Çok Kriterli Karar Verme Yöntemi Olarak Bulut Endeksi (BE)'nin R'da Fonksiyonu ve Grafiği

Tevfik Bulut

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Yüklenen Kütüphaneler

```
kütüphane<-c("dplyr","tibble","tidyr","ggplot2","ggthemes", "kableExtra",
             "forcats", "readxl", "openxlsx", "report", "citation", "pander")
yükle<-sapply(kütüphane, require, character.only = TRUE, warn.conflicts = FALSE)

#Kütüphane yüklenme durumunu gösteren tablo

tibble(Sıra=1:length(kütüphane), Kütüphane=names(yükle),
       Durumu=as.logical(yükle)) %>%
mutate(Durumu=if_else(Durumu==TRUE, "Yüklendi", "Paket Kurulumu Gerekli")) %>%
pander(split.cell = 10, split.table = Inf, justify="left")
```

Sıra	Kütüphane	Durumu
1	dplyr	Yüklendi
2	tibble	Yüklendi
3	tidyr	Yüklendi
4	ggplot2	Yüklendi
5	ggthemes	Yüklendi
6	kableExtra	Yüklendi
7	forcats	Yüklendi
8	readxl	Yüklendi
9	openxlsx	Yüklendi
10	report	Yüklendi
11	citation	Yüklendi
12	pander	Yüklendi

Karar Matrsinin Okunması

```
km <- read_excel("km.xlsx") # Karar matrisi veri seti
ky <- c("min","max",rep("min",4),rep("max",3)) #kriterlerin yönü
ka <- c(rep(1/nrow(km), nrow(km))) #kriter ağırlıkları. Burada eşit alınmıştır.
#Dilerseniz farklı ağırlık düzeyleri belirleyebilirsiniz.
```

Bulut Endeksi (BE) Fonksiyonu

```
bi = function(km=as.matrix(km), ky=ky, ka=ka){
                  colnames(km)=paste("A", 1:ncol(km), sep="") #alternatifler
                  rownames(km)=paste("K", 1:nrow(km), sep="") #kriterler
                  #karar matrisinin oluşturulması
                  km2 <-km
                  ky1=ifelse(ky=="max", 1, 0)
                  ky2=ky1

                  #2. aşama
                  for (r in 1:nrow(km))
                      for (c in 1:ncol(km))
                          if (ky1[r]==1)
                          {
                                km2[r,c] <- km[r,c]-apply(km[r,], 1, max)
                          } else

                          {
                                km2[r,c] <- apply(km[r,], 1, min)-km[r,c]
                          }
                rownames(km2)=paste("K", 1:nrow(km), sep="") #kriterler
                #3. aşama
                ort=apply(km2,1,mean) # 3. aşama
                ss=apply(km2,1,sd) # 3. aşama
                nd=(km2-ort)/ss # 3. aşama

                #4. aşama
                md=nd+abs(apply(nd, 1, min))
                m_new<-md
                #5. aşama
                   for (i in 1:nrow(md))
                          if (ky2[i] == 0)
                          {
                              o <- order(md[i,], decreasing = T)
                              r <- order(md[i,], decreasing = F)
                              m_new[i,o] <- md[i,r]
                          }

                         else
                        {

                       md

                        }

                  rownames(m_new)=paste("K", 1:nrow(md), sep="") #kriterler

                  #5. aşama
                    wdm=as.matrix(m_new*ka) #ağırlıklandırılmış karar matrisi
                  erd=as.matrix(apply(wdm, 1, max))
                  rownames(erd)=paste("K", 1:nrow(km), sep="")
                  colnames(erd)=paste("Endeks Referans Değerleri")
```

```r
                  sis=as.matrix(apply(wdm,2, sum))
                  colnames(sis)=c("Sınıf İçi Skor")
                  be=as.matrix((sis/sum(erd))*100)
                  k=as.matrix(be[order(be[,1],decreasing=T),])
                  sira=as.matrix(1:nrow(be))
                  be=as.matrix(cbind(k, sira))
                  colnames(be)=c("BE", "Sıra")

                  liste=list(Karar_Matrisi=as.matrix(km), Asama_2=as.matrix(km2)
                         , Asama_3=as.matrix(nd), Asama_4=as.matrix(md),
                         Asama_5=as.matrix(m_new), ERD=erd,  Sınıf_Skoru=sis,
                         Bulut_Endeksi=be)
                    return(liste)
}

bi(km=km, ky=ky, ka=ka)
```

```
## $Karar_Matrisi
##      A1   A2   A3   A4   A5
## K1 -157  407 -936 -673 -512
## K2 -878  580 -546   36 -524
## K3  123  508  704  883 -896
## K4  -96  362  917  214  753
## K5 -396 -593   40  273  465
## K6 -266 -118 -501  820  546
## K7  282  585  243 -758  389
## K8  956  990  769 -833 -597
## K9 -879  645 -359 -245  553
##
## $Asama_2
##       A1    A2    A3    A4    A5
## K1  -779 -1343     0  -263  -424
## K2 -1458     0 -1126  -544 -1104
## K3 -1019 -1404 -1600 -1779     0
## K4     0  -458 -1013  -310  -849
## K5  -197     0  -633  -866 -1058
## K6  -235  -383     0 -1321 -1047
## K7  -303     0  -342 -1343  -196
## K8   -34     0  -221 -1823 -1587
## K9 -1524     0 -1004  -890   -92
##
## $Asama_3
##            A1         A2         A3         A4         A5
## K1 -0.4177428 -1.5024891  1.0805151  0.5746848  0.2650320
## K2 -1.0620764  1.4698193 -0.4855405  0.5251339 -0.4473363
## K3  0.1998810 -0.3443495 -0.6214122 -0.8744441  1.6403248
## K4  1.2857466  0.1662182 -1.1904155  0.5279872 -0.7895364
## K5  0.7951491  1.2378975 -0.1847407 -0.7083974 -1.1399085
## K6  0.6453661  0.3816604  1.0640878 -1.2896631 -0.8014513
## K7  0.2555107  0.8341337  0.1810345 -1.7305219  0.4598429
## K8  0.7808411  0.8188219  0.5719466 -1.2176206 -0.9539890
## K9 -1.2732577  1.0873806 -0.4677905 -0.2912073  0.9448749
##
```

```
## $Asama_4
##          A1        A2        A3        A4        A5
## K1 1.084746 0.0000000 2.5830042 2.0771739 1.7675211
## K2 0.000000 2.5318957 0.5765359 1.5872103 0.6147401
## K3 1.074325 0.5300946 0.2530318 0.0000000 2.5147689
## K4 2.476162 1.3566337 0.0000000 1.7184027 0.4008792
## K5 1.935058 2.3778061 0.9551678 0.4315111 0.0000000
## K6 1.935029 1.6713235 2.3537509 0.0000000 0.4882118
## K7 1.986033 2.5646557 1.9115564 0.0000000 2.1903649
## K8 1.998462 2.0364425 1.7895672 0.0000000 0.2636316
## K9 0.000000 2.3606383 0.8054671 0.9820503 2.2181326
##
## $Asama_5
##           A1        A2        A3        A4        A5
## K1 2.0771739 2.5830042 0.0000000 1.0847464 1.7675211
## K2 0.0000000 2.5318957 0.5765359 1.5872103 0.6147401
## K3 0.2530318 0.5300946 1.0743251 2.5147689 0.0000000
## K4 0.0000000 1.3566337 2.4761621 0.4008792 1.7184027
## K5 0.4315111 0.0000000 0.9551678 1.9350577 2.3778061
## K6 0.4882118 1.6713235 0.0000000 2.3537509 1.9350291
## K7 1.9860327 2.5646557 1.9115564 0.0000000 2.1903649
## K8 1.9984617 2.0364425 1.7895672 0.0000000 0.2636316
## K9 0.0000000 2.3606383 0.8054671 0.9820503 2.2181326
##
## $ERD
##    Endeks Referans Değerleri
## K1                 0.2870005
## K2                 0.2813217
## K3                 0.2794188
## K4                 0.2751291
## K5                 0.2642007
## K6                 0.2615279
## K7                 0.2849617
## K8                 0.2262714
## K9                 0.2622931
##
## $Sınıf_Skoru
##    Sınıf İçi Skor
## A1      0.8038248
## A2      1.7371876
## A3      1.0654202
## A4      1.2064960
## A5      1.4539587
##
## $Bulut_Endeksi
##          BE Sıra
## A2 71.72163    1
## A5 60.02823    2
## A4 49.81147    3
## A3 43.98700    4
## A1 33.18676    5
```

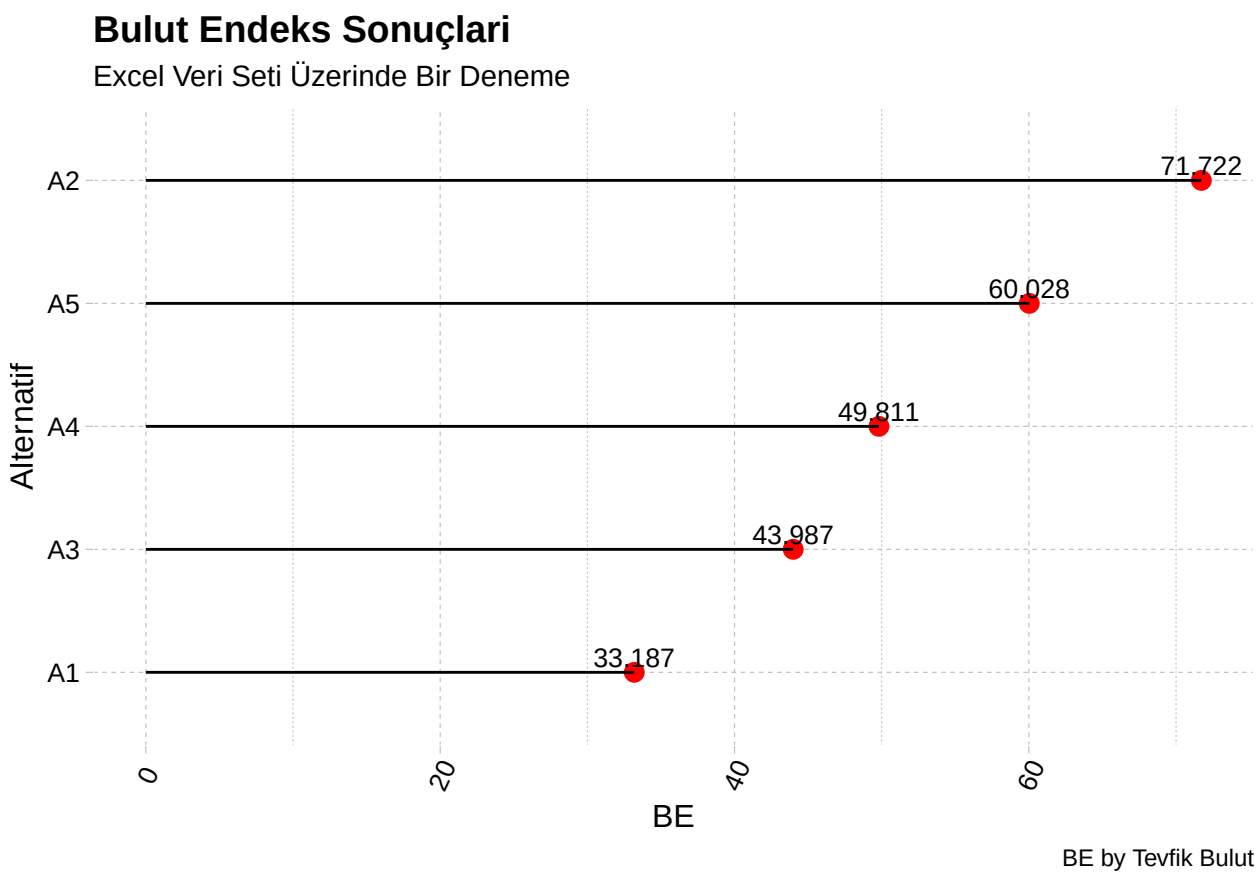
Sonuçların xlsx Uzantılı Microsoft Excel Çalışma Kitabına Yazdırılması

```
y=bi(km=km, ky=ky, ka=ka)

cikti <- list('Karar Matrisi' = y$Karar_Matrisi, '2. Aşama Matrisi' = y$Asama_2,
              '3.Aşama Matrisi' = y$Asama_3, '4.Aşama Matrisi' = y$Asama_4,
              'Endeks Referans Değerleri' = y$ERD,
              'Sınıf İçi Skor' = y$Sınıf_Skoru,
              'Bulut Endeks' = y$Bulut_Endeksi)
baslik_stili <- createStyle(
  textDecoration = "BOLD", fontColour = "#FFFFFF", fontSize = 12,
  fontName = "Arial Narrow", fgFill = "#4F80BD", halign = "center")
#elde edilen sonuçları "sonuçlar.xlsx" excel çalışma kitabına yazdırılması
write.xlsx(cikti, file = 'bi_sonuclar.xlsx', asTable = FALSE, overwrite = TRUE,
           rowNames = TRUE, borders = "rows", headerStyle = baslik_stili,
           colWidths="auto", Widths="auto")
```

Sonuçların Görselleştirilmesi

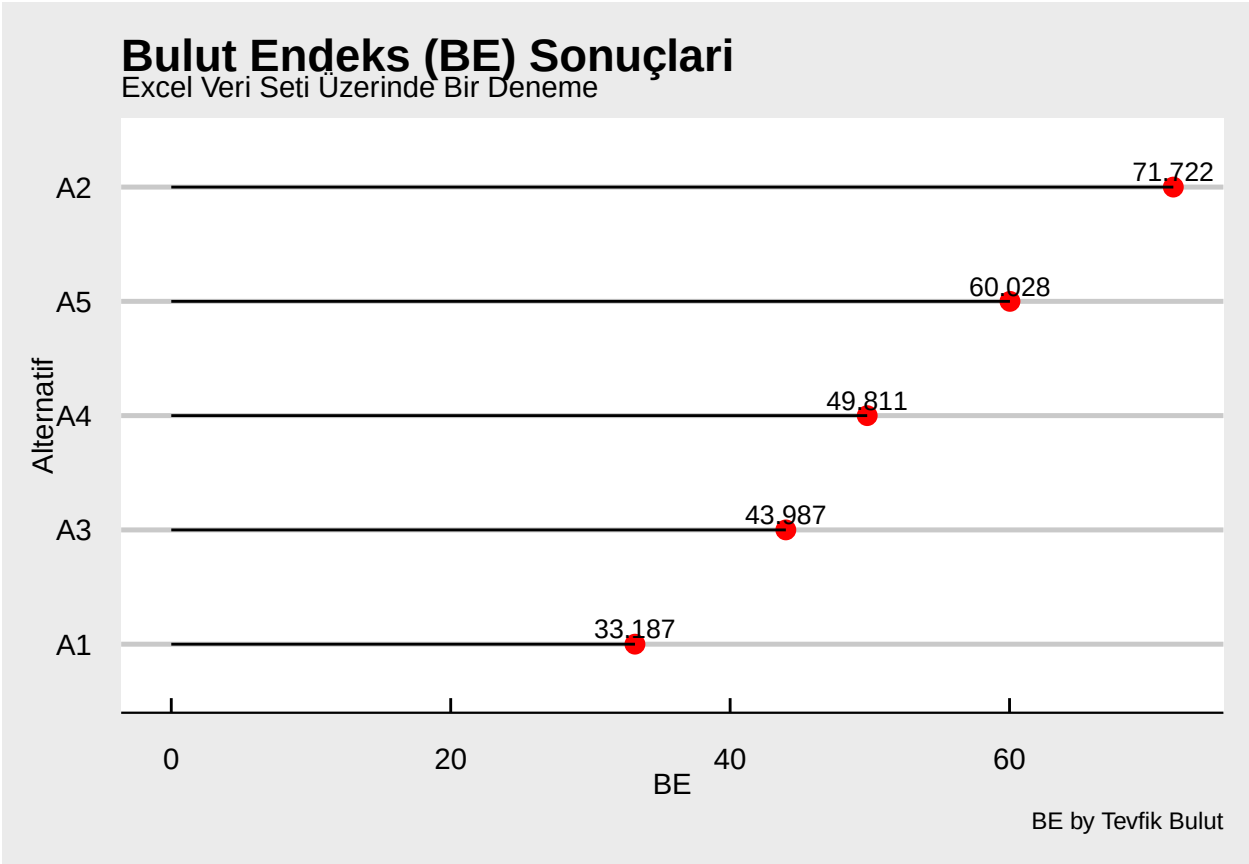
```
a=y$Bulut_Endeksi
tibble(Alternatif=c(row.names(a)), BE=round(a[,1],3)) %>%
mutate(Alternatif = fct_reorder(Alternatif, BE)) %>%
ggplot(aes(x=Alternatif, y=BE)) +
  geom_point(size=3, color="red") +
  geom_segment(aes(x=Alternatif,
                   xend=Alternatif,
                   y=0,
                   yend=BE)) +
  geom_text(aes(label=BE), vjust=-0.3, size=3.5)+
  labs(title="Bulut Endeks Sonuçları",
       subtitle="Excel Veri Seti Üzerinde Bir Deneme",
       caption="BE by Tevfik Bulut")+
       ylab("BE")+
       xlab("Alternatif")+
  theme(axis.text.x = element_text(angle=65, vjust=0.6))+
  coord_flip() +
  theme_pander()
```




```
#geom_hline(yintercept = erd, color="red")
```

Sonuçların Görselleştirilmesi II

```
a=y$Bulut_Endeksi
#erd=y$ERD*100
tibble(Alternatif=c(row.names(a)), BE=round(a[,1],3)) %>%
mutate(Alternatif = fct_reorder(Alternatif, BE)) %>%
ggplot(aes(x=Alternatif, y=BE)) +
  geom_point(size=3, color="red") +
  geom_segment(aes(x=Alternatif,
                   xend=Alternatif,
                   y=0,
                   yend=BE)) +
  geom_text(aes(label=BE), vjust=-0.3, size=3.5)+
  labs(title="Bulut Endeks (BE) Sonuçları",
       subtitle="Excel Veri Seti Üzerinde Bir Deneme",
       caption="BE by Tevfik Bulut")+
       ylab("BE")+
       xlab("Alternatif")+
  theme(axis.text.x = element_text(angle=65, vjust=0.6))+
  coord_flip() +
  theme_economist_white()
```

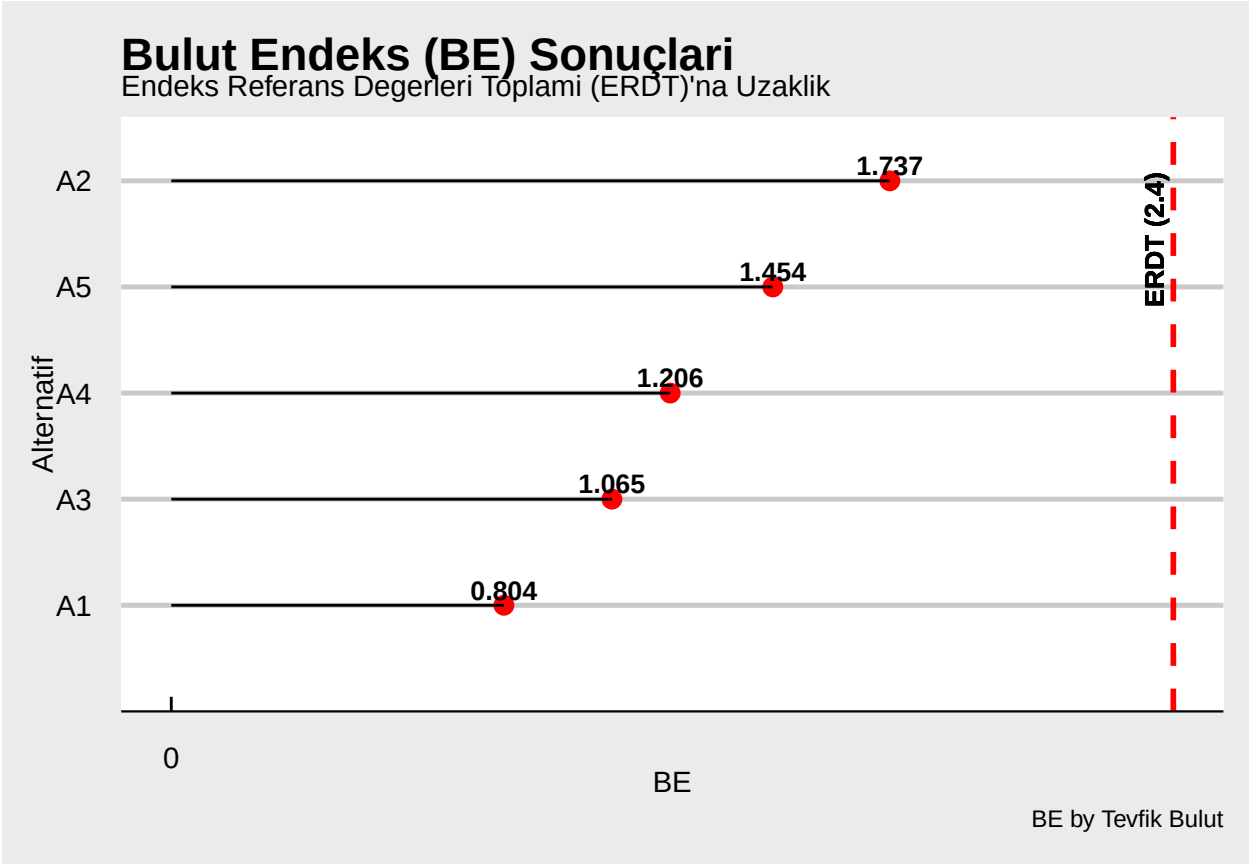


ERD (Endeks Referans Değerleri) Toplamına Uzaklık

```
a=y$Sınıf_Skoru

erd=sum(y$ERD)
tibble(Alternatif=c(row.names(a)), Uzaklik=round(a[,1],3)) %>%
mutate(Alternatif = fct_reorder(Alternatif, Uzaklik)) %>%
ggplot(aes(x=Alternatif, y=Uzaklik)) +
  geom_point(size=3, color="red") +
  geom_segment(aes(x=Alternatif,
                   xend=Alternatif,
                   y=0,
                   yend=Uzaklik)) +
  geom_text(aes(label=Uzaklik), vjust=-0.3, size=3.5, fontface = "bold")+
  labs(title="Bulut Endeks (BE) Sonuçları",
       subtitle="Endeks Referans Değerleri Toplamı (ERDT)'na Uzaklık",
       caption="BE by Tevfik Bulut")+
       ylab("BE")+
       xlab("Alternatif")+
  theme(axis.text.x = element_text(angle=65, vjust=0.6))+
  coord_flip() +
  theme_economist_white()+
  geom_hline(yintercept = erd, color="red", linetype = 2, size = 1)+
  scale_y_continuous(breaks = seq(0, erd, by = 5))+
```

```
geom_text(aes(0, erd, label=paste ("ERDT (",round(erd,1), ")", sep=""),
              hjust=-3, vjust=-0.5, angle = 90, fontface = "bold"), size=3.5)
```



Yararlanılan Kütüphaneler

ID	Referanslar
[1]	Dietrich J, Leoncio W (2022). *citation: Software Citation Tools*. Rpackage version 0.6.2.
[2]	Gergely Daróczi and Roman Tsegelskyi (2022). pander: An R 'Pandoc' Writer. R package version 0.6.5. https://CRAN.R-project.org/package=pander
[3]	H. Wickham. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York, 2016.
[4]	Hadley Wickham (2021). forcats: Tools for Working with Categorical Variables (Factors). R package version 0.5.1. https://CRAN.R-project.org/package=forcats
[5]	Hadley Wickham and Jennifer Bryan (2022). readxl: Read Excel Files. R package version 1.4.0. https://CRAN.R-project.org/package=readxl
[6]	Hadley Wickham and Maximilian Girlich (2022). tidyr: Tidy Messy Data. R package version 1.2.0. https://CRAN.R-project.org/package=tidyr
[7]	Hadley Wickham, Romain François, Lionel Henry and Kirill Müller (2022). dplyr: A Grammar of Data Manipulation. R package version 1.0.9. https://CRAN.R-project.org/package=dplyr
[8]	Hao Zhu (2021). kableExtra: Construct Complex Table with 'kable' and Pipe Syntax. R package version 1.3.4. https://CRAN.R-project.org/package=kableExtra
[9]	Jeffrey B. Arnold (2021). ggthemes: Extra Themes, Scales and Geoms for 'ggplot2'. R package version 4.2.4. https://CRAN.R-project.org/package=ggthemes
[10]	Kirill Müller and Hadley Wickham (2022). tibble: Simple Data Frames. R package version 3.1.7. https://CRAN.R-project.org/package=tibble

ID	Referanslar
[11]	Makowski, D., Ben-Shachar, M.S., Patil, I. & Lüdecke, D. (2020). Automated Results Reporting as a Practical Tool to Improve Reproducibility and Methodological Best Practices Adoption. CRAN. Available from https://github.com/easystats/report. doi: .
[12]	Philipp Schauberger and Alexander Walker (2021). openxlsx: Read, Write and Edit xlsx Files. R package version 4.2.5. https://CRAN.R-project.org/package=openxlsx
[13]	R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.