library(dplyr)

library(lavaan)

library(lavaanPlot)

library(lavaan)

# (ISTAT, 2023)

path <- file.choose()

datiR\_2023 <- read.delim(path, header = TRUE, stringsAsFactors = FALSE, check.names = FALSE)

avq\_clean <- datiR\_2023 %>%

mutate(across(c(TRAF, PARCH ,ILLSTR, CRIM),

~ ifelse(. == 5, NA, .)))

avq\_clean[c("FARMA", "PRSOC", "UFFPO", "POLICE", "UFFCOM", "MERCAT", "SMERC")] <-

lapply(avq\_clean[c("FARMA", "PRSOC", "UFFPO", "POLICE", "UFFCOM", "MERCAT", "SMERC")],

function(x) ifelse(x == 4, 0, 4 - x))

invert\_then\_normalize <- function(x) {

if (all(is.na(x))) return(rep(NA, length(x)))

inv\_x <- max(x, na.rm = TRUE) - x

rng <- range(inv\_x, na.rm = TRUE)

(inv\_x - rng[1]) / diff(rng)

}

avq\_scaled <- avq\_clean %>%

mutate(across(

c(

COLLEG, COLCO, COLCOM,

FRCMT, PUNMT, SEDMT, VELMT, PULMT, ATTMT, ORAMT, CBMT, INFMT,

FRTRE, PUTRE, PSTRE, VETRE, PULSTR, COMAT, COMORA, COBIG, INFTR,

FCORS, PUNT, POSSE, VELCO, PULIZ, COMOF, COMOR , CPSBI , SITE ),

invert\_then\_normalize,

.names = "norm\_inv\_{col}"

))

invert\_then\_normalize <- function(x, min\_val = 1, max\_val = 5) {

if (all(is.na(x))) return(rep(NA, length(x)))

x\_inv <- max\_val + min\_val - x

(x\_inv - min(x\_inv, na.rm = TRUE)) / (max(x\_inv, na.rm = TRUE) - min(x\_inv, na.rm = TRUE))

}

avq\_scaled <- avq\_scaled %>%

mutate(across(

c("RISEC"),

~invert\_then\_normalize(.x, min\_val = 1, max\_val = 5),

.names = "norm\_inv\_{col}"

))

invert\_then\_normalize <- function(x, min\_val = 1, max\_val = 6) {

if (all(is.na(x))) return(rep(NA, length(x)))

x\_inv <- max\_val + min\_val - x

(x\_inv - min(x\_inv, na.rm = TRUE)) / (max(x\_inv, na.rm = TRUE) - min(x\_inv, na.rm = TRUE))

}

avq\_scaled <- avq\_scaled %>%

mutate(across(

c("SF9", "SF15"),

~invert\_then\_normalize(.x, min\_val = 1, max\_val = 6),

.names = "norm\_inv\_{col}"

))

normalize <- function(x) {

rng <- range(x, na.rm = TRUE)

(x - rng[1]) / diff(rng)

}

avq\_scaled <- avq\_scaled %>%

mutate(across(c(PUNTIFI10, SF11, SF13, SF14, PUNTIFI8, PUNTIFI1, ILLSTR, CRIM, TRAF, PARCH,FARMA, PRSOC, UFFPO, POLICE, UFFCOM, MERCAT, SMERC ),

normalize, .names = "norm\_{col}"))

avq\_scaled$Connection <- rowMeans(avq\_scaled[, c( "norm\_inv\_COLLEG", "norm\_inv\_COLCO", "norm\_inv\_COLCOM")], na.rm = TRUE)

avq\_scaled$IND\_CLEAN <- rowMeans(avq\_scaled[, c("norm\_inv\_PULIZ", "norm\_inv\_PULMT", "norm\_inv\_PULSTR")], na.rm = TRUE)

avq\_scaled$IND\_SPEED <- rowMeans(avq\_scaled[, c("norm\_inv\_VELCO", "norm\_inv\_VELMT", "norm\_inv\_VETRE")], na.rm = TRUE)

avq\_scaled$IND\_PUNCTUALITY <- rowMeans(avq\_scaled[, c("norm\_inv\_PUNT", "norm\_inv\_PUNMT", "norm\_inv\_PUTRE")], na.rm = TRUE)

avq\_scaled$IND\_SEATS <- rowMeans(avq\_scaled[, c("norm\_inv\_POSSE", "norm\_inv\_SEDMT", "norm\_inv\_PSTRE")], na.rm = TRUE)

avq\_scaled$IND\_WAITING <- rowMeans(avq\_scaled[, c("norm\_inv\_COMOF", "norm\_inv\_ATTMT", "norm\_inv\_COMAT")], na.rm = TRUE)

avq\_scaled$IND\_TIME <- rowMeans(avq\_scaled[, c("norm\_inv\_COMOR", "norm\_inv\_ORAMT", "norm\_inv\_COMORA")], na.rm = TRUE)

avq\_scaled$IND\_COST <- rowMeans(avq\_scaled[, c("norm\_inv\_CPSBI", "norm\_inv\_CBMT", "norm\_inv\_COBIG")], na.rm = TRUE)

rename\_vec <- c(

WAITING = "IND\_WAITING",

SPEED = "IND\_SPEED",

SEATS = "IND\_SEATS",

TIME = "IND\_TIME",

COST = "IND\_COST",

PUNCTUALITY = "IND\_PUNCTUALITY",

CLEAN = "IND\_CLEAN",

CONNECTION = "Connection",

CONGESTION = "norm\_TRAF",

PARKING = "norm\_PARCH",

TRUST3 = "norm\_PUNTIFI10",

TRUST1 = "norm\_PUNTIFI1",

TRUST2 = "norm\_PUNTIFI8",

AFFORDABILITY1 = "norm\_inv\_RISEC",

AFFORDABILITY2 = "norm\_inv\_SITE",

HAPPINESS = "norm\_inv\_SF15",

RELAX = "norm\_inv\_SF9",

SADNESS = "norm\_SF11",

AGITATION = "norm\_SF13",

DESPONDENCY = "norm\_SF14",

HEALTH = "norm\_PRSOC",

SECURITY = "norm\_POLICE",

ADMINISTRATION = "norm\_UFFCOM",

FOOD = "norm\_SMERC"

)

avq\_scaled\_renamed <- avq\_scaled %>%

rename(!!!rename\_vec)

# CORRELATION (whalley, na)

vars\_cor <- avq\_scaled\_renamed %>% select(WAITING,SPEED ,SEATS ,TIME, COST ,PUNCTUALITY , CLEAN ,

CONNECTION, CONGESTION , PARKING, TRUST3 , TRUST1 ,

TRUST2, AFFORDABILITY1, AFFORDABILITY2, RELAX , SADNESS , AGITATION , DESPONDENCY , HAPPINESS

, HEALTH , SECURITY , ADMINISTRATION , FOOD

)

corr\_res\_spearman <- psych::corr.test(vars\_cor, use = "pairwise", method = "spearman")

print(corr\_res\_spearman$r)

print(corr\_res\_spearman$p)

# NORMALITY (Hallquist, 2017)

print(psych::describe(vars\_cor)[, c("skew", "kurtosis")])

# CRONBACH ALPHA (RPUBS, na)

alpha\_sets <- list(

Perceived\_accessibility = avq\_scaled\_renamed %>% select(WAITING , SPEED , SEATS , TIME , COST , PUNCTUALITY , CLEAN , CONNECTION),

Affordability = avq\_scaled\_renamed %>% select(AFFORDABILITY2, AFFORDABILITY1 ),

viability = avq\_scaled\_renamed %>% select(CONGESTION, PARKING),

Administration = avq\_scaled\_renamed %>% select(TRUST3, TRUST1, TRUST2),

health = avq\_scaled\_renamed %>% select(HAPPINESS , RELAX , SADNESS , AGITATION , DESPONDENCY),

Accessibility = avq\_scaled\_renamed %>% select(HEALTH , SECURITY , ADMINISTRATION , FOOD)

)

alphas <- lapply(alpha\_sets, psych::alpha)

alpha\_results <- lapply(alphas, function(a) a$total$raw\_alpha)

print(alpha\_results)

# COMPOSITE RELIABILITY E AVE (JORGENSEN, 2015)

model\_measurement <- '

Perceived\_accessibility =~ WAITING + SPEED + SEATS + TIME + COST + PUNCTUALITY + CLEAN + CONNECTION

Viability =~ CONGESTION + PARKING

Accessibility =~ HEALTH + SECURITY + ADMINISTRATION + FOOD

Administration =~ TRUST3 + TRUST1 + TRUST2

Affordability =~ AFFORDABILITY1 + AFFORDABILITY2

health =~ HAPPINESS + RELAX + SADNESS + AGITATION + DESPONDENCY

'

fit\_measurement <- sem(model\_measurement, data = avq\_scaled\_renamed, missing = "fiml")

library(semTools)

compRelSEM(fit\_measurement)

AVE(fit\_measurement)

#VIF (Bhale and Harpreet, 2024)

vars <- c(vars <- c("WAITING", "SPEED", "SEATS", "TIME", "COST", "PUNCTUALITY", "CLEAN", "CONNECTION", "CONGESTION", "PARKING", "TRUST3", "TRUST1", "TRUST2", "AFFORDABILITY1", "AFFORDABILITY2",

"HAPPINESS" ,"RELAX" , "SADNESS" , "AGITATION" , "DESPONDENCY" , "HEALTH" , "SECURITY" , "ADMINISTRATION" , "FOOD" )

)

calc\_all\_vif <- function(data, variables) {

vif\_results <- numeric(length(variables))

names(vif\_results) <- variables

for (var in variables) {

predictors <- setdiff(variables, var)

formula <- as.formula(paste(var, "~", paste(predictors, collapse = " + ")))

lm\_model <- lm(formula, data = data)

r2 <- summary(lm\_model)$r.squared

vif\_results[var] <- 1 / (1 - r2)

}

return(vif\_results)

}

vif\_all <- calc\_all\_vif(avq\_scaled\_renamed, vars)

print(vif\_all)

# SEM MODEL (OARC stats, 2025; Lavaan.org, 2025)

model\_new <- '

Perceived\_accessibility =~ WAITING + SPEED + SEATS + TIME + COST + PUNCTUALITY + CLEAN + CONNECTION

Viability =~ CONGESTION + PARKING

Accessibility =~ HEALTH + SECURITY + ADMINISTRATION + FOOD

Administration =~ TRUST3 + TRUST1 + TRUST2

Affordability =~ AFFORDABILITY1 + AFFORDABILITY2

health =~ HAPPINESS + RELAX + SADNESS + AGITATION + DESPONDENCY

Perceived\_accessibility ~ Administration + health + Accessibility + Affordability + Viability

'

fit <- sem(model\_new, data = avq\_scaled\_renamed, missing = "fiml")

summary(fit, standardized = TRUE, fit.measures = TRUE)

fitMeasures(fit)

# Plot (Lishinski, 2024)

lavaanPlot(model = fit,

node\_options = list(shape = "box", fontname = "Helvetica", fontsize = 14),

edge\_options = list(color = "black", lty = 1, lwd = 1.5),

coefs = TRUE,

stand = FALSE)

#R-Squared (RDRR.IO, na)

r2\_values <- inspect(fit, "r2")

print(r2\_values)

#other measures (STATISTIKA, 2025)

cfi <- fitMeasures(fit, "cfi")

df\_model <- fitMeasures(fit, "df")

df\_baseline <- fitMeasures(fit, "baseline.df")

print(cfi)

print(df\_model)

print(df\_baseline)

pcfi <- cfi \* (df\_model / df\_baseline)

pcfi

# List of references

# BHALE, U. A., and Harpreet S. B. 2024. What is mean by Multicollinearity in SEM?

#URL: https://www.researchgate.net/publication/377691806

# JORGENSEN, T. D., 2015. SemTools: Useful Tools for Structural Equation Modeling.

#URL: https://cran.r-project.org/web/packages/semTools/semTools.pdf

#HALLQUIST. 2017. Best practices in SEM PSY 597.

#URL: https://psu-psychology.github.io/psy-597-SEM/12\_best\_practices/best\_practices.html

#ISTAT. 2025. Aspetti della vita quotidiana, 2023.

#URL: https://www.istat.it/microdati/aspetti-della-vita-quotidiana/

# LAVAAN:ORG. 2025. Extracting information.

#URL: https://lavaan.ugent.be/tutorial/inspect.html

#LISHINSKI, A., 2024. Intro to lavaanPlot.

#URL: https://cran.r-project.org/web/packages/lavaanPlot/vignettes/Intro\_to\_lavaanPlot.html

# OARC stats. 2025. Introduction to Structural Equation Modeling (SEM) in R with lavaan. #URL:https://stats.oarc.ucla.edu/r/seminars/rsem/

#RDDR. LavInspect: Inspect or extract information from a fitted lavaan object.

#URL: https://rdrr.io/cran/lavaan/man/lavInspect.html

#RPUBS. Reliability analysis.

#URL: https://rpubs.com/hauselin/reliabilityanalysis

# STATISTIKA. 2025. How to interpret SEM model fit results in AMOS.

# UNIVERSITY OF FLORIDA. Spearman correlation in R.

#URL: https://users.phhp.ufl.edu/marsiske/r/AnalyzeCorrelateSpearman.html

# WHALLEY, B., Correlation.

#URL: https://benwhalley.github.io/just-enough-r/correlations.html