people in my workgroup are honest, open and transparent in their dealings*                     (
## The people in my workgroup cooperate to get the job done*                                          (
## The people in my workgroup are committed to workplace safety*                                      (
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds*  (
##                                                                                                  mir
## The people in my workgroup are honest, open and transparent in their dealings*                     1
## The people in my workgroup cooperate to get the job done*                                          1
## The people in my workgroup are committed to workplace safety*                                      1
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds*  1
##                                                                                                  mar
## The people in my workgroup are honest, open and transparent in their dealings*                     5
## The people in my workgroup cooperate to get the job done*                                          5
## The people in my workgroup are committed to workplace safety*                                      5
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds*  5
##                                                                                                  ran
## The people in my workgroup are honest, open and transparent in their dealings*
## The people in my workgroup cooperate to get the job done*
## The people in my workgroup are committed to workplace safety*
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds*
##                                                                                                   sk
## The people in my workgroup are honest, open and transparent in their dealings*                  -1
## The people in my workgroup cooperate to get the job done*                                       -1
## The people in my workgroup are committed to workplace safety*                                  -0
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds* -1
##                                                                                                  kur
## The people in my workgroup are honest, open and transparent in their dealings*
## The people in my workgroup cooperate to get the job done*
## The people in my workgroup are committed to workplace safety*
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds*
##                                                                                                  se
## The people in my workgroup are honest, open and transparent in their dealings*                   0
## The people in my workgroup cooperate to get the job done*                                        0
## The people in my workgroup are committed to workplace safety*                                    0
## The people in my workgroup behave in an accepting manner towards people from diverse backgrounds* 0
```

```r
# Descriptive statistics step 2
#scale 3: supervisor_engagement analysis

# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
supervisor_engagement_likert <- likert(supervisor_engagement_df)
summary(supervisor_engagement_likert)
```

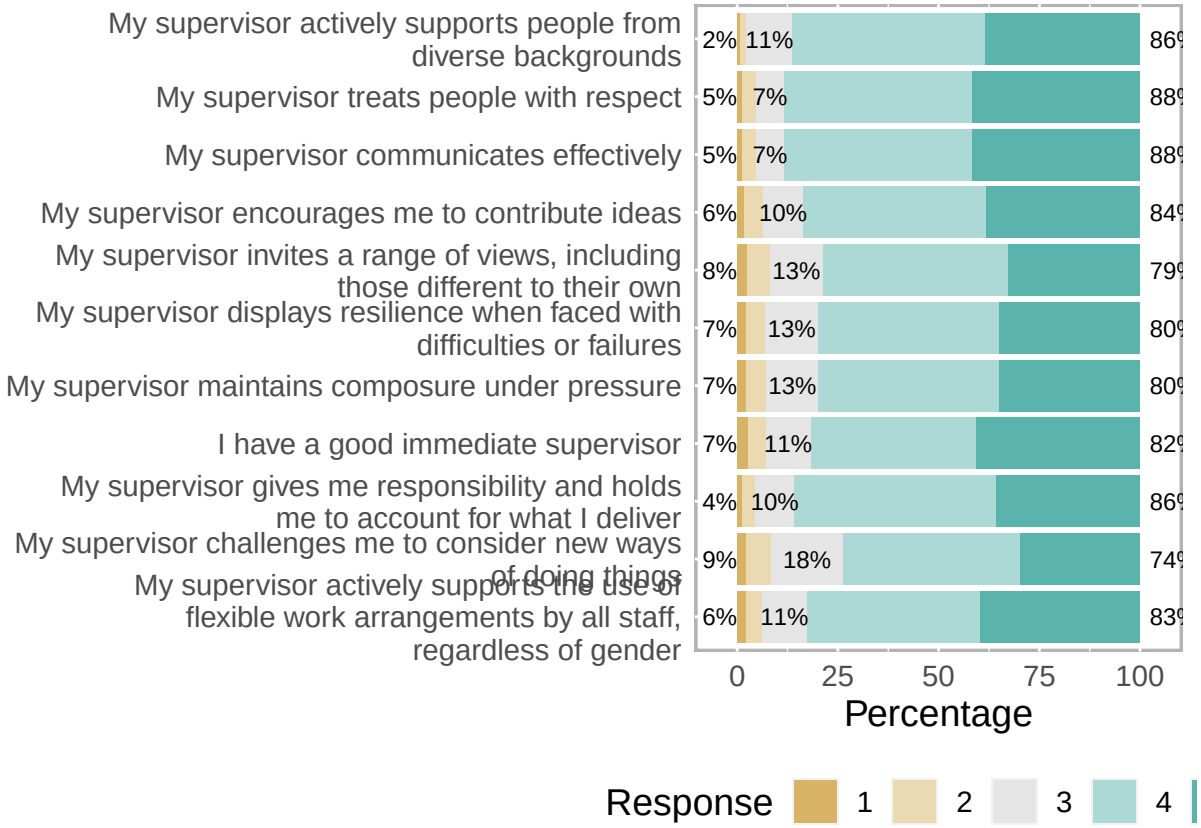
```
##
## 2                                                    My supervisor treats people with r
```

```
## 3                                                                  My supervisor communicates effe
## 1                                                  My supervisor actively supports people from diverse backg
## 9                                  My supervisor gives me responsibility and holds me to account for what I
## 4                                                      My supervisor encourages me to contribut
## 11 My supervisor actively supports the use of flexible work arrangements by all staff, regardless of
## 8                                                                  I have a good immediate sup
## 7                                                  My supervisor maintains composure under p
## 6                                  My supervisor displays resilience when faced with difficulties or f
## 5                                  My supervisor invites a range of views, including those different to th
## 10                                 My supervisor challenges me to consider new ways of doing
##         low   neutral     high     mean        sd
## 2  4.645351  7.076562 88.27809 4.237853 0.8268604
## 3  4.645351  7.076562 88.27809 4.237853 0.8268604
## 1  2.345556 11.366383 86.28806 4.216275 0.7644047
## 9  4.418891  9.887944 85.69317 4.156398 0.8229265
## 4  6.361983 10.075682 83.56233 4.133951 0.9005433
## 11 6.139044 11.294808 82.56615 4.137108 0.9236996
## 8  7.082429 11.125843 81.79173 4.126231 0.9586397
## 7  7.315928 12.801408 79.88266 4.051816 0.9378584
## 6  6.905251 13.341156 79.75359 4.056099 0.9310627
## 5  8.160751 13.174538 78.66471 4.006442 0.9527923
## 10 8.504547 17.760047 73.73541 3.927521 0.9570183
```

```
# centered bar plot showing the percent responses for each question (order from most to least agreement
plot(supervisor_engagement_likert, type="bar")
```

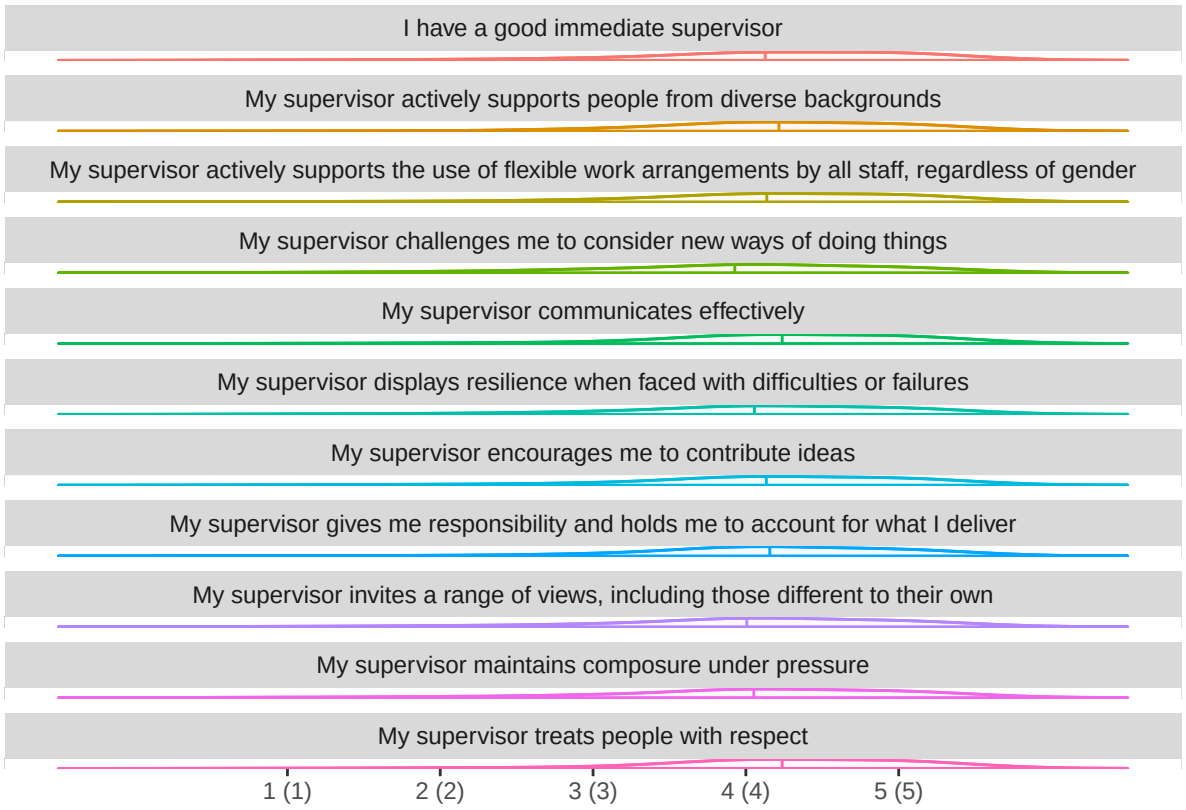


```r
# bar plot ordered by question (not centered)
plot(supervisor_engagement_likert, group.order = names(supervisor_engagement_df), centered = FALSE) + tl
```




```r
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(supervisor_engagement_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```


```
# density plot (treating Likert data like numeric data)
plot(supervisor_engagement_likert,
     type="density",
     facet = TRUE,
     bw = 0.5)
```




```r
# descriptive statistics (mean, sd, median, skewness)
psych::describe(supervisor_engagement_df)
```

```
##
## My supervisor actively supports people from diverse backgrounds*
## My supervisor treats people with respect*
## My supervisor communicates effectively*
## My supervisor encourages me to contribute ideas*
## My supervisor invites a range of views, including those different to their own*
## My supervisor displays resilience when faced with difficulties or failures*
## My supervisor maintains composure under pressure*
## I have a good immediate supervisor*
## My supervisor gives me responsibility and holds me to account for what I deliver*
## My supervisor challenges me to consider new ways of doing things*
## My supervisor actively supports the use of flexible work arrangements by all staff, regardless of ge
##
## My supervisor actively supports people from diverse backgrounds*
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## My supervisor treats people with respect*
## My supervisor communicates effectively*
```

```
## My supervisor encourages me to contribute ideas*
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## My supervisor displays resilience when faced with difficulties or failures*
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## My supervisor gives me responsibility and holds me to account for what I deliver*
```

```
## My supervisor challenges me to consider new ways of doing things*
## My supervisor actively supports the use of flexible work arrangements by all staff, regardless of ge
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## My supervisor actively supports people from diverse backgrounds*
## My supervisor treats people with respect*
## My supervisor communicates effectively*
## My supervisor encourages me to contribute ideas*
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## I have a good immediate supervisor*
## My supervisor gives me responsibility and holds me to account for what I deliver*
## My supervisor challenges me to consider new ways of doing things*
## My supervisor actively supports the use of flexible work arrangements by all staff, regardless of ge
```

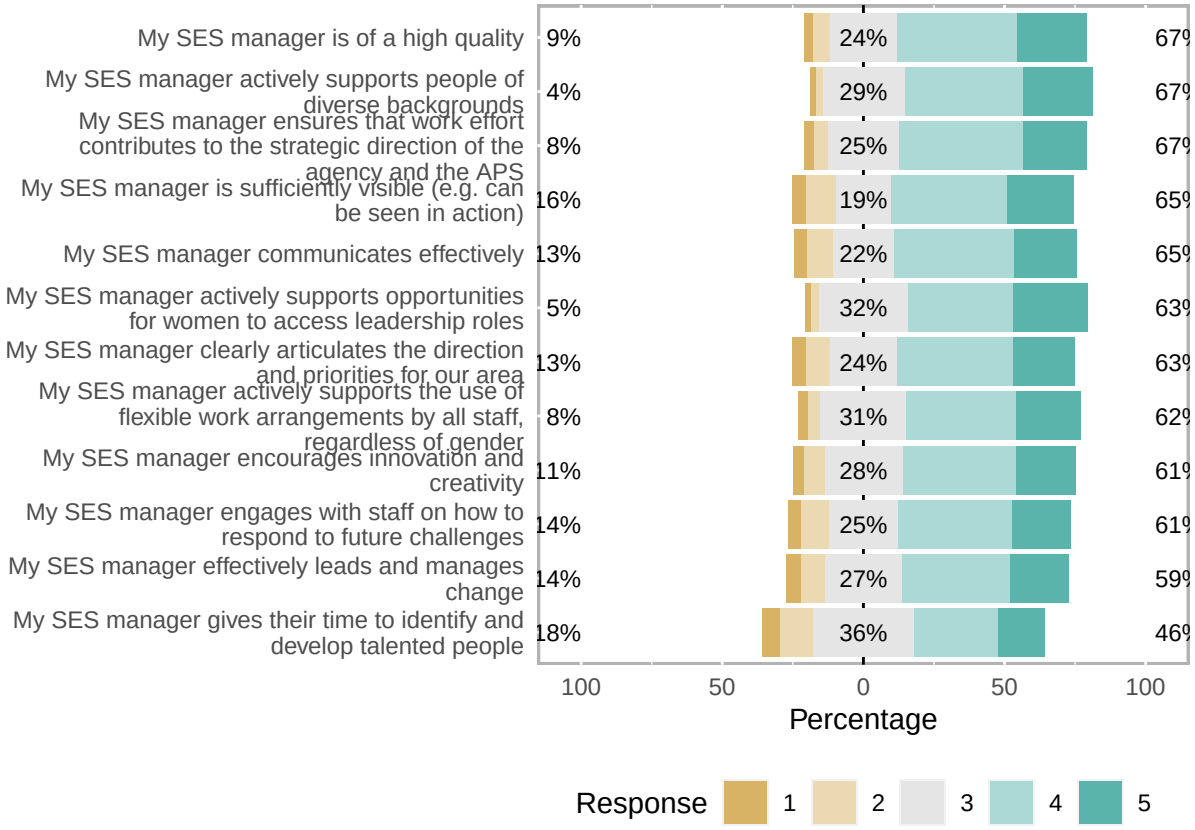
```r
# Descriptive statistics step 2
#scale 4: senior_manager_engagement analysis

# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
senior_manager_engagement_likert <- likert(senior_manager_engagement_df)
summary(senior_manager_engagement_likert)
```

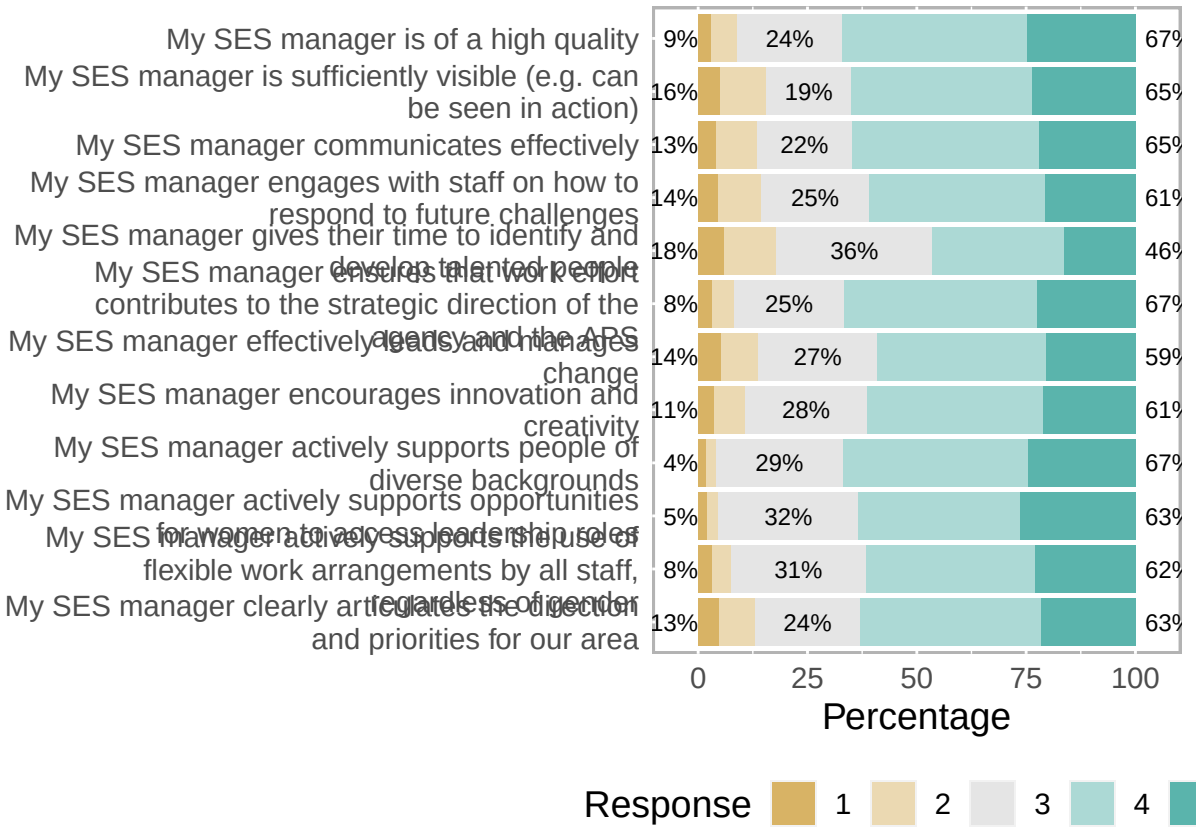
```
##
## 1                                                                    My SES manager is of a high
## 9                                              My SES manager actively supports people of diverse bac
## 6   My SES manager ensures that work effort contributes to the strategic direction of the agency and
## 2                                    My SES manager is sufficiently visible (e.g. can be seen in
## 3                                                                My SES manager communicates eff
## 10                      My SES manager actively supports opportunities for women to access leadersh
## 12                            My SES manager clearly articulates the direction and priorities for
## 11 My SES manager actively supports the use of flexible work arrangements by all staff, regardless o
## 8                                                    My SES manager encourages innovation and cr
## 4                                 My SES manager engages with staff on how to respond to future cha
## 7                                                    My SES manager effectively leads and manage
## 5                                  My SES manager gives their time to identify and develop talente
##          low  neutral     high     mean        sd
## 1   8.894104 24.09152 67.01437 3.797888 0.9795119
## 9   4.001173 29.21209 66.78674 3.856368 0.8771910
## 6   8.231153 25.12291 66.64594 3.777155 0.9575724
## 2  15.598709 19.48489 64.91640 3.681514 1.0954747
## 3  13.436198 21.70373 64.86008 3.692719 1.0460336
```

```
## 10  4.673511 31.93312 63.39337 3.831869 0.9174600
## 12 12.938692 24.20065 62.86066 3.668079 1.0507549
## 11  7.633910 30.66354 61.70255 3.737354 0.9656698
## 8  10.826635 27.80053 61.37284 3.679108 1.0022167
## 4  14.404224 24.64770 60.94808 3.626764 1.0569130
## 7  13.722499 27.23262 59.04488 3.606888 1.0638390
## 5  17.787034 35.85802 46.35494 3.388560 1.0792097
```

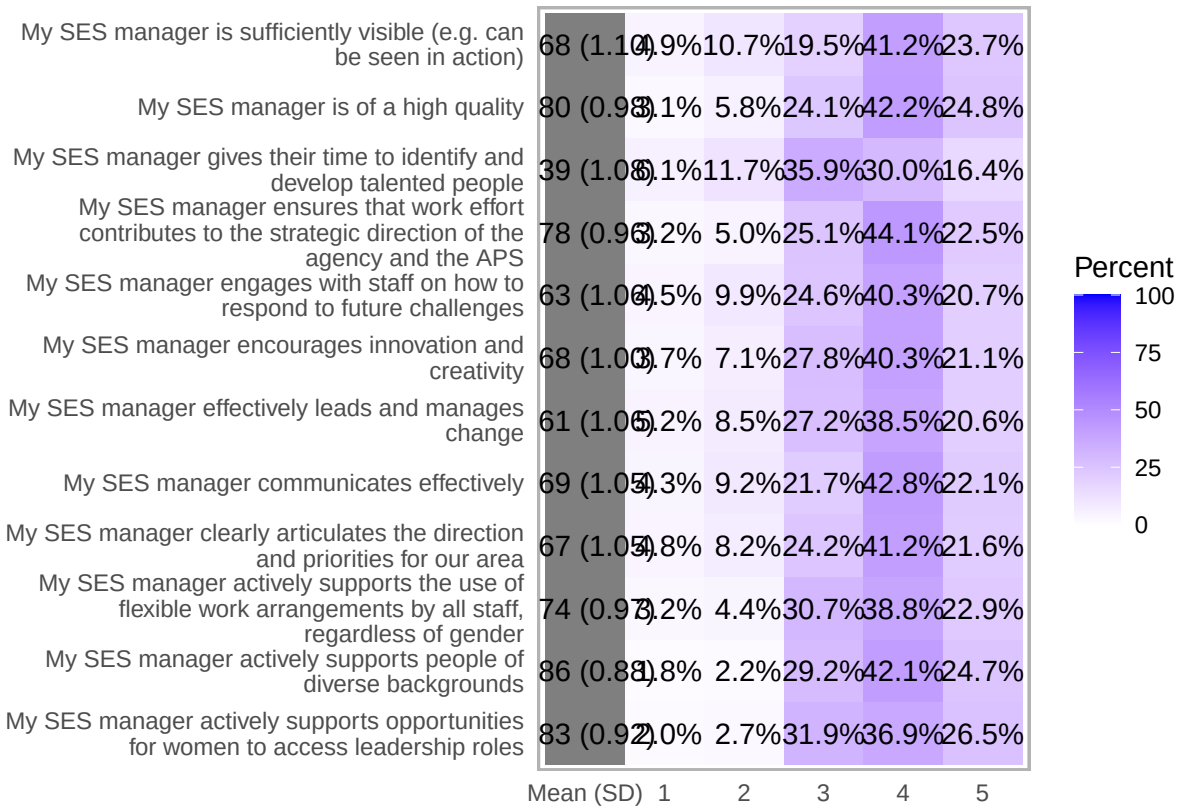
```
# centered bar plot showing the percent responses for each question (order from most to least agreement)
plot(senior_manager_engagement_likert, type="bar")
```



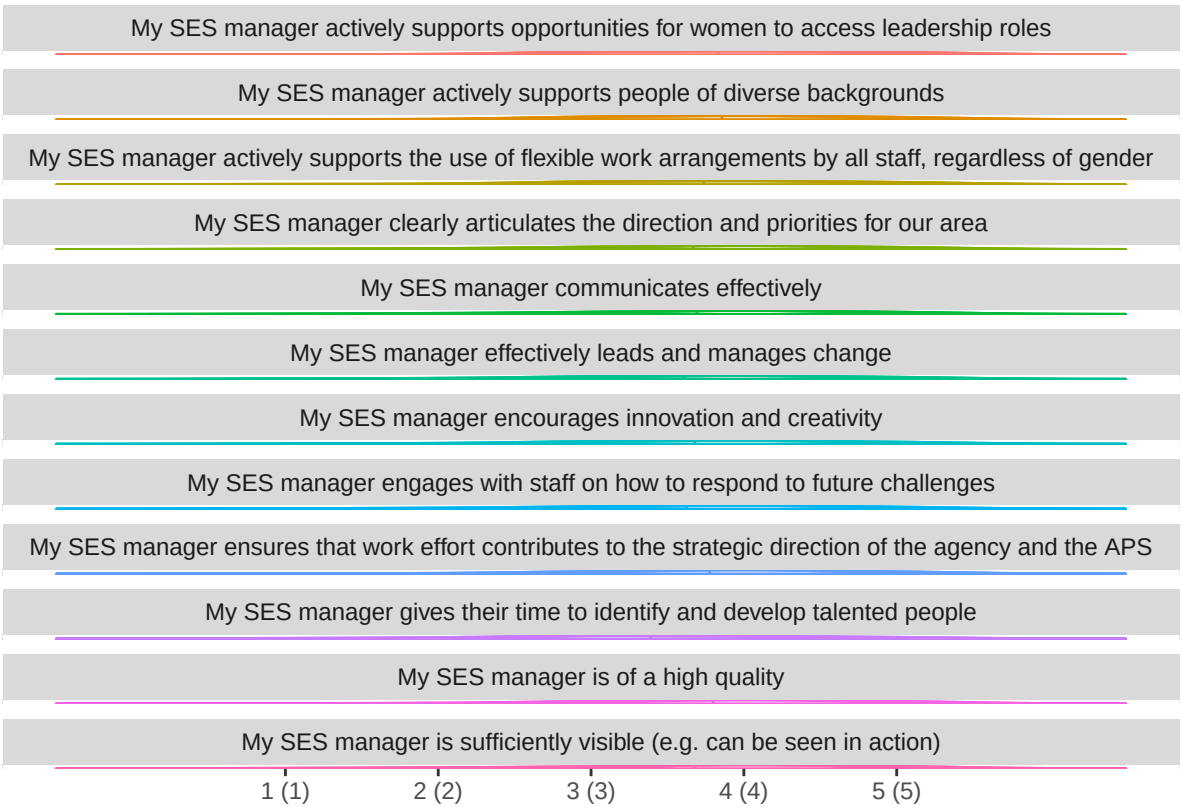

```
# bar plot ordered by question (not centered)
plot(senior_manager_engagement_likert, group.order = names(senior_manager_engagement_df), centered = FA
```




```
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(senior_manager_engagement_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```




```
# density plot (treating Likert data like numeric data)
plot(senior_manager_engagement_likert,
     type="density",
     facet = TRUE,
     bw = 0.5)
```




```r
# descriptive statistics (mean, sd, median, skewness)
psych::describe(senior_manager_engagement_df)
```

```
##
## My SES manager is of a high quality*
## My SES manager is sufficiently visible (e.g. can be seen in action)*
## My SES manager communicates effectively*
## My SES manager engages with staff on how to respond to future challenges*
## My SES manager gives their time to identify and develop talented people*
## My SES manager ensures that work effort contributes to the strategic direction of the agency and the
## My SES manager effectively leads and manages change*
## My SES manager encourages innovation and creativity*
## My SES manager actively supports people of diverse backgrounds*
## My SES manager actively supports opportunities for women to access leadership roles*
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## My SES manager clearly articulates the direction and priorities for our area*
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```

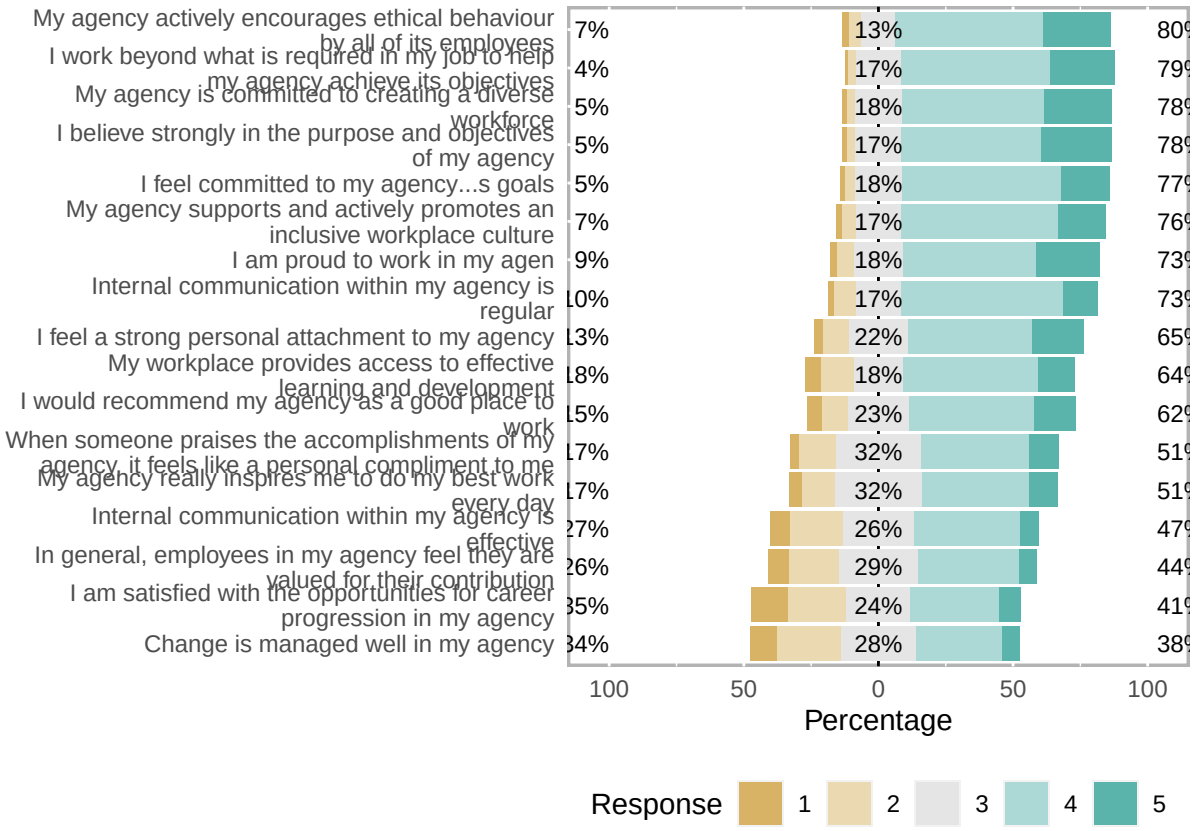
```r
# Descriptive statistics step 2
#scale 5: agency_engagement analysis

# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
agency_engagement_likert <- likert(agency_engagement_df)
summary(agency_engagement_likert)
```

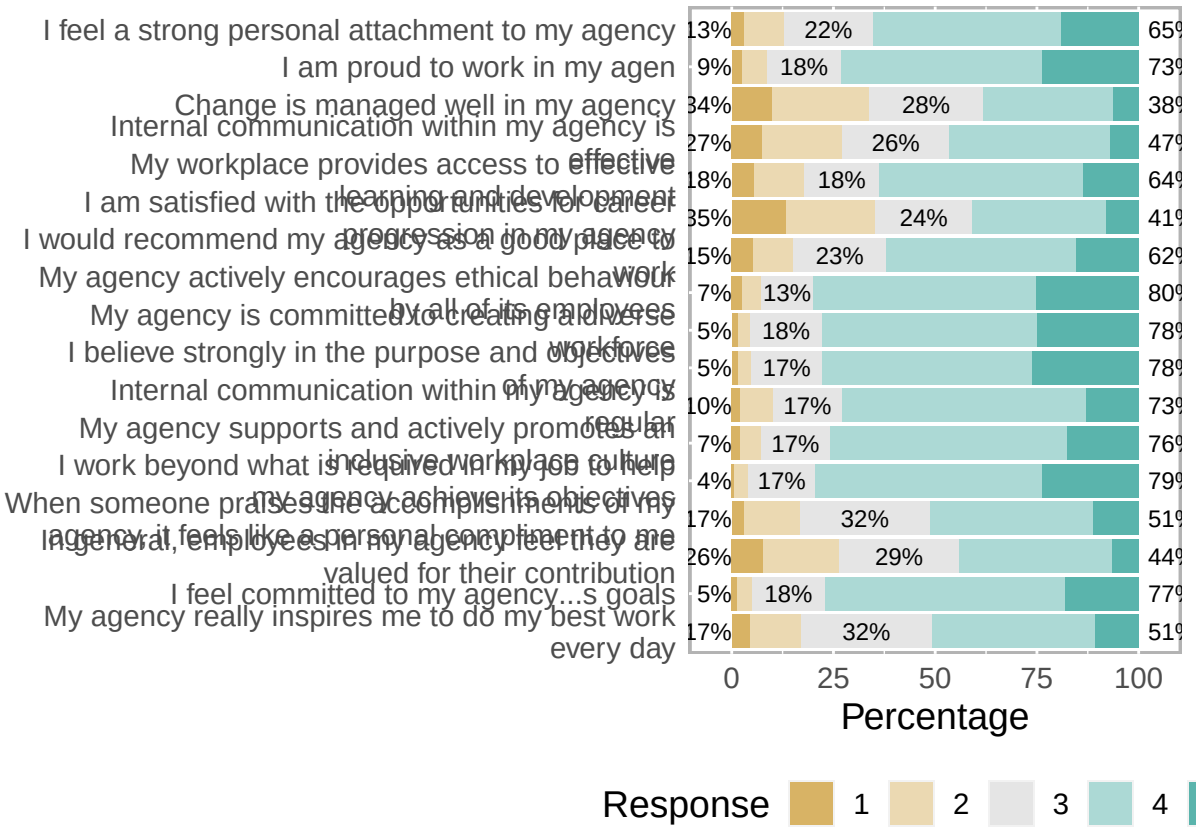
```
##                                                                                                 Item
## 8                           My agency actively encourages ethical behaviour by all of its employees
## 13                I work beyond what is required in my job to help my agency achieve its objectives
## 9                                             My agency is committed to creating a diverse workforce 
## 10                                    I believe strongly in the purpose and objectives of my agency
## 16                                                            I feel committed to my agency's goals
```

```
## 12                          My agency supports and actively promotes an inclusive workplace culture
## 2                                                                                I am proud to work in my agen
## 11                                                  Internal communication within my agency is regular
## 1                                                     I feel a strong personal attachment to my agency
## 5                                  My workplace provides access to effective learning and development
## 7                                                  I would recommend my agency as a good place to work
## 14 When someone praises the accomplishments of my agency, it feels like a personal compliment to me
## 17                                          My agency really inspires me to do my best work every day
## 4                                                Internal communication within my agency is effective
## 15                    In general, employees in my agency feel they are valued for their contribution
## 6                          I am satisfied with the opportunities for career progression in my agency
## 3                                                                Change is managed well in my agency
##          low  neutral     high     mean        sd
## 8   7.298328 12.70871 79.99296 3.953488 0.8920918
## 13  4.015254 16.61484 79.36990 3.983913 0.7769754
## 9   4.536228 17.61572 77.84805 3.967334 0.8301289
## 10  4.875330 17.32238 77.80229 3.973928 0.8418698
## 16  5.020827 17.86213 77.11704 3.886113 0.7881584
## 12  7.102376 17.19097 75.70666 3.840692 0.8416748
## 2   8.552655 18.41948 73.02787 3.857178 0.9299706
## 11 10.134350 16.97976 72.88589 3.734385 0.8631638
## 1  12.855383 21.89968 65.24494 3.683626 0.9879507
## 5  17.938398 18.25638 63.80522 3.538680 1.0516040
## 7  15.060135 22.95101 61.98885 3.571217 1.0319113
## 14 16.795541 31.90378 51.30067 3.425673 0.9625937
## 17 17.074802 32.16427 50.76093 3.397794 0.9911013
## 4  27.210326 26.28454 46.50513 3.187715 1.0636315
## 15 26.498093 29.30361 44.19830 3.164905 1.0514125
## 6  35.327662 23.80874 40.86360 3.000505 1.1849174
## 3  33.674391 28.16075 38.16486 3.008307 1.0999951
```

```r
# centered bar plot showing the percent responses for each question (order from most to least agreement)
plot(agency_engagement_likert, type="bar")
```




```
# bar plot ordered by question (not centered)
plot(agency_engagement_likert, group.order = names(agency_engagement_df), centered = FALSE) + theme(tex
```




```
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(agency_engagement_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <e2>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
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## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
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## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <80>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
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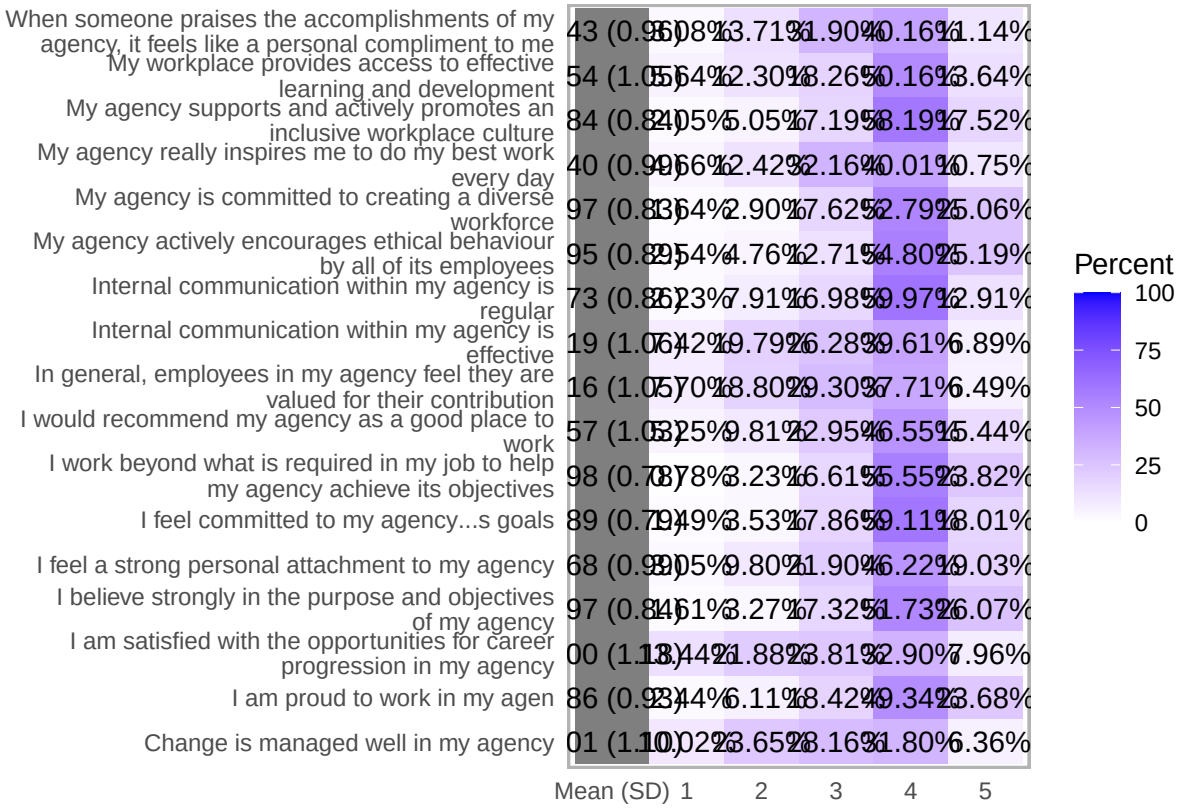


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# density plot (treating Likert data like numeric data)
plot(agency_engagement_likert,
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     facet = TRUE,
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```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <99>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <e2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <80>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <99>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <e2>
```

```
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <80>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'I feel committed to my agency's goals' in 'mbcsToSbcs':
## dot substituted for <99>
```


```r
# descriptive statistics (mean, sd, median, skewness)
psych::describe(agency_engagement_df)
```

```
##                                                                                          va
## I feel a strong personal attachment to my agency*
## I am proud to work in my agen*
## Change is managed well in my agency*
## Internal communication within my agency is effective*
## My workplace provides access to effective learning and development *
## I am satisfied with the opportunities for career progression in my agency*
## I would recommend my agency as a good place to work*
## My agency actively encourages ethical behaviour by all of its employees*
## My agency is committed to creating a diverse workforce *
## I believe strongly in the purpose and objectives of my agency*
## Internal communication within my agency is regular*
## My agency supports and actively promotes an inclusive workplace culture*
## I work beyond what is required in my job to help my agency achieve its objectives*
```

```
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me*
## In general, employees in my agency feel they are valued for their contribution*
## I feel committed to my agency's goals*
## My agency really inspires me to do my best work every day*
##
## I feel a strong personal attachment to my agency*                                                  85%
## I am proud to work in my agen*                                                                     85%
## Change is managed well in my agency*                                                               85%
## Internal communication within my agency is effective*                                              85%
## My workplace provides access to effective learning and development *                               85%
## I am satisfied with the opportunities for career progression in my agency*                         85%
## I would recommend my agency as a good place to work*                                               85%
## My agency actively encourages ethical behaviour by all of its employees*                           85%
## My agency is committed to creating a diverse workforce *                                           85%
## I believe strongly in the purpose and objectives of my agency*                                     85%
## Internal communication within my agency is regular*                                                85%
## My agency supports and actively promotes an inclusive workplace culture*                           85%
## I work beyond what is required in my job to help my agency achieve its objectives*                 85%
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me* 85%
## In general, employees in my agency feel they are valued for their contribution*                    85%
## I feel committed to my agency's goals*                                                             85%
## My agency really inspires me to do my best work every day*                                         85%
##                                                                                                    mea
## I feel a strong personal attachment to my agency*                                                  3.0
## I am proud to work in my agen*                                                                     3.8
## Change is managed well in my agency*                                                               3.0
## Internal communication within my agency is effective*                                              3.1
## My workplace provides access to effective learning and development *                               3.5
## I am satisfied with the opportunities for career progression in my agency*                         3.0
## I would recommend my agency as a good place to work*                                               3.5
## My agency actively encourages ethical behaviour by all of its employees*                           3.9
## My agency is committed to creating a diverse workforce *                                           3.9
## I believe strongly in the purpose and objectives of my agency*                                     3.9
## Internal communication within my agency is regular*                                                3.7
## My agency supports and actively promotes an inclusive workplace culture*                           3.8
## I work beyond what is required in my job to help my agency achieve its objectives*                 3.9
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me* 3.4
## In general, employees in my agency feel they are valued for their contribution*                    3.1
## I feel committed to my agency's goals*                                                             3.8
## My agency really inspires me to do my best work every day*                                         3.4
##                                                                                                      s
## I feel a strong personal attachment to my agency*                                                  0.9
## I am proud to work in my agen*                                                                     0.9
## Change is managed well in my agency*                                                               1.1
## Internal communication within my agency is effective*                                              1.0
## My workplace provides access to effective learning and development *                               1.0
## I am satisfied with the opportunities for career progression in my agency*                         1.1
## I would recommend my agency as a good place to work*                                               1.0
## My agency actively encourages ethical behaviour by all of its employees*                           0.8
## My agency is committed to creating a diverse workforce *                                           0.8
## I believe strongly in the purpose and objectives of my agency*                                     0.8
## Internal communication within my agency is regular*                                                0.8
## My agency supports and actively promotes an inclusive workplace culture*                           0.8
## I work beyond what is required in my job to help my agency achieve its objectives*                 0.7
```

```
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me* 0.9
## In general, employees in my agency feel they are valued for their contribution*                    1.0
## I feel committed to my agency's goals*                                                             0.7
## My agency really inspires me to do my best work every day*                                         0.9
##                                                                                                    med
## I feel a strong personal attachment to my agency*
## I am proud to work in my agen*
## Change is managed well in my agency*
## Internal communication within my agency is effective*
## My workplace provides access to effective learning and development *
## I am satisfied with the opportunities for career progression in my agency*
## I would recommend my agency as a good place to work*
## My agency actively encourages ethical behaviour by all of its employees*
## My agency is committed to creating a diverse workforce *
## I believe strongly in the purpose and objectives of my agency*
## Internal communication within my agency is regular*
## My agency supports and actively promotes an inclusive workplace culture*
## I work beyond what is required in my job to help my agency achieve its objectives*
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me*
## In general, employees in my agency feel they are valued for their contribution*
## I feel committed to my agency's goals*
## My agency really inspires me to do my best work every day*
##                                                                                                    tri
## I feel a strong personal attachment to my agency*
## I am proud to work in my agen*
## Change is managed well in my agency*
## Internal communication within my agency is effective*
## My workplace provides access to effective learning and development *
## I am satisfied with the opportunities for career progression in my agency*
## I would recommend my agency as a good place to work*
## My agency actively encourages ethical behaviour by all of its employees*
## My agency is committed to creating a diverse workforce *
## I believe strongly in the purpose and objectives of my agency*
## Internal communication within my agency is regular*
## My agency supports and actively promotes an inclusive workplace culture*
## I work beyond what is required in my job to help my agency achieve its objectives*
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me*
## In general, employees in my agency feel they are valued for their contribution*
## I feel committed to my agency's goals*
## My agency really inspires me to do my best work every day*
##                                                                                                     ma
## I feel a strong personal attachment to my agency*                                                  1.4
## I am proud to work in my agen*                                                                     1.4
## Change is managed well in my agency*                                                               1.4
## Internal communication within my agency is effective*                                              1.4
## My workplace provides access to effective learning and development *                               0.0
## I am satisfied with the opportunities for career progression in my agency*                         1.4
## I would recommend my agency as a good place to work*                                               1.4
## My agency actively encourages ethical behaviour by all of its employees*                           0.0
## My agency is committed to creating a diverse workforce *                                          0.0
## I believe strongly in the purpose and objectives of my agency*                                     0.0
## Internal communication within my agency is regular*                                                0.0
## My agency supports and actively promotes an inclusive workplace culture*                           0.0
## I work beyond what is required in my job to help my agency achieve its objectives*                 0.0
```

```
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me* 1.
## In general, employees in my agency feel they are valued for their contribution*                    1.
## I feel committed to my agency's goals*                                                             0.
## My agency really inspires me to do my best work every day*                                         1.
##                                                                                                    mi
## I feel a strong personal attachment to my agency*
## I am proud to work in my agen*
## Change is managed well in my agency*
## Internal communication within my agency is effective*
## My workplace provides access to effective learning and development *
## I am satisfied with the opportunities for career progression in my agency*
## I would recommend my agency as a good place to work*
## My agency actively encourages ethical behaviour by all of its employees*
## My agency is committed to creating a diverse workforce *
## I believe strongly in the purpose and objectives of my agency*
## Internal communication within my agency is regular*
## My agency supports and actively promotes an inclusive workplace culture*
## I work beyond what is required in my job to help my agency achieve its objectives*
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me*
## In general, employees in my agency feel they are valued for their contribution*
## I feel committed to my agency's goals*
## My agency really inspires me to do my best work every day*
##                                                                                                    ma
## I feel a strong personal attachment to my agency*                                                    5
## I am proud to work in my agen*                                                                       5
## Change is managed well in my agency*                                                                 5
## Internal communication within my agency is effective*                                                5
## My workplace provides access to effective learning and development *                                 5
## I am satisfied with the opportunities for career progression in my agency*                           5
## I would recommend my agency as a good place to work*                                                 5
## My agency actively encourages ethical behaviour by all of its employees*                             5
## My agency is committed to creating a diverse workforce *                                             5
## I believe strongly in the purpose and objectives of my agency*                                       5
## Internal communication within my agency is regular*                                                  5
## My agency supports and actively promotes an inclusive workplace culture*                             5
## I work beyond what is required in my job to help my agency achieve its objectives*                   5
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me*   5
## In general, employees in my agency feel they are valued for their contribution*                      5
## I feel committed to my agency's goals*                                                               5
## My agency really inspires me to do my best work every day*                                           5
##                                                                                                    ra
## I feel a strong personal attachment to my agency*
## I am proud to work in my agen*
## Change is managed well in my agency*
## Internal communication within my agency is effective*
## My workplace provides access to effective learning and development *
## I am satisfied with the opportunities for career progression in my agency*
## I would recommend my agency as a good place to work*
## My agency actively encourages ethical behaviour by all of its employees*
## My agency is committed to creating a diverse workforce *
## I believe strongly in the purpose and objectives of my agency*
## Internal communication within my agency is regular*
## My agency supports and actively promotes an inclusive workplace culture*
## I work beyond what is required in my job to help my agency achieve its objectives*
```

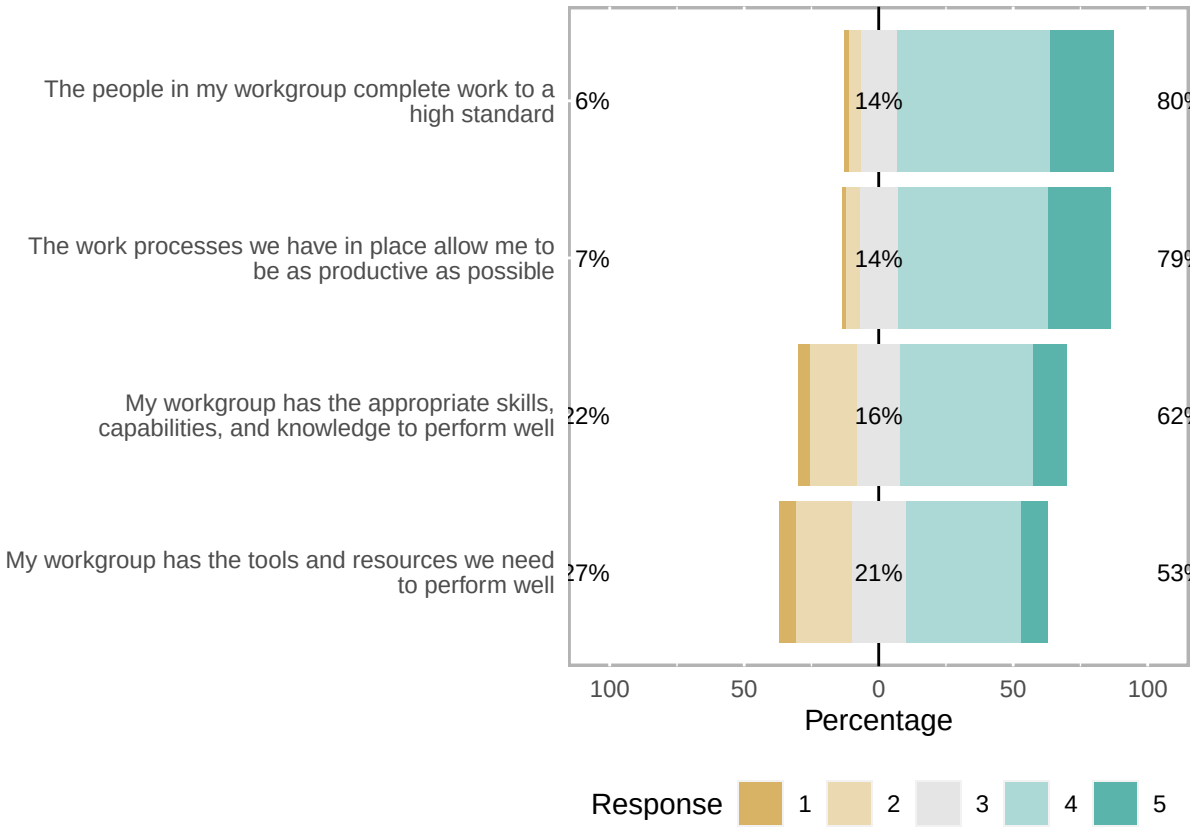
```
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me*
## In general, employees in my agency feel they are valued for their contribution*
## I feel committed to my agency's goals*
## My agency really inspires me to do my best work every day*
##                                                                                                  sl
## I feel a strong personal attachment to my agency*                                                -0
## I am proud to work in my agen*                                                                   -0
## Change is managed well in my agency*                                                             -0
## Internal communication within my agency is effective*                                            -0
## My workplace provides access to effective learning and development *                             -0
## I am satisfied with the opportunities for career progression in my agency*                       -0
## I would recommend my agency as a good place to work*                                             -0
## My agency actively encourages ethical behaviour by all of its employees*                         -1
## My agency is committed to creating a diverse workforce *                                         -0
## I believe strongly in the purpose and objectives of my agency*                                   -0
## Internal communication within my agency is regular*                                              -1
## My agency supports and actively promotes an inclusive workplace culture*                         -1
## I work beyond what is required in my job to help my agency achieve its objectives*               -0
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me* -0
## In general, employees in my agency feel they are valued for their contribution*                  -0
## I feel committed to my agency's goals*                                                           -0
## My agency really inspires me to do my best work every day*                                       -0
##                                                                                                  ku
## I feel a strong personal attachment to my agency*
## I am proud to work in my agen*
## Change is managed well in my agency*
## Internal communication within my agency is effective*
## My workplace provides access to effective learning and development *
## I am satisfied with the opportunities for career progression in my agency*
## I would recommend my agency as a good place to work*
## My agency actively encourages ethical behaviour by all of its employees*
## My agency is committed to creating a diverse workforce *
## I believe strongly in the purpose and objectives of my agency*
## Internal communication within my agency is regular*
## My agency supports and actively promotes an inclusive workplace culture*
## I work beyond what is required in my job to help my agency achieve its objectives*
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me*
## In general, employees in my agency feel they are valued for their contribution*
## I feel committed to my agency's goals*
## My agency really inspires me to do my best work every day*
##                                                                                                  se
## I feel a strong personal attachment to my agency*                                                 0
## I am proud to work in my agen*                                                                    0
## Change is managed well in my agency*                                                              0
## Internal communication within my agency is effective*                                             0
## My workplace provides access to effective learning and development *                              0
## I am satisfied with the opportunities for career progression in my agency*                        0
## I would recommend my agency as a good place to work*                                              0
## My agency actively encourages ethical behaviour by all of its employees*                          0
## My agency is committed to creating a diverse workforce *                                          0
## I believe strongly in the purpose and objectives of my agency*                                    0
## Internal communication within my agency is regular*                                               0
## My agency supports and actively promotes an inclusive workplace culture*                          0
## I work beyond what is required in my job to help my agency achieve its objectives*                0
```

```
## When someone praises the accomplishments of my agency, it feels like a personal compliment to me*  0
## In general, employees in my agency feel they are valued for their contribution*                     0
## I feel committed to my agency's goals*                                                              0
## My agency really inspires me to do my best work every day*                                          0
```

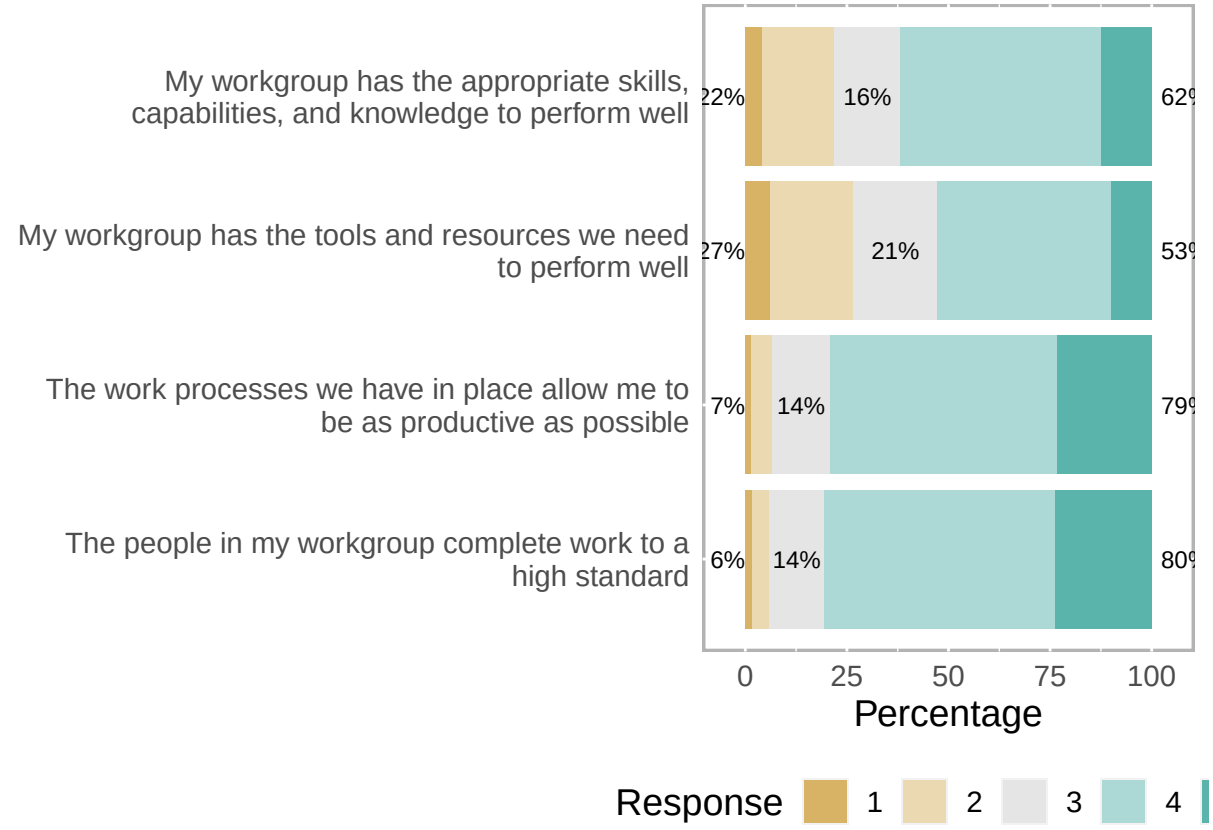
```
# Descriptive statistics step 2
#scale 6: team_performance_support analysis

# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
team_performance_support_likert <- likert(team_performance_support_df)
summary(team_performance_support_likert)
```

```
##                                                                                 Item
## 4                          The people in my workgroup complete work to a high standard
## 3         The work processes we have in place allow me to be as productive as possible
## 1 My workgroup has the appropriate skills, capabilities, and knowledge to perform well
## 2                      My workgroup has the tools and resources we need to perform well
##         low  neutral     high     mean        sd
## 4  5.777647 13.72485 80.49751 3.968307 0.8296365
## 3  6.652977 14.19771 79.14931 3.943092 0.8388534
## 1 21.892637 16.32972 61.77765 3.481737 1.0520228
## 2 26.667058 20.52801 52.80493 3.299149 1.0900622
```

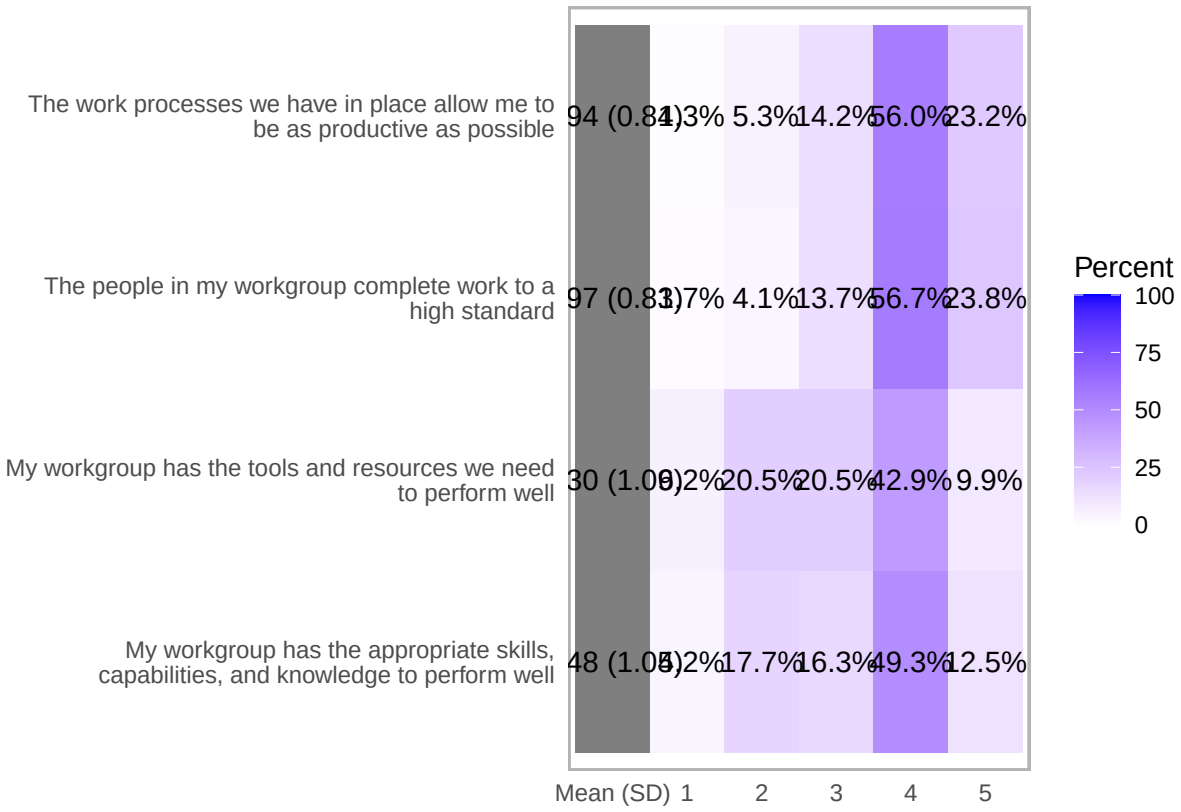
```
# centered bar plot showing the percent responses for each question (order from most to least agreement
plot(team_performance_support_likert, type="bar")
```



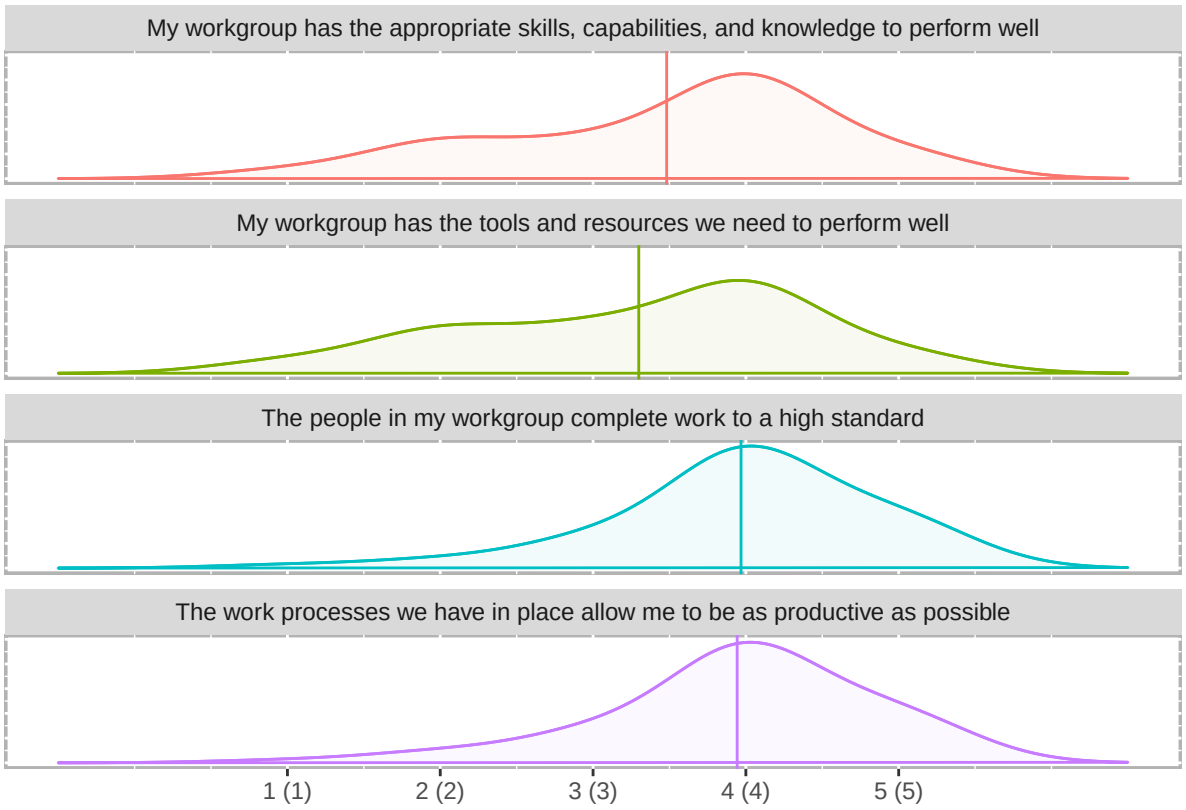
```r
# bar plot ordered by question (not centered)
plot(team_performance_support_likert, group.order = names(team_performance_support_df), centered = FALSE
```




```r
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(team_performance_support_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```




```
# density plot (treating Likert data like numeric data)
plot(team_performance_support_likert,
     type="density",
     facet = TRUE,
     bw = 0.5)
```




```
# descriptive statistics (mean, sd, median, skewness)
psych::describe(team_performance_support_df)
```

```
##                                                                                vars
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well*    1
## My workgroup has the tools and resources we need to perform well*                        2
## The work processes we have in place allow me to be as productive as possible*            3
## The people in my workgroup complete work to a high standard*                             4
##                                                                                        n
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well* 85225
## My workgroup has the tools and resources we need to perform well*                     85225
## The work processes we have in place allow me to be as productive as possible*         85225
## The people in my workgroup complete work to a high standard*                          85225
##                                                                                     mean
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well* 3.48
## My workgroup has the tools and resources we need to perform well*                     3.30
## The work processes we have in place allow me to be as productive as possible*         3.94
## The people in my workgroup complete work to a high standard*                          3.97
##                                                                                       sd
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well* 1.05
## My workgroup has the tools and resources we need to perform well*                     1.09
## The work processes we have in place allow me to be as productive as possible*         0.84
## The people in my workgroup complete work to a high standard*                          0.83
##                                                                                   median
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well*      4
```

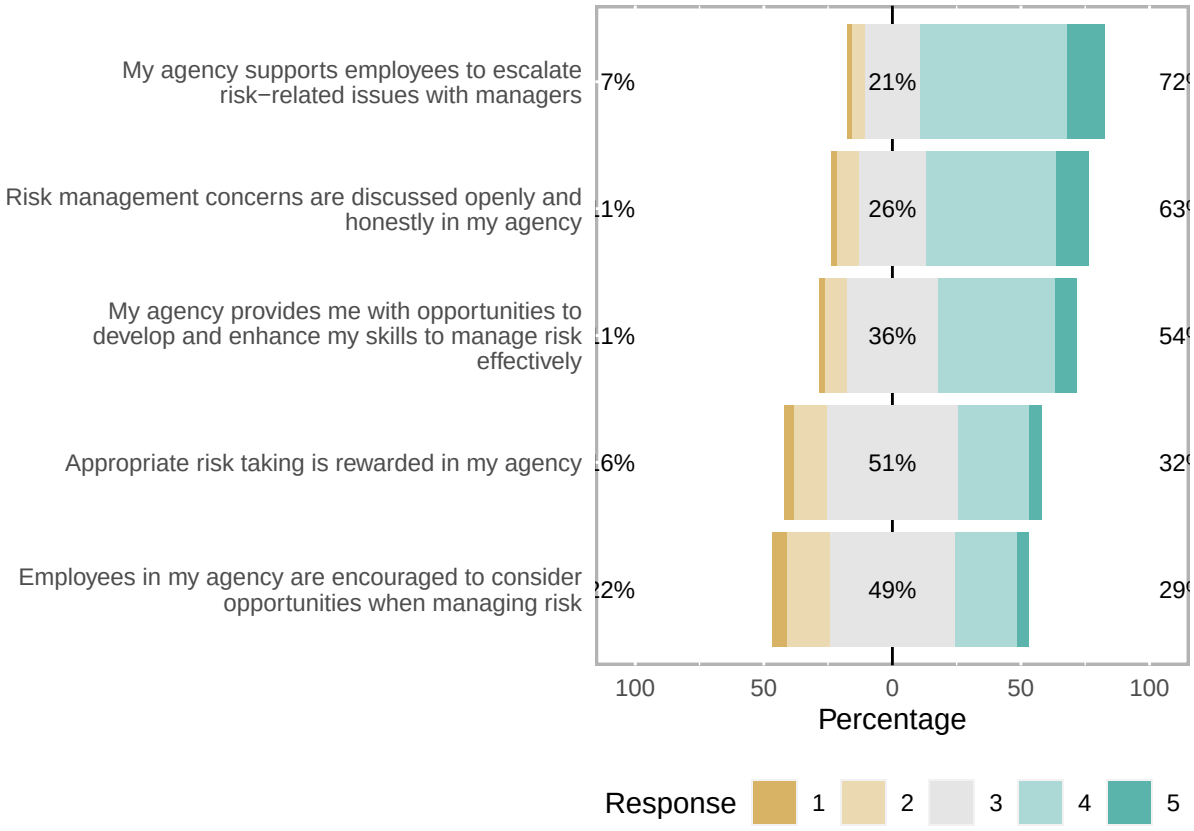
```
## My workgroup has the tools and resources we need to perform well*                          4
## The work processes we have in place allow me to be as productive as possible*              4
## The people in my workgroup complete work to a high standard*                               4
##                                                                                       trimmed
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well*    3.53
## My workgroup has the tools and resources we need to perform well*                        3.33
## The work processes we have in place allow me to be as productive as possible*            4.03
## The people in my workgroup complete work to a high standard*                             4.05
##                                                                                        mad
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well* 1.48
## My workgroup has the tools and resources we need to perform well*                     1.48
## The work processes we have in place allow me to be as productive as possible*         0.00
## The people in my workgroup complete work to a high standard*                          0.00
##                                                                                       min
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well*   1
## My workgroup has the tools and resources we need to perform well*                        1
## The work processes we have in place allow me to be as productive as possible*            1
## The people in my workgroup complete work to a high standard*                             1
##                                                                                       max
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well*   5
## My workgroup has the tools and resources we need to perform well*                        5
## The work processes we have in place allow me to be as productive as possible*            5
## The people in my workgroup complete work to a high standard*                             5
##                                                                                     range
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well*     4
## My workgroup has the tools and resources we need to perform well*                         4
## The work processes we have in place allow me to be as productive as possible*             4
## The people in my workgroup complete work to a high standard*                              4
##                                                                                      skew
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well* -0.63
## My workgroup has the tools and resources we need to perform well*                     -0.44
## The work processes we have in place allow me to be as productive as possible*         -0.98
## The people in my workgroup complete work to a high standard*                          -1.07
##                                                                                    kurtosis
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well*    -0.42
## My workgroup has the tools and resources we need to perform well*                        -0.70
## The work processes we have in place allow me to be as productive as possible*             1.38
## The people in my workgroup complete work to a high standard*                              1.85
##                                                                                       se
## My workgroup has the appropriate skills, capabilities, and knowledge to perform well*  0
## My workgroup has the tools and resources we need to perform well*                      0
## The work processes we have in place allow me to be as productive as possible*          0
## The people in my workgroup complete work to a high standard*                           0
```

```
# Descriptive statistics step 2
#scale 7: risk_culture analysis

# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
risk_culture_likert <- likert(risk_culture_df)
summary(risk_culture_likert)
```

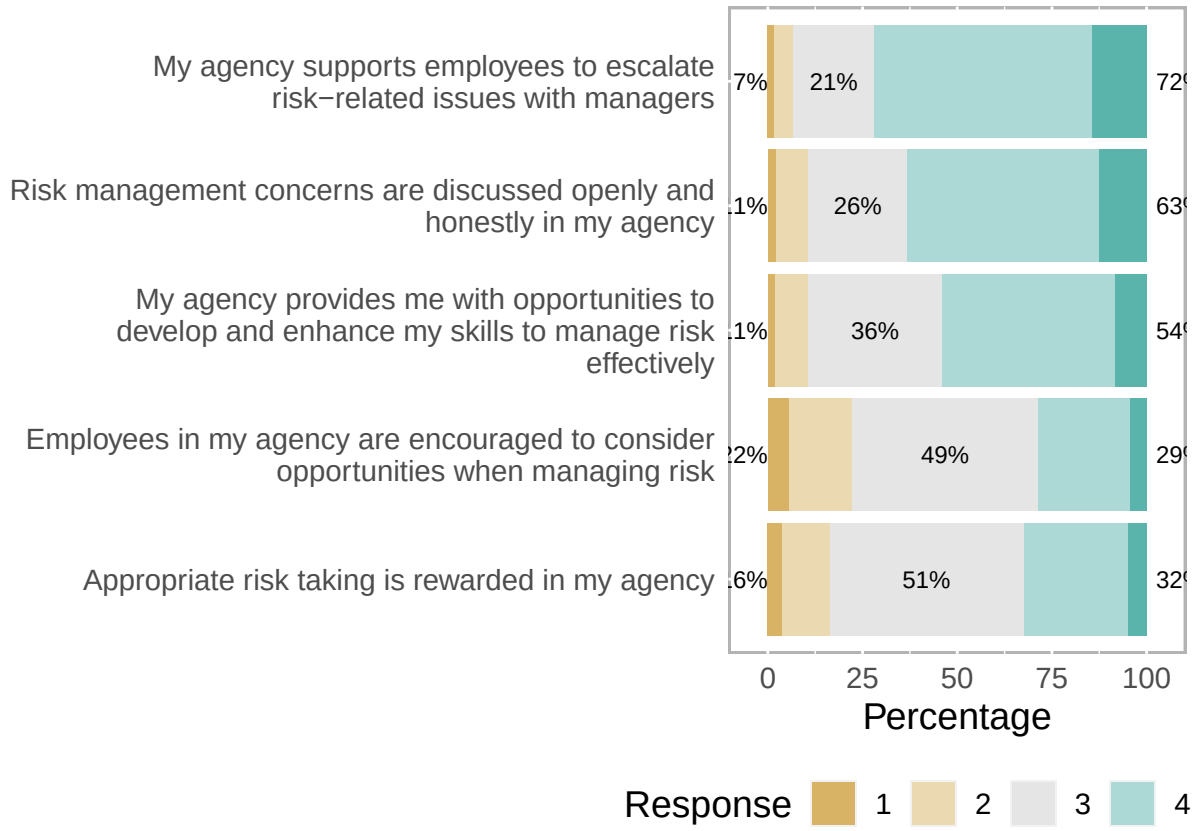
```
##                                                                                        It
## 1                          My agency supports employees to escalate risk-related issues with manage
```

```
## 2                              Risk management concerns are discussed openly and honestly in my agenc
## 3 My agency provides me with opportunities to develop and enhance my skills to manage risk effectivel
## 5                                                  Appropriate risk taking is rewarded in my agenc
## 4                    Employees in my agency are encouraged to consider opportunities when managing ris
##         low  neutral     high     mean        sd
## 1  6.647111 21.47023 71.88266 3.781109 0.8124453
## 2 10.655324 26.11206 63.23262 3.628290 0.8869735
## 3 10.611910 35.50484 53.88325 3.494151 0.8428955
## 5 16.310942 51.20211 32.48695 3.172356 0.8452860
## 4 22.337342 49.02200 28.64066 3.052097 0.8971876
```

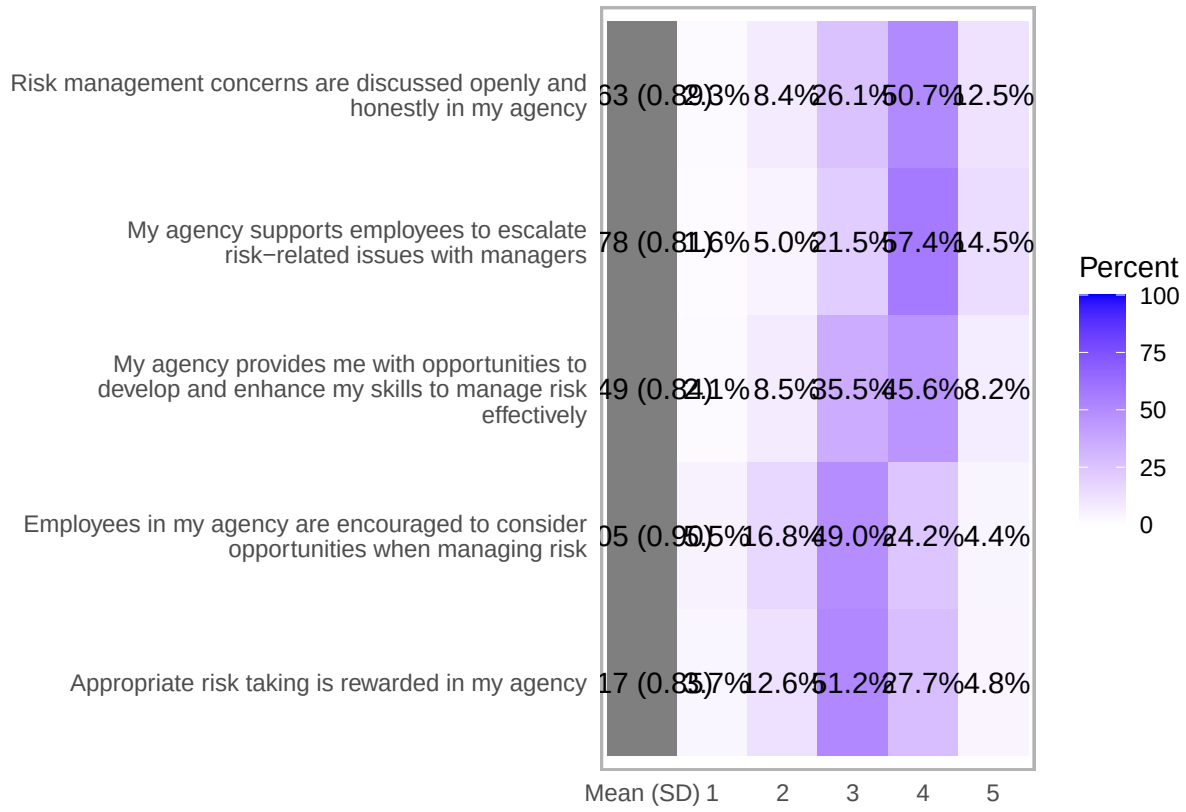
```r
# centered bar plot showing the percent responses for each question (order from most to least agreement)
plot(risk_culture_likert, type="bar")
```



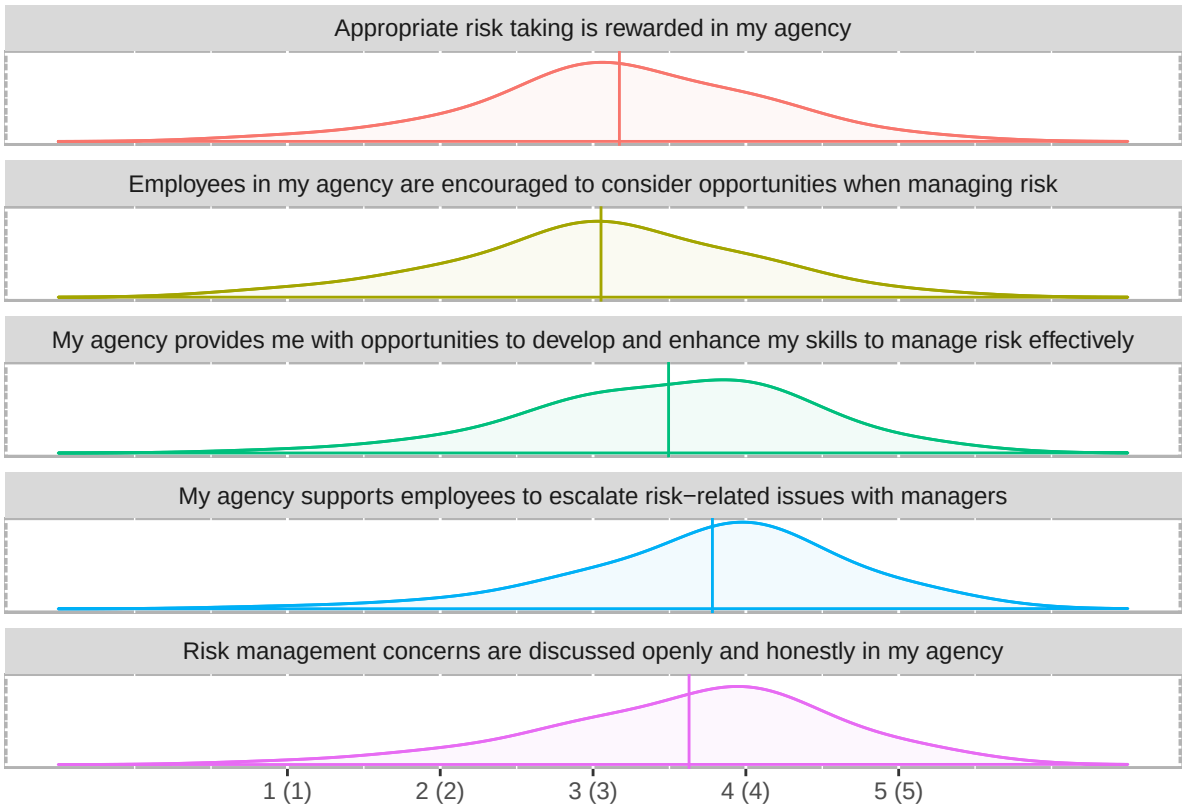

```r
# bar plot ordered by question (not centered)
plot(risk_culture_likert, group.order = names(risk_culture_df), centered = FALSE) + theme(text = elemen
```




```
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(risk_culture_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```




```
# density plot (treating Likert data like numeric data)
plot(risk_culture_likert,
     type="density",
     facet = TRUE,
     bw = 0.5)
```



```r
# descriptive statistics (mean, sd, median, skewness)
psych::describe(risk_culture_df)
```

```
##
## My agency supports employees to escalate risk-related issues with managers*
## Risk management concerns are discussed openly and honestly in my agency*
## My agency provides me with opportunities to develop and enhance my skills to manage risk effectively
## Employees in my agency are encouraged to consider opportunities when managing risk*
## Appropriate risk taking is rewarded in my agency*
##
## My agency supports employees to escalate risk-related issues with managers*
## Risk management concerns are discussed openly and honestly in my agency*
## My agency provides me with opportunities to develop and enhance my skills to manage risk effectively
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## Risk management concerns are discussed openly and honestly in my agency*
## My agency provides me with opportunities to develop and enhance my skills to manage risk effectively
```

```
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##
## My agency supports employees to escalate risk-related issues with managers*
## Risk management concerns are discussed openly and honestly in my agency*
## My agency provides me with opportunities to develop and enhance my skills to manage risk effectively
```
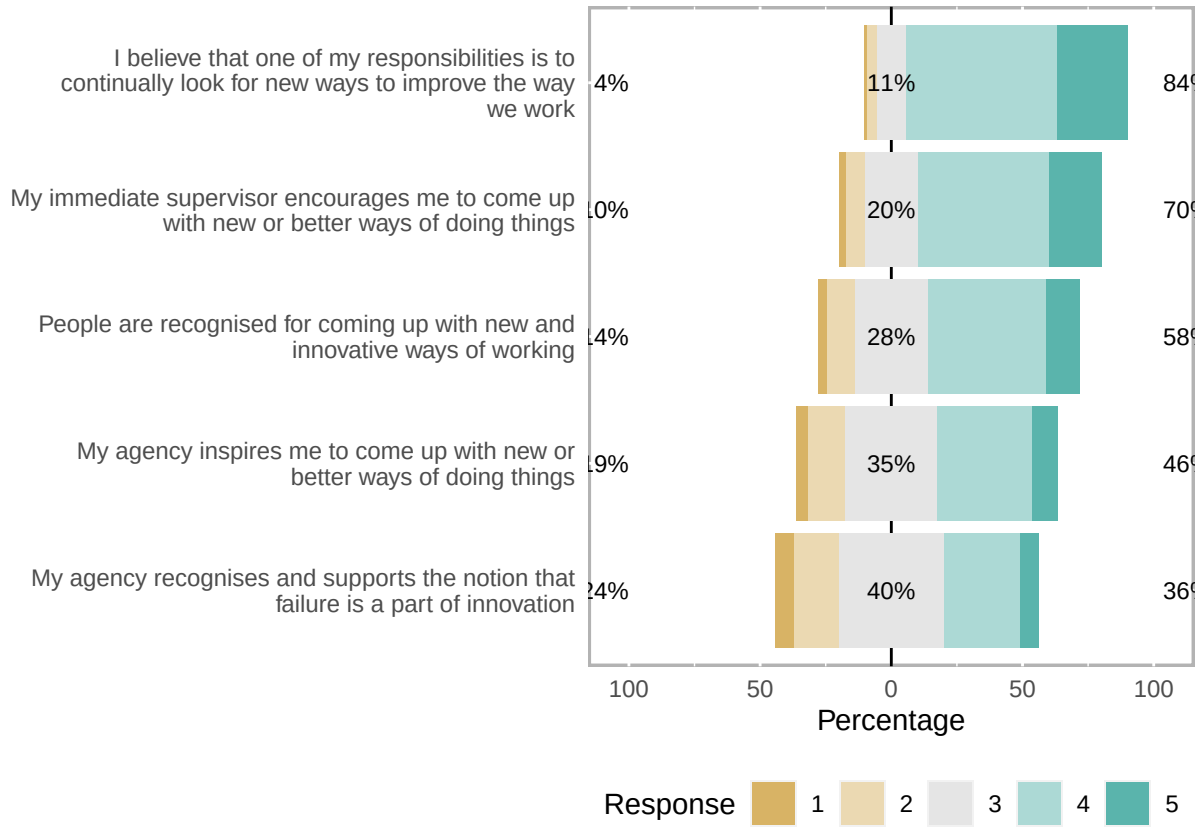

```
## Employees in my agency are encouraged to consider opportunities when managing risk*
## Appropriate risk taking is rewarded in my agency*
```

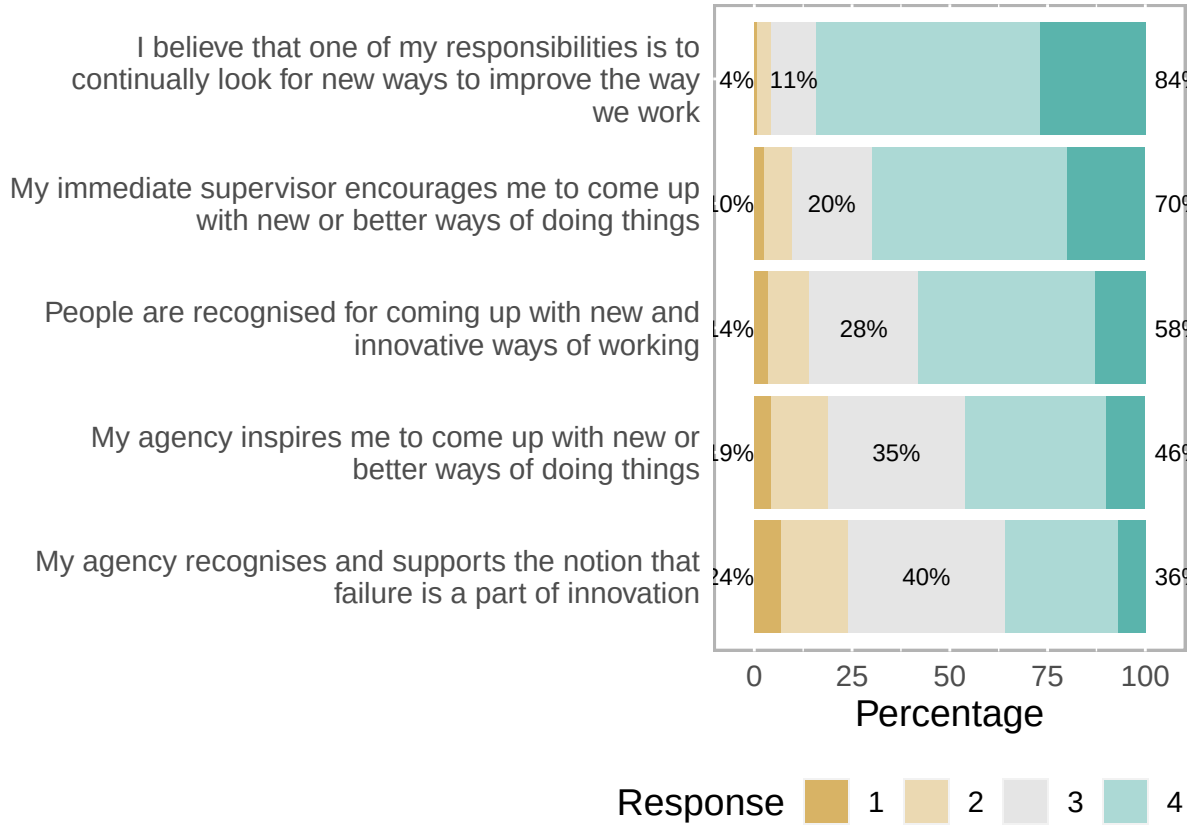
```
# Descriptive statistics step 2
#scale 8: innovation analysis

# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
innovation_likert <- likert(innovation_df)
summary(innovation_likert)
```

```
##
## 1 I believe that one of my responsibilities is to continually look for new ways to improve the way w
## 2                 My immediate supervisor encourages me to come up with new or better ways of doing
## 3                              People are recognised for coming up with new and innovative ways of w
## 4                                 My agency inspires me to come up with new or better ways of doing
## 5                        My agency recognises and supports the notion that failure is a part of innov
##         low  neutral     high     mean        sd
## 1  4.430625 11.29363 84.27574 4.058915 0.7720688
## 2  9.707246 20.29569 69.99707 3.776873 0.9296263
## 3 14.126137 27.76415 58.10971 3.534116 0.9620672
## 4 18.823115 35.14931 46.02757 3.327204 0.9851853
## 5 23.940158 40.22763 35.83221 3.117606 1.0011154
```

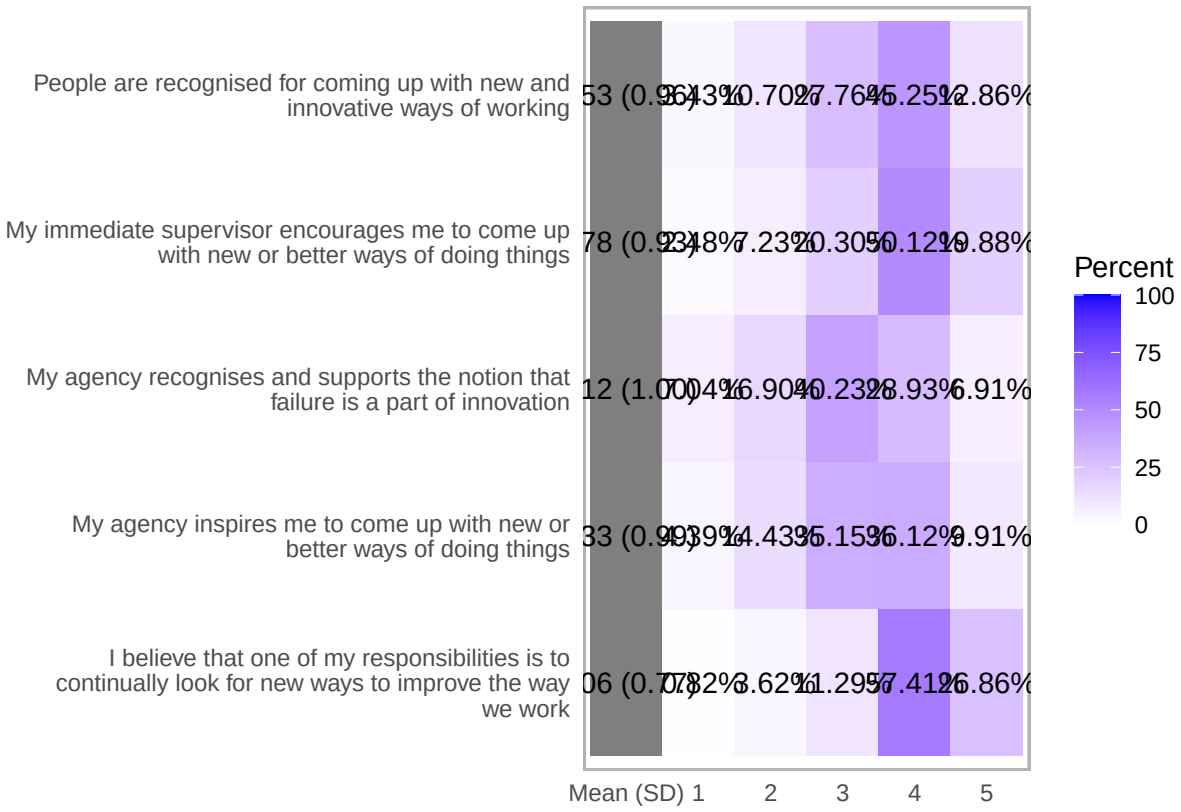
```
# centered bar plot showing the percent responses for each question (order from most to least agreement)
plot(innovation_likert, type="bar")
```



```
# bar plot ordered by question (not centered)
plot(innovation_likert, group.order = names(innovation_df), centered = FALSE) + theme(text = element_te
```




```
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(innovation_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```




```
# density plot (treating Likert data like numeric data)
plot(innovation_likert,
     type="density",
     facet = TRUE,
     bw = 0.5)
```

```r
# descriptive statistics (mean, sd, median, skewness)
psych::describe(innovation_df)
```

```
##
## I believe that one of my responsibilities is to continually look for new ways to improve the way we
## My immediate supervisor encourages me to come up with new or better ways of doing things*
## People are recognised for coming up with new and innovative ways of working*
## My agency inspires me to come up with new or better ways of doing things*
## My agency recognises and supports the notion that failure is a part of innovation*
##
## I believe that one of my responsibilities is to continually look for new ways to improve the way we
## My immediate supervisor encourages me to come up with new or better ways of doing things*
## People are recognised for coming up with new and innovative ways of working*
## My agency inspires me to come up with new or better ways of doing things*
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```

```
## My agency inspires me to come up with new or better ways of doing things*
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## I believe that one of my responsibilities is to continually look for new ways to improve the way we
## My immediate supervisor encourages me to come up with new or better ways of doing things*
## People are recognised for coming up with new and innovative ways of working*
```

```
## My agency inspires me to come up with new or better ways of doing things*
## My agency recognises and supports the notion that failure is a part of innovation*
```

```
# Descriptive statistics step 2
#scale 9: leadership_engagement analysis

str(leadership_engagement_df)
```

```
## 'data.frame':    85225 obs. of  7 variables:
##  $ In my agency, the SES are sufficiently visible (e.g. can be seen in action)
##  $ In myagency, communication between the SES and other employees is effective
##  $ In my agency, the SES actively contribute to the work of our agency
##  $ In my agency, the SES are of a high quality
##  $ In my agency, the SES supports and provides opportunities for new ways of working in a digital en
##  $ In my agency, the SES work as a team
##  $ In my agency, the SES clearly articulate the direction and priorities for our agency
```

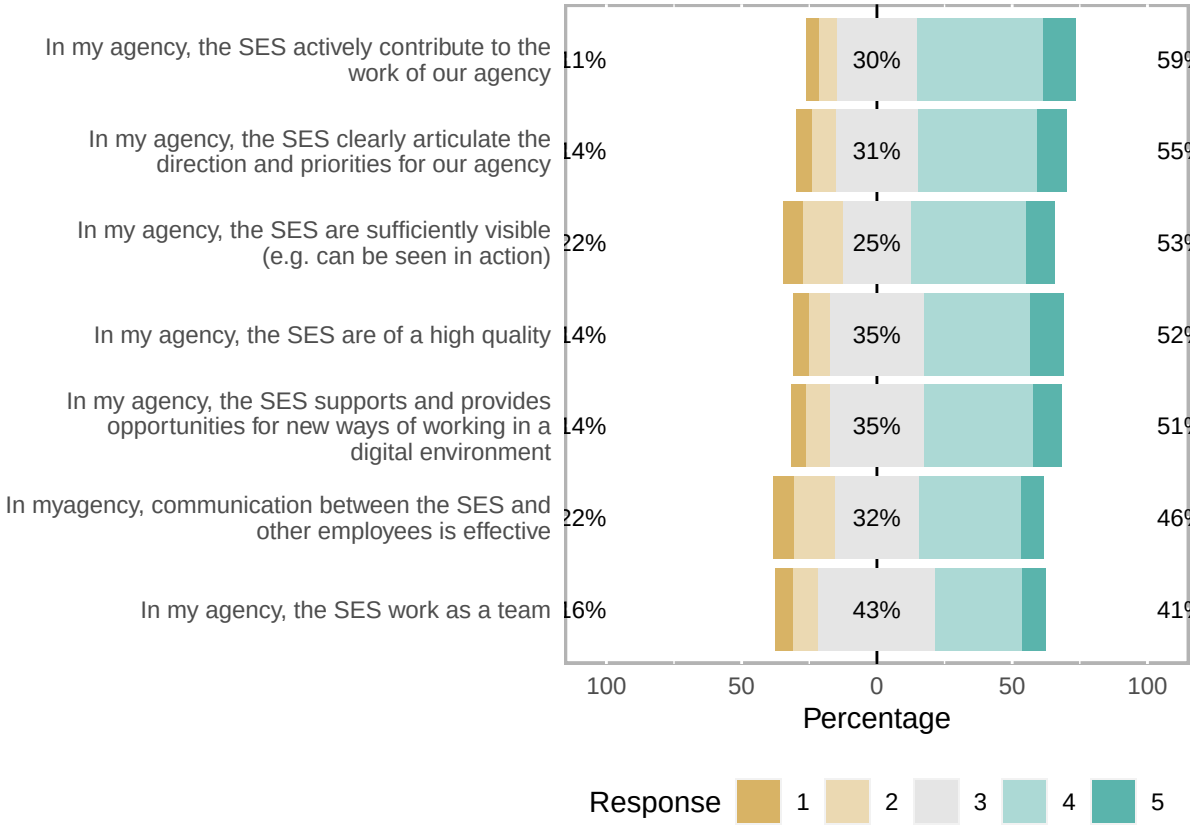
```
leadership_engagement_df <- droplevels(leadership_engagement_df)
str(leadership_engagement_df)
```

```
## 'data.frame':    85225 obs. of  7 variables:
##  $ In my agency, the SES are sufficiently visible (e.g. can be seen in action)
##  $ In myagency, communication between the SES and other employees is effective
##  $ In my agency, the SES actively contribute to the work of our agency
##  $ In my agency, the SES are of a high quality
##  $ In my agency, the SES supports and provides opportunities for new ways of working in a digital en
##  $ In my agency, the SES work as a team
##  $ In my agency, the SES clearly articulate the direction and priorities for our agency
```

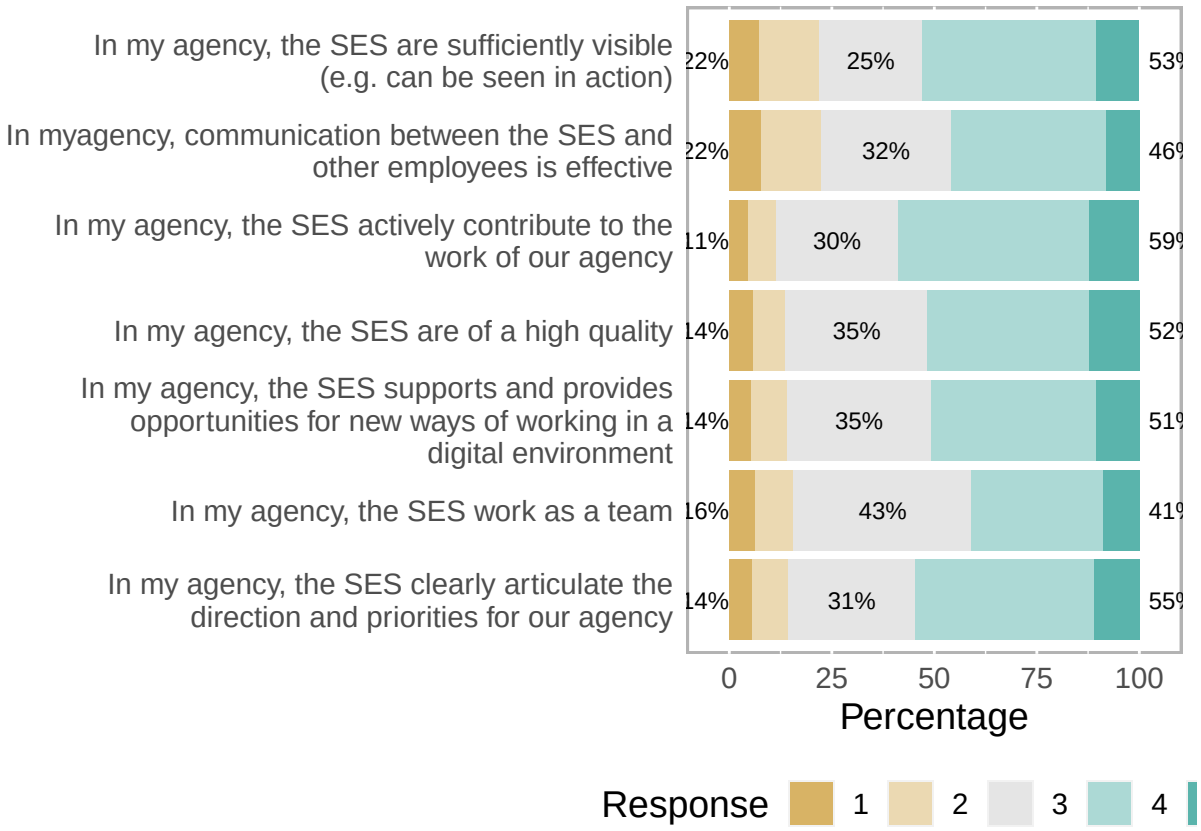
```
# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
leadership_engagement_likert <- likert(leadership_engagement_df)
summary(leadership_engagement_likert)
```

```
##
## 3                                      In my agency, the SES actively contribute to the work of ou
## 7                         In my agency, the SES clearly articulate the direction and priorities for ou
## 1                                 In my agency, the SES are sufficiently visible (e.g. can be seen in
## 4                                                                 In my agency, the SES are of a high
## 5 In my agency, the SES supports and provides opportunities for new ways of working in a digital envi
## 2                                 In myagency, communication between the SES and other employees is e
## 6                                                                      In my agency, the SES work as
##        low  neutral     high     mean        sd
## 3 11.33236 29.88560 58.78205 3.548912 0.9513805
## 7 14.43943 30.84306 54.71751 3.457554 0.9898261
## 1 21.83162 25.30126 52.86712 3.342364 1.0763718
## 4 13.73541 34.67762 51.58698 3.443731 0.9989693
## 5 14.06043 35.17160 50.76797 3.418046 0.9784345
## 2 22.49223 31.57524 45.93253 3.239097 1.0502093
## 6 15.70197 43.42974 40.86829 3.277137 0.9714628
```

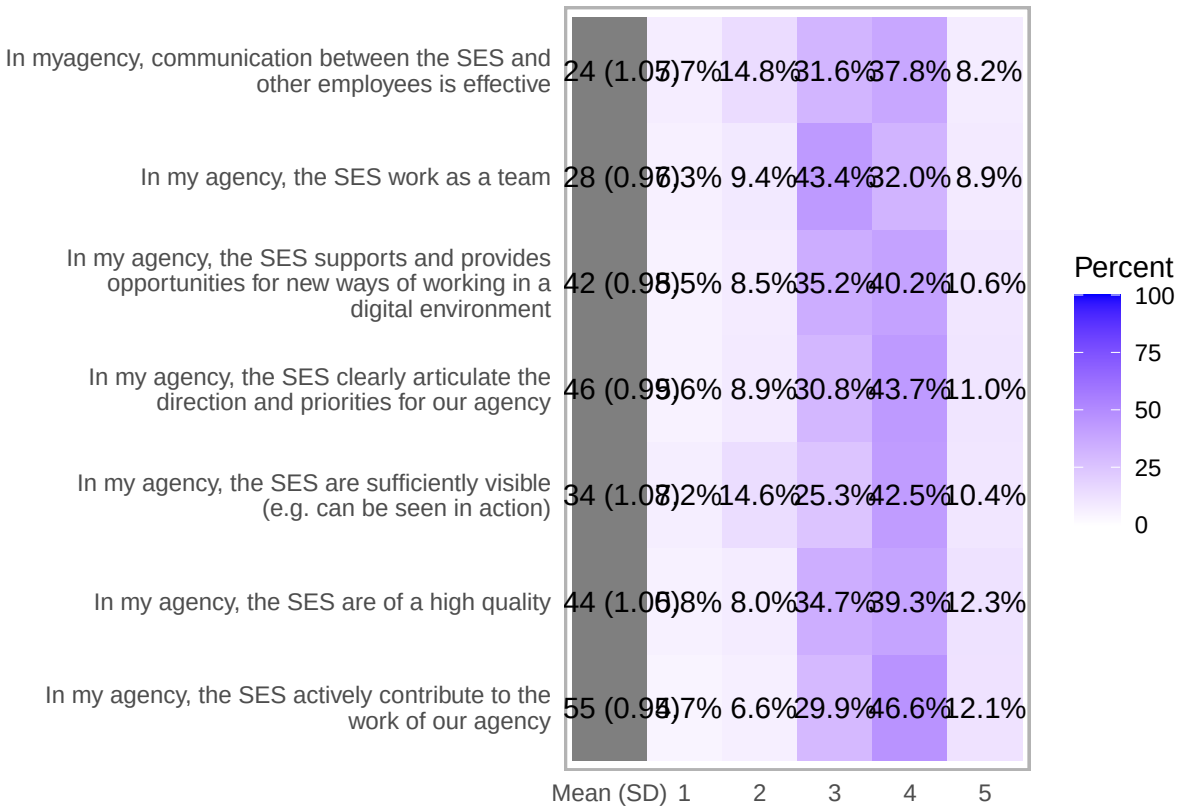
```
# centered bar plot showing the percent responses for each question (order from most to least agreement
plot(leadership_engagement_likert, type="bar")
```



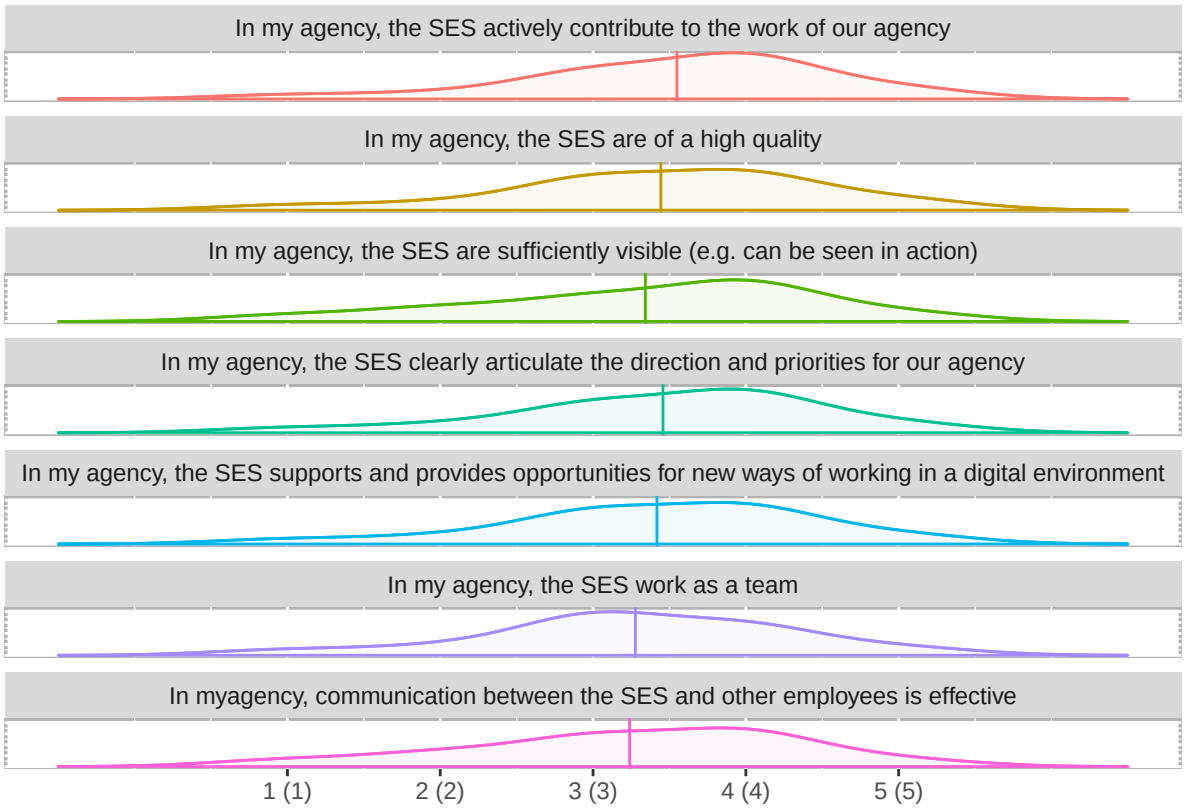

```
# bar plot ordered by question (not centered)
plot(leadership_engagement_likert, group.order = names(leadership_engagement_df), centered = FALSE) + tl
```




```
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(leadership_engagement_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```




```
# density plot (treating Likert data like numeric data)
plot(leadership_engagement_likert,
     type="density",
     facet = TRUE,
     bw = 0.5)
```




```
# descriptive statistics (mean, sd, median, skewness)
psych::describe(leadership_engagement_df)
```

```
##
## In my agency, the SES are sufficiently visible (e.g. can be seen in action)*
## In myagency, communication between the SES and other employees is effective*
## In my agency, the SES actively contribute to the work of our agency*
## In my agency, the SES are of a high quality*
## In my agency, the SES supports and provides opportunities for new ways of working in a digital envir
## In my agency, the SES work as a team*
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## In my agency, the SES are of a high quality*
## In my agency, the SES supports and provides opportunities for new ways of working in a digital envir
```

```
## In my agency, the SES work as a team*
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## In my agency, the SES work as a team*
## In my agency, the SES clearly articulate the direction and priorities for our agency*
##
## In my agency, the SES are sufficiently visible (e.g. can be seen in action)*
## In myagency, communication between the SES and other employees is effective*
## In my agency, the SES actively contribute to the work of our agency*
## In my agency, the SES are of a high quality*
## In my agency, the SES supports and provides opportunities for new ways of working in a digital envir
## In my agency, the SES work as a team*
## In my agency, the SES clearly articulate the direction and priorities for our agency*
##
## In my agency, the SES are sufficiently visible (e.g. can be seen in action)*
## In myagency, communication between the SES and other employees is effective*
## In my agency, the SES actively contribute to the work of our agency*
```

```
## In my agency, the SES are of a high quality*
## In my agency, the SES supports and provides opportunities for new ways of working in a digital envir
## In my agency, the SES work as a team*
## In my agency, the SES clearly articulate the direction and priorities for our agency*
##
## In my agency, the SES are sufficiently visible (e.g. can be seen in action)*
## In myagency, communication between the SES and other employees is effective*
## In my agency, the SES actively contribute to the work of our agency*
## In my agency, the SES are of a high quality*
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## In my agency, the SES work as a team*
## In my agency, the SES clearly articulate the direction and priorities for our agency*
##
## In my agency, the SES are sufficiently visible (e.g. can be seen in action)*
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## In my agency, the SES supports and provides opportunities for new ways of working in a digital envir
## In my agency, the SES work as a team*
## In my agency, the SES clearly articulate the direction and priorities for our agency*
```

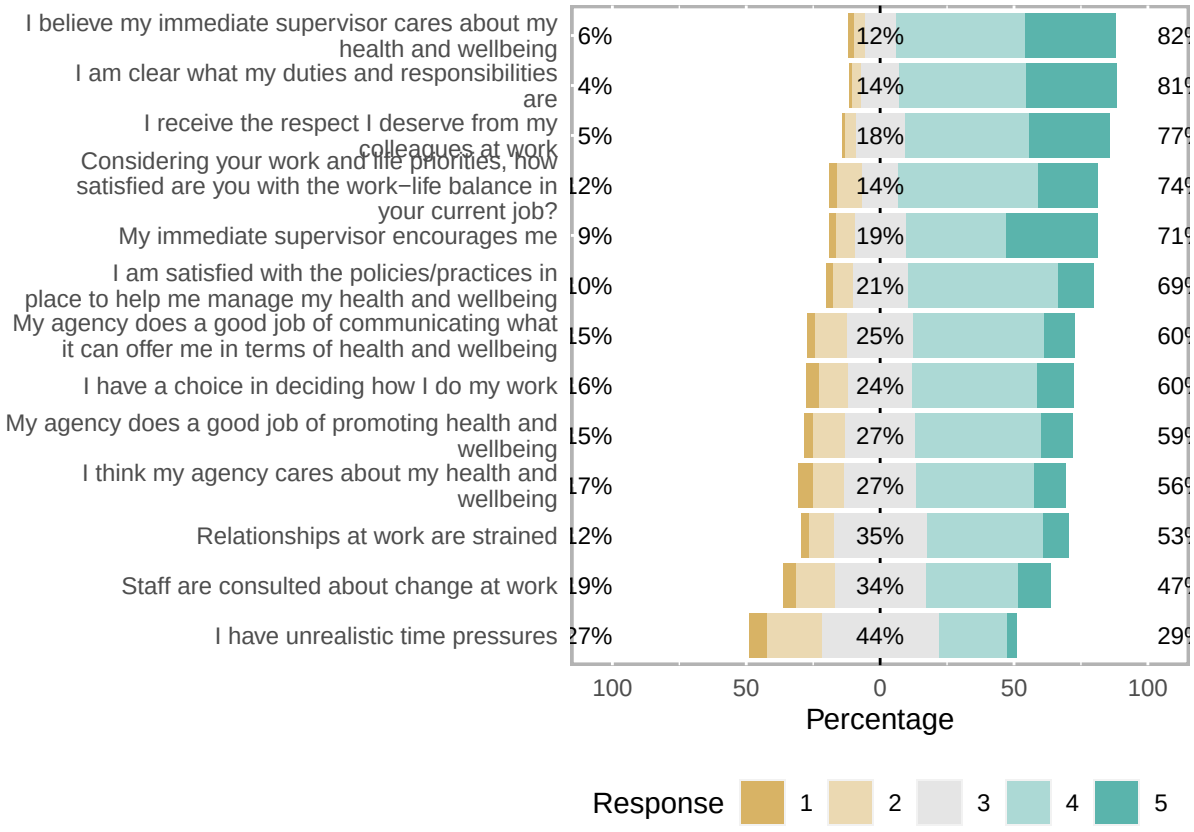
```
# Descriptive statistics step 2
#scale 10: wellbeing analysis

# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
wellbeing_likert <- likert(wellbeing_df)
summary(wellbeing_likert)
```

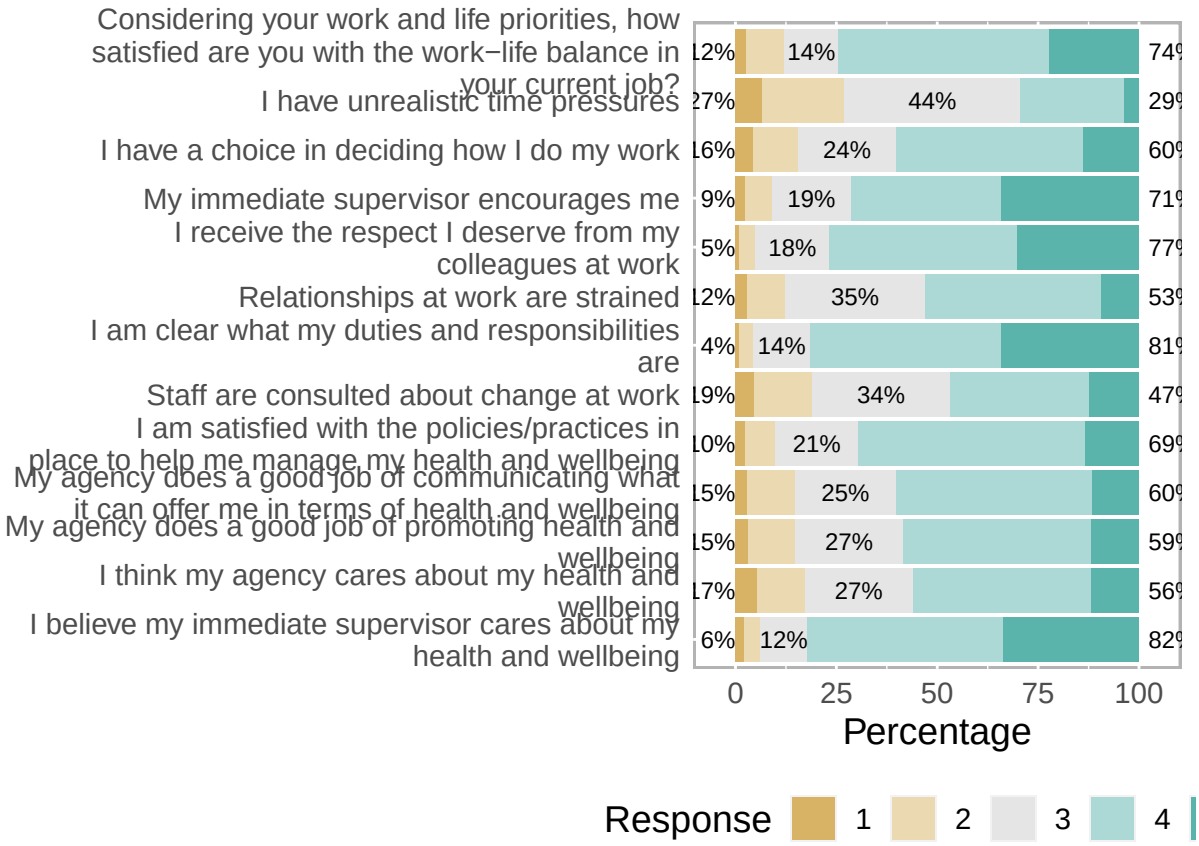
```
##
## 13                                            I believe my immediate supervisor cares about my healt
## 7                                                                 I am clear what my duties and respo
## 5                                                         I receive the respect I deserve from my coll
## 1  Considering your work and life priorities, how satisfied are you with the work-life balance in you
## 4                                                                              My immediate supervisor
## 9                     I am satisfied with the policies/practices in place to help me manage my healt
## 10                 My agency does a good job of communicating what it can offer me in terms of healt
## 3                                                                       I have a choice in deciding h
## 11                                                      My agency does a good job of promoting healt
## 12                                                            I think my agency cares about my healt
## 6                                                                                 Relationships at wo
## 8                                                                           Staff are consulted about
## 2                                                                                  I have unrealistic
##          low  neutral     high     mean        sd
## 13  6.033441 11.87562 82.09094 4.076011 0.8940756
## 7   4.401291 14.15430 81.44441 4.101813 0.8294821
```

```
## 5   4.938692 18.38897 76.67234 4.007944 0.8541951
## 1  11.994133 13.60516 74.40070 3.818469 0.9682157
## 4   9.174538 19.35817 71.46729 3.940780 1.0069581
## 9   9.843356 20.68407 69.47257 3.703866 0.8756471
## 10 14.752713 25.03960 60.20769 3.540780 0.9439027
## 3  15.511880 24.31329 60.17483 3.539361 1.0080301
## 11 14.871223 26.55793 58.57084 3.523802 0.9527954
## 12 17.237900 26.66236 56.09974 3.452942 1.0199682
## 6  12.252273 34.87240 52.87533 3.470719 0.8949910
## 8  19.004987 34.21179 46.78322 3.354344 1.0190626
## 2  26.973306 43.63274 29.39396 2.994086 0.9336441
```

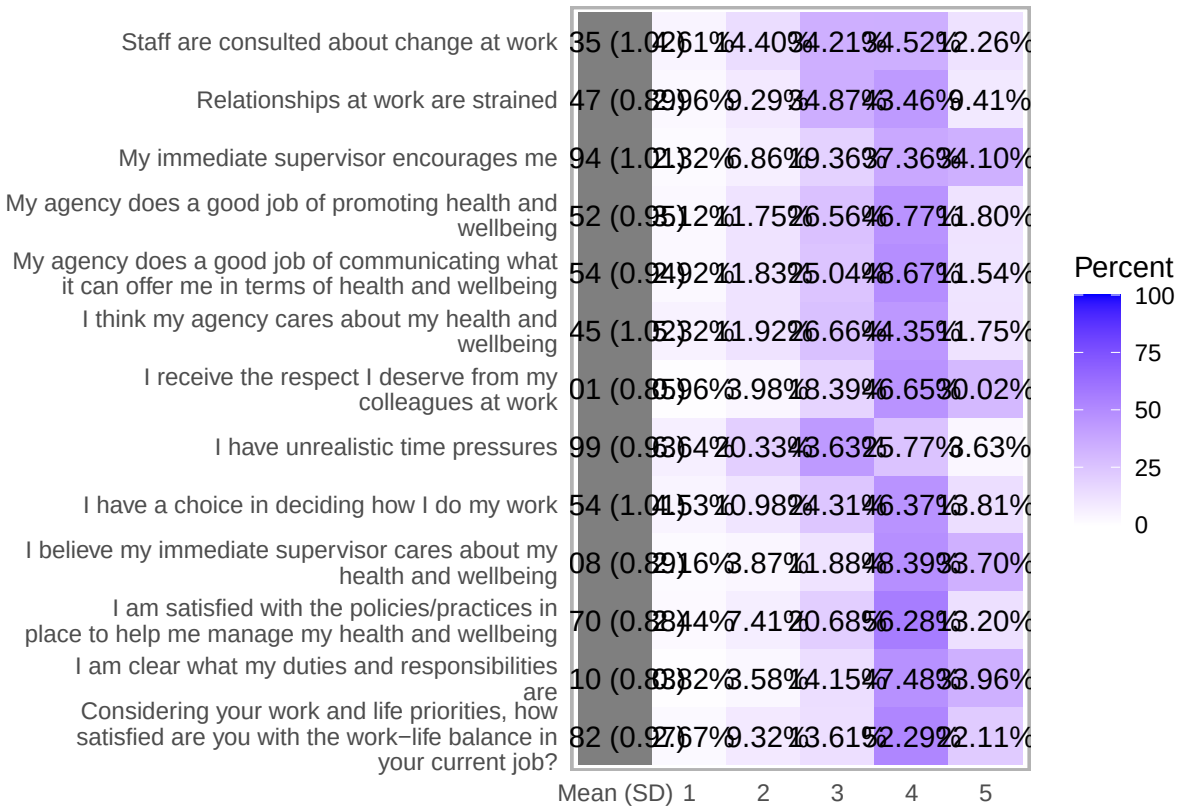
```r
# centered bar plot showing the percent responses for each question (order from most to least agreement
plot(wellbeing_likert, type="bar")
```




```r
# bar plot ordered by question (not centered)
plot(wellbeing_likert, group.order = names(wellbeing_df), centered = FALSE) + theme(text = element_text
```




```
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(wellbeing_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```




```
# density plot (treating Likert data like numeric data)
plot(wellbeing_likert,
     type="density",
     facet = TRUE,
     bw = 0.5)
```


```
# descriptive statistics (mean, sd, median, skewness)
psych::describe(wellbeing_df)
```

```
##
## Considering your work and life priorities, how satisfied are you with the work-life balance in your
## I have unrealistic time pressures*
## I have a choice in deciding how I do my work*
## My immediate supervisor encourages me*
## I receive the respect I deserve from my colleagues at work*
## Relationships at work are strained*
## I am clear what my duties and responsibilities are*
## Staff are consulted about change at work*
## I am satisfied with the policies/practices in place to help me manage my health and wellbeing*
## My agency does a good job of communicating what it can offer me in terms of health and wellbeing*
## My agency does a good job of promoting health and wellbeing*
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```
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## My agency does a good job of promoting health and wellbeing*
## I think my agency cares about my health and wellbeing*
## I believe my immediate supervisor cares about my health and wellbeing*
```

```r
# Descriptive statistics step 2
#scale 11: values analysis

str(values_df)
```

```
## 'data.frame':    85225 obs. of  3 variables:
##  $ Do colleagues in your immediate workgroup act in accordance with the APS Values in their everyday
##  $ Does your supervisor act in accordance with the APS Values in his or her everyday work?
##  $ Do senior leaders (i.e. the SES) in your agency act in accordance with the APS Values?
```

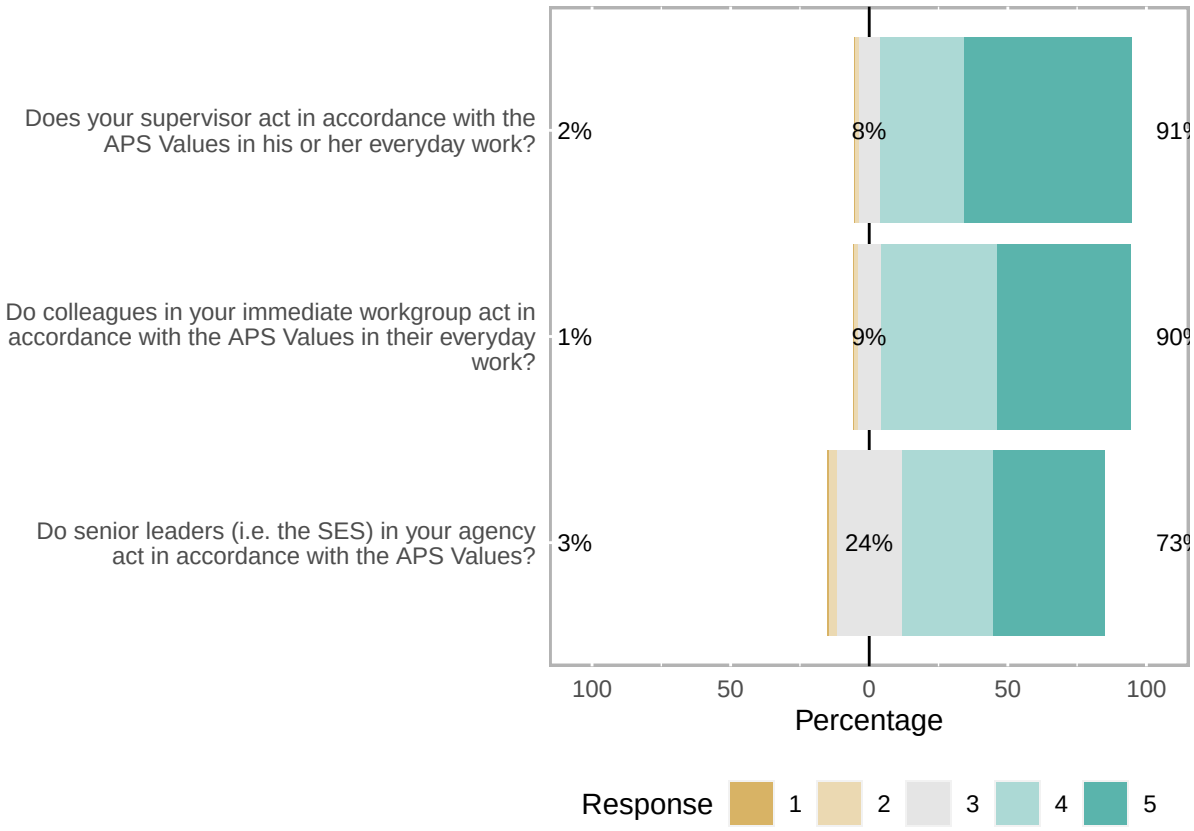
```r
values_df <- droplevels(values_df)
str(values_df)
```

```
## 'data.frame':    85225 obs. of  3 variables:
##  $ Do colleagues in your immediate workgroup act in accordance with the APS Values in their everyday
##  $ Does your supervisor act in accordance with the APS Values in his or her everyday work?
##  $ Do senior leaders (i.e. the SES) in your agency act in accordance with the APS Values?
```

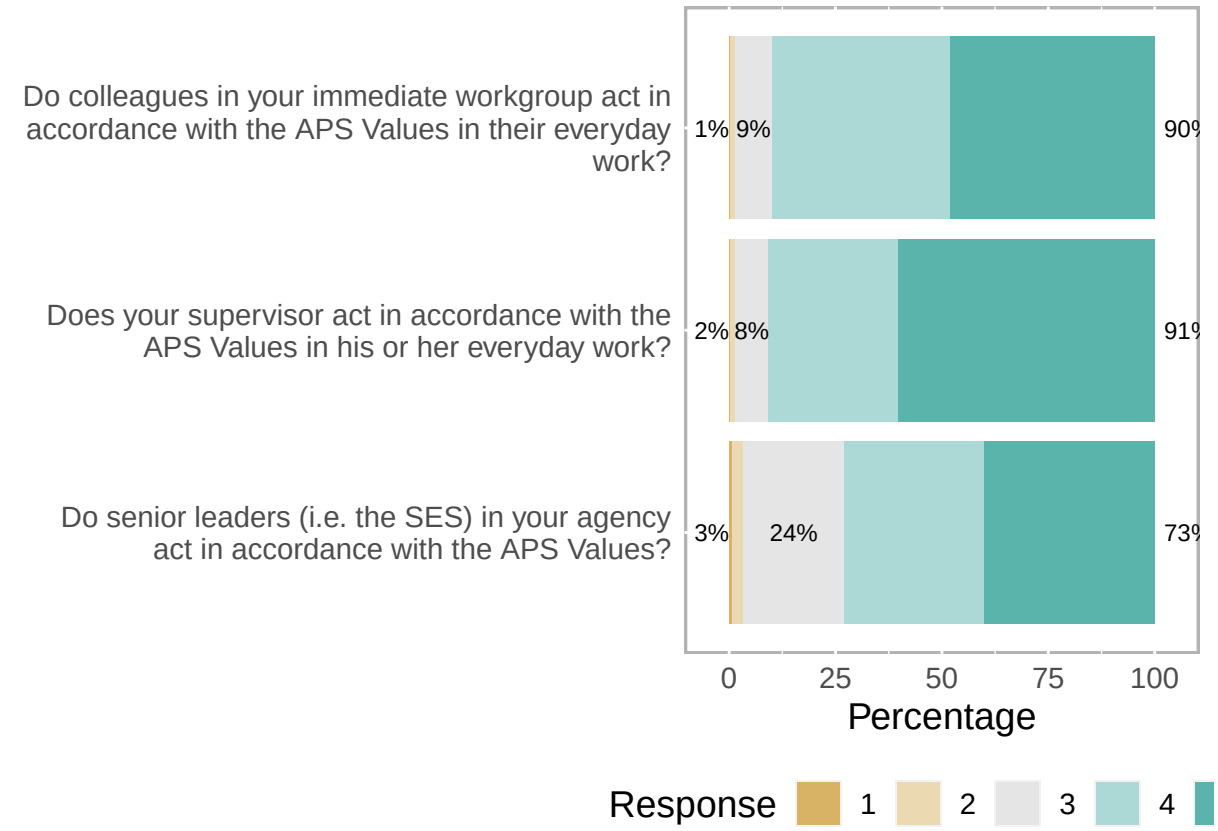
```r
# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
values_likert <- likert(values_df)
summary(values_likert)
```

```
##
## 2                 Does your supervisor act in accordance with the APS Values in his or her everyday w
## 1 Do colleagues in your immediate workgroup act in accordance with the APS Values in their everyday w
## 3                  Do senior leaders (i.e. the SES) in your agency act in accordance with the APS Val
##        low   neutral     high     mean        sd
## 2 1.565268  7.575242 90.85949 4.492930 0.7174030
## 1 1.412731  8.643004 89.94427 4.363074 0.7082541
## 3 3.391024 23.584629 73.02435 4.090408 0.8934769
```

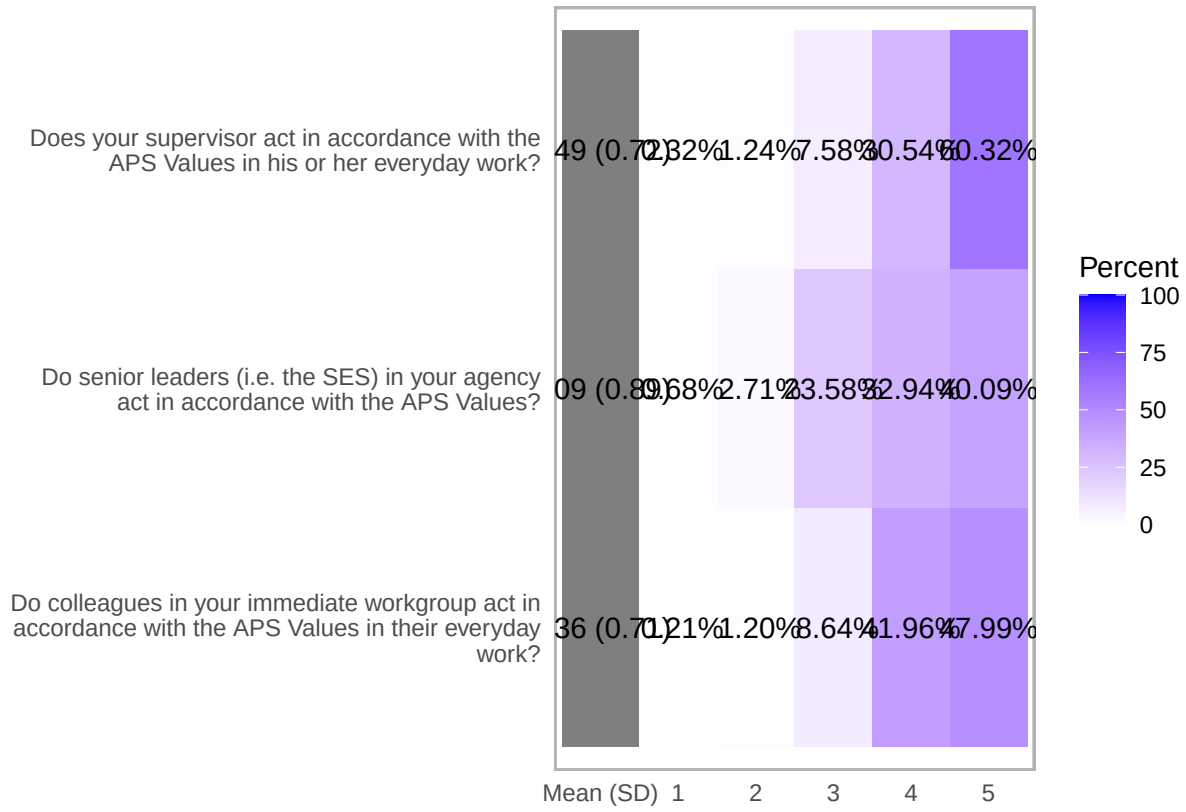
```r
# centered bar plot showing the percent responses for each question (order from most to least agreement
plot(values_likert, type="bar")
```



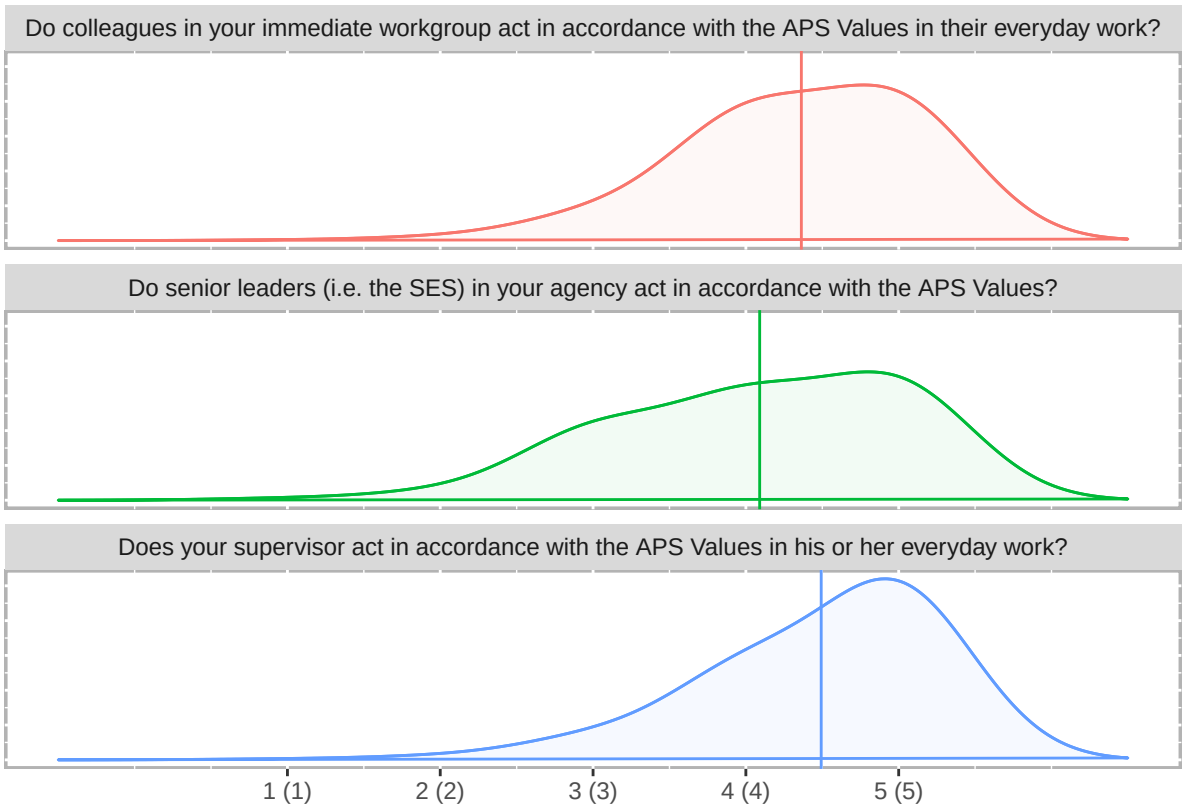

```
# bar plot ordered by question (not centered)
plot(values_likert, group.order = names(values_df), centered = FALSE) + theme(text = element_text(size =
```




```
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(values_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```




```
# density plot (treating Likert data like numeric data)
plot(values_likert,
     type="density",
     facet = TRUE,
     bw = 0.5)
```



```r
# descriptive statistics (mean, sd, median, skewness)
psych::describe(values_df)
```

```
##
## Do colleagues in your immediate workgroup act in accordance with the APS Values in their everyday wo
## Does your supervisor act in accordance with the APS Values in his or her everyday work?*
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## Does your supervisor act in accordance with the APS Values in his or her everyday work?*
## Do senior leaders (i.e. the SES) in your agency act in accordance with the APS Values?*
```

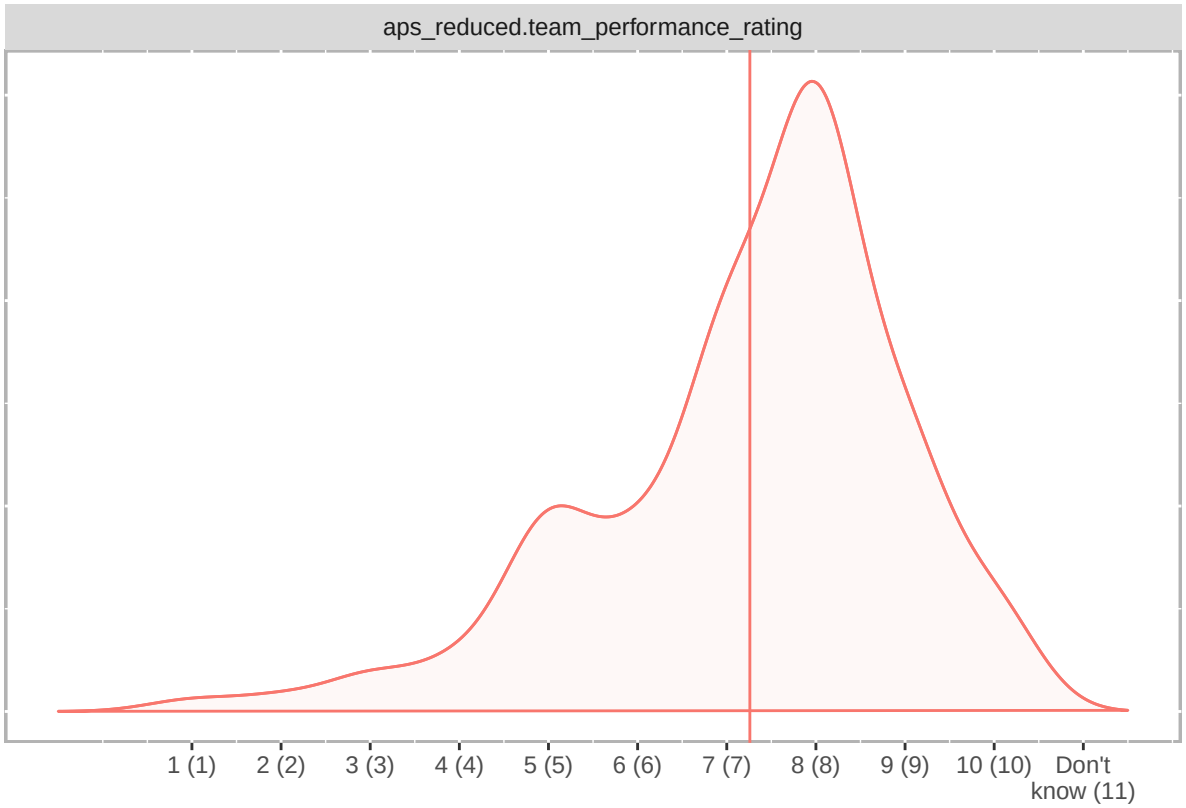
```r
# Descriptive statistics step 2
# team performance rating analysis

# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
team_performance_rating <- data.frame(aps_reduced$team_performance_rating)
team_performance_rating_likert <- likert(team_performance_rating)
summary(team_engagement_likert)
```

```
##                                                                                            Item
## 4 The people in my workgroup behave in an accepting manner towards people from diverse backgrounds
## 3                                     The people in my workgroup are committed to workplace safety
## 2                                         The people in my workgroup cooperate to get the job done
## 1                     The people in my workgroup are honest, open and transparent in their dealings
##        low   neutral     high     mean        sd
## 4 3.470813  7.585802 88.94339 4.201162 0.7645863
## 3 2.291581 10.806688 86.90173 4.121830 0.7093272
## 2 6.299795  9.898504 83.80170 4.059407 0.8473169
## 1 8.800235 12.463479 78.73629 3.947609 0.9250462
```

```r
# density plot (treating Likert data like numeric data)
plot(team_performance_rating_likert,
```

```
    type="density",
    facet = TRUE,
    bw = 0.5)
```




```
# descriptive statistics (mean, sd, median, skewness)
psych::describe(team_performance_rating)
```

```
## Warning in psych::describe(team_performance_rating): You were trying to describe
## a non-numeric data.frame or vector which describe converted to numeric.
```

```
##    vars     n mean   sd median trimmed  mad min max range  skew kurtosis   se
## X1    1 85225 7.26 1.71      8     7.4 1.48   1  10     9 -0.94     1.04 0.01
```

```
# converting all variables to numerical
# a- questions making up 11 data frames b- org_size and employee level c- dependent var

# a- converting questions making up 11 data frames to numeric
aps_reduced$job_engagement_1 <- as.numeric(aps_reduced$job_engagement_1)
aps_reduced$job_engagement_2 <- as.numeric(aps_reduced$job_engagement_2)
aps_reduced$job_engagement_3 <- as.numeric(aps_reduced$job_engagement_3)
aps_reduced$job_engagement_4 <- as.numeric(aps_reduced$job_engagement_4)
aps_reduced$job_engagement_5 <- as.numeric(aps_reduced$job_engagement_5)
aps_reduced$job_engagement_6 <- as.numeric(aps_reduced$job_engagement_6)
aps_reduced$job_engagement_7 <- as.numeric(aps_reduced$job_engagement_7)
```

```r
aps_reduced$job_engagement_8 <- as.numeric(aps_reduced$job_engagement_8)
aps_reduced$job_engagement_9 <- as.numeric(aps_reduced$job_engagement_9)
aps_reduced$job_engagement_10 <- as.numeric(aps_reduced$job_engagement_10)

aps_reduced$team_engagement_1 <- as.numeric(aps_reduced$team_engagement_1)
aps_reduced$team_engagement_2 <- as.numeric(aps_reduced$team_engagement_2)
aps_reduced$team_engagement_3 <- as.numeric(aps_reduced$team_engagement_3)
aps_reduced$team_engagement_4 <- as.numeric(aps_reduced$team_engagement_4)

aps_reduced$supervisor_engagement_1 <- as.numeric(aps_reduced$supervisor_engagement_1)
aps_reduced$supervisor_engagement_2 <- as.numeric(aps_reduced$supervisor_engagement_2)
aps_reduced$supervisor_engagement_3 <- as.numeric(aps_reduced$supervisor_engagement_3)
aps_reduced$supervisor_engagement_4 <- as.numeric(aps_reduced$supervisor_engagement_4)
aps_reduced$supervisor_engagement_5 <- as.numeric(aps_reduced$supervisor_engagement_5)
aps_reduced$supervisor_engagement_6 <- as.numeric(aps_reduced$supervisor_engagement_6)
aps_reduced$supervisor_engagement_7 <- as.numeric(aps_reduced$supervisor_engagement_7)
aps_reduced$supervisor_engagement_8 <- as.numeric(aps_reduced$supervisor_engagement_8)
aps_reduced$supervisor_engagement_9 <- as.numeric(aps_reduced$supervisor_engagement_9)
aps_reduced$supervisor_engagement_10 <- as.numeric(aps_reduced$supervisor_engagement_10)
aps_reduced$supervisor_engagement_11 <- as.numeric(aps_reduced$supervisor_engagement_11)

aps_reduced$senior_manager_engagement_1 <- as.numeric(aps_reduced$senior_manager_engagement_1)
aps_reduced$senior_manager_engagement_2 <- as.numeric(aps_reduced$senior_manager_engagement_2)
aps_reduced$senior_manager_engagement_3 <- as.numeric(aps_reduced$senior_manager_engagement_3)
aps_reduced$senior_manager_engagement_4 <- as.numeric(aps_reduced$senior_manager_engagement_4)
aps_reduced$senior_manager_engagement_5 <- as.numeric(aps_reduced$senior_manager_engagement_5)
aps_reduced$senior_manager_engagement_6 <- as.numeric(aps_reduced$senior_manager_engagement_6)
aps_reduced$senior_manager_engagement_7 <- as.numeric(aps_reduced$senior_manager_engagement_7)
aps_reduced$senior_manager_engagement_8 <- as.numeric(aps_reduced$senior_manager_engagement_8)
aps_reduced$senior_manager_engagement_9 <- as.numeric(aps_reduced$senior_manager_engagement_9)
aps_reduced$senior_manager_engagement_10 <- as.numeric(aps_reduced$senior_manager_engagement_10)
aps_reduced$senior_manager_engagement_11 <- as.numeric(aps_reduced$senior_manager_engagement_11)
aps_reduced$senior_manager_engagement_12 <- as.numeric(aps_reduced$senior_manager_engagement_12)

aps_reduced$agency_engagement_1 <- as.numeric(aps_reduced$agency_engagement_1)
aps_reduced$agency_engagement_2 <- as.numeric(aps_reduced$agency_engagement_2)
aps_reduced$agency_engagement_3 <- as.numeric(aps_reduced$agency_engagement_3)
aps_reduced$agency_engagement_4 <- as.numeric(aps_reduced$agency_engagement_4)
aps_reduced$agency_engagement_5 <- as.numeric(aps_reduced$agency_engagement_5)
aps_reduced$agency_engagement_6 <- as.numeric(aps_reduced$agency_engagement_6)
aps_reduced$agency_engagement_7 <- as.numeric(aps_reduced$agency_engagement_7)
aps_reduced$agency_engagement_8 <- as.numeric(aps_reduced$agency_engagement_8)
aps_reduced$agency_engagement_9 <- as.numeric(aps_reduced$agency_engagement_9)
aps_reduced$agency_engagement_10 <- as.numeric(aps_reduced$agency_engagement_10)
aps_reduced$agency_engagement_11 <- as.numeric(aps_reduced$agency_engagement_11)
aps_reduced$agency_engagement_12 <- as.numeric(aps_reduced$agency_engagement_12)
aps_reduced$agency_engagement_13 <- as.numeric(aps_reduced$agency_engagement_13)
aps_reduced$agency_engagement_14 <- as.numeric(aps_reduced$agency_engagement_14)
aps_reduced$agency_engagement_15 <- as.numeric(aps_reduced$agency_engagement_15)
aps_reduced$agency_engagement_16 <- as.numeric(aps_reduced$agency_engagement_16)
aps_reduced$agency_engagement_17 <- as.numeric(aps_reduced$agency_engagement_17)

aps_reduced$team_performance_support_1 <- as.numeric(aps_reduced$team_performance_support_1)
```

```r
aps_reduced$team_performance_support_2 <- as.numeric(aps_reduced$team_performance_support_2)
aps_reduced$team_performance_support_3 <- as.numeric(aps_reduced$team_performance_support_3)
aps_reduced$team_performance_support_4 <- as.numeric(aps_reduced$team_performance_support_4)

aps_reduced$risk_culture_1 <- as.numeric(aps_reduced$risk_culture_1)
aps_reduced$risk_culture_2 <- as.numeric(aps_reduced$risk_culture_2)
aps_reduced$risk_culture_3 <- as.numeric(aps_reduced$risk_culture_3)
aps_reduced$risk_culture_4 <- as.numeric(aps_reduced$risk_culture_4)
aps_reduced$risk_culture_5 <- as.numeric(aps_reduced$risk_culture_5)

aps_reduced$innovation_1 <- as.numeric(aps_reduced$innovation_1)
aps_reduced$innovation_2 <- as.numeric(aps_reduced$innovation_2)
aps_reduced$innovation_3 <- as.numeric(aps_reduced$innovation_3)
aps_reduced$innovation_4 <- as.numeric(aps_reduced$innovation_4)
aps_reduced$innovation_5 <- as.numeric(aps_reduced$innovation_5)

aps_reduced$leadership_engagement_1 <- as.numeric(aps_reduced$leadership_engagement_1)
aps_reduced$leadership_engagement_2 <- as.numeric(aps_reduced$leadership_engagement_2)
aps_reduced$leadership_engagement_3 <- as.numeric(aps_reduced$leadership_engagement_3)
aps_reduced$leadership_engagement_4 <- as.numeric(aps_reduced$leadership_engagement_4)
aps_reduced$leadership_engagement_5 <- as.numeric(aps_reduced$leadership_engagement_5)
aps_reduced$leadership_engagement_6 <- as.numeric(aps_reduced$leadership_engagement_6)
aps_reduced$leadership_engagement_7 <- as.numeric(aps_reduced$leadership_engagement_7)

aps_reduced$wellbeing_1 <- as.numeric(aps_reduced$wellbeing_1)
aps_reduced$wellbeing_2 <- as.numeric(aps_reduced$wellbeing_2)
aps_reduced$wellbeing_3 <- as.numeric(aps_reduced$wellbeing_3)
aps_reduced$wellbeing_4 <- as.numeric(aps_reduced$wellbeing_4)
aps_reduced$wellbeing_5 <- as.numeric(aps_reduced$wellbeing_5)
aps_reduced$wellbeing_6 <- as.numeric(aps_reduced$wellbeing_6)
aps_reduced$wellbeing_7 <- as.numeric(aps_reduced$wellbeing_7)
aps_reduced$wellbeing_8 <- as.numeric(aps_reduced$wellbeing_8)
aps_reduced$wellbeing_9 <- as.numeric(aps_reduced$wellbeing_9)
aps_reduced$wellbeing_10 <- as.numeric(aps_reduced$wellbeing_10)
aps_reduced$wellbeing_11 <- as.numeric(aps_reduced$wellbeing_11)
aps_reduced$wellbeing_12 <- as.numeric(aps_reduced$wellbeing_12)
aps_reduced$wellbeing_13 <- as.numeric(aps_reduced$wellbeing_13)

aps_reduced$values_1 <- as.numeric(aps_reduced$values_1)
aps_reduced$values_2 <- as.numeric(aps_reduced$values_2)
aps_reduced$values_3 <- as.numeric(aps_reduced$values_3)

# b- converting dependent var (team_performance_rating) to numeric
aps_reduced$team_performance_rating <- as.numeric(aps_reduced$team_performance_rating)


# checking that changes were successful
summary(aps_reduced)
```

```
##                              org_size                  employee_level
##  Large (1,001 or more employees):73782   EL                    :26802
##  Medium (251 to 1,000 employees): 8222   SES                   : 2303
##  Small (Less than 250 employees): 3221   Trainee/Graduate/APS:56119
```

```
##                                       NA's                :    1
##
##
##  job_engagement_1 job_engagement_2 job_engagement_3 job_engagement_4
##  Min.   :1.000    Min.   :1.000    Min.   :1.000    Min.   :1.00
##  1st Qu.:4.000    1st Qu.:3.000    1st Qu.:3.000    1st Qu.:3.00
##  Median :4.000    Median :4.000    Median :4.000    Median :4.00
##  Mean   :3.921    Mean   :3.757    Mean   :3.493    Mean   :3.46
##  3rd Qu.:4.000    3rd Qu.:4.000    3rd Qu.:4.000    3rd Qu.:4.00
##  Max.   :5.000    Max.   :5.000    Max.   :5.000    Max.   :5.00
##  job_engagement_5 job_engagement_6 job_engagement_7 job_engagement_8
##  Min.   :1.000    Min.   :1.000    Min.   :1.000    Min.   :1.000
##  1st Qu.:4.000    1st Qu.:3.000    1st Qu.:4.000    1st Qu.:4.000
##  Median :4.000    Median :4.000    Median :4.000    Median :4.000
##  Mean   :3.883    Mean   :3.708    Mean   :4.041    Mean   :4.258
##  3rd Qu.:4.000    3rd Qu.:4.000    3rd Qu.:4.000    3rd Qu.:5.000
##  Max.   :5.000    Max.   :5.000    Max.   :5.000    Max.   :5.000
##  job_engagement_9 job_engagement_10 team_engagement_1 team_engagement_2
##  Min.   :1.000    Min.   :1.000     Min.   :1.000     Min.   :1.000
##  1st Qu.:3.000    1st Qu.:4.000     1st Qu.:4.000     1st Qu.:4.000
##  Median :4.000    Median :4.000     Median :4.000     Median :4.000
##  Mean   :3.697    Mean   :4.007     Mean   :3.948     Mean   :4.059
##  3rd Qu.:4.000    3rd Qu.:5.000     3rd Qu.:5.000     3rd Qu.:5.000
##  Max.   :5.000    Max.   :5.000     Max.   :5.000     Max.   :5.000
##  team_engagement_3 team_engagement_4 supervisor_engagement_1
##  Min.   :1.000     Min.   :1.000     Min.   :1.000
##  1st Qu.:4.000     1st Qu.:4.000     1st Qu.:4.000
##  Median :4.000     Median :4.000     Median :4.000
##  Mean   :4.122     Mean   :4.201     Mean   :4.216
##  3rd Qu.:5.000     3rd Qu.:5.000     3rd Qu.:5.000
##  Max.   :5.000     Max.   :5.000     Max.   :5.000
##  supervisor_engagement_2 supervisor_engagement_3 supervisor_engagement_4
##  Min.   :1.000           Min.   :1.000           Min.   :1.000
##  1st Qu.:4.000           1st Qu.:4.000           1st Qu.:4.000
##  Median :4.000           Median :4.000           Median :4.000
##  Mean   :4.238           Mean   :4.238           Mean   :4.134
##  3rd Qu.:5.000           3rd Qu.:5.000           3rd Qu.:5.000
##  Max.   :5.000           Max.   :5.000           Max.   :5.000
##  supervisor_engagement_5 supervisor_engagement_6 supervisor_engagement_7
##  Min.   :1.000           Min.   :1.000           Min.   :1.000
##  1st Qu.:4.000           1st Qu.:4.000           1st Qu.:4.000
##  Median :4.000           Median :4.000           Median :4.000
##  Mean   :4.006           Mean   :4.056           Mean   :4.052
##  3rd Qu.:5.000           3rd Qu.:5.000           3rd Qu.:5.000
##  Max.   :5.000           Max.   :5.000           Max.   :5.000
##  supervisor_engagement_8 supervisor_engagement_9 supervisor_engagement_10
##  Min.   :1.000           Min.   :1.000           Min.   :1.000
##  1st Qu.:4.000           1st Qu.:4.000           1st Qu.:3.000
##  Median :4.000           Median :4.000           Median :4.000
##  Mean   :4.126           Mean   :4.156           Mean   :3.928
##  3rd Qu.:5.000           3rd Qu.:5.000           3rd Qu.:5.000
##  Max.   :5.000           Max.   :5.000           Max.   :5.000
##  supervisor_engagement_11 senior_manager_engagement_1
##  Min.   :1.000            Min.   :1.000
```

```
##  1st Qu.:4.000            1st Qu.:3.000
##  Median :4.000            Median :4.000
##  Mean   :4.137            Mean   :3.798
##  3rd Qu.:5.000            3rd Qu.:4.000
##  Max.   :5.000            Max.   :5.000
##  senior_manager_engagement_2 senior_manager_engagement_3
##  Min.   :1.000               Min.   :1.000
##  1st Qu.:3.000               1st Qu.:3.000
##  Median :4.000               Median :4.000
##  Mean   :3.682               Mean   :3.693
##  3rd Qu.:4.000               3rd Qu.:4.000
##  Max.   :5.000               Max.   :5.000
##  senior_manager_engagement_4 senior_manager_engagement_5
##  Min.   :1.000               Min.   :1.000
##  1st Qu.:3.000               1st Qu.:3.000
##  Median :4.000               Median :3.000
##  Mean   :3.627               Mean   :3.389
##  3rd Qu.:4.000               3rd Qu.:4.000
##  Max.   :5.000               Max.   :5.000
##  senior_manager_engagement_6 senior_manager_engagement_7
##  Min.   :1.000               Min.   :1.000
##  1st Qu.:3.000               1st Qu.:3.000
##  Median :4.000               Median :4.000
##  Mean   :3.777               Mean   :3.607
##  3rd Qu.:4.000               3rd Qu.:4.000
##  Max.   :5.000               Max.   :5.000
##  senior_manager_engagement_8 senior_manager_engagement_9
##  Min.   :1.000               Min.   :1.000
##  1st Qu.:3.000               1st Qu.:3.000
##  Median :4.000               Median :4.000
##  Mean   :3.679               Mean   :3.856
##  3rd Qu.:4.000               3rd Qu.:4.000
##  Max.   :5.000               Max.   :5.000
##  senior_manager_engagement_10 senior_manager_engagement_11
##  Min.   :1.000                Min.   :1.000
##  1st Qu.:3.000                1st Qu.:3.000
##  Median :4.000                Median :4.000
##  Mean   :3.832                Mean   :3.737
##  3rd Qu.:5.000                3rd Qu.:4.000
##  Max.   :5.000                Max.   :5.000
##  senior_manager_engagement_12 leadership_engagement_1 leadership_engagement_2
##  Min.   :1.000                Min.   :1.000           Min.   :1.000
##  1st Qu.:3.000                1st Qu.:3.000           1st Qu.:3.000
##  Median :4.000                Median :4.000           Median :3.000
##  Mean   :3.668                Mean   :3.342           Mean   :3.239
##  3rd Qu.:4.000                3rd Qu.:4.000           3rd Qu.:4.000
##  Max.   :5.000                Max.   :5.000           Max.   :5.000
##  leadership_engagement_3 leadership_engagement_4 leadership_engagement_5
##  Min.   :1.000           Min.   :1.000           Min.   :1.000
##  1st Qu.:3.000           1st Qu.:3.000           1st Qu.:3.000
##  Median :4.000           Median :4.000           Median :4.000
##  Mean   :3.549           Mean   :3.444           Mean   :3.418
##  3rd Qu.:4.000           3rd Qu.:4.000           3rd Qu.:4.000
##  Max.   :5.000           Max.   :5.000           Max.   :5.000
```

```
##  leadership_engagement_6 leadership_engagement_7 agency_engagement_1
##  Min.   :1.000           Min.   :1.000           Min.   :1.000
##  1st Qu.:3.000           1st Qu.:3.000           1st Qu.:3.000
##  Median :3.000           Median :4.000           Median :4.000
##  Mean   :3.277           Mean   :3.458           Mean   :3.684
##  3rd Qu.:4.000           3rd Qu.:4.000           3rd Qu.:4.000
##  Max.   :5.000           Max.   :5.000           Max.   :5.000
##  agency_engagement_2 agency_engagement_3 agency_engagement_4
##  Min.   :1.000       Min.   :1.000       Min.   :1.000
##  1st Qu.:3.000       1st Qu.:2.000       1st Qu.:2.000
##  Median :4.000       Median :3.000       Median :3.000
##  Mean   :3.857       Mean   :3.008       Mean   :3.188
##  3rd Qu.:4.000       3rd Qu.:4.000       3rd Qu.:4.000
##  Max.   :5.000       Max.   :5.000       Max.   :5.000
##  agency_engagement_5 agency_engagement_6 agency_engagement_7
##  Min.   :1.000       Min.   :1.000       Min.   :1.000
##  1st Qu.:3.000       1st Qu.:2.000       1st Qu.:3.000
##  Median :4.000       Median :3.000       Median :4.000
##  Mean   :3.539       Mean   :3.001       Mean   :3.571
##  3rd Qu.:4.000       3rd Qu.:4.000       3rd Qu.:4.000
##  Max.   :5.000       Max.   :5.000       Max.   :5.000
##  agency_engagement_8 agency_engagement_9 agency_engagement_10
##  Min.   :1.000       Min.   :1.000       Min.   :1.000
##  1st Qu.:4.000       1st Qu.:4.000       1st Qu.:4.000
##  Median :4.000       Median :4.000       Median :4.000
##  Mean   :3.953       Mean   :3.967       Mean   :3.974
##  3rd Qu.:5.000       3rd Qu.:5.000       3rd Qu.:5.000
##  Max.   :5.000       Max.   :5.000       Max.   :5.000
##  agency_engagement_11 agency_engagement_12 agency_engagement_13
##  Min.   :1.000        Min.   :1.000        Min.   :1.000
##  1st Qu.:3.000        1st Qu.:4.000        1st Qu.:4.000
##  Median :4.000        Median :4.000        Median :4.000
##  Mean   :3.734        Mean   :3.841        Mean   :3.984
##  3rd Qu.:4.000        3rd Qu.:4.000        3rd Qu.:4.000
##  Max.   :5.000        Max.   :5.000        Max.   :5.000
##  agency_engagement_14 agency_engagement_15 agency_engagement_16
##  Min.   :1.000        Min.   :1.000        Min.   :1.000
##  1st Qu.:3.000        1st Qu.:2.000        1st Qu.:4.000
##  Median :4.000        Median :3.000        Median :4.000
##  Mean   :3.426        Mean   :3.165        Mean   :3.886
##  3rd Qu.:4.000        3rd Qu.:4.000        3rd Qu.:4.000
##  Max.   :5.000        Max.   :5.000        Max.   :5.000
##  agency_engagement_17  wellbeing_1     wellbeing_2     wellbeing_3
##  Min.   :1.000        Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:3.000        1st Qu.:3.000   1st Qu.:2.000   1st Qu.:3.000
##  Median :4.000        Median :4.000   Median :3.000   Median :4.000
##  Mean   :3.398        Mean   :3.818   Mean   :2.994   Mean   :3.539
##  3rd Qu.:4.000        3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000
##  Max.   :5.000        Max.   :5.000   Max.   :5.000   Max.   :5.000
##   wellbeing_4     wellbeing_5     wellbeing_6     wellbeing_7
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:3.000   1st Qu.:4.000   1st Qu.:3.000   1st Qu.:4.000
##  Median :4.000   Median :4.000   Median :4.000   Median :4.000
##  Mean   :3.941   Mean   :4.008   Mean   :3.471   Mean   :4.102
```

```
##  3rd Qu.:5.000   3rd Qu.:5.000   3rd Qu.:4.000   3rd Qu.:5.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##   wellbeing_8     wellbeing_9     wellbeing_10    wellbeing_11
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:3.000   1st Qu.:3.000   1st Qu.:3.000   1st Qu.:3.000
##  Median :3.000   Median :4.000   Median :4.000   Median :4.000
##  Mean   :3.354   Mean   :3.704   Mean   :3.541   Mean   :3.524
##  3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##   wellbeing_12    wellbeing_13   risk_culture_1  risk_culture_2
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:3.000   1st Qu.:4.000   1st Qu.:3.000   1st Qu.:3.000
##  Median :4.000   Median :4.000   Median :4.000   Median :4.000
##  Mean   :3.453   Mean   :4.076   Mean   :3.781   Mean   :3.628
##  3rd Qu.:4.000   3rd Qu.:5.000   3rd Qu.:4.000   3rd Qu.:4.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  risk_culture_3  risk_culture_4  risk_culture_5   innovation_1
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:3.000   1st Qu.:3.000   1st Qu.:3.000   1st Qu.:4.000
##  Median :4.000   Median :3.000   Median :3.000   Median :4.000
##  Mean   :3.494   Mean   :3.052   Mean   :3.172   Mean   :4.059
##  3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:5.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##   innovation_2    innovation_3    innovation_4    innovation_5
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:3.000   1st Qu.:3.000   1st Qu.:3.000   1st Qu.:3.000
##  Median :4.000   Median :4.000   Median :3.000   Median :3.000
##  Mean   :3.777   Mean   :3.534   Mean   :3.327   Mean   :3.118
##  3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  team_performance_rating team_performance_support_1 team_performance_support_2
##  Min.   : 1.000          Min.   :1.000              Min.   :1.000
##  1st Qu.: 6.000          1st Qu.:3.000              1st Qu.:2.000
##  Median : 8.000          Median :4.000              Median :4.000
##  Mean   : 7.259          Mean   :3.482              Mean   :3.299
##  3rd Qu.: 8.000          3rd Qu.:4.000              3rd Qu.:4.000
##  Max.   :10.000          Max.   :5.000              Max.   :5.000
##  team_performance_support_3 team_performance_support_4    values_1
##  Min.   :1.000              Min.   :1.000              Min.   :1.000
##  1st Qu.:4.000              1st Qu.:4.000              1st Qu.:4.000
##  Median :4.000              Median :4.000              Median :4.000
##  Mean   :3.943              Mean   :3.968              Mean   :4.363
##  3rd Qu.:4.000              3rd Qu.:4.000              3rd Qu.:5.000
##  Max.   :5.000              Max.   :5.000              Max.   :5.000
##     values_2        values_3    number_skipped_questions
##  Min.   :1.000   Min.   :1.00   Min.   :0.0000
##  1st Qu.:4.000   1st Qu.:3.00   1st Qu.:0.0000
##  Median :5.000   Median :4.00   Median :0.0000
##  Mean   :4.493   Mean   :4.09   Mean   :0.1654
##  3rd Qu.:5.000   3rd Qu.:5.00   3rd Qu.:0.0000
##  Max.   :5.000   Max.   :5.00   Max.   :3.0000
```

```
str(aps_reduced)
```

```
## 'data.frame':    85225 obs. of  95 variables:
##  $ org_size                    : Factor w/ 3 levels "Large (1,001 or more employees)",..: 3 1 1 1 1 1
##  $ employee_level              : Factor w/ 3 levels "EL","SES","Trainee/Graduate/APS": 3 3 3 3 1 1 3
##  $ job_engagement_1            : num  2 5 4 4 5 4 2 5 4 4 ...
##  $ job_engagement_2            : num  2 4 5 4 4 3 2 5 3 2 ...
##  $ job_engagement_3            : num  3 4 5 4 4 3 4 5 3 3 ...
##  $ job_engagement_4            : num  3 4 5 4 4 5 4 5 2 3 ...
##  $ job_engagement_5            : num  3 4 5 4 4 4 5 5 3 4 ...
##  $ job_engagement_6            : num  2 4 4 3 4 2 5 4 1 2 ...
##  $ job_engagement_7            : num  3 4 5 4 3 4 4 4 4 4 ...
##  $ job_engagement_8            : num  5 4 5 4 5 4 4 5 5 4 ...
##  $ job_engagement_9            : num  2 4 4 4 4 3 4 5 4 2 ...
##  $ job_engagement_10           : num  3 4 5 4 5 4 4 5 4 2 ...
##  $ team_engagement_1           : num  4 4 4 4 4 5 5 5 4 3 ...
##  $ team_engagement_2           : num  4 4 4 4 4 5 5 4 3 2 ...
##  $ team_engagement_3           : num  4 4 5 4 4 5 5 4 4 4 ...
##  $ team_engagement_4           : num  4 4 4 4 4 4 5 4 4 4 ...
##  $ supervisor_engagement_1     : num  5 3 5 4 5 5 5 5 4 4 ...
##  $ supervisor_engagement_2     : num  5 4 5 4 5 5 5 5 3 4 ...
##  $ supervisor_engagement_3     : num  5 4 5 4 5 5 5 5 3 4 ...
##  $ supervisor_engagement_4     : num  3 4 5 4 5 5 5 5 1 5 ...
##  $ supervisor_engagement_5     : num  4 4 5 4 5 4 5 5 2 4 ...
##  $ supervisor_engagement_6     : num  3 4 5 4 5 4 5 5 2 4 ...
##  $ supervisor_engagement_7     : num  3 4 5 4 5 4 5 5 2 4 ...
##  $ supervisor_engagement_8     : num  4 4 5 5 5 5 5 5 4 5 ...
##  $ supervisor_engagement_9     : num  4 4 4 5 3 3 5 5 5 5 ...
##  $ supervisor_engagement_10    : num  3 4 4 5 4 5 5 5 1 5 ...
##  $ supervisor_engagement_11    : num  4 5 5 5 5 5 5 5 1 5 ...
##  $ senior_manager_engagement_1 : num  4 4 2 3 4 5 3 5 2 4 ...
##  $ senior_manager_engagement_2 : num  3 4 3 3 4 3 2 5 1 4 ...
##  $ senior_manager_engagement_3 : num  3 4 2 3 4 4 3 5 2 4 ...
##  $ senior_manager_engagement_4 : num  3 3 3 3 4 4 2 5 1 4 ...
##  $ senior_manager_engagement_5 : num  2 3 2 3 4 2 1 5 1 3 ...
##  $ senior_manager_engagement_6 : num  3 4 3 3 4 4 2 5 2 4 ...
##  $ senior_manager_engagement_7 : num  3 4 2 3 4 4 2 5 2 4 ...
##  $ senior_manager_engagement_8 : num  3 4 3 3 4 4 2 5 1 3 ...
##  $ senior_manager_engagement_9 : num  3 3 3 3 3 4 3 5 4 4 ...
##  $ senior_manager_engagement_10: num  3 4 3 3 3 5 3 5 3 4 ...
##  $ senior_manager_engagement_11: num  1 4 3 3 3 4 4 5 1 4 ...
##  $ senior_manager_engagement_12: num  3 3 3 3 4 4 3 5 2 4 ...
##  $ leadership_engagement_1     : num  4 3 4 3 4 4 4 4 1 3 ...
##  $ leadership_engagement_2     : num  3 4 2 3 4 5 3 4 1 3 ...
##  $ leadership_engagement_3     : num  4 4 3 3 4 4 4 4 1 3 ...
##  $ leadership_engagement_4     : num  3 4 2 3 4 5 4 4 3 3 ...
##  $ leadership_engagement_5     : num  4 4 2 3 4 4 3 4 3 3 ...
##  $ leadership_engagement_6     : num  3 3 4 3 3 4 2 4 3 3 ...
##  $ leadership_engagement_7     : num  3 4 1 3 4 4 4 4 1 3 ...
##  $ agency_engagement_1         : num  2 4 4 4 4 2 4 4 5 2 ...
##  $ agency_engagement_2         : num  2 4 4 4 4 3 4 5 2 2 ...
##  $ agency_engagement_3         : num  4 4 2 4 3 5 3 4 1 1 ...
##  $ agency_engagement_4         : num  4 4 2 4 3 4 2 4 1 2 ...
##  $ agency_engagement_5         : num  3 4 3 4 4 3 4 4 2 2 ...
##  $ agency_engagement_6         : num  1 4 2 2 3 2 2 4 1 2 ...
##  $ agency_engagement_7         : num  2 4 3 4 4 3 4 4 1 2 ...
```

```
##  $ agency_engagement_8         : num  4 4 4 4 5 5 4 4 4 4 ...
##  $ agency_engagement_9         : num  4 4 5 4 4 5 4 4 4 4 ...
##  $ agency_engagement_10        : num  3 4 4 4 4 4 5 4 3 4 ...
##  $ agency_engagement_11        : num  4 4 4 4 3 4 4 4 1 3 ...
##  $ agency_engagement_12        : num  4 4 3 4 4 4 4 4 1 4 ...
##  $ agency_engagement_13        : num  3 4 3 4 3 4 4 4 5 4 ...
##  $ agency_engagement_14        : num  4 4 4 4 4 3 4 4 5 2 ...
##  $ agency_engagement_15        : num  3 4 3 4 4 3 4 4 1 2 ...
##  $ agency_engagement_16        : num  4 4 4 4 4 3 4 4 3 4 ...
##  $ agency_engagement_17        : num  3 4 2 4 3 3 3 4 1 2 ...
##  $ wellbeing_1                 : num  4 5 5 4 4 5 4 5 2 4 ...
##  $ wellbeing_2                 : num  4 4 3 4 3 4 2 4 2 4 ...
##  $ wellbeing_3                 : num  4 4 5 5 4 5 3 4 4 4 ...
##  $ wellbeing_4                 : num  1 4 5 5 4 4 4 4 1 4 ...
##  $ wellbeing_5                 : num  5 4 4 5 4 4 5 4 3 3 ...
##  $ wellbeing_6                 : num  4 3 4 4 4 4 3 4 2 3 ...
##  $ wellbeing_7                 : num  5 4 4 5 4 4 3 4 3 4 ...
##  $ wellbeing_8                 : num  4 4 3 5 3 5 2 4 2 3 ...
##  $ wellbeing_9                 : num  4 4 5 4 4 5 4 4 2 4 ...
##  $ wellbeing_10                : num  4 4 5 4 3 5 4 4 2 4 ...
##  $ wellbeing_11                : num  4 4 5 4 3 5 4 4 2 4 ...
##  $ wellbeing_12                : num  4 4 4 4 3 5 4 4 1 4 ...
##  $ wellbeing_13                : num  4 5 5 4 4 4 5 4 4 4 ...
##  $ risk_culture_1              : num  3 5 2 4 4 4 4 4 3 4 ...
##  $ risk_culture_2              : num  3 5 2 4 3 5 4 4 3 4 ...
##  $ risk_culture_3              : num  3 5 3 4 3 4 3 4 2 4 ...
##  $ risk_culture_4              : num  3 3 2 4 4 3 2 4 3 3 ...
##  $ risk_culture_5              : num  3 4 3 4 3 4 2 4 3 3 ...
##  $ innovation_1                : num  4 4 4 4 4 5 2 4 1 4 ...
##  $ innovation_2                : num  1 4 4 4 4 4 4 4 3 4 ...
##  $ innovation_3                : num  4 4 4 4 4 4 2 3 1 3 ...
##  $ innovation_4                : num  3 5 4 4 4 4 2 3 2 3 ...
##  $ innovation_5                : num  3 5 5 4 3 4 2 3 3 3 ...
##  $ team_performance_rating     : num  8 8 8 9 6 7 9 7 2 3 ...
##  $ team_performance_support_1  : num  2 4 3 4 4 4 2 4 2 2 ...
##  $ team_performance_support_2  : num  2 5 3 4 3 4 1 4 5 1 ...
##  $ team_performance_support_3  : num  5 4 3 4 4 3 5 4 4 2 ...
##  $ team_performance_support_4  : num  4 5 4 4 4 4 4 4 3 4 ...
##  $ values_1                    : num  5 5 3 5 5 5 5 4 4 3 ...
##  $ values_2                    : num  5 5 4 5 5 5 5 5 4 4 ...
##  $ values_3                    : num  5 5 3 3 5 5 4 4 4 3 ...
##  $ number_skipped_questions    : num  0 0 0 0 1 1 0 0 0 0 ...
```

```
# developing the scales - using the 11 data frames created earlier

job_engagement_df <- data.frame(aps_reduced$job_engagement_1, aps_reduced$job_engagement_2, aps_reduced$
job_engagement <- rowMeans(job_engagement_df)
summary(job_engagement)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.500   3.900   3.822   4.200   5.000
```

```r
team_engagement_df <- data.frame(aps_reduced$team_engagement_1, aps_reduced$team_engagement_2, aps_redu
team_engagement <- rowMeans(team_engagement_df)
summary(team_engagement)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.750   4.000   4.083   4.500   5.000
```

```r
supervisor_engagement_df <- data.frame(aps_reduced$supervisor_engagement_1, aps_reduced$supervisor_enga
supervisor_engagement <- rowMeans(supervisor_engagement_df)
summary(supervisor_engagement)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.818   4.000   4.117   4.818   5.000
```

```r
senior_manager_engagement_df <- data.frame(aps_reduced$senior_manager_engagement_1, aps_reduced$senior_
senior_manager_engagement <- rowMeans(senior_manager_engagement_df)
summary(senior_manager_engagement)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.083   3.833   3.695   4.250   5.000
```

```r
agency_engagement_df <- data.frame(aps_reduced$agency_engagement_1, aps_reduced$agency_engagement_2, aps
agency_engagement <- rowMeans(agency_engagement_df)
summary(agency_engagement)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.176   3.647   3.599   4.000   5.000
```

```r
team_performance_support_df <- data.frame(aps_reduced$team_performance_support_1, aps_reduced$team_perf
team_performance_support <- rowMeans(team_performance_support_df)
summary(team_performance_support)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.250   3.750   3.673   4.000   5.000
```

```r
risk_culture_df <- data.frame(aps_reduced$risk_culture_1, aps_reduced$risk_culture_2, aps_reduced$risk_
risk_culture <- rowMeans(risk_culture_df)
summary(risk_culture)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.000   3.400   3.426   4.000   5.000
```

```r
innovation_df <- data.frame(aps_reduced$innovation_1, aps_reduced$innovation_2, aps_reduced$innovation_
innovation <- rowMeans(innovation_df)
summary(innovation)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.200   3.600   3.563   4.000   5.000
```

```r
leadership_engagement_df <- data.frame(aps_reduced$leadership_engagement_1, aps_reduced$leadership_engag
leadership_engagement <- rowMeans(leadership_engagement_df)
summary(leadership_engagement)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.000   3.429   3.390   4.000   5.000
```

```r
wellbeing_df <- data.frame(aps_reduced$wellbeing_1, aps_reduced$wellbeing_2, aps_reduced$wellbeing_3, ap
wellbeing <- rowMeans(wellbeing_df)
summary(wellbeing)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.308   3.692   3.656   4.077   5.000
```

```r
values_df <- data.frame(aps_reduced$values_1, aps_reduced$values_2, aps_reduced$values_3)
values <- rowMeans(values_df)
summary(values)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   4.000   4.333   4.315   5.000   5.000
```

```r
# new data frame with the 11 new scales and dependant var
# this data frame (aps_with_scales) will be used for (numeric) regression analysis

# assigning the ind variable to a unique variable - separate from aps_reduced data frame
team_performance_rating <- aps_reduced$team_performance_rating

aps_with_scales <- data.frame(job_engagement, team_engagement, supervisor_engagement, senior_manager_eng
str(aps_with_scales)
```

```
## 'data.frame':    85225 obs. of  12 variables:
##  $ job_engagement           : num  2.8 4.1 4.7 3.9 4.2 3.6 3.8 4.8 3.3 3 ...
##  $ team_engagement          : num  4 4 4.25 4 4 4.75 5 4.25 3.75 3.25 ...
##  $ supervisor_engagement    : num  3.91 4 4.82 4.36 4.73 ...
##  $ senior_manager_engagement: num  2.83 3.67 2.67 3 3.75 ...
##  $ agency_engagement        : num  3.18 4 3.29 3.88 3.71 ...
##  $ team_performance_support : num  3.25 4.5 3.25 4 3.75 3.75 3 4 3.5 2.25 ...
##  $ risk_culture             : num  3 4.4 2.4 4 3.4 4 3 4 2.8 3.6 ...
##  $ innovation               : num  3 4.4 4.2 4 3.8 4.2 2.4 3.4 2 3.4 ...
##  $ leadership_engagement    : num  3.43 3.71 2.57 3 3.86 ...
##  $ wellbeing                : num  3.92 4.08 4.38 4.38 3.62 ...
##  $ values                   : num  5 5 3.33 4.33 5 ...
##  $ team_performance_rating  : num  8 8 8 9 6 7 9 7 2 3 ...
```

```r
# Visualizing 11 new scales vs. dependent variable

# step 1: converting 11 new scales and dep var to factors for use with likert functions
job_engagement_f <- as.factor(round(job_engagement))
team_engagement_f <- as.factor(round(team_engagement))
supervisor_engagement_f <- as.factor(round(supervisor_engagement))
```

```
senior_manager_engagement_f <- as.factor(round(senior_manager_engagement))
agency_engagement_f <- as.factor(round(agency_engagement))
team_performance_support_f <- as.factor(round(team_performance_support))
risk_culture_f <- as.factor(round(risk_culture))
innovation_f <- as.factor(round(innovation))
leadership_engagement_f <- as.factor(round(leadership_engagement))
wellbeing_f <- as.factor(round(wellbeing))
values_f <- as.factor(round(values))

# transforming team_performance_rating to 5 point scale to visualize vs. other questions
# using likert functions
team_performance_rating_5scale <- mgsub(aps_reduced$team_performance_rating, c(1,2,3,4,5,6,7,8,9,10), c
str(team_performance_rating_5scale)
```

```
##  chr [1:85225] "4" "4" "4" "5" "3" "4" "5" "4" "1" "2" "3" "2" "3" "4" "4" ...
```

```
team_performance_rating_5scale <- as.numeric(team_performance_rating_5scale)
str(team_performance_rating_5scale)
```

```
##  num [1:85225] 4 4 4 5 3 4 5 4 1 2 ...
```

```
team_performance_rating_5scale_f <- as.factor(team_performance_rating_5scale)

# Data frame to be used for likert visualizations
aps_with_scales_factors_excl_depVar <- data.frame(job_engagement_f, team_engagement_f, supervisor_engag

aps_with_scales_factors <- data.frame(job_engagement_f, team_engagement_f, supervisor_engagement_f, seni
str(aps_with_scales_factors)
```

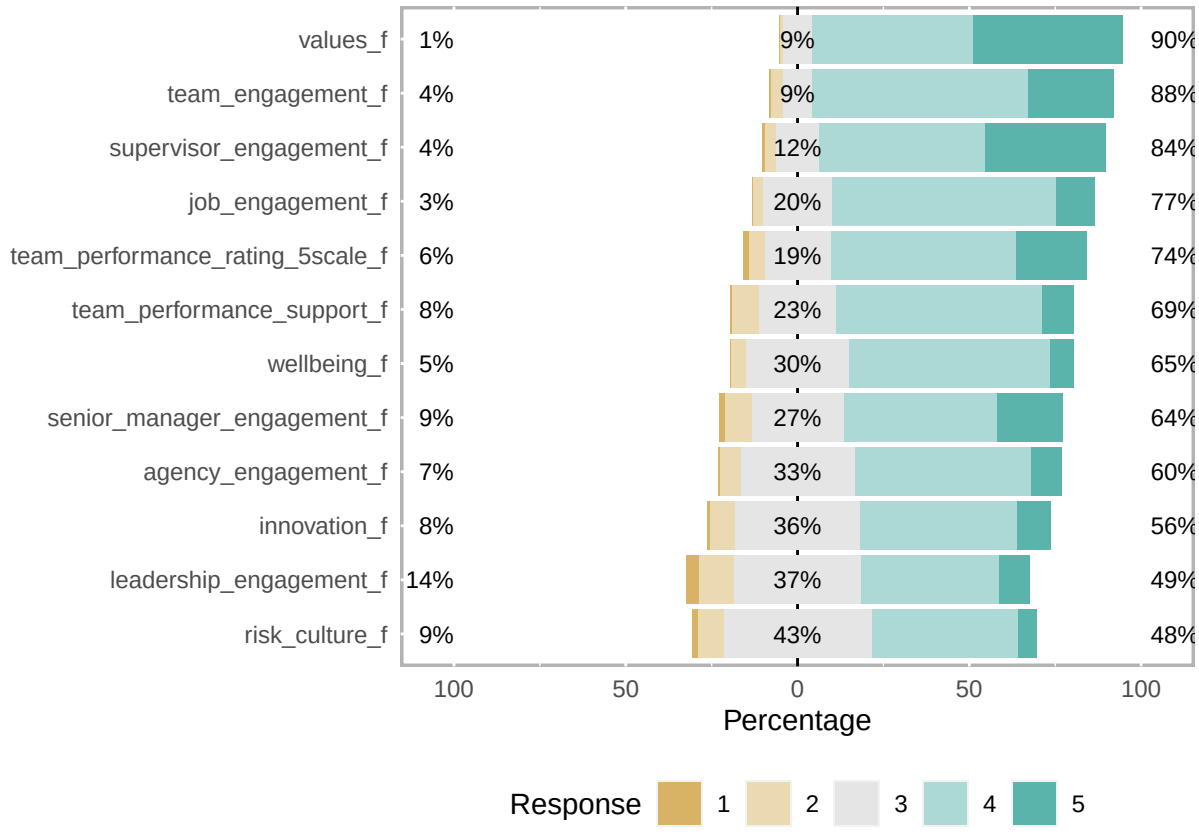
```
## 'data.frame':    85225 obs. of  12 variables:
##  $ job_engagement_f               : Factor w/ 5 levels "1","2","3","4",..: 3 4 5 4 4 4 4 5 3 3 ...
##  $ team_engagement_f              : Factor w/ 5 levels "1","2","3","4",..: 4 4 4 4 4 5 5 4 4 3 ...
##  $ supervisor_engagement_f        : Factor w/ 5 levels "1","2","3","4",..: 4 4 5 4 5 5 5 5 3 4 ...
##  $ senior_manager_engagement_f    : Factor w/ 5 levels "1","2","3","4",..: 3 4 3 3 4 4 2 5 2 4 ...
##  $ agency_engagement_f            : Factor w/ 5 levels "1","2","3","4",..: 3 4 3 4 4 4 4 4 2 3 ...
##  $ team_performance_support_f     : Factor w/ 5 levels "1","2","3","4",..: 3 4 3 4 4 4 3 4 4 2 ...
##  $ risk_culture_f                 : Factor w/ 5 levels "1","2","3","4",..: 3 4 2 4 3 4 3 4 3 4 ...
##  $ innovation_f                   : Factor w/ 5 levels "1","2","3","4",..: 3 4 4 4 4 4 2 3 2 3 ...
##  $ leadership_engagement_f        : Factor w/ 5 levels "1","2","3","4",..: 3 4 3 3 4 4 3 4 2 3 ...
##  $ wellbeing_f                    : Factor w/ 5 levels "1","2","3","4",..: 4 4 4 4 4 5 4 4 2 4 ...
##  $ values_f                       : Factor w/ 5 levels "1","2","3","4",..: 5 5 3 4 5 5 5 4 4 3 ...
##  $ team_performance_rating_5scale_f: Factor w/ 5 levels "1","2","3","4",..: 4 4 4 5 3 4 5 4 1 2 ...
```

```
# summary of low scores (strongly disagree + disagree), neutral (neither agree nor disagree)
# high (strongly agree + agree) and mean and sd
aps_with_scales_factors_likert <- likert(aps_with_scales_factors)
summary(aps_with_scales_factors_likert)
```

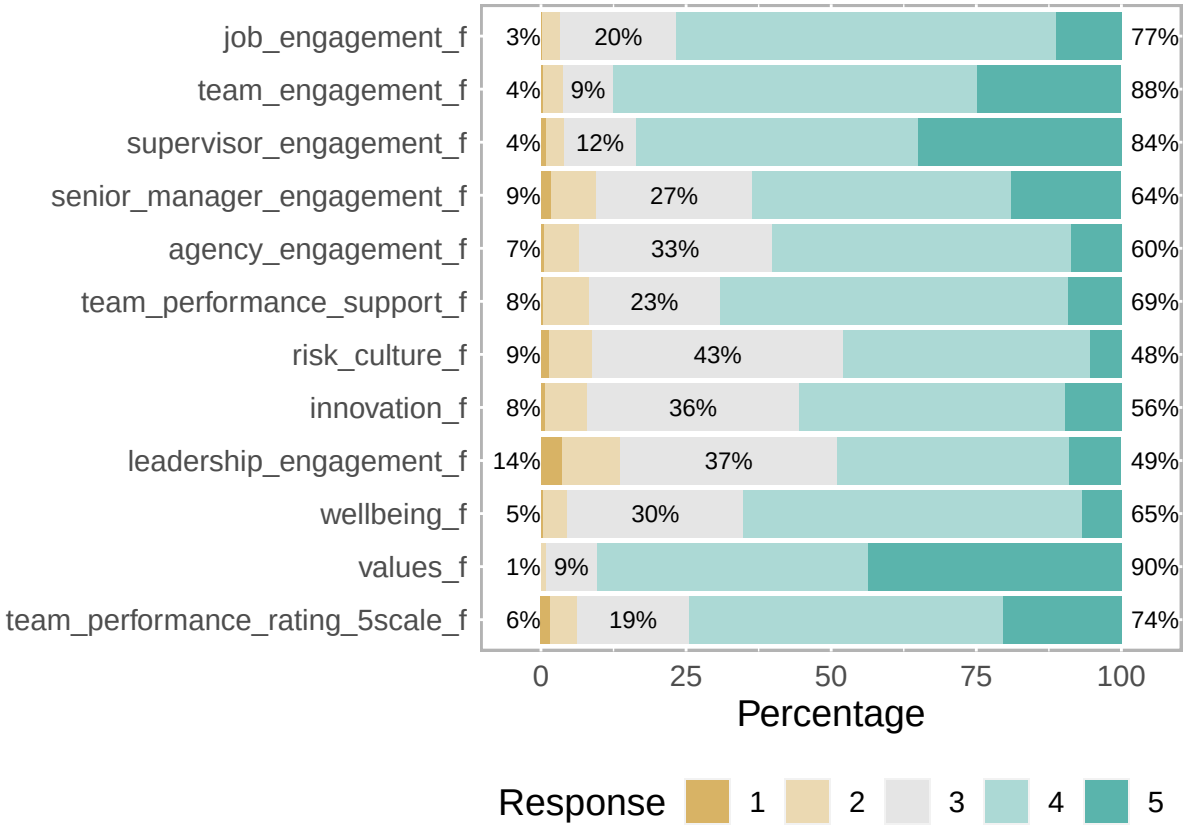
```
##                              Item        low   neutral     high     mean
## 11                       values_f  0.9304781  8.691112 90.37841 4.329281
## 2                team_engagement_f  3.8028747  8.600763 87.59636 4.081690
```

```
## 3           supervisor_engagement_f  4.0000000 12.381344 83.61866 4.138621
## 1                 job_engagement_f  3.3652097 19.944852 76.68994 3.844353
## 12 team_performance_rating_5scale_f  6.2305661 19.315928 74.45351 3.871035
## 6        team_performance_support_f  8.2628337 22.536814 69.20035 3.697507
## 10                    wellbeing_f  4.5632150 30.297448 65.13934 3.670261
## 4       senior_manager_engagement_f  9.4784394 26.881784 63.63978 3.713476
## 5             agency_engagement_f  6.5379877 33.217952 60.24406 3.618633
## 8                   innovation_f  7.9870930 36.490466 55.52244 3.564658
## 9          leadership_engagement_f 13.7213259 37.248460 49.03021 3.406759
## 7                   risk_culture_f  8.8025814 43.298328 47.89909 3.430367
##           sd
## 11 0.6759571
## 2  0.7079963
## 3  0.8106579
## 1  0.6576916
## 12 0.8415038
## 6  0.7613755
## 10 0.6768877
## 4  0.9177192
## 5  0.7515965
## 8  0.7943965
## 9  0.9157796
## 7  0.7676932
```

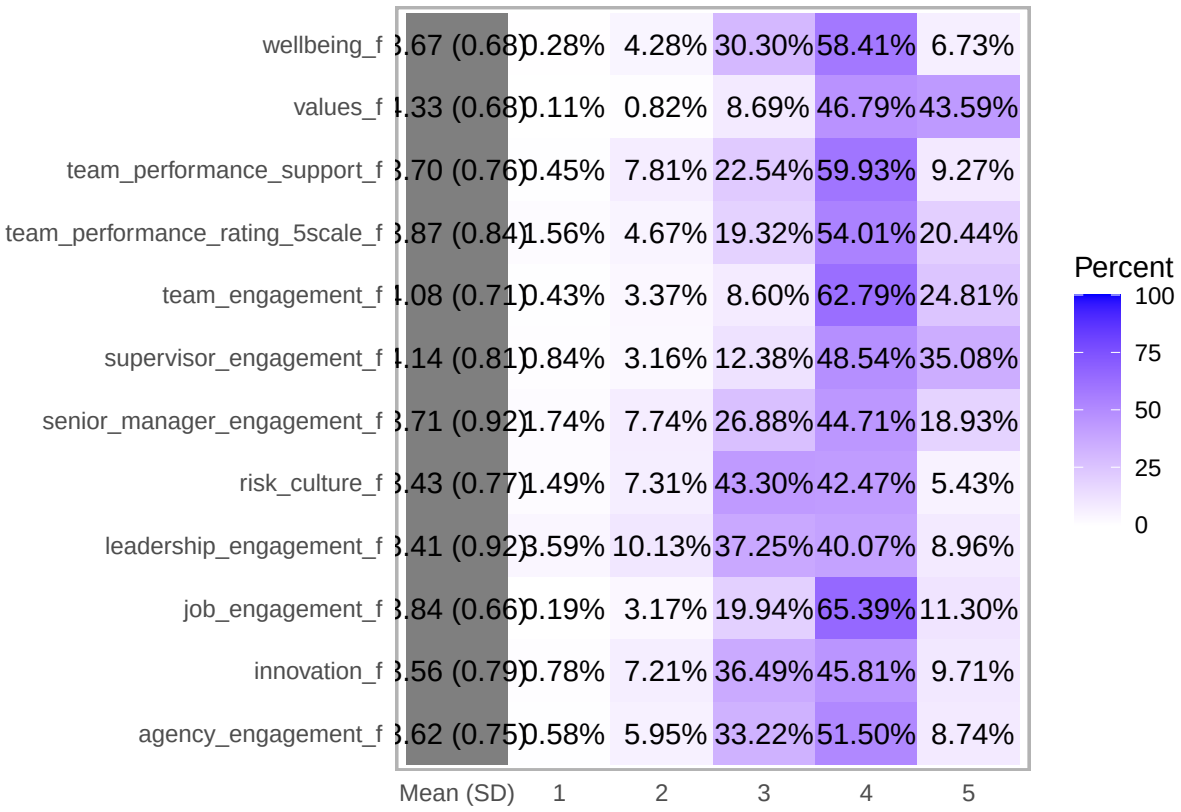
```
# centered bar plot showing the percent responses for each question (order from most to least agreement
plot(aps_with_scales_factors_likert, type="bar")
```



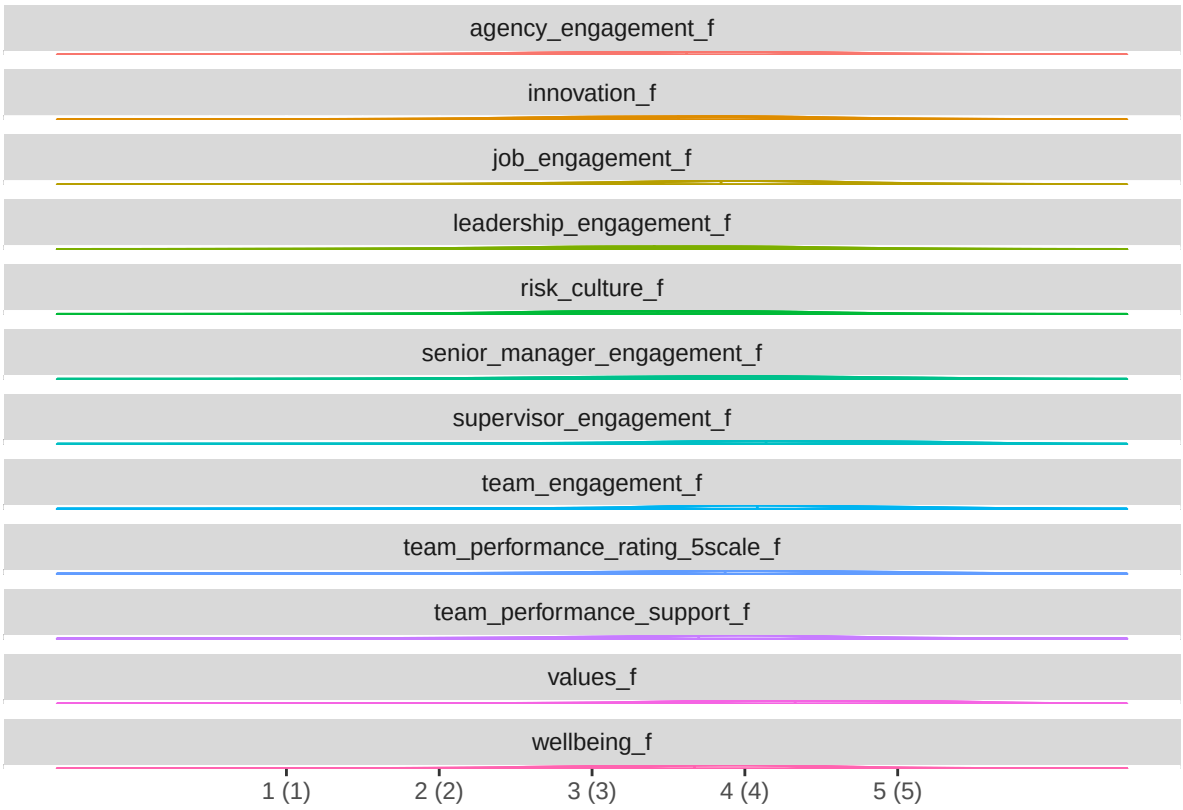
```r
# bar plot ordered by question (not centered)
plot(aps_with_scales_factors_likert, group.order = names(aps_with_scales_factors), centered = FALSE) +
```




```r
# heat plot (mean, standard deviation, and percent selection of responses for each question)
plot(aps_with_scales_factors_likert,
     type="heat",
     low.color = "white",
     high.color = "blue",
     text.color = "black",
     text.size = 4,
     wrap = 50)
```




```
# density plot (treating Likert data like numeric data)
plot(aps_with_scales_factors_likert,
     type="density",
     facet = TRUE,
     bw = 0.5)
```




```
# descriptive statistics (mean, sd, median, skewness)
psych::describe(aps_with_scales_factors)
```

```
##                                  vars     n mean   sd median trimmed  mad min
## job_engagement_f*                   1 85225 3.84 0.66      4    3.85 0.00   1
## team_engagement_f*                  2 85225 4.08 0.71      4    4.16 0.00   1
## supervisor_engagement_f*            3 85225 4.14 0.81      4    4.23 1.48   1
## senior_manager_engagement_f*        4 85225 3.71 0.92      4    3.78 1.48   1
## agency_engagement_f*                5 85225 3.62 0.75      4    3.63 0.00   1
## team_performance_support_f*         6 85225 3.70 0.76      4    3.74 0.00   1
## risk_culture_f*                     7 85225 3.43 0.77      3    3.47 1.48   1
## innovation_f*                       8 85225 3.56 0.79      4    3.57 1.48   1
## leadership_engagement_f*            9 85225 3.41 0.92      3    3.44 1.48   1
## wellbeing_f*                       10 85225 3.67 0.68      4    3.69 0.00   1
## values_f*                          11 85225 4.33 0.68      4    4.42 1.48   1
## team_performance_rating_5scale_f*  12 85225 3.87 0.84      4    3.94 0.00   1
##                                  max range  skew kurtosis se
## job_engagement_f*                  5     4 -0.66     1.26  0
## team_engagement_f*                 5     4 -0.98     2.25  0
## supervisor_engagement_f*           5     4 -0.99     1.34  0
## senior_manager_engagement_f*       5     4 -0.54     0.10  0
## agency_engagement_f*               5     4 -0.42     0.33  0
## team_performance_support_f*        5     4 -0.74     0.61  0
## risk_culture_f*                    5     4 -0.38     0.50  0
## innovation_f*                      5     4 -0.30     0.10  0
```

```
## leadership_engagement_f*           5     4 -0.47     0.18  0
## wellbeing_f*                       5     4 -0.53     0.60  0
## values_f*                          5     4 -0.75     0.54  0
## team_performance_rating_5scale_f*  5     4 -0.85     1.14  0
```

```r
# Correlation analysis

# Pearson correlation (11 scales and dep var)
Pcorrelation_and_significance <- Hmisc::rcorr(as.matrix(aps_with_scales), type = "pearson")
Pcorrelation_and_significance
```

```
##                           job_engagement team_engagement supervisor_engagement
## job_engagement                      1.00            0.54                 0.57
## team_engagement                     0.54            1.00                 0.59
## supervisor_engagement               0.57            0.59                 1.00
## senior_manager_engagement           0.58            0.44                 0.49
## agency_engagement                   0.75            0.53                 0.52
## team_performance_support            0.55            0.51                 0.52
## risk_culture                        0.50            0.40                 0.41
## innovation                          0.63            0.45                 0.56
## leadership_engagement               0.55            0.38                 0.38
## wellbeing                           0.71            0.57                 0.64
## values                              0.46            0.53                 0.52
## team_performance_rating             0.40            0.46                 0.40
##                           senior_manager_engagement agency_engagement
## job_engagement                                 0.58              0.75
## team_engagement                                0.44              0.53
## supervisor_engagement                          0.49              0.52
## senior_manager_engagement                      1.00              0.63
## agency_engagement                              0.63              1.00
## team_performance_support                       0.48              0.62
## risk_culture                                   0.50              0.65
## innovation                                     0.56              0.70
## leadership_engagement                          0.71              0.71
## wellbeing                                      0.57              0.74
## values                                         0.48              0.53
## team_performance_rating                        0.36              0.45
##                           team_performance_support risk_culture innovation
## job_engagement                                0.55         0.50       0.63
## team_engagement                               0.51         0.40       0.45
## supervisor_engagement                         0.52         0.41       0.56
## senior_manager_engagement                     0.48         0.50       0.56
## agency_engagement                             0.62         0.65       0.70
## team_performance_support                      1.00         0.55       0.58
## risk_culture                                  0.55         1.00       0.65
## innovation                                    0.58         0.65       1.00
## leadership_engagement                         0.49         0.58       0.57
## wellbeing                                     0.65         0.60       0.67
## values                                        0.48         0.45       0.47
## team_performance_rating                       0.53         0.38       0.42
##                           leadership_engagement wellbeing values
## job_engagement                             0.55      0.71   0.46
## team_engagement                            0.38      0.57   0.53
## supervisor_engagement                      0.38      0.64   0.52
```

```
## senior_manager_engagement                  0.71      0.57   0.48
## agency_engagement                          0.71      0.74   0.53
## team_performance_support                   0.49      0.65   0.48
## risk_culture                               0.58      0.60   0.45
## innovation                                 0.57      0.67   0.47
## leadership_engagement                      1.00      0.58   0.48
## wellbeing                                  0.58      1.00   0.56
## values                                     0.48      0.56   1.00
## team_performance_rating                    0.34      0.45   0.39
##                           team_performance_rating
## job_engagement                               0.40
## team_engagement                              0.46
## supervisor_engagement                        0.40
## senior_manager_engagement                    0.36
## agency_engagement                            0.45
## team_performance_support                     0.53
## risk_culture                                 0.38
## innovation                                   0.42
## leadership_engagement                        0.34
## wellbeing                                    0.45
## values                                       0.39
## team_performance_rating                      1.00
##
## n= 85225
##
##
## P
##                           job_engagement team_engagement supervisor_engagement
## job_engagement                            0               0
## team_engagement            0                              0
## supervisor_engagement      0              0
## senior_manager_engagement  0              0               0
## agency_engagement          0              0               0
## team_performance_support   0              0               0
## risk_culture               0              0               0
## innovation                 0              0               0
## leadership_engagement      0              0               0
## wellbeing                  0              0               0
## values                     0              0               0
## team_performance_rating    0              0               0
##                           senior_manager_engagement agency_engagement
## job_engagement             0                        0
## team_engagement            0                        0
## supervisor_engagement      0                        0
## senior_manager_engagement                           0
## agency_engagement          0
## team_performance_support   0                        0
## risk_culture               0                        0
## innovation                 0                        0
## leadership_engagement      0                        0
## wellbeing                  0                        0
## values                     0                        0
## team_performance_rating    0                        0
##                           team_performance_support risk_culture innovation
```

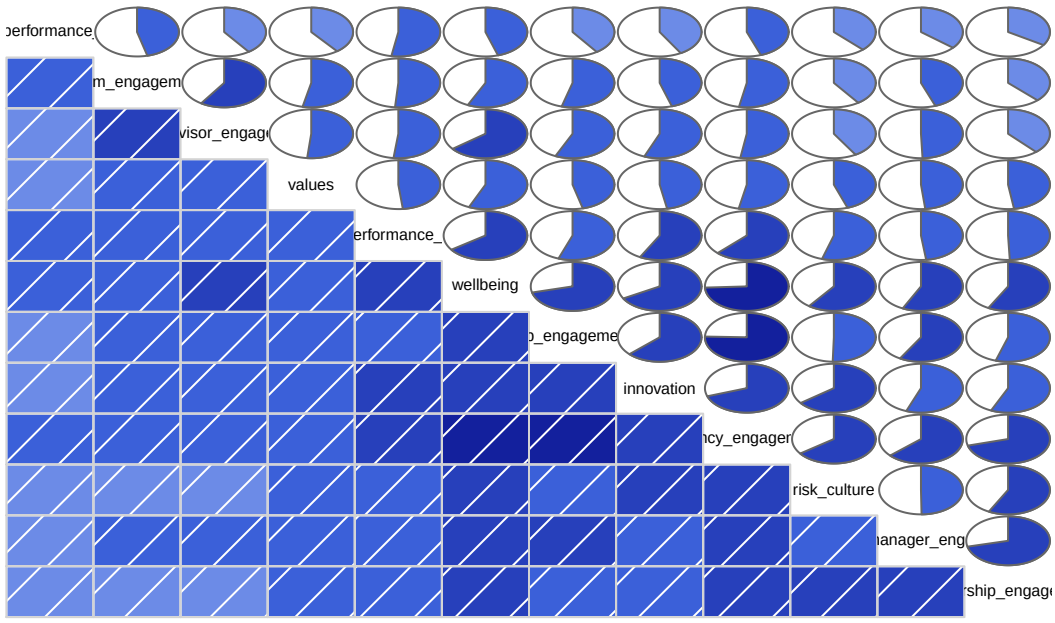
```
## job_engagement             0                         0           0
## team_engagement            0                         0           0
## supervisor_engagement      0                         0           0
## senior_manager_engagement  0                         0           0
## agency_engagement          0                         0           0
## team_performance_support                             0           0
## risk_culture               0                                     0
## innovation                 0                         0
## leadership_engagement      0                         0           0
## wellbeing                  0                         0           0
## values                     0                         0           0
## team_performance_rating    0                         0           0
##                          leadership_engagement wellbeing values
## job_engagement             0                       0         0
## team_engagement            0                       0         0
## supervisor_engagement      0                       0         0
## senior_manager_engagement  0                       0         0
## agency_engagement          0                       0         0
## team_performance_support   0                       0         0
## risk_culture               0                       0         0
## innovation                 0                       0         0
## leadership_engagement                              0         0
## wellbeing                  0                                 0
## values                     0                       0
## team_performance_rating    0                       0         0
##                          team_performance_rating
## job_engagement             0
## team_engagement            0
## supervisor_engagement      0
## senior_manager_engagement  0
## agency_engagement          0
## team_performance_support   0
## risk_culture               0
## innovation                 0
## leadership_engagement      0
## wellbeing                  0
## values                     0
## team_performance_rating
```

```
Pcorr_aps_with_scales <- cor(aps_with_scales, method = "pearson")
Pcorr_aps_with_scales
```

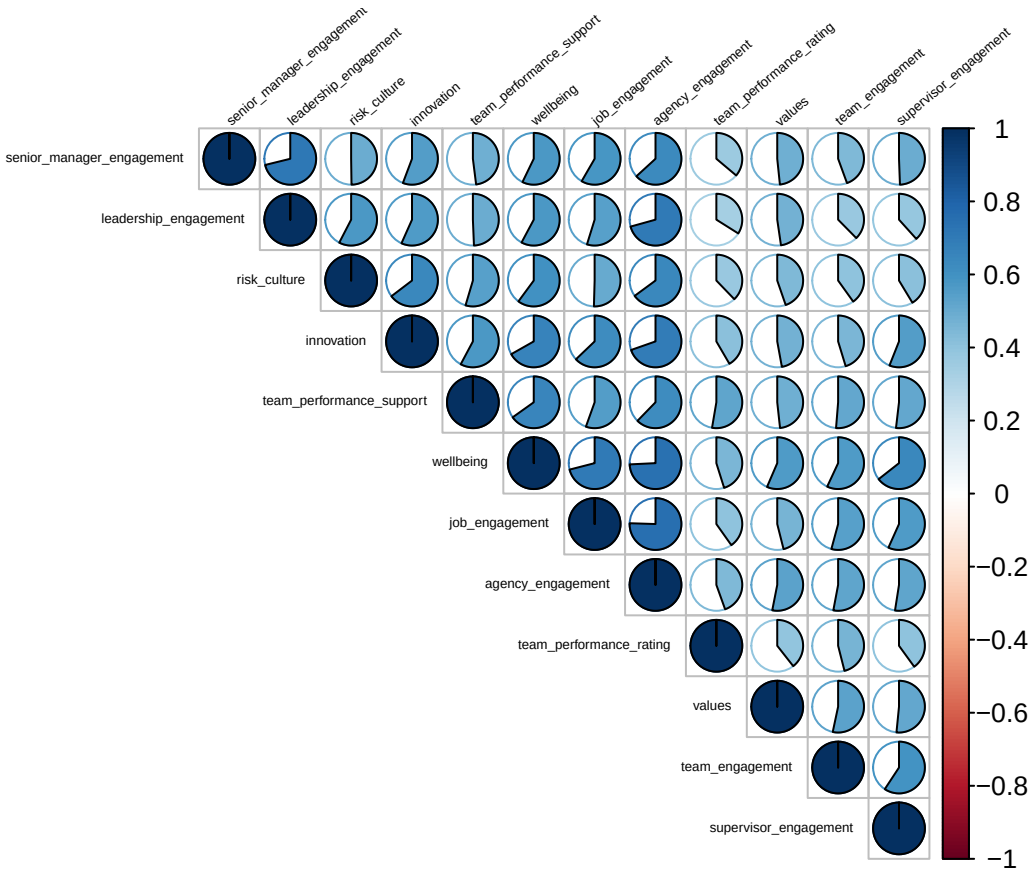
```
##                          job_engagement team_engagement supervisor_engagement
## job_engagement                1.0000000       0.5419913             0.5671127
## team_engagement               0.5419913       1.0000000             0.5925929
## supervisor_engagement         0.5671127       0.5925929             1.0000000
## senior_manager_engagement     0.5835261       0.4441467             0.4940271
## agency_engagement             0.7548780       0.5297688             0.5247124
## team_performance_support      0.5546794       0.5127437             0.5185664
## risk_culture                  0.5044287       0.4010274             0.4133929
## innovation                    0.6285909       0.4529027             0.5599314
## leadership_engagement         0.5478137       0.3760601             0.3832608
## wellbeing                     0.7098903       0.5694844             0.6440649
## values                        0.4606819       0.5333406             0.5156177
```

```
## team_performance_rating        0.4019067       0.4603336             0.4000508
##                           senior_manager_engagement agency_engagement
## job_engagement                            0.5835261         0.7548780
## team_engagement                           0.4441467         0.5297688
## supervisor_engagement                     0.4940271         0.5247124
## senior_manager_engagement                 1.0000000         0.6320223
## agency_engagement                         0.6320223         1.0000000
## team_performance_support                  0.4800846         0.6227191
## risk_culture                              0.4977669         0.6490339
## innovation                                0.5572475         0.6961849
## leadership_engagement                     0.7116808         0.7068004
## wellbeing                                 0.5719012         0.7424776
## values                                    0.4835871         0.5309823
## team_performance_rating                   0.3613395         0.4451092
##                           team_performance_support risk_culture innovation
## job_engagement                           0.5546794    0.5044287  0.6285909
## team_engagement                          0.5127437    0.4010274  0.4529027
## supervisor_engagement                    0.5185664    0.4133929  0.5599314
## senior_manager_engagement                0.4800846    0.4977669  0.5572475
## agency_engagement                        0.6227191    0.6490339  0.6961849
## team_performance_support                 1.0000000    0.5458152  0.5778625
## risk_culture                             0.5458152    1.0000000  0.6463295
## innovation                               0.5778625    0.6463295  1.0000000
## leadership_engagement                    0.4934137    0.5760340  0.5666322
## wellbeing                                0.6516033    0.6009870  0.6678669
## values                                   0.4827392    0.4471368  0.4714118
## team_performance_rating                  0.5267947    0.3781082  0.4159437
##                           leadership_engagement wellbeing    values
## job_engagement                        0.5478137 0.7098903 0.4606819
## team_engagement                       0.3760601 0.5694844 0.5333406
## supervisor_engagement                 0.3832608 0.6440649 0.5156177
## senior_manager_engagement             0.7116808 0.5719012 0.4835871
## agency_engagement                     0.7068004 0.7424776 0.5309823
## team_performance_support              0.4934137 0.6516033 0.4827392
## risk_culture                          0.5760340 0.6009870 0.4471368
## innovation                            0.5666322 0.6678669 0.4714118
## leadership_engagement                 1.0000000 0.5780821 0.4770644
## wellbeing                             0.5780821 1.0000000 0.5645506
## values                                0.4770644 0.5645506 1.0000000
## team_performance_rating               0.3395009 0.4515806 0.3940262
##                           team_performance_rating
## job_engagement                          0.4019067
## team_engagement                         0.4603336
## supervisor_engagement                   0.4000508
## senior_manager_engagement               0.3613395
## agency_engagement                       0.4451092
## team_performance_support                0.5267947
## risk_culture                            0.3781082
## innovation                              0.4159437
## leadership_engagement                   0.3395009
## wellbeing                               0.4515806
## values                                  0.3940262
## team_performance_rating                 1.0000000
```

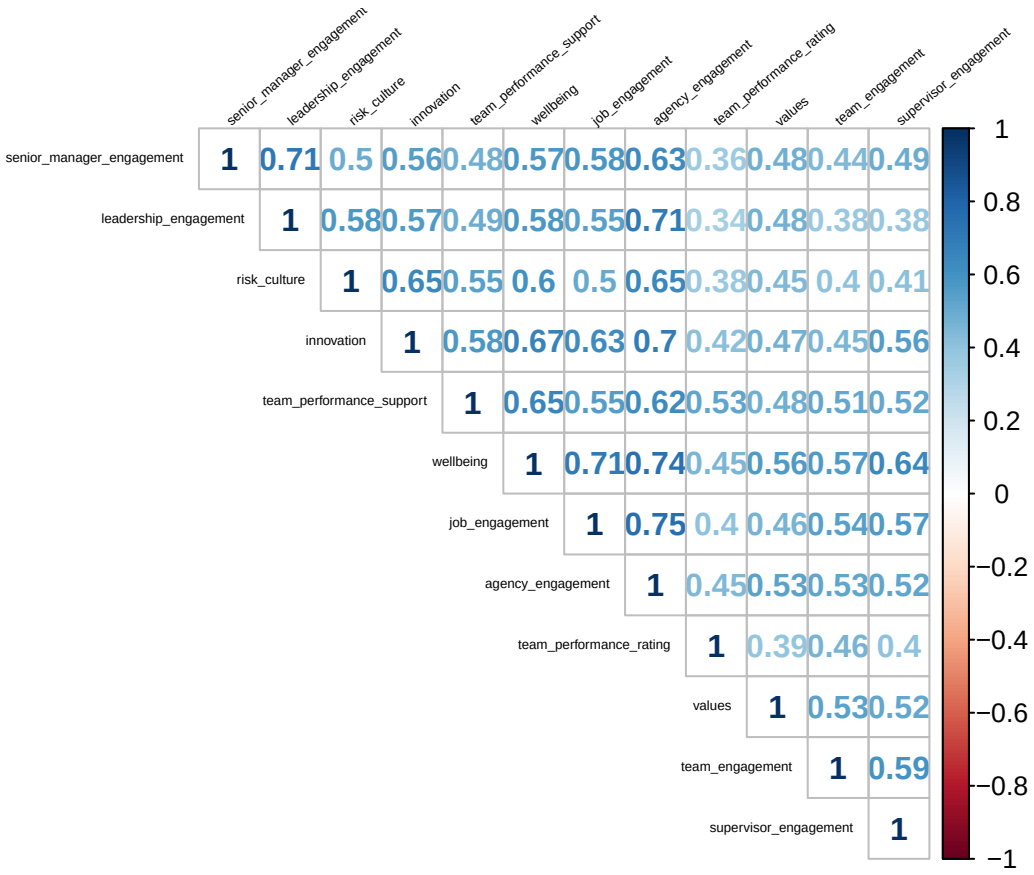
```
corrgram(Pcorr_aps_with_scales, order=TRUE, lower.panel=panel.shade,
         upper.panel=panel.pie, text.panel=panel.txt,
         main="Correlation analysis - Pearson")
```




```
corrplot(Pcorr_aps_with_scales, method="pie", type = "upper", order = "hclust",
         tl.col = "black", tl.srt = 40, tl.cex = 0.4)
```




```
corrplot(Pcorr_aps_with_scales, method="number", type = "upper", order = "hclust",
         tl.col = "black", tl.srt = 40, tl.cex = 0.4)
```




```
# Spearman correlation (11 scales and dep var)

Scorrelation_and_significance <- Hmisc::rcorr(as.matrix(aps_with_scales), type = "spearman")
Scorrelation_and_significance
```

```
##                           job_engagement team_engagement supervisor_engagement
## job_engagement                      1.00            0.52                 0.55
## team_engagement                     0.52            1.00                 0.58
## supervisor_engagement               0.55            0.58                 1.00
## senior_manager_engagement           0.56            0.42                 0.49
## agency_engagement                   0.73            0.50                 0.51
## team_performance_support            0.53            0.47                 0.49
## risk_culture                        0.47            0.35                 0.38
## innovation                          0.60            0.42                 0.53
## leadership_engagement               0.52            0.35                 0.37
## wellbeing                           0.68            0.52                 0.60
## values                              0.43            0.48                 0.45
## team_performance_rating             0.36            0.41                 0.36
##                           senior_manager_engagement agency_engagement
## job_engagement                                 0.56              0.73
## team_engagement                                0.42              0.50
## supervisor_engagement                          0.49              0.51
## senior_manager_engagement                      1.00              0.61
## agency_engagement                              0.61              1.00
## team_performance_support                       0.46              0.60
```

```
## risk_culture                                0.47             0.62
## innovation                                  0.54             0.68
## leadership_engagement                       0.70             0.70
## wellbeing                                   0.54             0.72
## values                                      0.46             0.50
## team_performance_rating                     0.33             0.41
##                           team_performance_support risk_culture innovation
## job_engagement                            0.53         0.47       0.60
## team_engagement                           0.47         0.35       0.42
## supervisor_engagement                     0.49         0.38       0.53
## senior_manager_engagement                 0.46         0.47       0.54
## agency_engagement                         0.60         0.62       0.68
## team_performance_support                  1.00         0.51       0.55
## risk_culture                              0.51         1.00       0.62
## innovation                                0.55         0.62       1.00
## leadership_engagement                     0.48         0.55       0.55
## wellbeing                                 0.62         0.56       0.64
## values                                    0.45         0.41       0.44
## team_performance_rating                   0.48         0.34       0.38
##                           leadership_engagement wellbeing values
## job_engagement                             0.52      0.68   0.43
## team_engagement                            0.35      0.52   0.48
## supervisor_engagement                      0.37      0.60   0.45
## senior_manager_engagement                  0.70      0.54   0.46
## agency_engagement                          0.70      0.72   0.50
## team_performance_support                   0.48      0.62   0.45
## risk_culture                               0.55      0.56   0.41
## innovation                                 0.55      0.64   0.44
## leadership_engagement                      1.00      0.56   0.47
## wellbeing                                  0.56      1.00   0.52
## values                                     0.47      0.52   1.00
## team_performance_rating                    0.31      0.40   0.35
##                           team_performance_rating
## job_engagement                              0.36
## team_engagement                             0.41
## supervisor_engagement                       0.36
## senior_manager_engagement                   0.33
## agency_engagement                           0.41
## team_performance_support                    0.48
## risk_culture                                0.34
## innovation                                  0.38
## leadership_engagement                       0.31
## wellbeing                                   0.40
## values                                      0.35
## team_performance_rating                     1.00
##
## n= 85225
##
##
## P
##                           job_engagement team_engagement supervisor_engagement
## job_engagement                         0               0
## team_engagement            0                           0
## supervisor_engagement      0             0
```

```
## senior_manager_engagement  0              0              0
## agency_engagement          0              0              0
## team_performance_support   0              0              0
## risk_culture               0              0              0
## innovation                 0              0              0
## leadership_engagement      0              0              0
## wellbeing                  0              0              0
## values                     0              0              0
## team_performance_rating    0              0              0
##                           senior_manager_engagement agency_engagement
## job_engagement             0                         0
## team_engagement            0                         0
## supervisor_engagement      0                         0
## senior_manager_engagement                            0
## agency_engagement          0
## team_performance_support   0                         0
## risk_culture               0                         0
## innovation                 0                         0
## leadership_engagement      0                         0
## wellbeing                  0                         0
## values                     0                         0
## team_performance_rating    0                         0
##                           team_performance_support risk_culture innovation
## job_engagement             0                        0            0
## team_engagement            0                        0            0
## supervisor_engagement      0                        0            0
## senior_manager_engagement  0                        0            0
## agency_engagement          0                        0            0
## team_performance_support                            0            0
## risk_culture               0                                     0
## innovation                 0                        0
## leadership_engagement      0                        0            0
## wellbeing                  0                        0            0
## values                     0                        0            0
## team_performance_rating    0                        0            0
##                           leadership_engagement wellbeing values
## job_engagement             0                     0         0
## team_engagement            0                     0         0
## supervisor_engagement      0                     0         0
## senior_manager_engagement  0                     0         0
## agency_engagement          0                     0         0
## team_performance_support   0                     0         0
## risk_culture               0                     0         0
## innovation                 0                     0         0
## leadership_engagement                            0         0
## wellbeing                  0                               0
## values                     0                     0
## team_performance_rating    0                     0         0
##                           team_performance_rating
## job_engagement             0
## team_engagement            0
## supervisor_engagement      0
## senior_manager_engagement  0
## agency_engagement          0
```

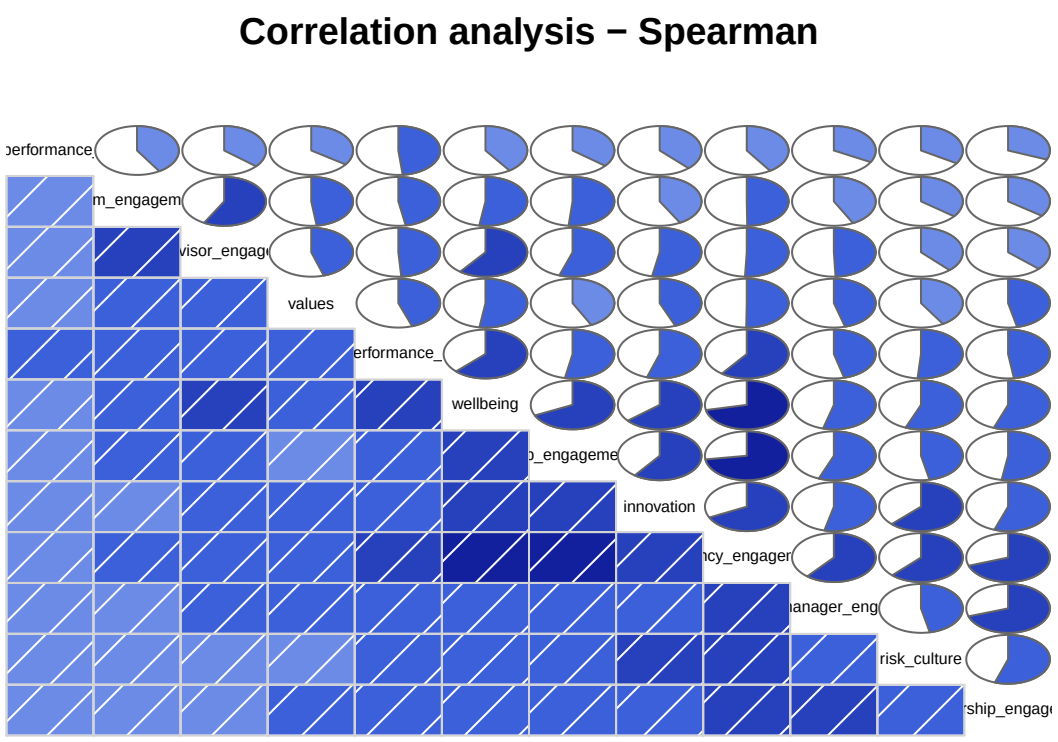
```
## team_performance_support   0
## risk_culture               0
## innovation                 0
## leadership_engagement      0
## wellbeing                  0
## values                     0
## team_performance_rating
```

```
Scorr_aps_with_scales <- cor(aps_with_scales, method = "spearman")
Scorr_aps_with_scales
```

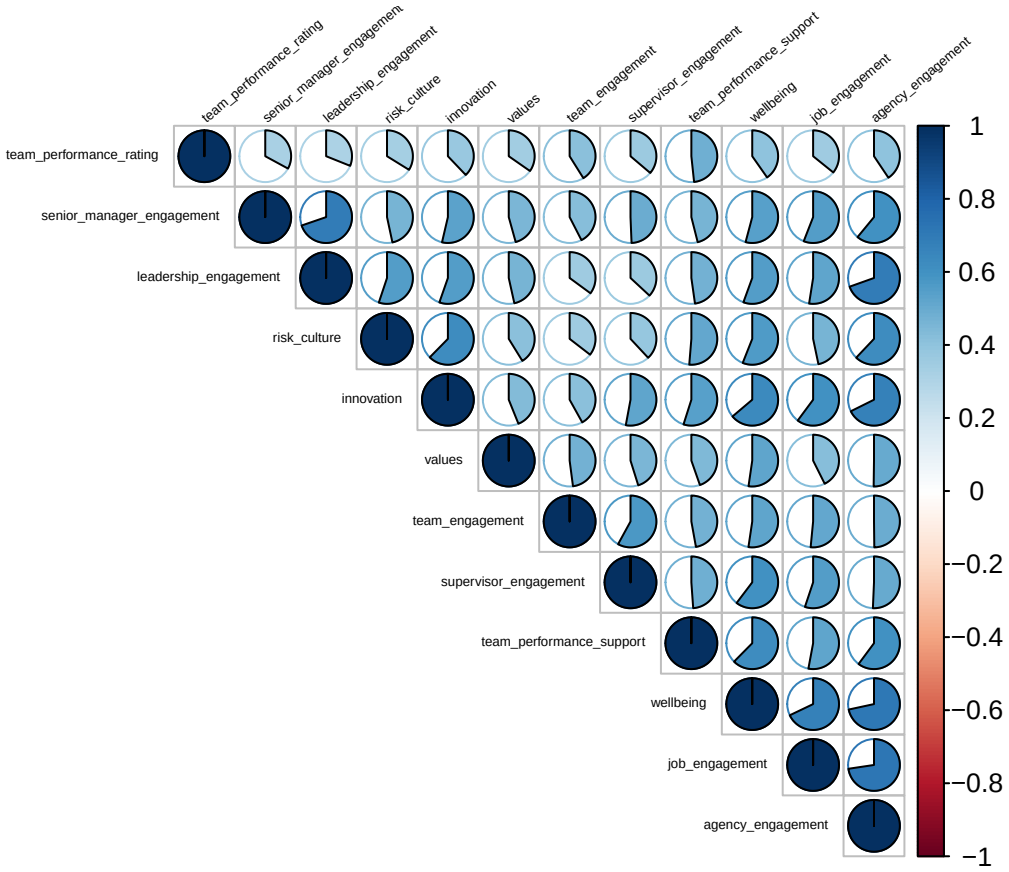
```
##                           job_engagement team_engagement supervisor_engagement
## job_engagement                 1.0000000       0.5151938             0.5512418
## team_engagement                0.5151938       1.0000000             0.5796465
## supervisor_engagement          0.5512418       0.5796465             1.0000000
## senior_manager_engagement      0.5590489       0.4245723             0.4935763
## agency_engagement              0.7264341       0.4981584             0.5068256
## team_performance_support       0.5294291       0.4717698             0.4887811
## risk_culture                   0.4671793       0.3548224             0.3806507
## innovation                     0.6014826       0.4192114             0.5291258
## leadership_engagement          0.5247938       0.3507011             0.3690444
## wellbeing                      0.6790029       0.5236470             0.6032917
## values                         0.4261000       0.4792134             0.4516440
## team_performance_rating        0.3579035       0.4108787             0.3619258
##                           senior_manager_engagement agency_engagement
## job_engagement                            0.5590489         0.7264341
## team_engagement                           0.4245723         0.4981584
## supervisor_engagement                     0.4935763         0.5068256
## senior_manager_engagement                 1.0000000         0.6097344
## agency_engagement                         0.6097344         1.0000000
## team_performance_support                  0.4606028         0.6015910
## risk_culture                              0.4663351         0.6205267
## innovation                                0.5365491         0.6766279
## leadership_engagement                     0.6973533         0.6955119
## wellbeing                                 0.5415736         0.7161051
## values                                    0.4568746         0.5020836
## team_performance_rating                   0.3291379         0.4059821
##                           team_performance_support risk_culture innovation
## job_engagement                           0.5294291    0.4671793  0.6014826
## team_engagement                          0.4717698    0.3548224  0.4192114
## supervisor_engagement                    0.4887811    0.3806507  0.5291258
## senior_manager_engagement                0.4606028    0.4663351  0.5365491
## agency_engagement                        0.6015910    0.6205267  0.6766279
## team_performance_support                 1.0000000    0.5129788  0.5491258
## risk_culture                             0.5129788    1.0000000  0.6233979
## innovation                               0.5491258    0.6233979  1.0000000
## leadership_engagement                    0.4776417    0.5512811  0.5533932
## wellbeing                                0.6240878    0.5600040  0.6381884
## values                                   0.4464839    0.4120400  0.4390487
## team_performance_rating                  0.4833737    0.3380267  0.3788382
##                           leadership_engagement wellbeing    values
## job_engagement                        0.5247938 0.6790029 0.4261000
## team_engagement                       0.3507011 0.5236470 0.4792134
## supervisor_engagement                 0.3690444 0.6032917 0.4516440
```

```
## senior_manager_engagement              0.6973533 0.5415736 0.4568746
## agency_engagement                      0.6955119 0.7161051 0.5020836
## team_performance_support               0.4776417 0.6240878 0.4464839
## risk_culture                           0.5512811 0.5600040 0.4120400
## innovation                             0.5533932 0.6381884 0.4390487
## leadership_engagement                  1.0000000 0.5555577 0.4653146
## wellbeing                              0.5555577 1.0000000 0.5230278
## values                                 0.4653146 0.5230278 1.0000000
## team_performance_rating                0.3106175 0.4027728 0.3468835
##                            team_performance_rating
## job_engagement                           0.3579035
## team_engagement                          0.4108787
## supervisor_engagement                    0.3619258
## senior_manager_engagement                0.3291379
## agency_engagement                        0.4059821
## team_performance_support                 0.4833737
## risk_culture                             0.3380267
## innovation                               0.3788382
## leadership_engagement                    0.3106175
## wellbeing                                0.4027728
## values                                   0.3468835
## team_performance_rating                  1.0000000
```

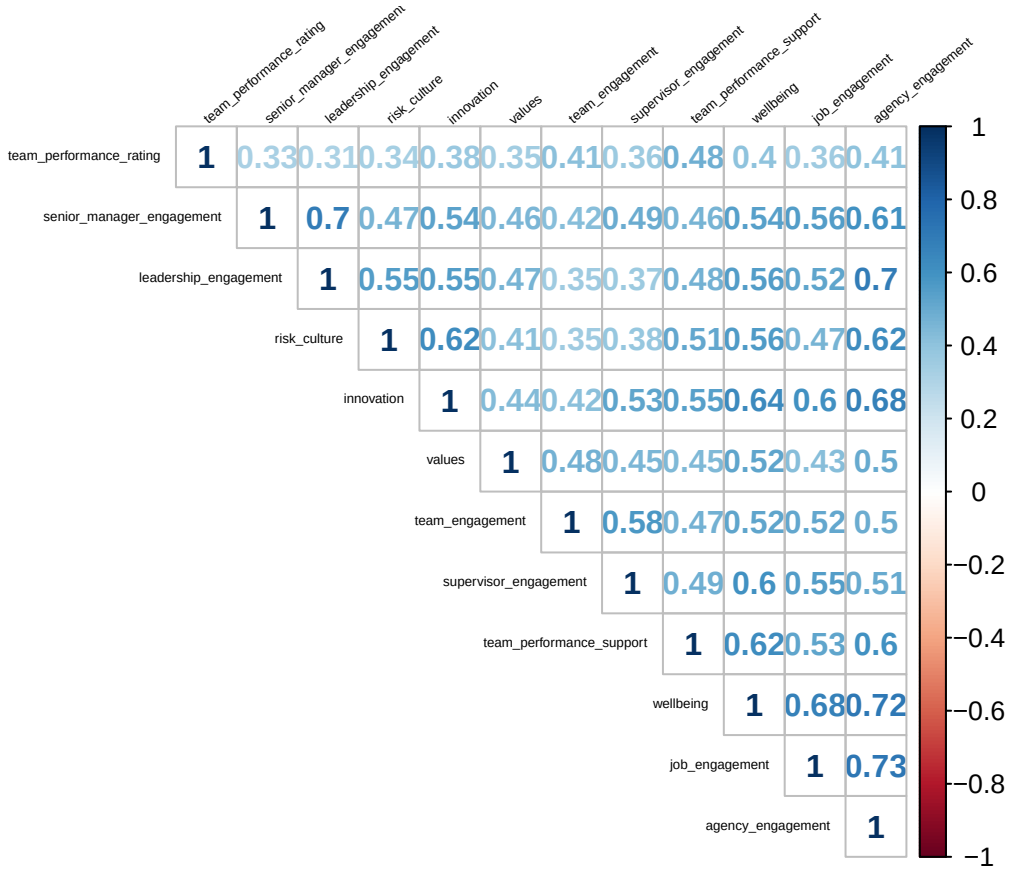
```
corrgram(Scorr_aps_with_scales, order=TRUE, lower.panel=panel.shade,
         upper.panel=panel.pie, text.panel=panel.txt,
         main="Correlation analysis - Spearman")
```



```
corrplot(Scorr_aps_with_scales, method="pie", type = "upper", order = "hclust",
         tl.col = "black", tl.srt = 40, tl.cex = 0.4)
```



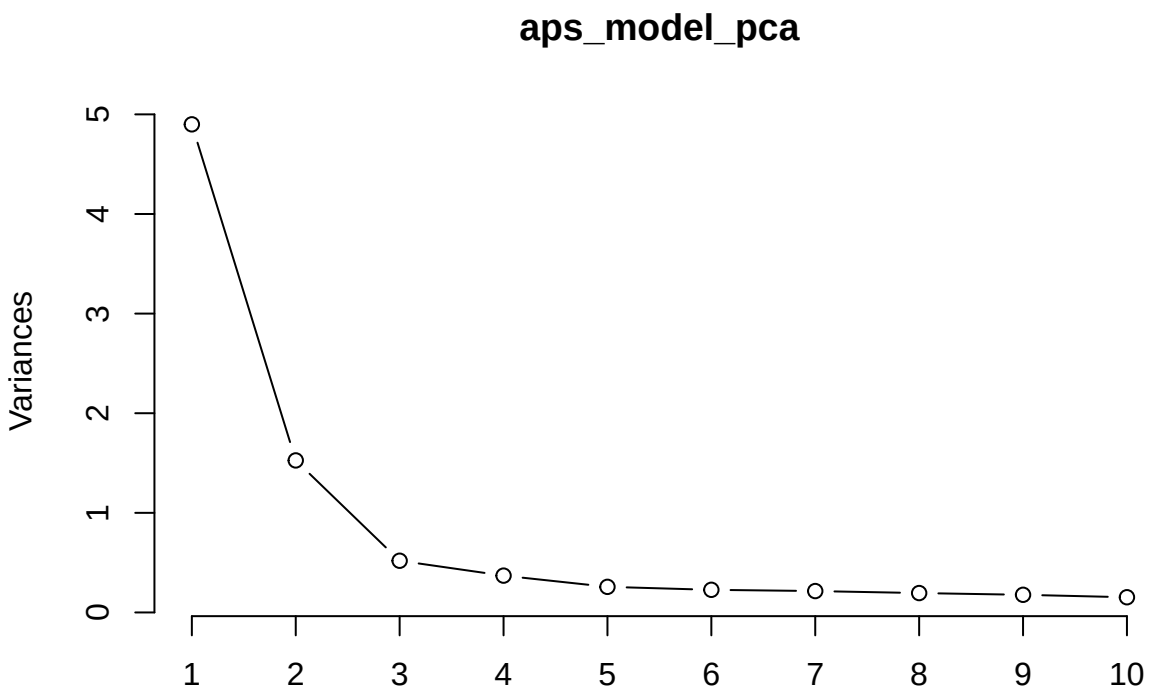

```
corrplot(Scorr_aps_with_scales, method="number", type = "upper", order = "hclust",
         tl.col = "black", tl.srt = 40, tl.cex = 0.4)
```




```
# PCA analysis
aps_model_pca <- prcomp(aps_with_scales)
summary(aps_model_pca)
```

```
## Importance of components:
##                           PC1    PC2     PC3     PC4    PC5     PC6     PC7
## Standard deviation     2.2135 1.2354 0.72053 0.60802 0.5071 0.47676 0.46343
## Proportion of Variance 0.5621 0.1751 0.05956 0.04241 0.0295 0.02608 0.02464
## Cumulative Proportion  0.5621 0.7372 0.79676 0.83917 0.8687 0.89475 0.91938
##                           PC8     PC9    PC10    PC11    PC12
## Standard deviation     0.44131 0.42101 0.39086 0.30638 0.28996
## Proportion of Variance 0.02234 0.02033 0.01753 0.01077 0.00965
## Cumulative Proportion  0.94173 0.96206 0.97959 0.99035 1.00000
```

```
plot(aps_model_pca, type = "l")
```




```
aps_model_pca$rotation
```

```
##                                PC1         PC2         PC3         PC4
## job_engagement            0.1963622 -0.17746598  0.11348859 -0.02879067
## team_engagement           0.2093671 -0.07730500  0.41620482  0.25769923
## supervisor_engagement     0.2279633 -0.15805804  0.54419472  0.25841185
## senior_manager_engagement 0.2706988 -0.31293922 -0.34129890  0.55315902
## agency_engagement         0.2403279 -0.22106476 -0.04879712 -0.17431577
## team_performance_support  0.2456585 -0.08795953  0.15371680 -0.28598837
## risk_culture              0.2105689 -0.19297384 -0.09025078 -0.51664413
## innovation                0.2386619 -0.21164922  0.06722370 -0.36341756
## leadership_engagement     0.2639318 -0.33202466 -0.53773566  0.09154948
## wellbeing                 0.2102595 -0.16898988  0.16497910 -0.10727179
## values                    0.1813226 -0.12209797  0.16816139  0.16769641
## team_performance_rating   0.6528483  0.73977686 -0.13390603  0.02865621
##                                PC5         PC6         PC7         PC8
## job_engagement             0.18190405  0.30014758 -0.42720495  0.08825835
## team_engagement           -0.40424907  0.08889109 -0.38715868 -0.48816856
## supervisor_engagement      0.37378231 -0.20909320  0.22260729  0.28579496
## senior_manager_engagement  0.27921671  0.02445678  0.25709843 -0.42670149
## agency_engagement         -0.02237945  0.17716408 -0.34236577  0.13355000
## team_performance_support  -0.20391719  0.61900422  0.61000215 -0.04414104
## risk_culture              -0.10734776 -0.43707321  0.08923064 -0.45360083
## innovation                 0.38941453 -0.24680698 -0.05224589  0.01061708
## leadership_engagement     -0.24543922  0.02046582 -0.09673874  0.38718437
```

```
## wellbeing                  0.02300372  0.10429996 -0.07026462  0.15075698
## values                    -0.56292000 -0.42145242  0.19064339  0.30177604
## team_performance_rating    0.05403359 -0.04766775 -0.03607467  0.02811324
##                                   PC9        PC10         PC11         PC12
## job_engagement             0.2695582505  0.29252159 -0.336528661 -0.575574335
## team_engagement           -0.2206625134 -0.31598205  0.049922302  0.002414573
## supervisor_engagement     -0.4358333036  0.14408945 -0.169779474  0.076956822
## senior_manager_engagement  0.2561197350  0.08086777  0.049417504  0.070770512
## agency_engagement          0.1255632940  0.18562867 -0.197120583  0.777552040
## team_performance_support  -0.0007848519 -0.10955025 -0.121473349 -0.030654337
## risk_culture              -0.2257229960  0.39441886 -0.093124571 -0.109058917
## innovation                 0.2555460178 -0.69184662  0.030576517 -0.036926993
## leadership_engagement     -0.4760918269 -0.20586353  0.002964053 -0.183241184
## wellbeing                  0.0755418138  0.24978798  0.882228962 -0.054836687
## values                     0.5086168854  0.03764348 -0.106785338 -0.048865483
## team_performance_rating   -0.0039866295  0.02042047  0.005460959 -0.004581893
```

```
varimax(aps_model_pca$rotation)
```

```
## $loadings
##
## Loadings:
##                           PC1 PC2 PC3 PC4 PC5 PC6 PC7 PC8 PC9 PC10 PC11 PC12
## job_engagement            -1
## team_engagement                                     -1
## supervisor_engagement                1
## senior_manager_engagement                1
## agency_engagement                                                        1
## team_performance_support                          1
## risk_culture                                          1
## innovation                                                      -1
## leadership_engagement                                      -1
## wellbeing                                                             1
## values                                      -1
## team_performance_rating        1
##
##                  PC1   PC2   PC3   PC4   PC5   PC6   PC7   PC8   PC9  PC10
## SS loadings    1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000
## Proportion Var 0.083 0.083 0.083 0.083 0.083 0.083 0.083 0.083 0.083 0.083
## Cumulative Var 0.083 0.167 0.250 0.333 0.417 0.500 0.583 0.667 0.750 0.833
##                 PC11  PC12
## SS loadings    1.000 1.000
## Proportion Var 0.083 0.083
## Cumulative Var 0.917 1.000
##
## $rotmat
##              [,1]         [,2]        [,3]        [,4]        [,5]
##  [1,] -0.19636708  0.652847906  0.22796232  0.27069931 -0.18132242
##  [2,]  0.17746871  0.739777222 -0.15805696 -0.31293960  0.12209786
##  [3,] -0.11348680 -0.133906065  0.54419637 -0.34129891 -0.16816147
##  [4,]  0.02880058  0.028656641  0.25841190  0.55315828 -0.16769661
##  [5,] -0.18190211  0.054033398  0.37378288  0.27921662  0.56291998
##  [6,] -0.30013704 -0.047667985 -0.20909307  0.02445595  0.42145220
##  [7,]  0.42720487 -0.036074189  0.22260763  0.25709807 -0.19064351
```

```
##  [8,] -0.08824943  0.028113483  0.28579400 -0.42670231 -0.30177625
##  [9,] -0.26955322 -0.003986911 -0.43583202  0.25611944 -0.50861695
## [10,] -0.29252969  0.020419777  0.14408963  0.08086866 -0.03764331
## [11,]  0.33653036  0.005461498 -0.16977929  0.04941720  0.10678527
## [12,]  0.57557648 -0.004580959  0.07695766  0.07077005  0.04886534
##                [,6]         [,7]         [,8]         [,9]        [,10]
##  [1,]  0.2456599817  0.21056444 -0.209366570 -0.263932291 -0.23866185
##  [2,] -0.0879608521 -0.19296929  0.077304456  0.332025011  0.21164920
##  [3,]  0.1537163267 -0.09025254 -0.416205065  0.537733963 -0.06722373
##  [4,] -0.2859909085 -0.51664238 -0.257699929 -0.091550640  0.36341741
##  [5,] -0.2039169660 -0.10735181  0.404249176  0.245438221 -0.38941453
##  [6,]  0.6190027924 -0.43708265 -0.088892001 -0.020465539  0.24680694
##  [7,]  0.6100018184  0.08923533  0.387158437  0.096738098  0.05224584
##  [8,] -0.0441430961 -0.45360198  0.488167803 -0.387185391 -0.01061716
##  [9,] -0.0007851477 -0.22572969  0.220662087  0.476092950 -0.25554606
## [10,] -0.1095474684  0.39441250  0.315982987  0.205863516  0.69184672
## [11,] -0.1214745784 -0.09311722 -0.049922641 -0.002963693 -0.03057656
## [12,] -0.0306561265 -0.10904731 -0.002415098  0.183240799  0.03692691
##              [,11]       [,12]
##  [1,]  0.21025945  0.24032787
##  [2,] -0.16898988 -0.22106477
##  [3,]  0.16497912 -0.04879713
##  [4,] -0.10727179 -0.17431582
##  [5,]  0.02300372 -0.02237949
##  [6,]  0.10429995  0.17716400
##  [7,] -0.07026460 -0.34236575
##  [8,]  0.15075699  0.13354998
##  [9,]  0.07554180  0.12556325
## [10,]  0.24978798  0.18562868
## [11,]  0.88222896 -0.19712056
## [12,] -0.05483667  0.77755208
```

```
head(aps_model_pca$x)
```

```
##              PC1        PC2         PC3         PC4        PC5        PC6
## [1,] -0.25370201  1.2287556  0.02579704  0.20756351 -0.8975822 -0.5986471
## [2,]  1.48954509 -0.2564394 -0.07014645 -1.06887887 -0.3394657 -0.2229667
## [3,]  0.09078901  1.0266029  1.28295174 -0.19408465  1.3285060  0.5196306
## [4,]  1.43004622  1.1683800  0.45951677 -1.00393946  0.1774000 -0.1813531
## [5,] -0.27619837 -1.4132540  0.37236835  0.16800595 -0.1466935 -0.2240638
## [6,]  0.90612110 -1.1081145  0.22987567 -0.03195633 -0.5150610 -0.6302417
##              PC7        PC8         PC9        PC10        PC11        PC12
## [1,]  0.15987118 0.69063104 -0.14116645 -0.08343508  0.65656442  0.20457640
## [2,]  0.33287394 0.04420997  0.40284299 -0.04352340 -0.02034524 -0.14085099
## [3,] -1.01284903 0.60257081 -0.07095960 -0.30515364  0.51905277 -0.50444875
## [4,] -0.06734361 0.19525937  0.01363575  0.26759220  0.40721313  0.07932149
## [5,]  0.14954496 0.59589061  0.07532078 -0.04002158 -0.36717672 -0.20273248
## [6,]  0.06853834 0.09545791 -0.32365071 -0.37531975  0.72352576 -0.20892753
```

```
# importing and formatting 2019 test data
aps_with_scales_lr_test <- read.csv("/Users/ibrahimibrahim/Documents/Ryerson/820/data set/aps_with_scale
aps_with_scales_factors_ordReg_test <- read.csv("/Users/ibrahimibrahim/Documents/Ryerson/820/data set/ap

str(aps_with_scales_lr_test)
```

```
## 'data.frame':    85981 obs. of  13 variables:
##  $ X                             : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ job_engagement                : num  4.7 3.4 3.8 3.8 4.4 3 4 4.1 3.8 3.9 ...
##  $ team_engagement               : num  5 3.5 4 4.75 4.25 4 4 4.5 5 3 ...
##  $ supervisor_engagement         : num  5 3.73 3.91 4 5 ...
##  $ senior_manager_engagement     : num  3.67 1.33 4 3.67 5 ...
##  $ agency_engagement             : num  4.53 2.82 3.88 3.59 2.71 ...
##  $ team_performance_support      : num  3.5 3.5 4.25 2.75 3.5 3 3.5 3 3.25 3.25 ...
##  $ risk_culture                  : num  3.6 2 3.8 3 3 3 4 3.6 3.6 1.2 ...
##  $ innovation                    : num  4.2 2.6 4.2 3.6 3.2 3.4 4 4.4 3.8 2 ...
##  $ leadership_engagement         : num  2.29 1.71 4 3.86 2.29 ...
##  $ wellbeing                     : num  4.77 3.15 3.85 3.38 3.54 ...
##  $ values                        : num  4.67 3.67 5 4 4.67 ...
##  $ team_performance_rating_binary: int  1 0 1 0 0 1 1 0 0 1 ...
```

```
aps_with_scales_lr_test <- aps_with_scales_lr_test[-1]
str(aps_with_scales_lr_test)
```

```
## 'data.frame':    85981 obs. of  12 variables:
##  $ job_engagement                : num  4.7 3.4 3.8 3.8 4.4 3 4 4.1 3.8 3.9 ...
##  $ team_engagement               : num  5 3.5 4 4.75 4.25 4 4 4.5 5 3 ...
##  $ supervisor_engagement         : num  5 3.73 3.91 4 5 ...
##  $ senior_manager_engagement     : num  3.67 1.33 4 3.67 5 ...
##  $ agency_engagement             : num  4.53 2.82 3.88 3.59 2.71 ...
##  $ team_performance_support      : num  3.5 3.5 4.25 2.75 3.5 3 3.5 3 3.25 3.25 ...
##  $ risk_culture                  : num  3.6 2 3.8 3 3 3 4 3.6 3.6 1.2 ...
##  $ innovation                    : num  4.2 2.6 4.2 3.6 3.2 3.4 4 4.4 3.8 2 ...
##  $ leadership_engagement         : num  2.29 1.71 4 3.86 2.29 ...
##  $ wellbeing                     : num  4.77 3.15 3.85 3.38 3.54 ...
##  $ values                        : num  4.67 3.67 5 4 4.67 ...
##  $ team_performance_rating_binary: int  1 0 1 0 0 1 1 0 0 1 ...
```

```
aps_with_scales_lr_test$team_performance_rating <- as.numeric(aps_with_scales_lr_test$team_performance_
str(aps_with_scales_lr_test)
```

```
## 'data.frame':    85981 obs. of  13 variables:
##  $ job_engagement                : num  4.7 3.4 3.8 3.8 4.4 3 4 4.1 3.8 3.9 ...
##  $ team_engagement               : num  5 3.5 4 4.75 4.25 4 4 4.5 5 3 ...
##  $ supervisor_engagement         : num  5 3.73 3.91 4 5 ...
##  $ senior_manager_engagement     : num  3.67 1.33 4 3.67 5 ...
##  $ agency_engagement             : num  4.53 2.82 3.88 3.59 2.71 ...
##  $ team_performance_support      : num  3.5 3.5 4.25 2.75 3.5 3 3.5 3 3.25 3.25 ...
##  $ risk_culture                  : num  3.6 2 3.8 3 3 3 4 3.6 3.6 1.2 ...
##  $ innovation                    : num  4.2 2.6 4.2 3.6 3.2 3.4 4 4.4 3.8 2 ...
##  $ leadership_engagement         : num  2.29 1.71 4 3.86 2.29 ...
##  $ wellbeing                     : num  4.77 3.15 3.85 3.38 3.54 ...
##  $ values                        : num  4.67 3.67 5 4 4.67 ...
##  $ team_performance_rating_binary: int  1 0 1 0 0 1 1 0 0 1 ...
##  $ team_performance_rating       : num  1 0 1 0 0 1 1 0 0 1 ...
```

```r
str(aps_with_scales_factors_ordReg_test)
```

```
## 'data.frame':    85981 obs. of  13 variables:
##  $ X                             : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ job_engagement_f              : int  5 3 4 4 4 3 4 4 4 4 ...
##  $ team_engagement_f             : int  5 4 4 5 4 4 4 4 5 3 ...
##  $ supervisor_engagement_f       : int  5 4 4 4 5 4 3 4 5 3 ...
##  $ senior_manager_engagement_f   : int  4 1 4 4 5 4 3 3 4 3 ...
##  $ agency_engagement_f           : int  5 3 4 4 3 3 4 4 4 3 ...
##  $ team_performance_support_f    : int  4 4 4 3 4 3 4 3 3 3 ...
##  $ risk_culture_f                : int  4 2 4 3 3 3 4 4 4 1 ...
##  $ innovation_f                  : int  4 3 4 4 3 3 4 4 4 2 ...
##  $ leadership_engagement_f       : int  2 2 4 4 2 3 4 4 4 2 ...
##  $ wellbeing_f                   : int  5 3 4 3 4 3 4 4 4 3 ...
##  $ values_f                      : int  5 4 5 4 5 4 5 5 5 4 ...
##  $ team_performance_rating_ordReg: int  2 0 2 1 1 2 2 1 1 2 ...
```

```r
aps_with_scales_factors_ordReg_test <- aps_with_scales_factors_ordReg_test[-1]
str(aps_with_scales_factors_ordReg_test)
```

```
## 'data.frame':    85981 obs. of  12 variables:
##  $ job_engagement_f              : int  5 3 4 4 4 3 4 4 4 4 ...
##  $ team_engagement_f             : int  5 4 4 5 4 4 4 4 5 3 ...
##  $ supervisor_engagement_f       : int  5 4 4 4 5 4 3 4 5 3 ...
##  $ senior_manager_engagement_f   : int  4 1 4 4 5 4 3 3 4 3 ...
##  $ agency_engagement_f           : int  5 3 4 4 3 3 4 4 4 3 ...
##  $ team_performance_support_f    : int  4 4 4 3 4 3 4 3 3 3 ...
##  $ risk_culture_f                : int  4 2 4 3 3 3 4 4 4 1 ...
##  $ innovation_f                  : int  4 3 4 4 3 3 4 4 4 2 ...
##  $ leadership_engagement_f       : int  2 2 4 4 2 3 4 4 4 2 ...
##  $ wellbeing_f                   : int  5 3 4 3 4 3 4 4 4 3 ...
##  $ values_f                      : int  5 4 5 4 5 4 5 5 5 4 ...
##  $ team_performance_rating_ordReg: int  2 0 2 1 1 2 2 1 1 2 ...
```

```r
aps_with_scales_factors_ordReg_test$job_engagement_f <- as.factor(aps_with_scales_factors_ordReg_test$j
aps_with_scales_factors_ordReg_test$team_engagement_f <- as.factor(aps_with_scales_factors_ordReg_test$
aps_with_scales_factors_ordReg_test$supervisor_engagement_f <- as.factor(aps_with_scales_factors_ordReg
aps_with_scales_factors_ordReg_test$senior_manager_engagement_f <- as.factor(aps_with_scales_factors_or
aps_with_scales_factors_ordReg_test$agency_engagement_f <- as.factor(aps_with_scales_factors_ordReg_tes
aps_with_scales_factors_ordReg_test$team_performance_support_f <- as.factor(aps_with_scales_factors_ord
aps_with_scales_factors_ordReg_test$risk_culture_f <- as.factor(aps_with_scales_factors_ordReg_test$ris
aps_with_scales_factors_ordReg_test$innovation_f <- as.factor(aps_with_scales_factors_ordReg_test$innov
aps_with_scales_factors_ordReg_test$leadership_engagement_f <- as.factor(aps_with_scales_factors_ordReg
aps_with_scales_factors_ordReg_test$wellbeing_f <- as.factor(aps_with_scales_factors_ordReg_test$wellbe
aps_with_scales_factors_ordReg_test$values_f <- as.factor(aps_with_scales_factors_ordReg_test$values_f)
aps_with_scales_factors_ordReg_test$team_performance_rating_ordReg <- as.factor(aps_with_scales_factors_

str(aps_with_scales_factors_ordReg_test)
```

```
## 'data.frame':    85981 obs. of  12 variables:
##  $ job_engagement_f              : Factor w/ 5 levels "1","2","3","4",..: 5 3 4 4 4 3 4 4 4 4 ...
```

```
##  $ team_engagement_f             : Factor w/ 5 levels "1","2","3","4",..: 5 4 4 5 4 4 4 4 5 3 ...
##  $ supervisor_engagement_f       : Factor w/ 5 levels "1","2","3","4",..: 5 4 4 4 5 4 3 4 5 3 ...
##  $ senior_manager_engagement_f   : Factor w/ 5 levels "1","2","3","4",..: 4 1 4 4 5 4 3 3 4 3 ...
##  $ agency_engagement_f           : Factor w/ 5 levels "1","2","3","4",..: 5 3 4 4 3 3 4 4 4 3 ...
##  $ team_performance_support_f    : Factor w/ 5 levels "1","2","3","4",..: 4 4 4 3 4 3 4 3 3 3 ...
##  $ risk_culture_f                : Factor w/ 5 levels "1","2","3","4",..: 4 2 4 3 3 3 4 4 4 1 ...
##  $ innovation_f                  : Factor w/ 5 levels "1","2","3","4",..: 4 3 4 4 3 3 4 4 4 2 ...
##  $ leadership_engagement_f       : Factor w/ 5 levels "1","2","3","4",..: 2 2 4 4 2 3 4 4 4 2 ...
##  $ wellbeing_f                   : Factor w/ 5 levels "1","2","3","4",..: 5 3 4 3 4 3 4 4 4 3 ...
##  $ values_f                      : Factor w/ 5 levels "1","2","3","4",..: 5 4 5 4 5 4 5 5 5 4 ...
##  $ team_performance_rating_ordReg: Factor w/ 3 levels "0","1","2": 3 1 3 2 2 3 3 2 2 3 ...
```

```
# Logistic regression model

# transforming the values of the dependent variable to be binary

table(aps_reduced$team_performance_rating)
```

```
##
##     1     2     3     4     5     6     7     8     9    10
##   595   734  1736  2245  9207  7255 17346 28687 12291  5129
```

```
team_performance_rating_binary <- mgsub(aps_reduced$team_performance_rating, c(1,2,3,4,5,6,7,8,9,10), c
team_performance_rating_binary <- as.numeric(team_performance_rating_binary)
table(team_performance_rating_binary)
```

```
## team_performance_rating_binary
##     0     1
## 39118 46107
```

```
str(team_performance_rating_binary)
```

```
##  num [1:85225] 1 1 1 1 0 0 1 0 0 0 ...
```

```
summary(team_performance_rating_binary)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.000   0.000   1.000   0.541   1.000   1.000
```

```
# new data frame with the new scales plus the 2 ordinal variables - for logistic regression
aps_with_scales_lr <- data.frame(job_engagement, team_engagement, supervisor_engagement, senior_manager
str(aps_with_scales_lr)
```

```
## 'data.frame':    85225 obs. of  12 variables:
##  $ job_engagement                : num  2.8 4.1 4.7 3.9 4.2 3.6 3.8 4.8 3.3 3 ...
##  $ team_engagement               : num  4 4 4.25 4 4 4.75 5 4.25 3.75 3.25 ...
##  $ supervisor_engagement         : num  3.91 4 4.82 4.36 4.73 ...
##  $ senior_manager_engagement     : num  2.83 3.67 2.67 3 3.75 ...
##  $ agency_engagement             : num  3.18 4 3.29 3.88 3.71 ...
##  $ team_performance_support      : num  3.25 4.5 3.25 4 3.75 3.75 3 4 3.5 2.25 ...
```

```
##  $ risk_culture                  : num  3 4.4 2.4 4 3.4 4 3 4 2.8 3.6 ...
##  $ innovation                    : num  3 4.4 4.2 4 3.8 4.2 2.4 3.4 2 3.4 ...
##  $ leadership_engagement         : num  3.43 3.71 2.57 3 3.86 ...
##  $ wellbeing                     : num  3.92 4.08 4.38 4.38 3.62 ...
##  $ values                        : num  5 5 3.33 4.33 5 ...
##  $ team_performance_rating_binary: num  1 1 1 1 0 0 1 0 0 0 ...
```

```
# 70-30 split
#train_index <- sample(1:nrow(aps_with_scales_lr), 0.7 * nrow(aps_with_scales_lr))
#train <- aps_with_scales_lr[train_index,]
#test <- aps_with_scales_lr[-train_index,]


# 10 fold cross validation
#library(caret)
#set.seed(430)
#index = createDataPartition(aps_with_scales_lr$team_performance_rating_binary, p = 0.75, list = FALSE)
#train = aps_with_scales_lr[index, ]
#test = aps_with_scales_lr[-index, ]
#fitcontrol1 <- trainControl(method = "cv", number = 10, savePredictions = T )
#lrmodel <- train(team_performance_rating_binary~., data = train, method = "glm", family = "binomial",


# using 2018 data as training set and 2019 data as test set
train <- aps_with_scales_lr
test <- aps_with_scales_lr_test

lrmodel <- glm(train$team_performance_rating_binary~.,data =  train, family = "binomial")
lrmodel
```

```
##
## Call:  glm(formula = train$team_performance_rating_binary ~ ., family = "binomial",
##     data = train)
##
## Coefficients:
##               (Intercept)             job_engagement
##                  -7.67605                   -0.06464
##           team_engagement      supervisor_engagement
##                   0.57836                    0.04255
## senior_manager_engagement          agency_engagement
##                   0.07220                    0.18524
##  team_performance_support               risk_culture
##                   0.90322                    0.05582
##                innovation      leadership_engagement
##                   0.16930                   -0.07569
##                 wellbeing                     values
##                  -0.03461                    0.20671
##
## Degrees of Freedom: 85224 Total (i.e. Null);  85213 Residual
## Null Deviance:       117600
## Residual Deviance: 97990     AIC: 98010
```

```r
summary(lrmodel)
```

```
##
## Call:
## glm(formula = train$team_performance_rating_binary ~ ., family = "binomial",
##     data = train)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.3855  -1.0134   0.4794   0.9535   3.3627
##
## Coefficients:
##                           Estimate Std. Error z value Pr(>|z|)
## (Intercept)               -7.67605    0.07685 -99.885  < 2e-16 ***
## job_engagement            -0.06464    0.02172  -2.976 0.002920 **
## team_engagement            0.57836    0.01622  35.652  < 2e-16 ***
## supervisor_engagement      0.04255    0.01525   2.790 0.005272 **
## senior_manager_engagement  0.07220    0.01387   5.206 1.93e-07 ***
## agency_engagement          0.18524    0.02332   7.944 1.96e-15 ***
## team_performance_support   0.90322    0.01595  56.619  < 2e-16 ***
## risk_culture               0.05582    0.01646   3.390 0.000698 ***
## innovation                 0.16930    0.01717   9.862  < 2e-16 ***
## leadership_engagement     -0.07569    0.01511  -5.010 5.44e-07 ***
## wellbeing                 -0.03461    0.02350  -1.473 0.140825
## values                     0.20671    0.01611  12.831  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 117573  on 85224  degrees of freedom
## Residual deviance:  97985  on 85213  degrees of freedom
## AIC: 98009
##
## Number of Fisher Scoring iterations: 4
```

```r
aov(lrmodel)
```

```
## Call:
##    aov(formula = lrmodel)
##
## Terms:
##                 job_engagement team_engagement supervisor_engagement
## Sum of Squares        1938.856        1014.953               111.635
## Deg. of Freedom              1               1                     1
##                 senior_manager_engagement agency_engagement
## Sum of Squares                    100.017           214.797
## Deg. of Freedom                         1                 1
##                 team_performance_support risk_culture innovation
## Sum of Squares                   822.211        4.349     19.060
## Deg. of Freedom                        1            1          1
##                 leadership_engagement wellbeing    values Residuals
## Sum of Squares                  1.970     0.008    30.758 16904.350
```

```
## Deg. of Freedom                      1         1         1     85213
##
## Residual standard error: 0.445396
## Estimated effects may be unbalanced
```

```
predicted <- predict(lrmodel, test, type="response")
str(predicted)
```

```
##  Named num [1:85981] 0.717 0.297 0.716 0.402 0.528 ...
##  - attr(*, "names")= chr [1:85981] "1" "2" "3" "4" ...
```

```
summary(predicted)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## 0.003102 0.390490 0.580911 0.548607 0.716066 0.940455
```

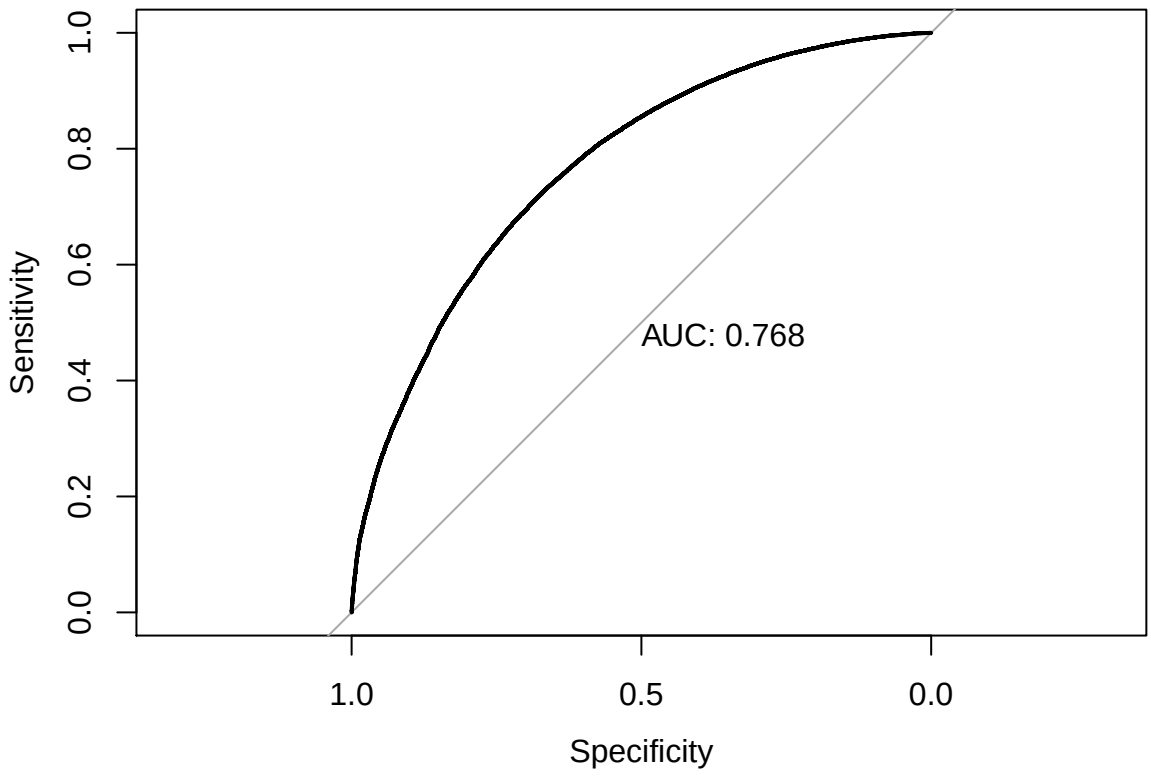
```
predicted_class <- ifelse(predicted>=0.562, 1, 0)

test$predicted <- predicted
g <- roc(test$team_performance_rating_binary ~ predicted, data = test)
```

```
## Setting levels: control = 0, case = 1
```

```
## Setting direction: controls < cases
```

```
plot(g,plot = TRUE, print.auc = TRUE)
```



```r
cm <- table(actual = test$team_performance_rating_binary, predicted = predicted_class)
cm
```

```
##       predicted
## actual     0     1
##      0 25369 11089
##      1 14948 34575
```

```r
accuracy <- sum(diag(cm))/nrow(test)
accuracy
```

```
## [1] 0.6971773
```

```r
accuracy <- (cm[1,1] + cm[2,2]) / (cm[1,1] + cm[1,2] + cm[2,1] + cm[2,2])
accuracy
```

```
## [1] 0.6971773
```

```r
sensitivity <- cm[2,2] / (cm[2,2] + cm[2,1])
sensitivity
```

```
## [1] 0.6981605
```

```r
# SN = TP / (TP + FN)
#quantifies how many diagnosis are predicted accurately

specificity <- cm[1,1] / (cm[1,1] + cm[1,2])
specificity
```

```
## [1] 0.6958418
```

```r
# SP = TN / (TN + FP)
#measures the proportion of actual negatives that are predicted correctly

precision <- cm[2,2] / (cm[2,2] + cm[1,2])
precision
```

```
## [1] 0.757161
```

```r
# Pr = TP / (TP + FP)

accuracy
```

```
## [1] 0.6971773
```

```r
sensitivity
```

```
## [1] 0.6981605
```

```
specificity
```

```
## [1] 0.6958418
```

```
precision
```

```
## [1] 0.757161
```

```
# Ordinal logistic regression

# preparing dep var
team_performance_rating_ordReg <- mgsub(aps_reduced$team_performance_rating, c(1,2,3,4,5,6,7,8,9,10), c
team_performance_rating_ordReg <- as.numeric(team_performance_rating_ordReg)
table(team_performance_rating_ordReg)
```

```
## team_performance_rating_ordReg
##     0     1     2
##  5310 33808 46107
```

```
team_performance_rating_ordReg <- as.factor(team_performance_rating_ordReg)
str(team_performance_rating_ordReg)
```

```
##  Factor w/ 3 levels "0","1","2": 3 3 3 3 2 2 3 2 1 1 ...
```

```
aps_with_scales_factors_ordReg <- data.frame(aps_with_scales_factors_excl_depVar, team_performance_ratin
str(aps_with_scales_factors_ordReg)
```

```
## 'data.frame':    85225 obs. of  12 variables:
##  $ job_engagement_f              : Factor w/ 5 levels "1","2","3","4",..: 3 4 5 4 4 4 4 5 3 3 ...
##  $ team_engagement_f             : Factor w/ 5 levels "1","2","3","4",..: 4 4 4 4 4 5 5 4 4 3 ...
##  $ supervisor_engagement_f       : Factor w/ 5 levels "1","2","3","4",..: 4 4 5 4 5 5 5 5 3 4 ...
##  $ senior_manager_engagement_f   : Factor w/ 5 levels "1","2","3","4",..: 3 4 3 3 4 4 2 5 2 4 ...
##  $ agency_engagement_f           : Factor w/ 5 levels "1","2","3","4",..: 3 4 3 4 4 4 4 4 2 3 ...
##  $ team_performance_support_f    : Factor w/ 5 levels "1","2","3","4",..: 3 4 3 4 4 4 3 4 4 2 ...
##  $ risk_culture_f                : Factor w/ 5 levels "1","2","3","4",..: 3 4 2 4 3 4 3 4 3 4 ...
##  $ innovation_f                  : Factor w/ 5 levels "1","2","3","4",..: 3 4 4 4 4 4 2 3 2 3 ...
##  $ leadership_engagement_f       : Factor w/ 5 levels "1","2","3","4",..: 3 4 3 3 4 4 3 4 2 3 ...
##  $ wellbeing_f                   : Factor w/ 5 levels "1","2","3","4",..: 4 4 4 4 4 5 4 4 2 4 ...
##  $ values_f                      : Factor w/ 5 levels "1","2","3","4",..: 5 5 3 4 5 5 5 4 4 3 ...
##  $ team_performance_rating_ordReg: Factor w/ 3 levels "0","1","2": 3 3 3 3 2 2 3 2 1 1 ...
```

```
# 70-30 split
#index <- sample(nrow(aps_with_scales_factors_ordReg), floor(nrow(aps_with_scales_factors_ordReg)*0.7))
#train <- aps_with_scales_factors_ordReg[index,]
#test <- aps_with_scales_factors_ordReg[-index,]


# 10 fold cross validation
#library(caret)
#set.seed(430)
```

```r
#index = createDataPartition(aps_with_scales_factors_ordReg$team_performance_rating_ordReg, p = 0.75, l
#train = aps_with_scales_factors_ordReg[index, ]
#test = aps_with_scales_factors_ordReg[-index, ]
#fitcontrol1 <- trainControl(method = "cv", number = 10, savePredictions = T )
#ordered_logistic_regression <- train(team_performance_rating_ordReg~., data = train, method = "glm", H


# using 2018 data as training set and 2019 data as test set
train <- aps_with_scales_factors_ordReg
test <- aps_with_scales_factors_ordReg_test


ordered_logistic_regression <- MASS::polr(formula = team_performance_rating_ordReg~., data = train, Hes
summary(ordered_logistic_regression)
```

```
## Call:
## MASS::polr(formula = team_performance_rating_ordReg ~ ., data = train,
##     Hess = TRUE)
##
## Coefficients:
##                                  Value Std. Error  t value
## job_engagement_f2             -0.667464    0.20153 -3.31191
## job_engagement_f3             -0.589520    0.20288 -2.90577
## job_engagement_f4             -0.507085    0.20334 -2.49378
## job_engagement_f5             -0.540020    0.20552 -2.62758
## team_engagement_f2             0.117947    0.13715  0.85999
## team_engagement_f3             0.623653    0.13763  4.53124
## team_engagement_f4             1.215077    0.13722  8.85495
## team_engagement_f5             1.774233    0.13838 12.82151
## supervisor_engagement_f2      -0.117921    0.09916 -1.18924
## supervisor_engagement_f3      -0.095733    0.09700 -0.98694
## supervisor_engagement_f4       0.046995    0.09732  0.48287
## supervisor_engagement_f5       0.139938    0.09844  1.42149
## senior_manager_engagement_f2 -0.090058    0.06778 -1.32868
## senior_manager_engagement_f3  0.004623    0.06836  0.06763
## senior_manager_engagement_f4  0.083939    0.06926  1.21200
## senior_manager_engagement_f5  0.179314    0.07243  2.47583
## agency_engagement_f2          0.157274    0.11531  1.36388
## agency_engagement_f3          0.227132    0.11848  1.91712
## agency_engagement_f4          0.382823    0.12009  3.18783
## agency_engagement_f5          0.603785    0.12726  4.74460
## team_performance_support_f2   0.839858    0.13140  6.39141
## team_performance_support_f3   1.776661    0.13232 13.42674
## team_performance_support_f4   2.505496    0.13275 18.87354
## team_performance_support_f5   3.149926    0.13758 22.89558
## risk_culture_f2               0.055714    0.07249  0.76853
## risk_culture_f3               0.147506    0.07182  2.05389
## risk_culture_f4               0.277387    0.07329  3.78462
## risk_culture_f5               0.397014    0.08726  4.54991
## innovation_f2                 0.079933    0.09307  0.85885
## innovation_f3                 0.288832    0.09374  3.08111
## innovation_f4                 0.459842    0.09503  4.83876
## innovation_f5                 0.538268    0.10114  5.32212
```

```
## leadership_engagement_f2     -0.065656    0.04839 -1.35671
## leadership_engagement_f3     -0.110443    0.04850 -2.27725
## leadership_engagement_f4     -0.127516    0.05120 -2.49048
## leadership_engagement_f5     -0.123486    0.06226 -1.98346
## wellbeing_f2                  0.248093    0.17192  1.44307
## wellbeing_f3                  0.256405    0.17582  1.45837
## wellbeing_f4                  0.279495    0.17700  1.57907
## wellbeing_f5                  0.367404    0.18221  2.01637
## values_f2                     0.704248    0.29308  2.40294
## values_f3                     0.925914    0.28707  3.22540
## values_f4                     1.145285    0.28749  3.98378
## values_f5                     1.334527    0.28786  4.63608
##
## Intercepts:
##     Value   Std. Error t value
## 0|1  2.0120  0.3298     6.0996
## 1|2  5.2657  0.3304    15.9359
##
## Residual Deviance: 124358.37
## AIC: 124450.37
```

```
coeffs <- coef(summary(ordered_logistic_regression))
p <- pnorm(abs(coeffs[,"t value"]), lower.tail = FALSE) * 2
cbind(coeffs, "p value" = round(p,3))
```

```
##                                    Value Std. Error     t value p value
## job_engagement_f2            -0.667463755 0.20153419 -3.31191323   0.001
## job_engagement_f3            -0.589519955 0.20287910 -2.90576977   0.004
## job_engagement_f4            -0.507084579 0.20333950 -2.49378299   0.013
## job_engagement_f5            -0.540020075 0.20551975 -2.62758242   0.009
## team_engagement_f2            0.117946505 0.13714797  0.85999456   0.390
## team_engagement_f3            0.623653342 0.13763417  4.53123908   0.000
## team_engagement_f4            1.215077198 0.13722008  8.85495183   0.000
## team_engagement_f5            1.774232920 0.13837937 12.82151300   0.000
## supervisor_engagement_f2     -0.117921410 0.09915657 -1.18924456   0.234
## supervisor_engagement_f3     -0.095732581 0.09699907 -0.98694325   0.324
## supervisor_engagement_f4      0.046994842 0.09732323  0.48287385   0.629
## supervisor_engagement_f5      0.139938074 0.09844465  1.42148988   0.155
## senior_manager_engagement_f2 -0.090058219 0.06778043 -1.32867592   0.184
## senior_manager_engagement_f3  0.004623412 0.06836004  0.06763326   0.946
## senior_manager_engagement_f4  0.083938945 0.06925682  1.21199543   0.226
## senior_manager_engagement_f5  0.179313876 0.07242580  2.47582862   0.013
## agency_engagement_f2          0.157273509 0.11531360  1.36387650   0.173
## agency_engagement_f3          0.227131849 0.11847563  1.91711880   0.055
## agency_engagement_f4          0.382823379 0.12008885  3.18783445   0.001
## agency_engagement_f5          0.603785250 0.12725730  4.74460215   0.000
## team_performance_support_f2   0.839858010 0.13140423  6.39140786   0.000
## team_performance_support_f3   1.776660670 0.13232253 13.42674377   0.000
## team_performance_support_f4   2.505495553 0.13275177 18.87353835   0.000
## team_performance_support_f5   3.149926054 0.13757789 22.89558348   0.000
## risk_culture_f2               0.055713506 0.07249395  0.76852627   0.442
## risk_culture_f3               0.147505684 0.07181754  2.05389485   0.040
## risk_culture_f4               0.277387240 0.07329326  3.78462127   0.000
## risk_culture_f5               0.397013802 0.08725755  4.54990784   0.000
```

```
## innovation_f2                0.079933141 0.09306979  0.85885164   0.390
## innovation_f3                0.288831673 0.09374265  3.08111288   0.002
## innovation_f4                0.459841664 0.09503297  4.83875947   0.000
## innovation_f5                0.538268330 0.10113800  5.32211739   0.000
## leadership_engagement_f2    -0.065655897 0.04839348 -1.35670969   0.175
## leadership_engagement_f3    -0.110443218 0.04849849 -2.27725083   0.023
## leadership_engagement_f4    -0.127515710 0.05120122 -2.49048170   0.013
## leadership_engagement_f5    -0.123486447 0.06225803 -1.98346229   0.047
## wellbeing_f2                 0.248092501 0.17191940  1.44307452   0.149
## wellbeing_f3                 0.256405041 0.17581668  1.45836586   0.145
## wellbeing_f4                 0.279494709 0.17699946  1.57907101   0.114
## wellbeing_f5                 0.367403603 0.18221050  2.01636895   0.044
## values_f2                    0.704248484 0.29307803  2.40293853   0.016
## values_f3                    0.925913564 0.28706964  3.22539700   0.001
## values_f4                    1.145285128 0.28748704  3.98378007   0.000
## values_f5                    1.334526559 0.28785668  4.63607991   0.000
## 0|1                          2.011957515 0.32984869  6.09963780   0.000
## 1|2                          5.265693522 0.33042909 15.93592590   0.000
```

```
predicted <- predict(ordered_logistic_regression, test, type = "class")
head(predicted)
```

```
## [1] 2 1 2 2 2 1
## Levels: 0 1 2
```

```
str(predicted)
```

```
##  Factor w/ 3 levels "0","1","2": 3 2 3 3 3 2 3 2 3 2 ...
```

```
summary(predicted)
```

```
##     0     1     2
##  1393 26917 57671
```

```
cm <- table(actual = test$team_performance_rating_ordReg, predicted = predicted)
cm
```

```
##       predicted
## actual     0     1     2
##      0   828  2971   649
##      1   461 15288 16261
##      2   104  8658 40761
```

```
accuracy <- sum(diag(cm))/nrow(test)
accuracy
```

```
## [1] 0.6615066
```

```r
# sensitivity: (TP) / (TP + FN)
sensitivity_low <- cm[1,1] / (cm[1,1] + cm[1,2] + cm[1,3])
sensitivity_low
```

```
## [1] 0.1861511
```

```r
sensitivity_medium <- cm[2,2] / (cm[2,2] + cm[2,1] + cm[2,3])
sensitivity_medium
```

```
## [1] 0.4776007
```

```r
sensitivity_high <- cm[3,3] / (cm[3,3] + cm[3,1] + cm[3,2])
sensitivity_high
```

```
## [1] 0.8230721
```

```r
sensitivity <- c(low = sensitivity_low, medium = sensitivity_medium, high = sensitivity_high)
sensitivity
```

```
##       low    medium      high
## 0.1861511 0.4776007 0.8230721
```

```r
# specificity: (TN) / (TN + FP)
specificity_low <- (cm[2,2] + cm[2,3] + cm[3,2] + cm[3,3]) / (cm[2,2] + cm[2,3] + cm[3,2] + cm[3,3] + cm
specificity_low
```

```
## [1] 0.9930703
```

```r
specificity_medium <- (cm[1,1] + cm[1,3] + cm[3,1] + cm[3,3]) / (cm[1,1] + cm[1,3] + cm[3,1] + cm[3,3] +
specificity_medium
```

```
## [1] 0.7845324
```

```r
specificity_high <- (cm[1,1] + cm[1,2] + cm[2,1] + cm[2,2]) / (cm[1,1] + cm[1,2] + cm[2,1] + cm[2,2] + c
specificity_high
```

```
## [1] 0.5361786
```

```r
specificity <- c(low = specificity_low, medium = specificity_medium, high = specificity_high)
specificity
```

```
##       low    medium      high
## 0.9930703 0.7845324 0.5361786
```

```r
# Pr = TP / (TP + FP)
precision <- cm[2,2] / (cm[2,2] + cm[1,2])
precision
```

```
## [1] 0.8372857
```

```r
precision_low <- cm[1,1] / (cm[1,1] + cm[2,1] + cm[3,1])
precision_low
```

```
## [1] 0.5944006
```

```r
precision_medium <- cm[2,2] / (cm[2,2] + cm[1,2] + cm[3,2])
precision_medium
```

```
## [1] 0.5679682
```

```r
precision_high <- cm[3,3] / (cm[3,3] +  cm[2,3] + cm[1,3])
precision_high
```

```
## [1] 0.706785
```

```r
precision <- c(low = precision_low, medium = precision_medium, high = precision_high)
precision
```

```
##       low    medium      high
## 0.5944006 0.5679682 0.7067850
```

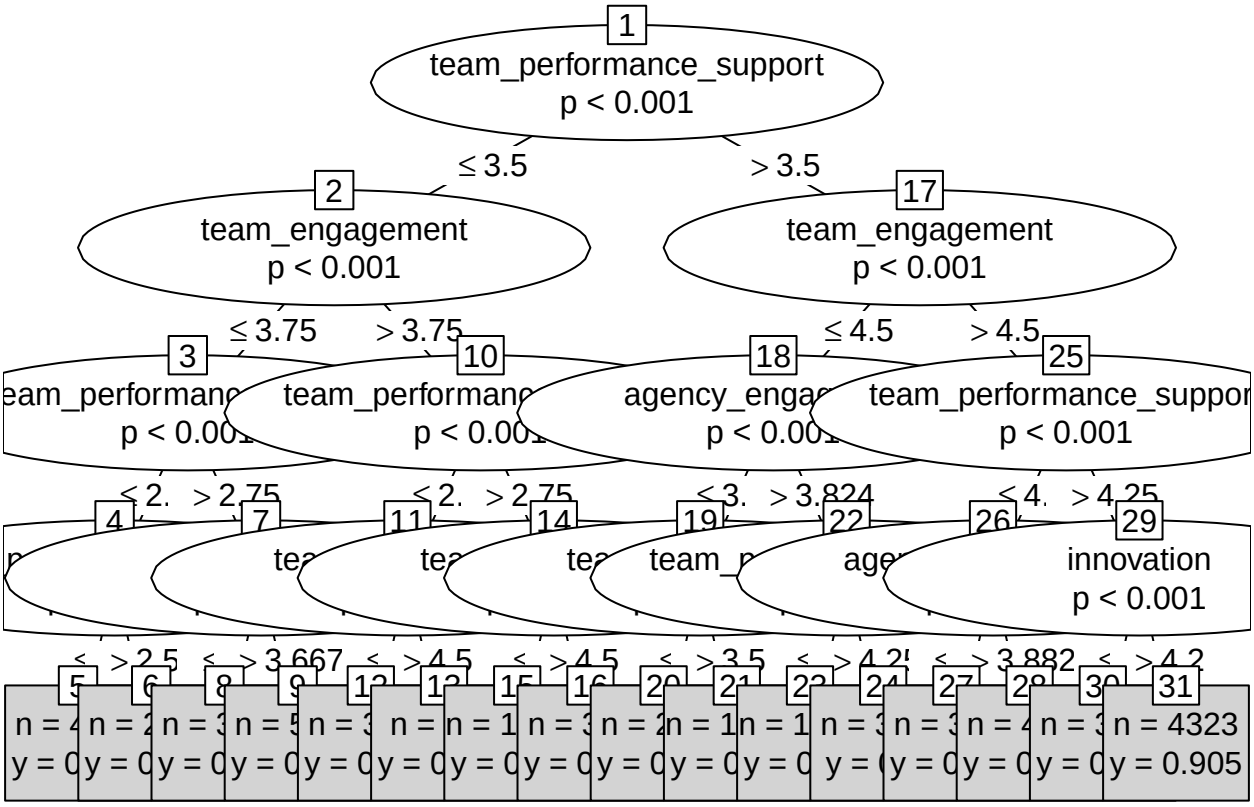
```r
# Decision tree using logitic regression aps_with_scales_lr data set

#simplified decision tree
aps_decision_tree <- ctree(
  team_performance_rating_binary ~.,
  data = aps_with_scales_lr,
  control = ctree_control(maxdepth = 4)
)
print(aps_decision_tree)
```

```
##
##   Conditional inference tree with 16 terminal nodes
##
## Response:  team_performance_rating_binary
## Inputs:  job_engagement, team_engagement, supervisor_engagement, senior_manager_engagement, agency_e
## Number of observations:  85225
##
## 1) team_performance_support <= 3.5; criterion = 1, statistic = 14329.924
##   2) team_engagement <= 3.75; criterion = 1, statistic = 2786.283
##     3) team_performance_support <= 2.75; criterion = 1, statistic = 727.231
##       4) team_performance_support <= 2.5; criterion = 1, statistic = 112.075
##         5)*  weights = 4714
##       4) team_performance_support > 2.5
##         6)*  weights = 2070
##     3) team_performance_support > 2.75
##       7) values <= 3.666667; criterion = 1, statistic = 131.714
##         8)*  weights = 3780
##       7) values > 3.666667
##         9)*  weights = 5139
```

```
##   2) team_engagement > 3.75
##     10) team_performance_support <= 2.75; criterion = 1, statistic = 733.057
##       11) team_engagement <= 4.5; criterion = 1, statistic = 80.159
##         12)*  weights = 3613
##       11) team_engagement > 4.5
##         13)*  weights = 851
##     10) team_performance_support > 2.75
##       14) team_engagement <= 4.5; criterion = 1, statistic = 373.119
##         15)*  weights = 12452
##       14) team_engagement > 4.5
##         16)*  weights = 3718
## 1) team_performance_support > 3.5
##   17) team_engagement <= 4.5; criterion = 1, statistic = 2596.657
##     18) agency_engagement <= 3.823529; criterion = 1, statistic = 848.386
##       19) team_engagement <= 3.5; criterion = 1, statistic = 375.83
##         20)*  weights = 2812
##       19) team_engagement > 3.5
##         21)*  weights = 14614
##     18) agency_engagement > 3.823529
##       22) team_performance_support <= 4.25; criterion = 1, statistic = 289.104
##         23)*  weights = 11833
##       22) team_performance_support > 4.25
##         24)*  weights = 3054
##   17) team_engagement > 4.5
##     25) team_performance_support <= 4.25; criterion = 1, statistic = 513.79
##       26) agency_engagement <= 3.882353; criterion = 1, statistic = 77.903
##         27)*  weights = 3729
##       26) agency_engagement > 3.882353
##         28)*  weights = 4941
##     25) team_performance_support > 4.25
##       29) innovation <= 4.2; criterion = 1, statistic = 89.486
##         30)*  weights = 3582
##       29) innovation > 4.2
##         31)*  weights = 4323
```

```
plot(aps_decision_tree, type="simple")
```




```
#full decision tree
# using 2018 data as training set and 2019 data as test set
aps_decision_tree <- ctree(
  team_performance_rating_binary ~.,
  data = aps_with_scales_lr)
print(aps_decision_tree)
```

```
##
##   Conditional inference tree with 90 terminal nodes
##
## Response:  team_performance_rating_binary
## Inputs:  job_engagement, team_engagement, supervisor_engagement, senior_manager_engagement, agency_en
## Number of observations:  85225
##
## 1) team_performance_support <= 3.5; criterion = 1, statistic = 14329.924
##   2) team_engagement <= 3.75; criterion = 1, statistic = 2786.283
##     3) team_performance_support <= 2.75; criterion = 1, statistic = 727.231
##       4) team_performance_support <= 2.5; criterion = 1, statistic = 112.075
##         5) values <= 3.333333; criterion = 1, statistic = 46.795
##           6) team_performance_support <= 2; criterion = 0.997, statistic = 13.506
##             7)*  weights = 1219
##           6) team_performance_support > 2
##             8) team_engagement <= 3.5; criterion = 0.986, statistic = 10.344
##               9)*  weights = 1020
##             8) team_engagement > 3.5
##               10)*  weights = 97
```

```
##         5) values > 3.333333
##           11) team_performance_support <= 2.25; criterion = 0.989, statistic = 10.842
##             12)*  weights = 1300
##           11) team_performance_support > 2.25
##             13) team_engagement <= 3; criterion = 0.998, statistic = 14.075
##               14)*  weights = 398
##             13) team_engagement > 3
##               15)*  weights = 680
##       4) team_performance_support > 2.5
##         16) job_engagement <= 3.2; criterion = 0.996, statistic = 12.85
##           17)*  weights = 968
##         16) job_engagement > 3.2
##           18) team_engagement <= 3; criterion = 0.971, statistic = 9.003
##             19)*  weights = 359
##           18) team_engagement > 3
##             20)*  weights = 743
##     3) team_performance_support > 2.75
##       21) values <= 3.666667; criterion = 1, statistic = 131.714
##         22) team_performance_support <= 3; criterion = 1, statistic = 41.477
##           23) team_engagement <= 3.5; criterion = 1, statistic = 18.444
##             24)*  weights = 1375
##           23) team_engagement > 3.5
##             25)*  weights = 289
##         22) team_performance_support > 3
##           26) team_engagement <= 3; criterion = 0.999, statistic = 15.65
##             27)*  weights = 812
##           26) team_engagement > 3
##             28)*  weights = 1304
##       21) values > 3.666667
##         29) innovation <= 3.4; criterion = 1, statistic = 39.802
##           30) team_engagement <= 3.5; criterion = 1, statistic = 21.726
##             31)*  weights = 2197
##           30) team_engagement > 3.5
##             32)*  weights = 1239
##         29) innovation > 3.4
##           33) team_performance_support <= 3; criterion = 1, statistic = 22.39
##             34)*  weights = 465
##           33) team_performance_support > 3
##             35) values <= 4.333333; criterion = 0.989, statistic = 10.819
##               36)*  weights = 806
##             35) values > 4.333333
##               37)*  weights = 432
##   2) team_engagement > 3.75
##     38) team_performance_support <= 2.75; criterion = 1, statistic = 733.057
##       39) team_engagement <= 4.5; criterion = 1, statistic = 80.159
##         40) team_performance_support <= 2.25; criterion = 1, statistic = 41.566
##           41)*  weights = 883
##         40) team_performance_support > 2.25
##           42) values <= 4; criterion = 1, statistic = 29.012
##             43)*  weights = 1583
##           42) values > 4
##             44) risk_culture <= 3.4; criterion = 0.995, statistic = 12.195
##               45)*  weights = 825
##             44) risk_culture > 3.4
```

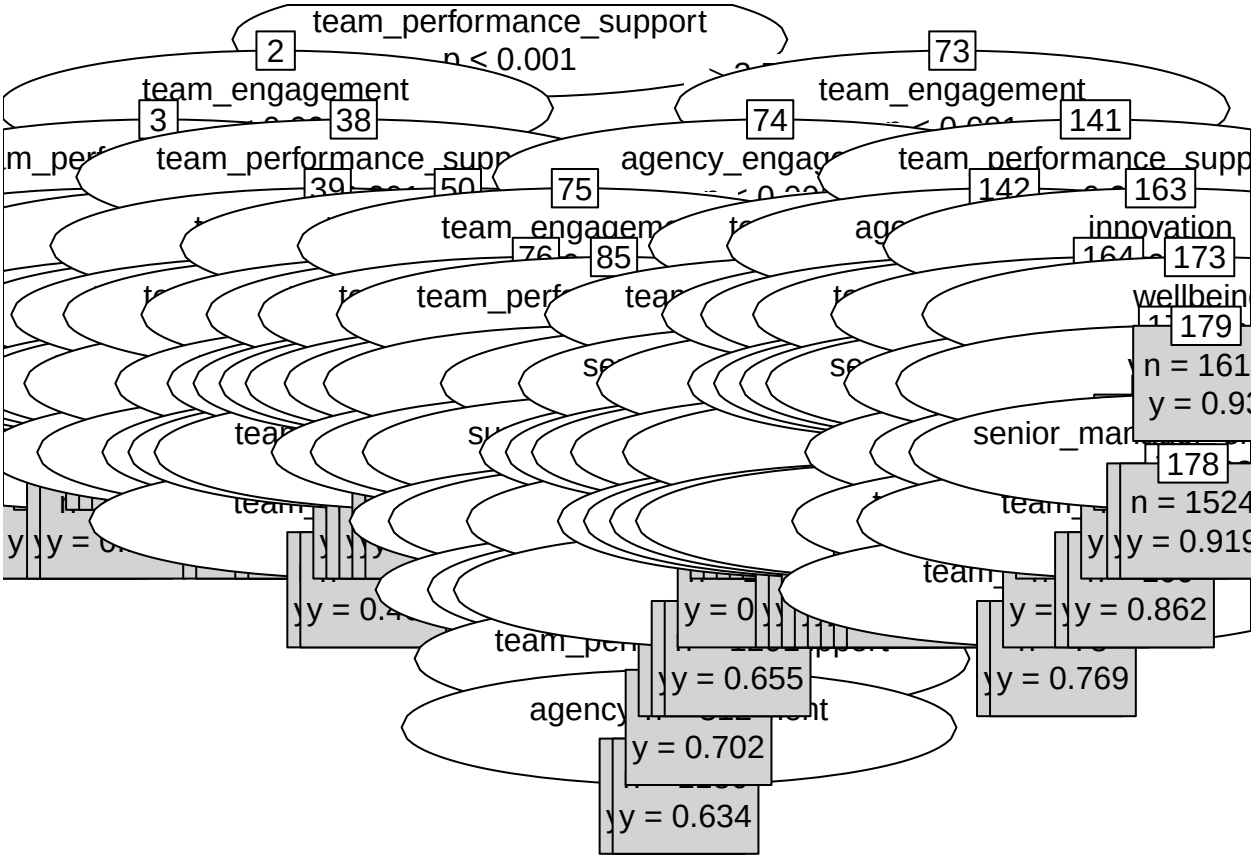
```
##               46)*  weights = 322
##       39) team_engagement > 4.5
##         47) team_performance_support <= 2.5; criterion = 1, statistic = 22.379
##           48)*  weights = 423
##         47) team_performance_support > 2.5
##           49)*  weights = 428
##     38) team_performance_support > 2.75
##       50) team_engagement <= 4.5; criterion = 1, statistic = 373.119
##         51) innovation <= 3.4; criterion = 1, statistic = 111.486
##           52) team_performance_support <= 3.25; criterion = 1, statistic = 58.046
##             53) values <= 4; criterion = 1, statistic = 24.036
##               54) team_engagement <= 4; criterion = 0.997, statistic = 13.17
##                 55)*  weights = 1796
##               54) team_engagement > 4
##                 56)*  weights = 496
##             53) values > 4
##               57)*  weights = 1862
##           52) team_performance_support > 3.25
##             58) senior_manager_engagement <= 4.833333; criterion = 0.977, statistic = 9.45
##               59)*  weights = 2620
##             58) senior_manager_engagement > 4.833333
##               60)*  weights = 75
##         51) innovation > 3.4
##           61) values <= 4.666667; criterion = 1, statistic = 32.581
##             62) team_performance_support <= 3.25; criterion = 1, statistic = 18.163
##               63)*  weights = 2034
##             62) team_performance_support > 3.25
##               64)*  weights = 1921
##           61) values > 4.666667
##             65)*  weights = 1648
##       50) team_engagement > 4.5
##         66) team_performance_support <= 3; criterion = 1, statistic = 61.627
##           67) team_engagement <= 4.75; criterion = 0.951, statistic = 8.039
##             68)*  weights = 312
##           67) team_engagement > 4.75
##             69)*  weights = 629
##         66) team_performance_support > 3
##           70) job_engagement <= 3.9; criterion = 1, statistic = 19.138
##             71)*  weights = 1313
##           70) job_engagement > 3.9
##             72)*  weights = 1464
## 1) team_performance_support > 3.5
##   73) team_engagement <= 4.5; criterion = 1, statistic = 2596.657
##     74) agency_engagement <= 3.823529; criterion = 1, statistic = 848.386
##       75) team_engagement <= 3.5; criterion = 1, statistic = 375.83
##         76) team_performance_support <= 3.75; criterion = 1, statistic = 35.599
##           77) team_engagement <= 2.75; criterion = 0.951, statistic = 8.065
##             78)*  weights = 170
##           77) team_engagement > 2.75
##             79)*  weights = 916
##         76) team_performance_support > 3.75
##           80) innovation <= 3.8; criterion = 1, statistic = 22.913
##             81) team_engagement <= 3; criterion = 0.997, statistic = 13.181
##               82)*  weights = 502
```

```
##             81) team_engagement > 3
##               83)*  weights = 820
##           80) innovation > 3.8
##             84)*  weights = 404
##       75) team_engagement > 3.5
##         85) team_performance_support <= 3.75; criterion = 1, statistic = 251.63
##           86) values <= 4; criterion = 1, statistic = 18.37
##             87) team_engagement <= 3.75; criterion = 0.963, statistic = 8.574
##               88)*  weights = 467
##             87) team_engagement > 3.75
##               89)*  weights = 1638
##           86) values > 4
##             90)*  weights = 2395
##         85) team_performance_support > 3.75
##           91) wellbeing <= 3.769231; criterion = 1, statistic = 96.347
##             92) supervisor_engagement <= 3.636364; criterion = 1, statistic = 44.366
##               93) team_performance_support <= 4; criterion = 0.987, statistic = 10.492
##                 94)*  weights = 740
##               93) team_performance_support > 4
##                 95)*  weights = 215
##             92) supervisor_engagement > 3.636364
##               96) innovation <= 3.4; criterion = 1, statistic = 23.831
##                 97) team_engagement <= 4; criterion = 0.97, statistic = 8.956
##                   98)*  weights = 1689
##                 97) team_engagement > 4
##                   99)*  weights = 494
##               96) innovation > 3.4
##                 100) team_engagement <= 4; criterion = 0.999, statistic = 14.977
##                   101) team_performance_support <= 4; criterion = 0.988, statistic = 10.625
##                     102) agency_engagement <= 3.352941; criterion = 0.986, statistic = 10.402
##                       103)*  weights = 390
##                     102) agency_engagement > 3.352941
##                       104)*  weights = 1186
##                   101) team_performance_support > 4
##                     105)*  weights = 312
##                 100) team_engagement > 4
##                   106)*  weights = 524
##           91) wellbeing > 3.769231
##             107) team_performance_support <= 4; criterion = 1, statistic = 43.09
##               108) innovation <= 3.8; criterion = 0.984, statistic = 10.153
##                 109) values <= 4; criterion = 0.988, statistic = 10.675
##                   110)*  weights = 702
##                 109) values > 4
##                   111)*  weights = 1291
##               108) innovation > 3.8
##                 112)*  weights = 1223
##             107) team_performance_support > 4
##               113)*  weights = 1348
##     74) agency_engagement > 3.823529
##       114) team_performance_support <= 4.25; criterion = 1, statistic = 289.104
##         115) team_performance_support <= 3.75; criterion = 1, statistic = 86.265
##           116) senior_manager_engagement <= 3.833333; criterion = 1, statistic = 21.45
##             117) innovation <= 3.8; criterion = 0.994, statistic = 11.883
##               118)*  weights = 461
```

```
##             117) innovation > 3.8
##               119)*  weights = 270
##           116) senior_manager_engagement > 3.833333
##             120) team_engagement <= 3.5; criterion = 0.958, statistic = 8.34
##               121)*  weights = 101
##             120) team_engagement > 3.5
##               122)*  weights = 1381
##         115) team_performance_support > 3.75
##           123) values <= 4.666667; criterion = 1, statistic = 69.373
##             124) wellbeing <= 3.769231; criterion = 1, statistic = 23.046
##               125) team_engagement <= 3; criterion = 0.999, statistic = 15.1
##                 126)*  weights = 42
##               125) team_engagement > 3
##                 127)*  weights = 1817
##             124) wellbeing > 3.769231
##               128) risk_culture <= 3.6; criterion = 0.991, statistic = 11.16
##                 129)*  weights = 1260
##               128) risk_culture > 3.6
##                 130)*  weights = 2536
##           123) values > 4.666667
##             131) wellbeing <= 3.615385; criterion = 1, statistic = 28.132
##               132) supervisor_engagement <= 3.454545; criterion = 0.993, statistic = 11.592
##                 133)*  weights = 32
##               132) supervisor_engagement > 3.454545
##                 134)*  weights = 342
##             131) wellbeing > 3.615385
##               135) risk_culture <= 3.8; criterion = 1, statistic = 21.403
##                 136)*  weights = 1581
##               135) risk_culture > 3.8
##                 137)*  weights = 2010
##       114) team_performance_support > 4.25
##         138) values <= 4.333333; criterion = 1, statistic = 26.044
##           139)*  weights = 865
##         138) values > 4.333333
##           140)*  weights = 2189
##   73) team_engagement > 4.5
##     141) team_performance_support <= 4.25; criterion = 1, statistic = 513.79
##       142) agency_engagement <= 3.882353; criterion = 1, statistic = 77.903
##         143) team_engagement <= 4.75; criterion = 1, statistic = 18.329
##           144) senior_manager_engagement <= 3.833333; criterion = 0.966, statistic = 8.705
##             145)*  weights = 612
##           144) senior_manager_engagement > 3.833333
##             146)*  weights = 632
##         143) team_engagement > 4.75
##           147) supervisor_engagement <= 4.818182; criterion = 0.985, statistic = 10.278
##             148)*  weights = 1259
##           147) supervisor_engagement > 4.818182
##             149)*  weights = 1226
##       142) agency_engagement > 3.882353
##         150) team_performance_support <= 3.75; criterion = 1, statistic = 36.522
##           151) senior_manager_engagement <= 3.5; criterion = 0.986, statistic = 10.305
##             152)*  weights = 102
##           151) senior_manager_engagement > 3.5
##             153)*  weights = 753
```

```
##         150) team_performance_support > 3.75
##           154) senior_manager_engagement <= 4.666667; criterion = 0.991, statistic = 11.262
##             155)*  weights = 2377
##           154) senior_manager_engagement > 4.666667
##             156) supervisor_engagement <= 4.545455; criterion = 0.973, statistic = 9.134
##               157) team_performance_support <= 4; criterion = 0.987, statistic = 10.454
##                 158) team_engagement <= 4.75; criterion = 0.983, statistic = 10.045
##                   159)*  weights = 38
##                 158) team_engagement > 4.75
##                   160)*  weights = 78
##               157) team_performance_support > 4
##                 161)*  weights = 80
##             156) supervisor_engagement > 4.545455
##               162)*  weights = 1513
##     141) team_performance_support > 4.25
##       163) innovation <= 4.2; criterion = 1, statistic = 89.486
##         164) agency_engagement <= 4.117647; criterion = 1, statistic = 16.932
##           165)*  weights = 1770
##         164) agency_engagement > 4.117647
##           166) team_performance_support <= 4.5; criterion = 0.995, statistic = 12.422
##             167)*  weights = 691
##           166) team_performance_support > 4.5
##             168) values <= 4.333333; criterion = 0.991, statistic = 11.225
##               169) team_engagement <= 4.75; criterion = 0.958, statistic = 8.344
##                 170)*  weights = 33
##               169) team_engagement > 4.75
##                 171)*  weights = 109
##             168) values > 4.333333
##               172)*  weights = 979
##       163) innovation > 4.2
##         173) wellbeing <= 4.615385; criterion = 1, statistic = 26.731
##           174) values <= 4.666667; criterion = 0.993, statistic = 11.745
##             175)*  weights = 753
##           174) values > 4.666667
##             176) senior_manager_engagement <= 4.333333; criterion = 0.997, statistic = 13.532
##               177)*  weights = 435
##             176) senior_manager_engagement > 4.333333
##               178)*  weights = 1524
##         173) wellbeing > 4.615385
##           179)*  weights = 1611
```

```
plot(aps_decision_tree, type="simple")
```




```
# 10fold cross validation
#library(caret)
#set.seed(430)
#index = createDataPartition(aps_with_scales_lr$team_performance_rating_binary, p = 0.75, list = FALSE)
#train = aps_with_scales_lr[index, ]
#test = aps_with_scales_lr[-index, ]
#fitcontrol1 <- trainControl(method = "cv", number = 10, savePredictions = T )
#aps_decision_tree <- train(team_performance_rating_binary~., data = train, method = "ctree", trcontrol
#print(aps_decision_tree)


aps_decision_tree_prediction <- predict(aps_decision_tree, aps_with_scales_lr_test)
head(aps_decision_tree_prediction)
```

```
##      team_performance_rating_binary
## [1,]                      0.6830601
## [2,]                      0.2598999
## [3,]                      0.7134725
## [4,]                      0.4976636
## [5,]                      0.6666667
## [6,]                      0.4119227
```

```
str(aps_decision_tree_prediction)
```

```
##  num [1:85981, 1] 0.683 0.26 0.713 0.498 0.667 ...
```

```
##  - attr(*, "dimnames")=List of 2
##   ..$ : NULL
##   ..$ : chr "team_performance_rating_binary"
```

```
summary(aps_decision_tree_prediction)
```

```
##  team_performance_rating_binary
##  Min.   :0.04348
##  1st Qu.:0.40323
##  Median :0.57550
##  Mean   :0.55395
##  3rd Qu.:0.74104
##  Max.   :0.93048
```

```
predicted_class <- ifelse(aps_decision_tree_prediction>=0.56, 1, 0)

cm <- table(actual = aps_with_scales_lr_test$team_performance_rating_binary, predicted = predicted_class
cm
```

```
##       predicted
## actual     0     1
##      0 25760 10698
##      1 15654 33869
```

```
accuracy <- (cm[1,1] + cm[2,2]) / (cm[1,1] + cm[1,2] + cm[2,1] + cm[2,2])
accuracy
```

```
## [1] 0.6935137
```

```
sensitivity <- cm[2,2] / (cm[2,2] + cm[2,1])
sensitivity
```

```
## [1] 0.6839044
```

```
specificity <- cm[1,1] / (cm[1,1] + cm[1,2])
specificity
```

```
## [1] 0.7065665
```

```
precision <- cm[2,2] / (cm[2,2] + cm[1,2])
precision
```

```
## [1] 0.7599569
```

```
accuracy
```

```
## [1] 0.6935137
```

```
sensitivity
```

```
## [1] 0.6839044
```

```
specificity
```

```
## [1] 0.7065665
```

```
precision
```

```
## [1] 0.7599569
```

```
#k-means clustering - analyzing APS data using binary dependent variable scale
aps_with_scales_k2 <- data.frame(job_engagement, team_engagement, supervisor_engagement, senior_manager

aps_with_scales_kmeans <- aps_with_scales_k2[-aps_with_scales_k2$team_performance_rating_binary]
aps_kmeans<- kmeans(aps_with_scales_kmeans, 6)
```

```
## Warning: Quick-TRANSfer stage steps exceeded maximum (= 4261250)
```

```
aps_kmeans
```

```
## K-means clustering with 6 clusters of sizes 13520, 4043, 14090, 26063, 11671, 15838
##
## Cluster means:
##   team_engagement supervisor_engagement senior_manager_engagement
## 1        3.625055              3.559568                  2.863135
## 2        2.697564              2.488386                  2.109840
## 3        4.258783              4.337906                  3.162337
## 4        4.302411              4.406682                  4.131790
## 5        4.769171              4.868462                  4.725045
## 6        3.801822              3.781877                  3.807730
##   agency_engagement team_performance_support risk_culture innovation
## 1          2.883284                 3.032970     2.847559   2.884749
## 2          2.259228                 2.358026     2.177492   2.201583
## 3          3.429370                 3.751632     3.292193   3.476991
## 4          3.916280                 3.958341     3.680351   3.865188
## 5          4.502462                 4.516708     4.245343   4.489915
## 6          3.512617                 3.394179     3.333047   3.385402
##   leadership_engagement wellbeing   values team_performance_rating_binary
## 1              2.533073  3.060776 3.818540                      0.2523669
## 2              1.930957  2.336955 3.101163                      0.1209498
## 3              2.789476  3.678288 4.328105                      0.6442158
## 4              3.796521  3.940567 4.618795                      0.7115067
## 5              4.460874  4.364012 4.846400                      0.8557964
## 6              3.567685  3.489703 4.148020                      0.2902513
##
## Clustering vector:
##     [1] 3 4 3 3 4 4 3 4 2 6 1 1 6 4 5 4 4 4 1 6 6 4 6 5 6 4 1 3 4 1 2 4 4 4 6 4
##    [37] 1 3 2 4 1 3 3 6 1 5 6 3 1 1 4 4 3 4 3 4 4 6 4 6 4 2 5 1 4 1 6 4 1 3 2 4
```

```
##    [73] 4 3 6 6 4 1 4 1 6 3 1 2 3 4 4 1 1 1 6 3 4 3 6 6 3 6 6 3 4 4 3 1 6 4 3 5
##   [109] 6 4 3 1 4 1 1 4 3 3 2 6 3 6 4 3 1 4 3 1 4 5 6 1 6 6 6 4 1 1 1 1 5 6 6 6
##   [145] 4 6 4 4 3 3 4 4 4 4 4 5 4 3 5 6 5 4 3 3 2 4 4 3 5 4 4 5 4 1 3 3 3 5 1 5
##   [181] 4 3 4 6 6 3 1 4 3 1 6 6 1 6 1 1 4 4 5 4 3 2 6 5 2 4 1 6 4 4 3 3 2 5 6 6
##   [217] 1 4 1 3 4 5 6 3 6 6 6 6 4 4 4 6 6 6 6 4 6 2 3 4 2 4 4 1 5 4 4 3 1 3 6 5
##   [253] 1 2 1 3 6 5 4 4 6 6 3 3 3 5 5 5 4 3 2 3 5 4 3 3 5 3 6 5 6 1 1 4 6 6 6 3
##   [289] 4 4 3 4 1 6 1 3 6 4 3 5 3 3 4 1 5 5 4 1 4 4 1 6 4 5 3 3 4 5 4 3 2 3 2 4
##   [325] 4 2 3 1 6 3 6 6 4 5 5 4 3 3 4 2 1 6 6 4 1 3 1 4 1 5 4 5 1 6 4 6 3 6 4 5
##   [361] 5 6 6 3 6 3 4 3 6 5 4 1 5 6 6 3 1 4 1 1 3 6 6 4 5 5 1 4 6 6 4 4 1 4 3 5
##   [397] 1 3 4 4 3 1 4 2 4 2 1 3 1 5 4 6 4 4 5 4 5 4 1 4 4 4 4 5 3 4 1 3 5 5 4 4 4
##   [433] 4 4 6 3 1 1 3 5 3 6 4 2 3 6 5 5 4 6 3 5 4 6 6 1 1 6 4 4 3 2 3 1 3 3 6 6
##   [469] 3 4 6 6 5 3 4 2 3 6 4 3 4 1 5 1 3 3 4 6 5 6 4 1 4 5 3 6 3 1 5 6 3 3 2 5
##   [505] 6 1 6 3 6 1 6 5 2 2 4 4 6 4 3 5 6 5 5 1 6 6 1 6 4 4 3 6 3 1 4 4 5 4 4 4
##   [541] 6 3 4 5 3 1 5 5 1 3 1 1 1 4 1 3 4 1 3 1 4 3 6 6 5 6 5 4 1 6 5 5 3 4 3 3
##   [577] 3 3 1 1 3 4 2 2 3 4 1 5 6 6 4 1 4 3 4 1 6 3 5 6 4 1 4 3 1 2 2 4 1 1 5 2
##   [613] 3 4 6 3 4 5 6 4 3 4 6 1 6 1 5 6 4 6 3 2 2 4 4 4 3 1 3 4 4 1 4 4 5 4 1 1
##   [649] 3 1 1 5 4 4 6 6 2 4 1 4 4 4 1 6 4 4 5 4 3 4 4 4 1 4 5 3 3 2 4 4 6 4 6 4
##   [685] 4 4 1 4 6 4 3 6 6 4 6 4 4 5 5 3 6 1 1 1 4 5 4 2 6 5 5 5 4 4 5 6 4 5 5 3
##   [721] 4 4 1 4 6 5 3 4 4 3 5 2 6 4 3 4 3 3 4 4 5 6 3 4 1 3 4 6 6 4 6 3 6 5 4 6
##   [757] 2 3 6 4 4 4 6 2 1 4 6 3 3 1 6 4 1 5 6 3 3 4 4 4 1 4 4 1 4 1 4 3 6 5 6 4
##   [793] 5 4 5 5 3 4 3 4 6 4 6 4 5 4 1 4 3 6 1 1 1 2 5 6 6 2 3 2 3 6 1 6 4 3 3 3
##   [829] 4 4 6 1 5 3 4 6 4 2 6 1 5 3 1 4 1 6 6 6 3 5 3 4 6 3 4 5 6 5 5 4 4 3 5 5
##   [865] 3 4 5 4 6 4 6 3 4 4 4 3 6 2 3 4 4 3 4 6 5 4 5 1 4 5 1 5 1 5 1 3 5 1 4 6
##   [901] 6 3 6 4 4 2 6 6 4 3 4 3 5 4 3 3 1 3 1 6 6 4 4 1 4 4 5 4 6 5 1 4 4 4 3 3
##   [937] 6 3 3 3 1 3 2 1 1 1 4 2 3 6 4 4 3 1 4 6 4 1 1 1 3 6 4 3 4 4 1 1 6 1 3 5
##   [973] 6 4 1 6 5 4 6 5 3 4 4 1 4 4 3 6 6 1 4 4 3 4 6 3 3 1 6 1 3 4 4 6 5 6 1 4
##  [1009] 6 5 3 4 6 4 3 4 4 2 2 1 2 4 4 6 5 4 3 1 4 4 5 4 5 6 4 4 4 2 6 5 4 3 4 4
##  [1045] 6 6 2 6 4 3 6 5 4 2 4 1 1 4 2 6 2 4 1 6 1 1 4 3 6 4 6 6 4 6 4 3 6 2 5 1
##  [1081] 5 2 4 4 4 6 4 4 4 5 6 4 6 4 1 3 3 1 4 1 4 5 4 6 3 1 3 6 4 4 4 1 5 4 3 4
##  [1117] 5 3 6 3 4 2 6 4 6 4 3 3 6 4 3 4 1 4 6 6 4 4 4 4 3 6 3 3 6 5 1 1 4 6 3 1
##  [1153] 4 4 4 4 4 3 1 1 4 4 1 4 4 4 2 5 4 6 6 5 4 5 3 1 5 6 5 6 5 4 3 1 6 4 4 6
##  [1189] 5 6 1 1 6 1 4 4 1 4 1 3 3 4 3 4 2 1 3 5 4 3 5 5 6 1 2 6 5 4 4 3 1 3 1 1
##  [1225] 3 4 4 1 1 4 4 2 5 2 6 4 4 6 1 6 5 3 5 4 4 4 6 6 1 1 3 4 4 5 5 4 5 5 4 4
##  [1261] 3 4 1 5 3 6 5 4 4 5 2 4 1 1 4 5 6 4 6 1 3 6 4 4 5 4 6 5 6 6 5 4 1 4 1 4
##  [1297] 4 3 4 5 3 4 1 3 4 4 6 2 4 2 6 6 2 4 1 5 4 6 5 6 6 4 5 1 4 5 6 4 5 6 5 4
##  [1333] 3 4 6 1 1 2 3 6 1 4 3 6 1 1 5 3 1 4 5 1 1 4 4 5 3 4 4 4 6 1 3 3 4 4 3 6
##  [1369] 3 1 2 4 5 3 1 4 4 3 1 6 4 1 3 6 4 6 4 4 3 3 4 2 6 3 1 6 2 4 5 1 5 1 5 4
##  [1405] 6 3 1 3 5 4 3 4 5 5 3 1 3 1 3 4 3 6 3 6 4 5 1 6 6 1 3 5 3 3 3 3 4 3 6 6
##  [1441] 3 3 1 4 2 4 1 6 6 5 1 1 5 1 5 2 5 4 6 1 6 5 6 4 1 5 4 6 5 3 5 3 1 1 6 1
##  [1477] 3 2 3 1 1 3 5 5 4 1 2 1 4 4 4 2 6 1 4 4 3 4 3 4 5 3 4 3 4 4 1 4 1 1 3 6
##  [1513] 5 6 4 1 6 1 1 3 4 3 5 4 4 4 5 5 1 1 4 6 3 5 6 1 6 4 1 3 6 1 5 3 4 5 3 4
##  [1549] 2 5 4 3 5 6 4 3 4 2 1 4 6 4 2 5 3 2 6 4 1 4 4 6 3 1 1 4 4 4 6 1 2 5 6 4
##  [1585] 3 4 1 4 5 6 1 6 2 4 5 4 1 6 6 3 6 4 6 1 1 1 3 4 1 1 1 6 1 6 1 6 1 1 5 2
##  [1621] 3 4 4 3 1 5 5 4 4 3 4 3 6 4 4 4 4 1 4 3 4 1 1 6 4 1 4 5 4 6 3 4 5 3 3 4
##  [1657] 3 6 1 5 5 5 1 3 1 3 5 4 1 4 1 6 4 3 5 3 1 6 6 1 5 6 4 4 6 3 6 3 6 6 2 3
##  [1693] 4 4 5 4 4 1 6 2 6 6 5 6 4 4 5 4 5 3 6 3 3 3 6 4 4 4 1 4 5 2 3 2 1 3 5 6
##  [1729] 2 1 6 6 2 1 1 5 4 3 4 3 4 4 5 3 6 6 6 1 4 6 3 5 4 4 5 3 6 4 4 4 6 6 5 3
##  [1765] 6 6 2 4 5 3 4 6 4 6 4 4 6 1 6 4 1 4 1 1 4 6 4 3 4 4 3 4 4 3 4 3 6 4 4 6
##  [1801] 3 6 4 2 6 4 6 4 4 5 3 4 4 1 6 4 4 5 3 2 4 4 6 3 4 4 4 4 4 4 6 5 3 2 5 5
##  [1837] 6 6 4 4 1 3 3 4 4 3 3 6 4 6 6 5 5 5 4 4 4 5 4 4 6 3 3 4 4 1 3 3 3 6 1 4
##  [1873] 1 6 4 2 4 3 4 1 2 5 6 6 2 3 5 5 3 6 4 3 6 5 5 3 6 3 6 4 5 4 1 2 4 4 4 4
##  [1909] 2 4 6 5 4 3 2 2 5 5 4 2 3 2 6 4 5 2 4 6 3 4 5 3 4 3 2 4 4 3 6 1 4 4 2 6
##  [1945] 4 4 6 5 4 3 5 1 3 4 6 6 2 1 3 2 4 3 3 6 3 1 4 3 4 5 6 4 4 4 5 6 6 1 3 5
##  [1981] 4 4 4 1 4 4 4 1 5 5 3 6 4 1 4 4 3 6 3 1 1 1 3 2 1 4 3 4 1 4 5 4 1 6 6 4
```

```
##  [2017] 4 5 1 2 4 4 6 3 4 4 4 2 1 1 3 4 3 5 6 5 1 4 1 4 3 1 5 2 5 6 6 2 6 3 3 1
##  [2053] 6 6 6 5 3 4 4 4 5 3 4 4 3 4 4 6 5 4 4 4 6 6 6 6 2 4 5 1 4 1 3 1 6 3 4 1
##  [2089] 4 3 1 1 6 6 4 4 5 4 6 1 4 3 4 6 1 5 5 3 1 1 4 2 1 5 4 4 6 1 3 6 6 6 5 5
##  [2125] 4 4 5 5 3 4 6 3 5 1 1 6 4 6 6 6 1 2 5 4 5 4 4 5 6 3 4 2 1 6 5 4 4 5 5 5
##  [2161] 6 1 4 6 5 6 4 6 2 6 6 2 3 5 6 4 1 5 1 6 5 4 1 5 3 5 4 4 4 3 2 5 5 3 1 4
##  [2197] 4 6 6 6 5 5 4 5 4 4 4 4 3 1 5 1 1 1 6 3 4 1 3 6 4 4 1 4 2 6 1 4 4 4 1 6
##  [2233] 4 4 6 6 5 1 5 6 6 5 3 5 6 3 6 1 1 1 4 4 1 4 4 2 6 5 6 5 1 3 6 4 4 3 3 4
##  [2269] 2 1 4 3 3 4 3 6 5 4 6 4 4 6 1 4 1 3 6 6 3 4 6 5 5 6 4 4 6 4 6 4 4 4 4 4
##  [2305] 2 6 5 6 1 4 4 2 6 5 4 4 3 6 1 6 4 1 1 3 4 4 5 4 3 5 6 6 4 5 5 4 4 4 5 6
##  [2341] 2 6 1 3 4 4 4 4 4 4 1 4 6 3 4 5 4 4 6 5 5 3 5 3 5 4 1 6 1 6 3 4 2 4 3 4
##  [2377] 4 5 3 1 6 4 4 4 3 3 1 6 4 1 3 2 3 1 3 6 6 5 1 2 3 6 1 6 5 6 3 5 3 5 4 4
##  [2413] 1 4 2 6 1 1 3 6 1 4 5 1 5 6 4 3 4 1 4 3 4 1 3 4 4 5 3 3 5 5 3 3 1 4 3 4
##  [2449] 1 5 3 3 4 5 4 4 1 3 3 6 1 3 6 6 4 4 4 4 4 5 3 1 6 6 6 4 4 1 6 4 3 3 3 1
##  [2485] 4 1 1 2 6 1 4 4 1 1 4 3 6 6 6 1 3 4 5 1 4 4 4 6 4 3 6 5 4 4 4 4 1 4 3 1
##  [2521] 1 1 2 1 1 3 6 6 1 1 6 5 6 4 5 4 1 6 1 1 6 4 3 6 6 6 6 4 4 6 4 4 4 4 6 5
##  [2557] 2 5 5 4 3 4 4 4 5 5 5 4 3 4 1 1 4 1 5 4 4 6 4 5 3 6 1 5 1 3 3 6 4 6 3 6
##  [2593] 6 4 6 6 4 3 1 5 3 5 1 5 4 5 6 4 4 4 4 1 3 3 6 1 3 4 6 6 4 3 5 4 4 2 5 2
##  [2629] 4 4 6 4 5 3 4 1 1 6 4 5 4 2 4 5 4 6 6 1 5 6 3 1 1 3 5 4 4 6 6 1 6 1 4 4
##  [2665] 6 3 5 3 6 1 6 3 4 4 6 6 6 1 1 6 5 6 6 4 6 6 1 6 4 5 6 2 5 4 6 4 6 4 3 3
##  [2701] 4 4 6 4 4 6 5 1 1 5 5 5 3 3 3 3 3 4 4 1 4 3 6 4 6 4 5 1 4 2 1 2 2 6 6 4
##  [2737] 3 4 5 3 2 4 4 4 4 5 1 6 3 3 3 5 5 4 4 4 3 5 4 6 6 1 6 4 5 1 4 5 1 4 3 3
##  [2773] 1 1 3 4 4 6 4 3 4 4 4 6 3 6 4 5 4 3 3 4 6 6 5 4 1 1 2 5 1 1 3 1 3 3 1 6
##  [2809] 5 5 5 4 4 3 3 4 6 4 1 3 1 6 3 5 6 5 1 4 5 4 4 2 6 6 6 3 3 4 1 4 1 3 4 2
##  [2845] 3 4 3 4 4 5 3 4 4 4 3 3 1 1 1 4 4 4 4 3 5 1 1 1 2 4 6 1 4 4 5 4 3 4 6 3
##  [2881] 5 4 6 4 1 5 6 3 3 1 3 3 3 6 5 1 4 1 3 4 4 4 1 6 1 5 5 5 3 4 4 4 4 5 6 4
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## [83593] 6 3 6 2 6 4 2 4 4 4 4 1 4 5 4 4 4 5 2 6 5 4 3 1 6 4 2 5 5 6 2 4 6 4 4 5
## [83629] 3 3 5 4 3 6 3 6 4 3 1 4 3 4 4 4 5 3 1 4 5 3 3 5 3 4 1 1 6 1 4 4 3 4 6 3
```

```
## [83665] 4 4 4 6 6 3 4 3 4 4 6 5 1 1 3 4 6 3 1 4 1 3 6 6 6 4 4 4 5 4 1 6 1 4 6 3
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## [84241] 3 3 4 4 1 2 3 3 1 4 3 5 4 3 4 3 6 4 6 2 1 4 2 4 4 3 4 4 3 1 6 4 5 4 5 6
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## [84457] 5 3 4 1 6 3 4 4 4 6 3 2 1 6 1 4 6 5 2 5 5 3 3 5 2 4 5 3 3 4 6 3 3 4 6 5
## [84493] 4 4 4 3 4 1 6 4 4 1 4 4 4 2 4 1 3 1 3 4 1 3 3 2 6 4 6 4 4 6 2 5 6 4 4 5
## [84529] 6 4 4 2 4 5 1 5 3 2 1 5 5 5 4 5 6 5 4 3 6 4 5 4 1 6 4 1 6 6 6 6 6 1 4 5
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## [84601] 3 4 4 3 4 6 4 6 3 4 3 2 4 5 5 6 4 6 4 3 4 4 4 4 4 3 6 4 4 4 4 1 6 4 6 6
## [84637] 6 4 4 4 4 4 4 6 4 5 5 6 1 6 1 6 4 1 6 1 3 3 1 3 3 5 5 5 4 3 6 2 6 2 4 3 4
## [84673] 6 4 6 2 5 3 4 4 1 4 4 4 3 4 3 4 4 5 6 3 4 6 4 1 5 6 6 1 6 1 5 4 1 6 5 4
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## [84889] 4 6 3 5 4 4 2 4 1 2 5 4 6 3 4 4 4 4 6 3 4 1 3 4 4 4 1 4 2 3 3 5 3 6 4 6
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## [84961] 4 5 3 3 3 3 5 4 3 4 5 3 1 4 6 3 3 4 6 4 1 5 6 3 4 4 1 4 2 1 1 5 6 3 4 4
## [84997] 6 5 4 1 6 3 4 5 5 3 4 4 2 6 4 1 6 4 4 3 6 3 5 6 1 6 5 1 3 5 6 1 1 3 3 1
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## [85105] 4 5 1 1 5 5 6 1 3 3 1 6 4 1 3 4 6 5 5 3 6 4 5 3 4 6 1 3 6 1 4 6 1 1 1 3
## [85141] 4 5 2 5 2 6 4 4 4 3 4 4 5 4 3 1 6 4 4 3 3 5 1 2 3 4 4 6 3 6 4 4 4 4 4 1
## [85177] 4 5 6 6 3 3 3 1 4 2 4 3 4 3 3 4 5 6 1 4 1 6 1 1 4 3 4 3 1 4 3 2 4 1 6 3
## [85213] 5 5 4 6 4 3 4 4 4 6 4 4 5
##
## Within cluster sum of squares by cluster:
## [1] 45114.61 21984.69 37112.41 51041.12 21605.96 37591.68
##  (between_SS / total_SS =  55.5 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

```
aps_kmeans$centers
```

```
##   team_engagement supervisor_engagement senior_manager_engagement
## 1        3.625055              3.559568                  2.863135
## 2        2.697564              2.488386                  2.109840
## 3        4.258783              4.337906                  3.162337
## 4        4.302411              4.406682                  4.131790
## 5        4.769171              4.868462                  4.725045
## 6        3.801822              3.781877                  3.807730
##   agency_engagement team_performance_support risk_culture innovation
## 1          2.883284                 3.032970     2.847559   2.884749
## 2          2.259228                 2.358026     2.177492   2.201583
## 3          3.429370                 3.751632     3.292193   3.476991
## 4          3.916280                 3.958341     3.680351   3.865188
## 5          4.502462                 4.516708     4.245343   4.489915
## 6          3.512617                 3.394179     3.333047   3.385402
##   leadership_engagement wellbeing   values team_performance_rating_binary
## 1              2.533073  3.060776 3.818540                      0.2523669
## 2              1.930957  2.336955 3.101163                      0.1209498
## 3              2.789476  3.678288 4.328105                      0.6442158
## 4              3.796521  3.940567 4.618795                      0.7115067
## 5              4.460874  4.364012 4.846400                      0.8557964
## 6              3.567685  3.489703 4.148020                      0.2902513
```

```
aps_kmeans_centres <- as.data.frame(aps_kmeans$centers)
aps_kmeans_centres
```

```
##   team_engagement supervisor_engagement senior_manager_engagement
## 1        3.625055              3.559568                  2.863135
## 2        2.697564              2.488386                  2.109840
## 3        4.258783              4.337906                  3.162337
## 4        4.302411              4.406682                  4.131790
## 5        4.769171              4.868462                  4.725045
## 6        3.801822              3.781877                  3.807730
##   agency_engagement team_performance_support risk_culture innovation
## 1          2.883284                 3.032970     2.847559   2.884749
## 2          2.259228                 2.358026     2.177492   2.201583
## 3          3.429370                 3.751632     3.292193   3.476991
## 4          3.916280                 3.958341     3.680351   3.865188
## 5          4.502462                 4.516708     4.245343   4.489915
## 6          3.512617                 3.394179     3.333047   3.385402
##   leadership_engagement wellbeing   values team_performance_rating_binary
## 1              2.533073  3.060776 3.818540                      0.2523669
## 2              1.930957  2.336955 3.101163                      0.1209498
## 3              2.789476  3.678288 4.328105                      0.6442158
## 4              3.796521  3.940567 4.618795                      0.7115067
## 5              4.460874  4.364012 4.846400                      0.8557964
## 6              3.567685  3.489703 4.148020                      0.2902513
```

```
table(aps_with_scales_k2$team_performance_rating_binary,aps_kmeans$cluster)
```

```
##
```

```
##          1     2     3     4     5     6
##   0 10108  3554  5013  7519  1683 11241
##   1  3412   489  9077 18544  9988  4597
```

```
aps_kmeans_centres %>%
  gather("Type", "Value",-team_performance_rating_binary) %>%
  ggplot(aes(team_performance_rating_binary, Value, fill = Type)) +
  geom_col(position = "dodge") +
  theme_bw()+
  facet_wrap(~team_performance_rating_binary,scales = "free_x")
```