Mini Project on Advanced Statistics

1. Is there evidence of Multi-Collinearity?
2. Perform Factor Analysis by extracting four factors.
3. Name the Factors
4. Perform Multiple Linear Regression with Customer Satisfaction as the dependent variable and the four factors as the independent variables. Comment on Model Validity.

The below code explains the Multi-Collinearity.

```
> mydata=read.csv("Factor-Hair-Revised (1).csv")
> attach(mydata)
> mydata
```

ID ProdQual Ecom TechSup CompRes Advertising ProdLine SalesFImage

ID	ProdQual	Ecom	TechSup	CompRes	Advertising	ProdLine	SalesFImage
1 1	8.5	3.9	2.5	5.9	4.8	4.9	6.0
2 2	8.2	2.7	5.1	7.2	3.4	7.9	3.1
3 3	9.2	3.4	5.6	5.6	5.4	7.4	5.8
4 4	6.4	3.3	7.0	3.7	4.7	4.7	4.5
5 5	9.0	3.4	5.2	4.6	2.2	6.0	4.5
6 6	6.5	2.8	3.1	4.1	4.0	4.3	3.7
7 7	6.9	3.7	5.0	2.6	2.1	2.3	5.4
8 8	6.2	3.3	3.9	4.8	4.6	3.6	5.1
9 9	5.8	3.6	5.1	6.7	3.7	5.9	5.8
10 10	6.4	4.5	5.1	6.1	4.7	5.7	5.7
11 11	8.7	3.2	4.6	4.8	2.7	6.8	4.6
12 12	6.1	4.9	6.3	3.9	4.4	3.9	6.4
13 13	9.5	5.6	4.6	6.9	5.0	6.9	6.6
14 14	9.2	3.9	5.7	5.5	2.4	8.4	4.8
15 15	6.3	4.5	4.7	6.9	4.5	6.8	5.9
16 16	8.7	3.2	4.0	6.8	3.2	7.8	3.8
17 17	5.7	4.0	6.7	6.0	3.3	5.5	5.1
18 18	5.9	4.1	5.5	7.2	3.5	6.4	5.5

19	19	5.6	3.4	5.1	6.4	3.7	5.7	5.6
20	20	9.1	4.5	3.6	6.4	5.3	5.3	7.1
21	21	5.2	3.8	7.1	5.2	3.9	4.3	5.0
22	22	9.6	5.7	6.8	5.9	5.4	8.3	7.8
23	23	8.6	3.6	7.4	5.1	3.5	7.3	4.7
24	24	9.3	2.4	2.6	7.2	2.2	7.2	4.5
25	25	6.0	4.1	5.3	4.7	3.5	5.3	5.3
26	26	6.4	3.6	6.6	6.1	4.0	3.9	5.3
27	27	8.5	3.0	7.2	5.8	4.1	7.6	3.7
28	28	7.0	3.3	5.4	5.5	2.6	4.8	4.2
29	29	8.5	3.0	5.7	6.0	2.3	7.6	3.7
30	30	7.6	3.6	3.0	4.0	5.1	4.2	4.6
31	31	6.9	3.4	8.5	4.3	4.5	6.4	4.7
32	32	8.1	2.5	7.2	4.5	2.3	5.1	3.8
33	33	6.7	3.7	6.5	5.3	5.3	5.1	4.9
34	34	8.0	3.3	6.1	5.7	5.5	4.6	4.7
35	35	6.7	4.0	5.2	3.9	3.0	5.4	6.8
36	36	8.7	3.2	6.1	4.3	3.5	6.1	2.9
37	37	9.0	3.4	5.9	4.6	3.9	6.0	4.5
38	38	9.6	4.1	6.2	7.3	2.9	7.7	5.5
39	39	8.2	3.6	3.9	6.2	5.8	4.9	5.0
40	40	6.1	4.9	3.0	4.8	5.1	3.9	6.4
41	41	8.3	3.4	3.3	5.5	3.1	4.6	5.2
42	42	9.4	3.8	4.7	5.4	3.8	6.5	4.9
43	43	9.3	5.1	4.6	6.8	5.8	6.6	6.3
44	44	5.1	5.1	6.6	6.9	4.4	5.4	7.8
45	45	8.0	2.5	4.7	7.1	3.6	7.7	3.0
46	46	5.9	4.1	5.7	5.9	5.8	6.4	5.5
47	47	10.0	4.3	7.1	6.3	2.9	5.4	4.5
48	48	5.7	3.8	6.8	7.5	5.7	5.7	6.0
49	49	9.9	3.7	3.7	6.1	4.2	7.0	6.7
50	50	7.9	3.9	4.3	5.8	4.4	6.9	5.8
51	51	6.7	3.6	5.9	4.2	3.4	4.7	4.8
52	52	8.2	2.7	3.7	7.4	2.7	7.9	3.1
53	53	9.4	2.5	4.8	6.1	3.2	7.3	4.6
54	54	6.9	3.4	5.7	4.4	3.3	6.4	4.7
55	55	8.0	3.3	3.8	5.8	3.2	4.6	4.7

56 56	9.3	3.8	7.3	5.7	3.7	6.4	5.5
57 57	7.4	5.1	4.8	7.7	4.5	7.2	6.9
58 58	7.6	3.6	5.2	5.8	5.6	6.6	5.4
59 59	10.0	4.3	5.3	3.7	4.2	5.4	4.5
60 60	9.9	2.8	7.2	6.9	2.6	5.8	3.5
61 61	8.7	3.2	8.4	6.1	2.8	7.8	3.8
62 62	8.4	3.8	6.7	5.0	4.5	4.7	5.9
63 63	8.8	3.9	3.8	5.1	4.3	4.7	4.8
64 64	7.7	2.2	6.3	4.5	2.4	4.7	3.4
65 65	6.6	3.6	5.8	4.1	4.9	4.7	4.8
66 66	5.7	3.8	3.5	6.7	5.4	5.7	6.0
67 67	5.7	4.0	7.9	6.4	2.7	5.5	5.1
68 68	5.5	3.7	4.7	5.4	4.3	5.3	4.9
69 69	7.5	3.5	3.8	3.5	2.9	4.1	4.5
70 70	6.4	3.6	2.7	5.3	3.9	3.9	5.3
71 71	9.1	4.5	6.1	5.9	6.3	5.3	7.1
72 72	6.7	3.2	3.0	3.7	4.8	6.3	4.5
73 73	6.5	4.3	2.7	6.6	6.5	6.3	6.0
74 74	9.9	3.7	7.5	4.7	5.6	7.0	6.7
75 75	8.5	3.9	5.3	5.5	5.0	4.9	6.0
76 76	9.9	3.0	6.8	5.0	5.4	5.9	4.8

	ComPricing	WartyClaim	OrdBilling	DelSpeed	Satisfaction
1	6.8	4.7	5.0	3.7	8.2
2	5.3	5.5	3.9	4.9	5.7
3	4.5	6.2	5.4	4.5	8.9
4	8.8	7.0	4.3	3.0	4.8
5	6.8	6.1	4.5	3.5	7.1
6	8.5	5.1	3.6	3.3	4.7
7	8.9	4.8	2.1	2.0	5.7
8	6.9	5.4	4.3	3.7	6.3
9	9.3	5.9	4.4	4.6	7.0
10	8.4	5.4	4.1	4.4	5.5
11	6.8	5.8	3.8	4.0	7.4
12	8.2	5.8	3.0	3.2	6.0
13	7.6	6.5	5.1	4.4	8.4
14	7.1	6.7	4.5	4.2	7.6
15	8.8	6.0	4.8	5.2	8.0

16	4.9	6.1	4.3	4.5	6.6
17	6.2	6.7	4.2	4.5	6.4
18	8.4	6.2	5.7	4.8	7.4
19	9.1	5.4	5.0	4.5	6.8
20	8.4	5.8	4.5	4.4	7.6
21	8.4	7.1	3.3	3.3	5.4
22	4.5	6.4	4.3	4.3	9.9
23	3.7	6.7	4.8	4.0	7.0
24	6.2	6.4	6.7	4.5	8.6
25	8.0	6.5	4.7	4.0	4.8
26	7.1	6.1	5.6	3.9	6.6
27	4.8	6.9	5.3	4.4	6.3
28	9.0	6.5	4.3	3.7	5.4
29	4.8	5.8	5.7	4.4	6.3
30	7.7	4.9	4.7	3.5	5.4
31	5.2	7.7	3.7	3.3	6.1
32	6.6	6.8	3.0	3.0	6.4
33	9.2	5.7	3.5	3.4	5.4
34	8.7	5.9	4.7	4.2	7.3
35	8.4	6.2	2.5	3.5	6.3
36	5.6	6.1	3.1	2.5	5.4
37	6.8	6.4	3.9	3.5	7.1
38	7.7	6.1	5.2	4.9	8.7
39	9.0	5.2	4.7	4.5	7.6
40	8.2	5.1	4.5	3.2	6.0
41	9.1	4.1	4.6	3.9	7.0
42	8.5	4.9	4.1	4.1	7.6
43	7.4	5.1	4.6	4.3	8.9
44	5.9	7.2	4.9	4.5	7.6
45	5.2	5.1	4.3	4.7	5.5
46	8.4	6.4	5.2	4.8	7.4
47	3.8	6.7	5.0	3.5	7.1
48	8.2	6.6	6.5	5.2	7.6
49	6.8	5.9	4.5	3.9	8.7
50	4.7	5.2	4.1	4.3	8.6
51	7.2	5.7	4.0	2.8	5.4
52	5.3	5.3	4.5	4.9	5.7

53	6.3	6.3	4.7	4.6	8.7
54	5.2	6.4	3.2	3.3	6.1
55	8.7	5.3	4.9	4.2	7.3
56	7.4	6.6	4.1	3.4	7.7
57	9.6	6.4	5.7	5.5	9.0
58	4.4	6.7	4.6	4.0	8.2
59	3.8	6.7	3.7	3.5	7.1
60	5.4	6.2	5.6	4.0	7.9
61	4.9	7.2	5.4	4.5	6.6
62	6.7	5.1	2.7	3.6	8.0
63	5.8	5.0	4.4	2.9	6.3
64	6.2	6.0	3.3	2.6	6.0
65	7.2	6.5	3.5	2.8	5.4
66	8.2	5.4	4.7	5.2	7.6
67	6.2	7.5	5.0	4.5	6.4
68	6.0	5.6	4.5	4.3	6.1
69	7.6	5.1	4.0	3.4	5.2
70	7.1	5.2	4.7	3.9	6.6
71	8.4	7.1	5.4	4.4	7.6
72	5.0	5.2	2.9	3.1	5.8
73	8.7	4.7	4.6	4.6	7.9
74	6.8	7.2	4.1	3.9	8.6
75	6.8	5.7	4.4	3.7	8.2
76	4.9	7.3	3.1	3.8	7.1

```
 [ reached 'max' / getOption("max.print") -- omitted 24 rows ]
> names(mydata)
 [1] "ID"         "ProdQual"    "Ecom"        "TechSup"
 [5] "CompRes"     "Advertising" "ProdLine"    "SalesFImage"
 [9] "ComPricing"  "WartyClaim"  "OrdBilling"  "DelSpeed"
[13] "Satisfaction"
> cor(mydata[,2:13])
          ProdQual         Ecom    TechSup  CompRes
ProdQual    1.00000000 -0.1371632174  0.0956004542
0.1063700
Ecom       -0.13716322  1.0000000000  0.0008667887
0.1401793
```

```
TechSup       0.09560045  0.0008667887  1.0000000000
0.0966566
CompRes       0.10637000  0.1401792611  0.0966565978
1.0000000
Advertising  -0.05347313  0.4298907110 -0.0628700668
0.1969168
ProdLine      0.47749341 -0.0526878383  0.1926254565
0.5614170
SalesFImage  -0.15181287  0.7915437115  0.0169905395
0.2297518
ComPricing   -0.40128188  0.2294624014 -0.2707866821 -
0.1279543
WartyClaim    0.08831231  0.0518981915  0.7971679258
0.1404083
OrdBilling    0.10430307  0.1561473316  0.0801018246
0.7568686
DelSpeed      0.02771800  0.1916360683  0.0254406935
0.8650917
Satisfaction  0.48632500  0.2827450147  0.1125971788
0.6032626
             Advertising    ProdLine SalesFImage  ComPricing
ProdQual     -0.05347313  0.47749341 -0.15181287 -
0.40128188
Ecom          0.42989071 -0.05268784  0.79154371
0.22946240
TechSup      -0.06287007  0.19262546  0.01699054 -
0.27078668
CompRes       0.19691685  0.56141695  0.22975176 -
0.12795425
Advertising   1.00000000 -0.01155082  0.54220366
0.13421689
ProdLine     -0.01155082  1.00000000 -0.06131553 -
0.49494840
SalesFImage   0.54220366 -0.06131553  1.00000000
0.26459655
ComPricing    0.13421689 -0.49494840  0.26459655
1.00000000
```

```
WartyClaim    0.01079207  0.27307753  0.10745534 -
0.24498605
OrdBilling    0.18423559  0.42440825  0.19512741 -
0.11456703
DelSpeed      0.27586308  0.60185021  0.27155126 -
0.07287173
Satisfaction  0.30466947  0.55054594  0.50020531 -
0.20829569
              WartyClaim  OrdBilling   DelSpeed Satisfaction
ProdQual      0.08831231  0.10430307  0.02771800
0.4863250
Ecom          0.05189819  0.15614733  0.19163607    0.2827450
TechSup       0.79716793  0.08010182  0.02544069
0.1125972
CompRes       0.14040830  0.75686859  0.86509170
0.6032626
Advertising   0.01079207  0.18423559  0.27586308
0.3046695
ProdLine      0.27307753  0.42440825  0.60185021
0.5505459
SalesFImage   0.10745534  0.19512741  0.27155126
0.5002053
ComPricing   -0.24498605 -0.11456703 -0.07287173   -
0.2082957
WartyClaim    1.00000000  0.19706512  0.10939460
0.1775448
OrdBilling    0.19706512  1.00000000  0.75100307
0.5217319
DelSpeed      0.10939460  0.75100307  1.00000000
0.5770423
Satisfaction  0.17754482  0.52173191  0.57704227
1.0000000
> Model1=lm(Satisfaction~ProdQual)
> summary(Model1)

Call:
lm(formula = Satisfaction ~ ProdQual)
```

Residuals:
```
    Min      1Q   Median      3Q      Max
-1.88746 -0.72711 -0.01577  0.85641  2.25220
```

Coefficients:
```
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.67593    0.59765   6.151 1.68e-08 ***
ProdQual     0.41512    0.07534   5.510 2.90e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 1.047 on 98 degrees of freedom
Multiple R-squared: 0.2365,   Adjusted R-squared: 0.2287
F-statistic: 30.36 on 1 and 98 DF, p-value: 2.901e-07

```
> Model2=lm(Satisfaction~ComPricing)
> summary(Model2)
```

Call:
lm(formula = Satisfaction ~ ComPricing)

Residuals:
```
   Min     1Q  Median     3Q     Max
-1.9728 -0.9915 -0.1156  0.9111  2.5845
```

Coefficients:
```
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  8.03856    0.54427  14.769  <2e-16 ***
ComPricing  -0.16068    0.07621  -2.108  0.0376 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 1.172 on 98 degrees of freedom
Multiple R-squared: 0.04339, Adjusted R-squared: 0.03363
F-statistic: 4.445 on 1 and 98 DF, p-value: 0.03756

```
> Model3=lm(Satisfaction~DelSpeed)
> summary(Model3)

Call:
lm(formula = Satisfaction ~ DelSpeed)

Residuals:
    Min      1Q   Median      3Q      Max
-2.22475 -0.54846  0.08796  0.54462  2.59432

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   3.2791     0.5294   6.194 1.38e-08 ***
DelSpeed      0.9364     0.1339   6.994 3.30e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9783 on 98 degrees of freedom
Multiple R-squared:  0.333,    Adjusted R-squared:  0.3262
F-statistic: 48.92 on 1 and 98 DF,  p-value: 3.3e-10

> summary(Model4)
Error in summary(Model4) : object 'Model4' not found
> summary(Model4)
Error in summary(Model4) : object 'Model4' not found
> Model4=lm(Satisfaction~SalesFImage)
> summary(Model4)

Call:
lm(formula = Satisfaction ~ SalesFImage)

Residuals:
   Min      1Q   Median      3Q      Max
-2.2164 -0.5884  0.1838  0.6922  2.0728

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
```

(Intercept) 4.06983   0.50874   8.000 2.54e-12 ***
SalesFImage 0.55596   0.09722   5.719 1.16e-07 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.037 on 98 degrees of freedom
Multiple R-squared: 0.2502,   Adjusted R-squared: 0.2426
F-statistic: 32.7 on 1 and 98 DF, p-value: 1.164e-07

Coefficients:
          Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.36141   0.67403 -2.020   0.0462 *
ProdQual   0.43316   0.04718 9.180 9.35e-15 ***
ComPricing -0.07985   0.04413 -1.809   0.0735 .
DelSpeed   0.68545   0.08632 7.941 4.00e-12 ***
SalesFImage 0.54454   0.06122 8.895 3.81e-14 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5996 on 95 degrees of freedom
Multiple R-squared: 0.7572,   Adjusted R-squared: 0.7469
F-statistic: 74.05 on 4 and 95 DF, p-value: < 2.2e-16.

3.The four factors are
1.ProdQal- Product Quality.
2.ComPricing-Competitive Pricing
3.Delspeed – Delivery Speed
4.salesFimage. - Salesforce Image

4.**Multiple Linear Regression**

Regression <- lm(Satisfaction~
ProdQual+ComPricing+DelSpeed+SalesFImage)
> summary(Regression)

Call:
lm(formula = Satisfaction ~ ProdQual + ComPricing +
DelSpeed +
    SalesFImage)

Residuals:
    Min   1Q   Median   3Q   Max
-1.52588 -0.35985 0.08988 0.32283 1.40827

Coefficients:
          Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.36141   0.67403 -2.020   0.0462 *
ProdQual   0.43316   0.04718   9.180 9.35e-15 ***
ComPricing -0.07985   0.04413 -1.809   0.0735 .
DelSpeed   0.68545   0.08632   7.941 4.00e-12 ***
SalesFImage 0.54454   0.06122   8.895 3.81e-14 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5996 on 95 degrees of freedom
Multiple R-squared: 0.7572,   Adjusted R-squared: 0.7469
F-statistic: 74.05 on 4 and 95 DF, p-value: < 2.2e-16.