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# Project: Grit Analysis for the 2024 Industrial Maintenance Data
# 01/20/2025
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# This R program is provided as supplementary material to support the findings of the
academic paper
# titled: U.S. Industrial Maintenance Workers: The Implications of Interest and Effort on
Leadership,
# Maturity, Retention, and Job Satisfaction.

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feedback and suggestions to improve
# this program. For inquiries or to report issues, please contact the corresponding author
at tolbert.research@tuta.com.

library(tidyverse)
library(magrittr)
library(car)
library(ggthemes)
theme_set(theme_light())
theme_update(plot.title = element_text(hjust = 0.5),
  strip.background =element_rect(fill="#F0A000"),
  strip.text = element_text(colour = 'black'))

#####
# Read data #
#####

setwd('C:/Analysis/Grit in Maintenance/') # Specify path to the folder on your machine
d = read_xlsx('Grit in Maintenance (combined).xlsx') %>%
  rowwise() %>%
  mutate(Interest = 6 - mean(c(Q1, Q3, Q5, Q6)),
    Effort = mean(c(Q2, Q4, Q7, Q8)),
    Grit = mean(c(Interest, Effort)),
    Experience_30 = Years >= 30,
    Experience_20 = Years >= 20,
    Experience_10 = Years >= 10) %>%
  ungroup() %>%
  rename(Retention = Q9,
    Satisfaction = Q10)

colSums(is.na(d)) # checking missing values

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#####
# Plots #
#####

# Grit
ggplot(d) +
  aes(Grit) +
  geom_histogram(fill = 'darkblue', color = 'yellow', bins = 10) +
  labs (title = 'Distribution of Grit')

# Interest
ggplot(d) +
  aes(Interest) +
  geom_histogram(fill = 'darkblue', color = 'yellow', bins = 10) +
  labs (title = 'Distribution of Interest')

# Effort
ggplot(d) +
  aes(Effort) +
  geom_histogram(fill = 'darkblue', color = 'yellow', bins = 10) +
  labs (title = 'Distribution of Effort')

# Effort by Leadership
ggplot(d %>% filter(!is.na(Leadership))) +
  aes(Leadership, Effort) +
  geom_boxplot(fill = 'orange', color = 'black') +
  labs(title = 'Effort by Leadership') +
  scale_x_discrete(labels = c('No', 'Yes'))

# Interest by Leadership
ggplot(d %>% filter(!is.na(Leadership))) +
  aes(Leadership, Interest) +
  geom_boxplot(fill = 'orange', color = 'black') +
  labs(title = 'Interest by Leadership') +
  scale_x_discrete(labels = c('No', 'Yes'))

# Effort by Experience_20
ggplot(d) +
  aes(Experience_20, Effort) +
  geom_boxplot(fill = 'darkorange', color = 'black') +
  labs(title = 'Effort by Experience_20') +
  scale_x_discrete(labels = c('< 20 years', '20+ years'))

# Interest by Experience_20
ggplot(d) +
  aes(Experience_20, Interest) +
  geom_boxplot(fill = 'darkorange', color = 'black') +
  labs(title = 'Interest by Experience_20') +
  scale_x_discrete(labels = c('< 20 years', '20+ years'))

# Interest against Retention
ggplot(d) +
  aes(Interest, Retention) +
  stat_summary() +
  labs(title = 'Retention by level of Interest')

# Effort against Job Satisfaction
ggplot(d) +
  aes(Effort, Satisfaction) +
  stat_summary() +
  labs(title = 'Job Satisfaction by level of Effort')

#####
# Descriptives #
#####
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table(d$Leadership)
table(d$Experience_20)

sapply(d[c('Grit', 'Interest', 'Effort')], function(x) {
  c(
    Mean = mean(x),
    SD = sd(x),
    Minimum = min(x),
    Q1 = quantile(x, 0.25)[[1]],
    Median = median(x),
    Q3 = quantile(x, 0.75)[[1]],
    Maximum = max(x)
  )
}) %>%
  round(2) %>%
  t()

#####
# Main tests #
#####

# Leadership
leveneTest(Interest ~ Leadership, d) # testing if variance between groups is equal
t.test(Interest ~ Leadership, d, var.equal = F, alternative = 'less') # no visible effect

leveneTest(Effort ~ Leadership, d)
t.test(Effort ~ Leadership, d, var.equal = T, alternative = 'less') # clear effect
wilcox.test(Effort ~ Leadership, d, var.equal = T, alternative = 'less')

# 20+ years of Experience_20
leveneTest(Interest ~ Experience_20, d)
t.test(Interest ~ Experience_20, d %>% filter(Years < 75), var.equal = F, alternative =
'less') # clear effect

leveneTest(Effort ~ Experience_20, d)
t.test(Effort ~ Experience_20, d %>% filter(Years < 75), var.equal = T, alternative =
'less') # no visible effect
wilcox.test(Effort ~ Experience_20, d, var.equal = T, alternative = 'less')

t.test(Effort ~ Experience_10, d %>% filter(Years < 75), var.equal = T, alternative =
'less')
wilcox.test(Effort ~ Experience_10, d, var.equal = T, alternative = 'less')

t.test(Effort ~ Experience_30, d %>% filter(Years < 75), var.equal = T, alternative =
'less')
wilcox.test(Effort ~ Experience_30, d, var.equal = T, alternative = 'less')

# Retention
cor.test(d$Interest, d$Retention, alternative = 'greater', method = 'spearman') # no
correlation
cor.test(d[d$Interest >= 1.5,]$Interest, d[d$Interest >= 1.5,]$Retention, alternative =
'greater') # correlated when interest >= 1.5

# Job satisfaction
cor.test(d$Effort, d$Satisfaction, alternative = 'greater') # absolutely clear correlation

#####
# Additional tests #
#####

# Effects of technical strengths

lm(Interest ~ Mechanical + Construction + Electrical + Automation + Reliability +
  Years + Leadership, d) %>% summary()

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lm(Effort ~ Mechanical + Construction + Electrical + Automation + Reliability +
  Years + Leadership, d) %>% summary()

lm(Grit ~ Mechanical + Construction + Electrical + Automation + Reliability +
  Years + Leadership, d) %>% summary()

categories = d %>%
  pivot_longer(cols = c('Mechanical', 'Construction', 'Electrical', 'Automation',
    'Reliability'), names_to = 'Category', values_to = 'Value') %>%
  filter(Value == TRUE) %>%
  group_by(Category) %>%
  summarise(Grit = mean(Grit),
    Interest = mean(Interest),
    Effort = mean(Effort))

ggplot(categories) +
  aes(x = Category, y = Interest) +
  geom_bar(stat = 'identity', fill = 'midnightblue') +
  labs(
    title = 'Average Interest for people with certain technical strength',
    x = 'Technical strength',
    y = 'Average Interest'
  )

ggplot(categories) +
  aes(x = Category, y = Effort) +
  geom_bar(stat = 'identity', fill = 'midnightblue') +
  labs(
    title = 'Average Effort for people with certain technical strength',
    x = 'Technical strength',
    y = 'Average Effort'
  )

ggplot(categories) +
  aes(x = Category, y = Grit) +
  geom_bar(stat = 'identity', fill = 'midnightblue') +
  labs(
    title = 'Average Grit for people with certain technical strength',
    x = 'Technical strength',
    y = 'Average Grit'
  )

# Years intervals

ggplot(d) +
  aes(Years, Interest) +
  geom_jitter(width=.1, height=.1, color = 'midnightblue', alpha = .7) +
  xlim(c(0,60)) +
  labs(title = 'Relationship of Interest and Years of Experience_20')

ggplot(d) +
  aes(Years, Effort) +
  geom_jitter(width=.1, height=.1, color = 'midnightblue', alpha = .7) +
  xlim(c(0,60)) +
  labs(title = 'Relationship of Effort and Years of Experience_20')

ggplot(d) +
  aes(Years, Grit) +
  geom_jitter(width=.1, height=.1, color = 'midnightblue', alpha = .7) +
  xlim(c(0,60))

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