Chp66-1. Evaluate the profit comparison of four e-commerce website designs A/B/C/D. Which sets of designs have significant differences in pairwise comparisons? (Using SPSS software for analysis)

(1). [Question]: What are the x and y variables in this analysis question?

	A	B	C
1	ID	設計樣式	消費金額
2	1	設計1	481
3	2	設計1	1476
4	3	設計1	854
5	4	設計1	617
6	5	設計1	1199
7	6	設計1	1324
8	7	設計1	1372
9	8	設計1	1448
10	9	設計1	1072
11	10	設計1	1689
12	11	設計1	700
13	12	設計1	897
14	13	設計1	800
15	14	設計1	1149
16	15	設計1	1360
17	16	設計1	1700
18	17	設計1	739
19	18	設計1	1189
20	19	設計1	1690
21	20	設計1	1316
22	21	設計1	1094

	A	B	C
1274	1273	設計4	1540
1275	1274	設計4	1410
1276	1275	設計4	1043
1277	1276	設計4	1602
1278	1277	設計4	1338
1279	1278	設計4	812
1280	1279	設計4	842
1281	1280	設計4	1172
1282	1281	設計4	1676
1283	1282	設計4	1042
1284	1283	設計4	851
1285	1284	設計4	1538
1286	1285	設計4	991
1287	1286	設計4	2122
1288	1287	設計4	1476
1289	1288	設計4	706
1290	1289	設計4	1245
1291	1290	設計4	1730
1292	1291	設計4	1316
1293	1292	設計4	1373
1294	1293	設計4	1015
1295	1294	設計4	924

(1). [Question]: What [statistical test] should be used to

discuss the pairwise differences between these data?

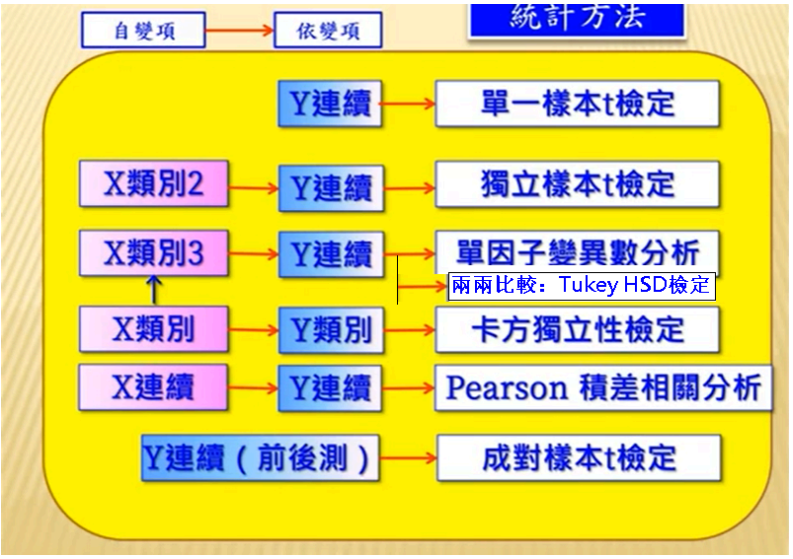
(1). Performing A/B/C/D multiple analysis requires 2 steps:

Step 1 Method: One-way ANOVA test (Assess whether there are overall differences?)

Step 2 Method: Tukey HSD test (Compare pairwise differences)

Because x is a four-category variable and y is a continuous numerical value

(Note: There is only one x factor, so it is called [One-way])



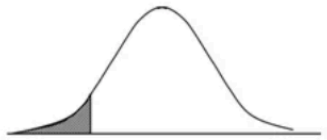
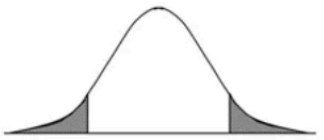
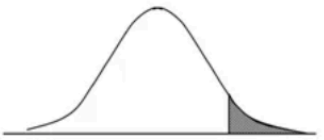
(2). What is a [post-hoc test]?

➜Step 1 [Analysis of Variance, ANOVA] must be performed first. If the results show that there is a significant difference between at least one set of means,

➜Step 2 [Multiple Comparisons, such as Tukey HSD] can then be performed to find out which sets have differences

➜[What is the Tukey HSD test?]: This is a "multiple comparison" method used to compare differences between multiple means.

(3). [Question]: Is this a [two-tailed test, a right-tailed test, or a left-tailed test]?

單尾檢定 （左尾）	雙尾檢定	單尾檢定 （右尾）
$H_0 : \mu = \mu_0$ $H_1 : \mu < \mu_0$	$H_0 : \mu = \mu_0$ $H_1 : \mu \neq \mu_0$	$H_0 : \mu = \mu_0$ $H_1 : \mu > \mu_0$
		

[Is there a difference in the average purchase amount for designs ABCD?], which belongs to a two-tailed test

(4-1). Step 1: One-way ANOVA (Assess whether there are overall differences?)'s 2 hypotheses:

➜The proposition of the question: Is there a difference in the profit comparison of the four website designs A/B/C/D?

➜Transformed into: Statistical hypothesis:

- **1. H0 Null Hypothesis (Hypothesis that negates the proposition)**
  - **μOriginal Design A = μDesign B = μDesign C = μDesign D**
- **2. H1 Alternative Hypothesis (Hypothesis that affirms the proposition)➜**
  - **At least two design styles have different average sales amounts**

➜[Note]: H0 Null Hypothesis/Negative Hypothesis: is the opposite of the proposition

➜[Note]: H1 Alternative Hypothesis/Affirmative Hypothesis: is the affirmation of the proposition

(4-2). Step 1: One-way ANOVA? (Assess whether there are overall differences?)

敘述統計

消費金額

	N	平均值	標準差	標準誤	平均值的 95% 信賴區間		最小值	最大值
					下限	上限		
設計樣式1	323	1236.93	345.433	19.220	1199.12	1274.75	171	2253
設計樣式2	325	1240.51	349.757	19.401	1202.34	1278.68	326	2388
設計樣式3	330	1330.21	347.091	19.107	1292.62	1367.79	305	2357
設計樣式4	325	1256.54	342.418	18.994	1219.17	1293.91	219	2139
總計	1303	1266.34	347.865	9.637	1247.43	1285.24	171	2388

變異數分析

消費金額

	平方和	自由度	均方	F	顯著性
群組之間	1873468.605	3	624489.535	5.211	.001
群組內	155681522.5	1299	119847.207		
總計	157554991.1	1302			

Significance p-value 0.01 < 0.05 Confidence level 0.05,

➜So it meets the H1 alternative hypothesis

➜H1 Alternative Hypothesis: There is a difference in the profit comparison of the four website designs A/B/C/D

➜H1 Alternative Hypothesis: At least two design styles have different average sales amounts

(4-3). Step 1 Conclusion:

1. [Conclusion 1]: These 4 website design methods have a significant impact on sales amount (at least two groups have significant differences) 2. [Conclusion 2]: Currently, it is only known that there are significant differences in the sales effects of at least 2 designs among these 4 website design methods, but who is with whom? (I don't know the influence relationship between the 4)

(5-1). Step 2: Tukey HSD test (Comparing pairwise differences, multiple comparisons)'s 2 hypotheses:

- 1. H0 Null Hypothesis (Hypothesis that negates the proposition)➜No difference between 2 groups
  - μDesign 1 = μDesign 2
- 2. H1 Alternative Hypothesis (Hypothesis that affirms the proposition)➜There is a difference between 2 groups
  - μDesign 1 ≠ μDesign 2

(5-2). Step 2: Tukey HSD test (Comparing pairwise differences, multiple comparisons):

事後檢定

多重比較

依變數: 消費金額

Tukey HSD

(I) 設計樣式	(J) 設計樣式	平均值差異 (I-J)	標準誤	顯著性	95% 信賴區間	
					下限	上限
設計樣式1	設計樣式2	-3.576	27.199	.999	-73.54	66.39
	設計樣式3	-93.274*	27.096	.003	-162.98	-23.57
	設計樣式4	-19.607	27.199	.889	-89.57	50.36
設計樣式2	設計樣式1	3.576	27.199	.999	-66.39	73.54
	設計樣式3	-89.698*	27.054	.005	-159.29	-20.11
	設計樣式4	-16.031	27.157	.935	-85.89	53.83
設計樣式3	設計樣式1	93.274*	27.096	.003	23.57	162.98
	設計樣式2	89.698*	27.054	.005	20.11	159.29
	設計樣式4	73.668*	27.054	.033	4.07	143.26
設計樣式4	設計樣式1	19.607	27.199	.889	-50.36	89.57
	設計樣式2	16.031	27.157	.935	-53.83	85.89
	設計樣式3	-73.668*	27.054	.033	-143.26	-4.07

※Look at [Significance p-value] 1. [For Design Style 1]➜See if the significance value is <0.05

➜[Only Design Style 3 has a p-value of 0.003 < 0.05]
➜Indicates [There is a significant difference in the effect between Design 1/3]
2. [For Design Style 2]➜See if the significance value is <0.05
➜[Only Design Style 3 has a p-value of 0.005 < 0.05]
➜Indicates [There is a significant difference in the effect between Design 2/3]
3. [For Design Style 3]➜See if the significance value is <0.05
➜[Only Design Style 3 has a p-value of 0.003 < 0.05]
➜Indicates [There is a significant difference in the effect between Design 3/1, 2, 4] 4. [For Design Style 4]➜See if the significance value is <0.05

➜[Only Design Style 3 has a p-value of 0.033 < 0.05]

➜Indicates [There is a significant difference in the effect between Design 4/3]

(5-3). Step 2 Conclusion:

1. [Conclusion 1]: For the original design [Design Style 1], The improved [3rd Design] is the most capable of increasing the [Sales Amount] to [93.274] yuan, which is the highest. The range of its increase (upper limit, lower limit) is [23.57～162.98]

多重比較

依變數: 消費金額

Tukey HSD

(I) 設計樣式	(J) 設計樣式	平均值差異 (I-J)	標準誤	顯著性	95% 信賴區間	
					下限	上限
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設計樣式3	設計樣式1	93.274*	27.096	.003	23.57	162.98
	設計樣式2	89.698*	27.054	.005	20.11	159.29
	設計樣式4	73.668*	27.054	.033	4.07	143.26

2. [Conclusion 2]: For the original design [Design Style 1], The improved [2nd, 4th Design] is not the best. Although it can increase the [Upper Limit, Lower Limit] of the [Sales Amount], it may be [Positive] or [Negative], so the improvement effect is not

significant (therefore p-value > 0.05)

(I) 設計樣式	(J) 設計樣式	平均值差異 (I-J)	標準誤	顯著性	95% 信賴區間	
					下限	上限
設計樣式1	設計樣式2	-3.576	27.199	.999	-73.54	66.39
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	設計樣式3	-89.698*	27.054	.005	-159.29	-20.11
	設計樣式4	-16.031	27.157	.935	-85.89	53.83

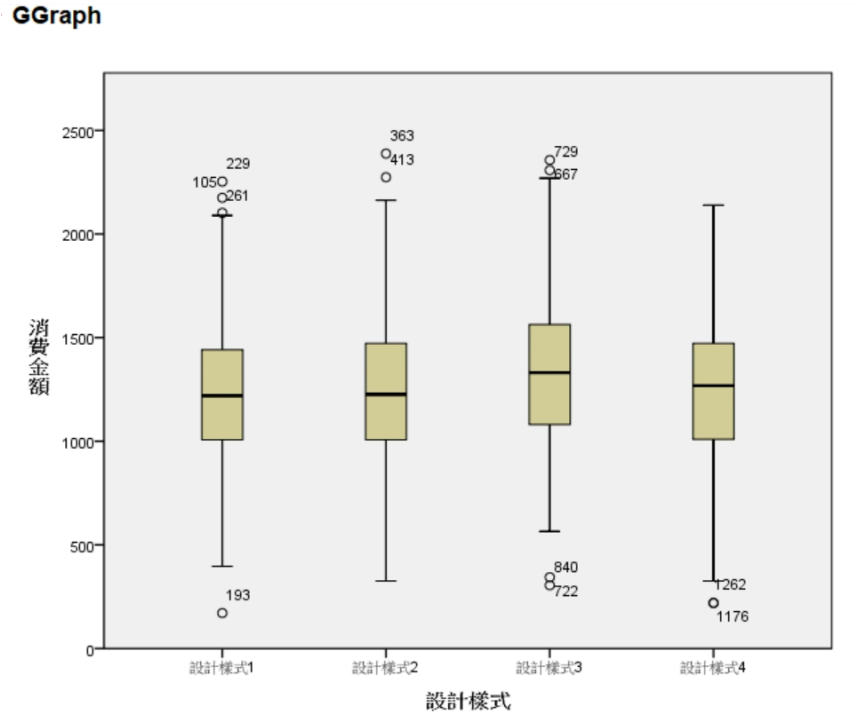
3. [Conclusion 3]: Use [tukey HSD test] to observe the [Upper Limit, Lower Limit, Average Difference] between the [Design Style 3 vs. Original Design Style 1] with the highest effect,
Let [Managers] know that the [Sales Amount can be increased by an average of 93.274] after modifying the design, so they can roughly calculate [How long it will take to recover the cost]

4. [Conclusion 4]: Use [tukey HSD test] to observe the [Upper Limit, Lower Limit, Average Difference] between the [Design Style 2, 4] vs. [Original Design Style 1] with the second highest effect. Although the average value has increased, the [Upper Limit, Lower Limit] oscillates between [Positive Value～Negative Value], so it cannot be guaranteed to increase the [Sales Amount], so it is not included in the design considerations (because p-value > 0.05)

5. [Conclusion 5]: Make a [Recommendation Table for A/B/C/D Plans]

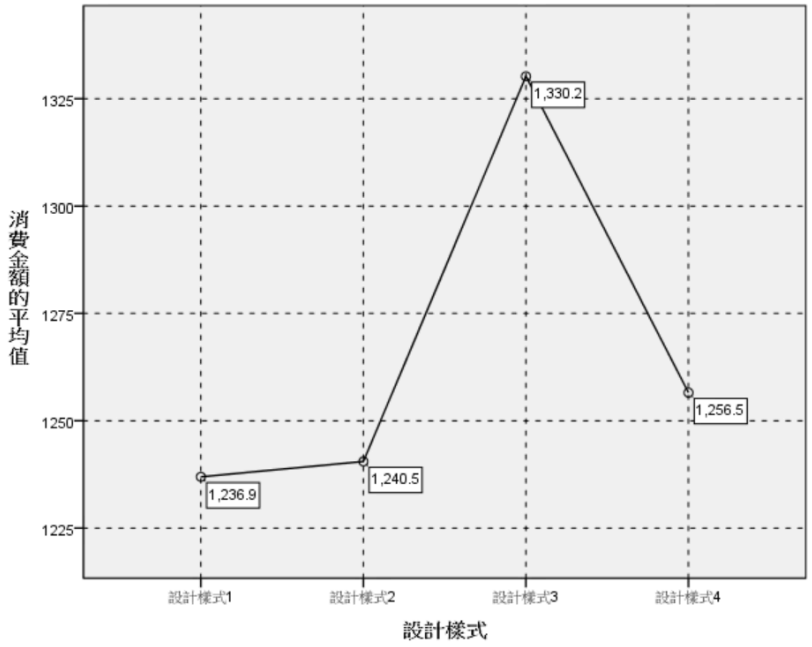
網站設計種類	平均銷售金額	建議採用順序
設計3	1330	1
設計4	1256	2
設計2	1240	3
設計1(原本設計)	1236	4

(6). [Drawing]: Box Plot



(7). [Drawing]: Line Chart

平均值圖形


消費金額的平均值
1325
1300
1275
1250
1225
1,330.2
1,256.5
1,240.5
1,236.9
設計樣式1
設計樣式2
設計樣式3
設計樣式4
設計樣式