Chp68-1. Evaluating Customer Dwell Time Comparison of Three E-commerce Ads A/B/C, Handling When Samples Do Not Conform to Normal Distribution (Using SPSS Software Analysis, Shapiro–Wilk Normality Test + Kruskal-Wallis Test)

(1). [Concept]: The complexity and difficulty of One-Way ANOVA: It has 3 basic assumption limitations

3 Basic Assumptions of One-Way ANOVA:

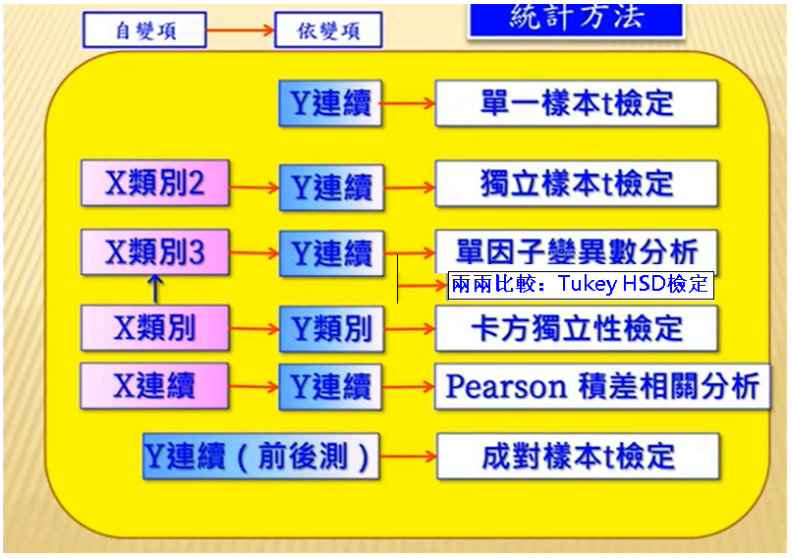
1. Each group of samples is independent

2. Each sample comes from a normally distributed population

3. The variances of each population are equal

(2). [Statistical Test Judgment Diagram]: Basic Diagram, Advanced Diagram

2-1 Basic Diagram



2-2 Advanced Diagram (Anova Test)

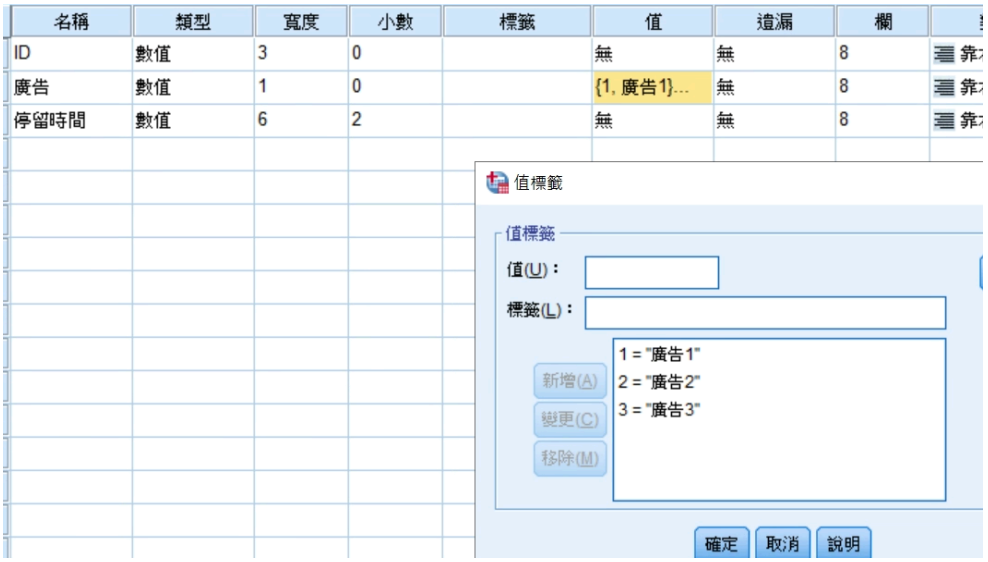
✅ 單因子變異數分析（One-Way ANOVA）檢定流程與事後檢定對照表

狀況	建議方法	事後檢定方式（Post Hoc Test）
母體 ≥ 3，常態分布、變異數相等	One-Way ANOVA	**Tukey HSD**（最常用）、Bonferroni、Scheffé
母體 ≥ 3，常態分布、變異數不等	Welch ANOVA	**Games-Howell**（適用變異數不齊）
母體 ≥ 3，非常態分布	Kruskal-Wallis Test	**Dunn's Test**（需 Bonferroni 或 Holm 校正）

(3). [SPSS Implementation]: So the first step in doing one-way ANOVA is to check: whether the samples conform to a normal distribution?

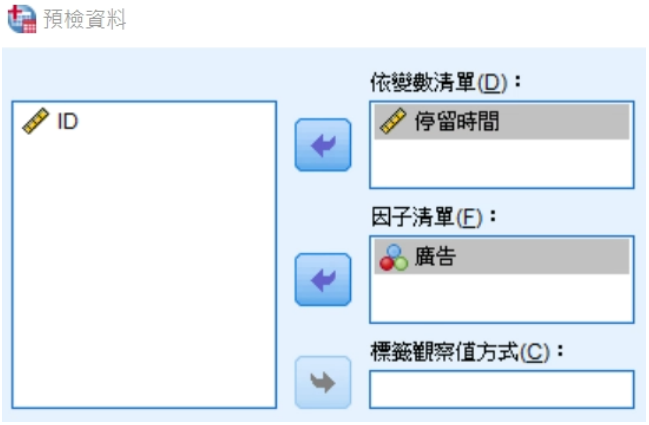
How to Perform Shapiro–Wilk Normality Test in SPSS

1. **Open SPSS and load the data**

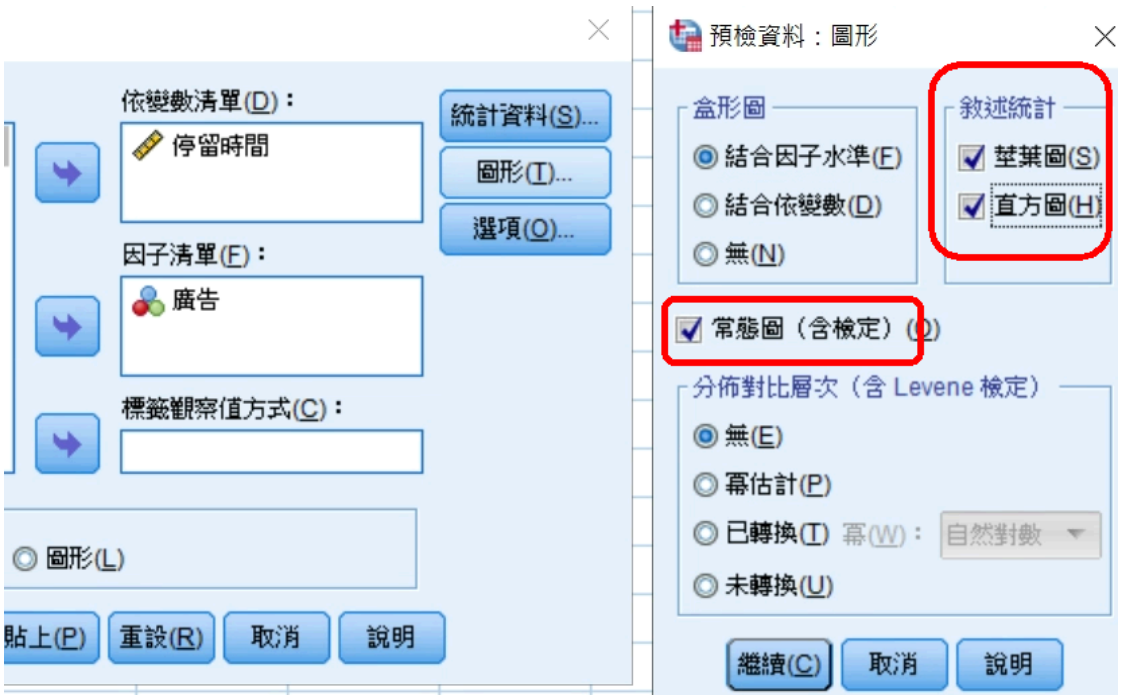


2. **Select the statistical test path**
    - Click Analyze → Descriptive Statistics → Explore.

3. **Set Variables**
    - In the Dependent List, select the numerical variable to be tested for normality.
    - In the Factor List, you can select a categorical variable (can be omitted).



4. **Enable Normality Test**
    - Click the Plots button.
    - On the Descriptive page, check Normality plots with tests.
    - **Ensure the Shapiro-Wilk test is included (**
    - **SPSS automatically calculates Shapiro-Wilk when the sample size is less than 50,**
    - **Kolmogorov-Smirnov test is provided when the sample size exceeds 50).**



How to Interpret the Results

- In the output Tests of Normality table:
  - **Shapiro–Wilk's p-value (Sig.)**
    - If p > 0.05, it means the data follows a normal distribution.
    - If p ≤ 0.05, it means the data significantly deviates from a normal distribution.

常態檢定

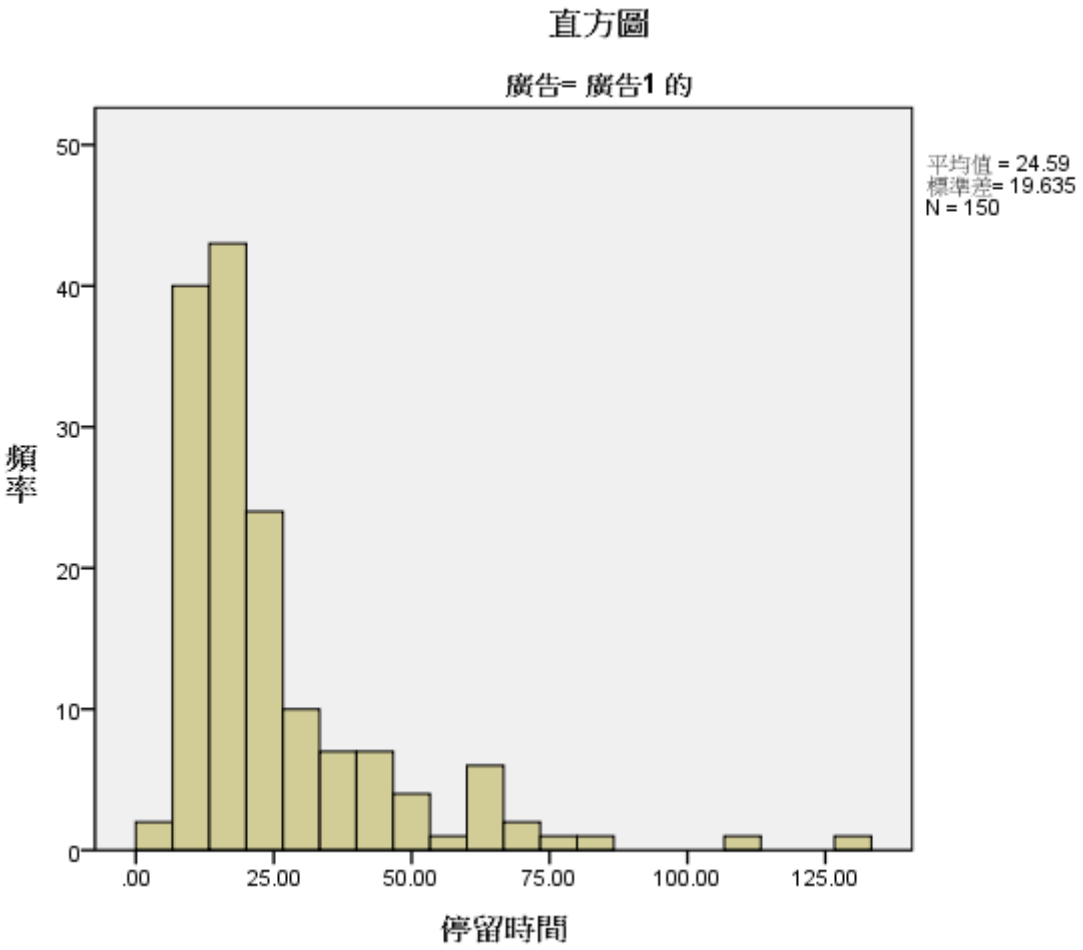
		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	廣告	統計量	自由度	顯著性	統計量	自由度	顯著性
停留時間	廣告1	.209	150	.000	.746	150	.000
	廣告2	.153	150	.000	.881	150	.000
	廣告3	.147	150	.000	.808	150	.000

a. Lilliefors 顯著性更正

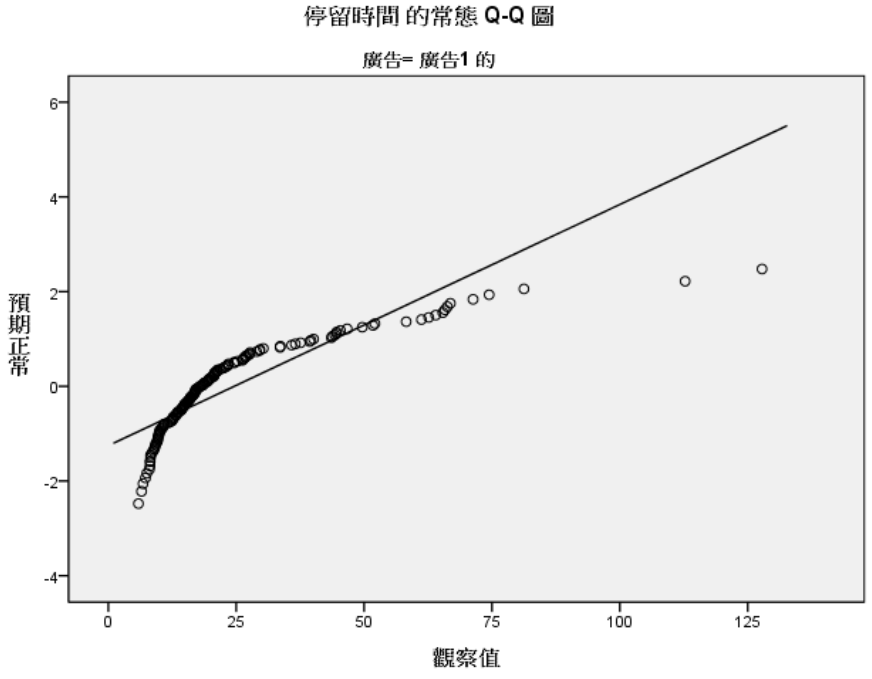
Conclusion: Because the sample size is 450, look at the [Kolmogorov-Smirnov Test]

Significance p-value 0 < 0.05, so it means that the data significantly deviates from the normal distribution

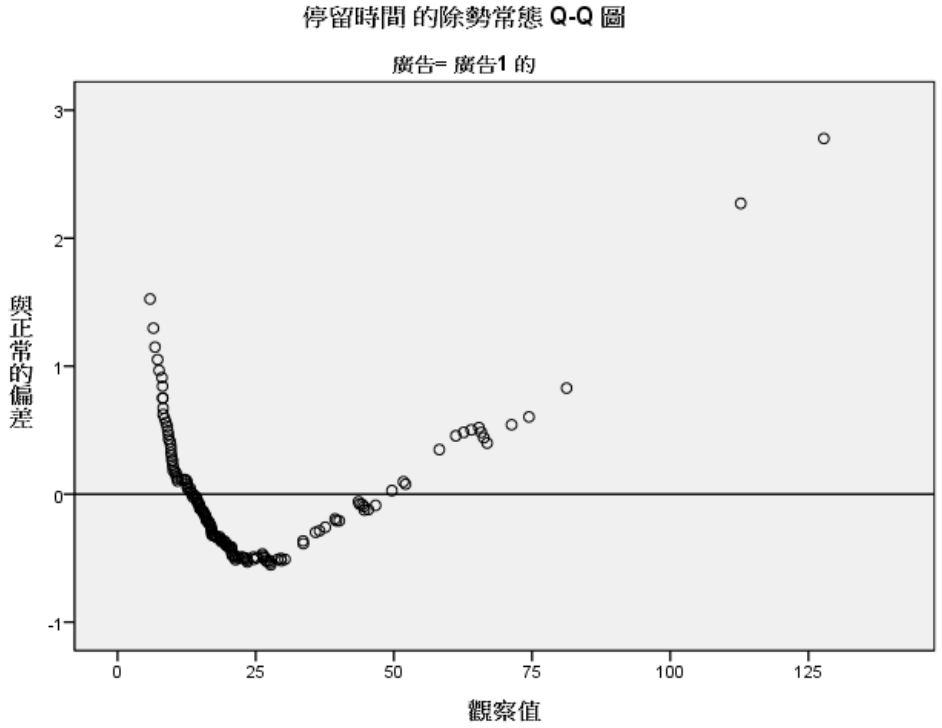
Graphical Proof 1: Histogram



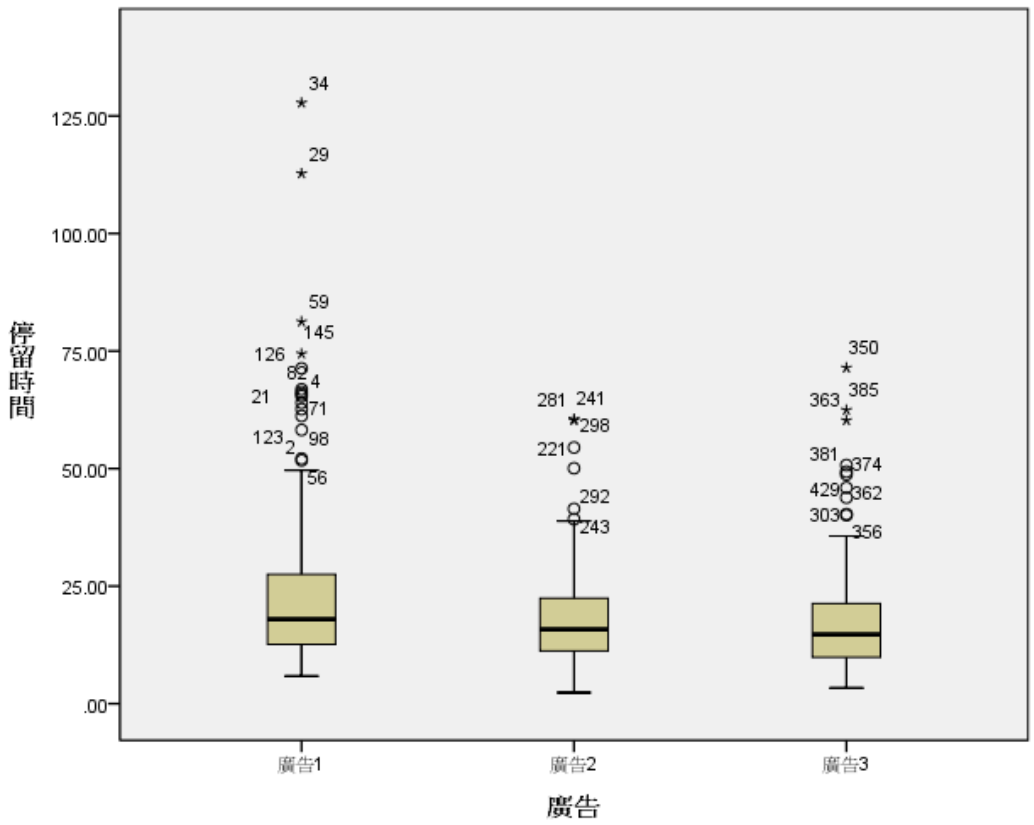
Graphical Proof 2: QQ Plot (data must be on a straight line to be normally distributed)



Graphical Proof 3: Detrended QQ Plot (data must be close to the horizontal 0 axis to be normally distributed)



Graphical Proof 4: Box Plot (data must have no outliers outside the quartiles to be normally distributed)



(4). [Concept]: If the data does not conform to a normal distribution, the ANOVA test cannot be used and the Kruskal-Wallis test must be used instead

3 Basic Assumptions of One-Way ANOVA:

1. Each group of samples is independent

2. Each sample comes from a normally distributed population

3. The variances of each population are equal

Advanced Diagram (Anova Test)

✅ 單因子變異數分析（One-Way ANOVA）檢定流程與事後檢定對照表

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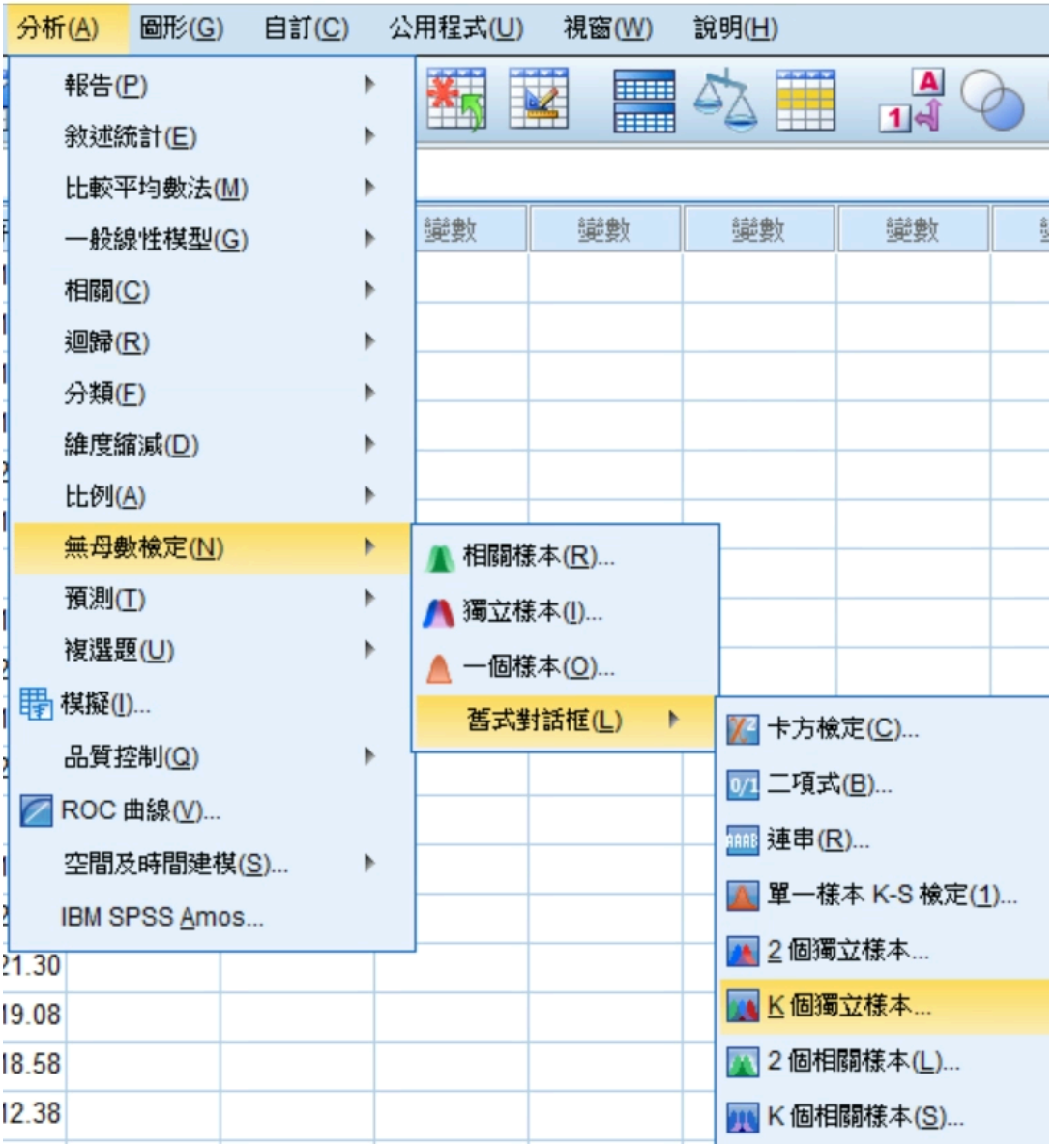
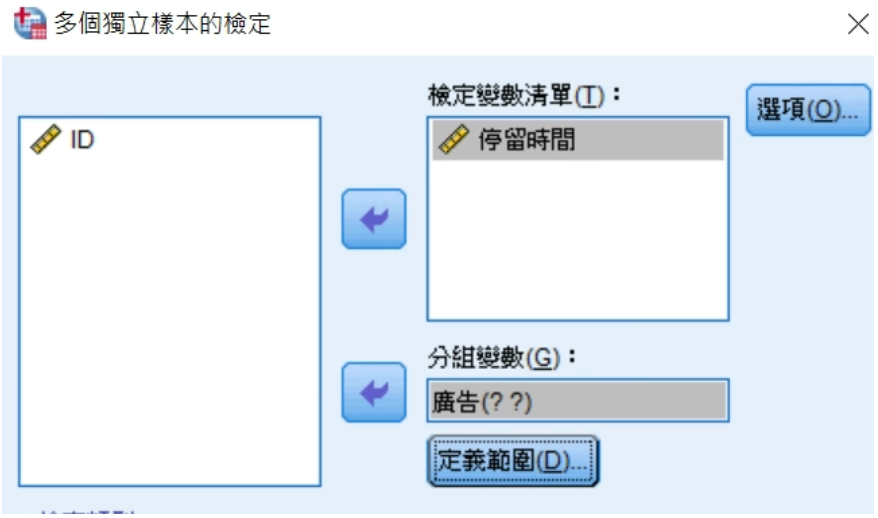
(5). [SPSS Implementation]: Kruskal-Wallis Test

How to Perform Kruskal-Wallis Test in SPSS

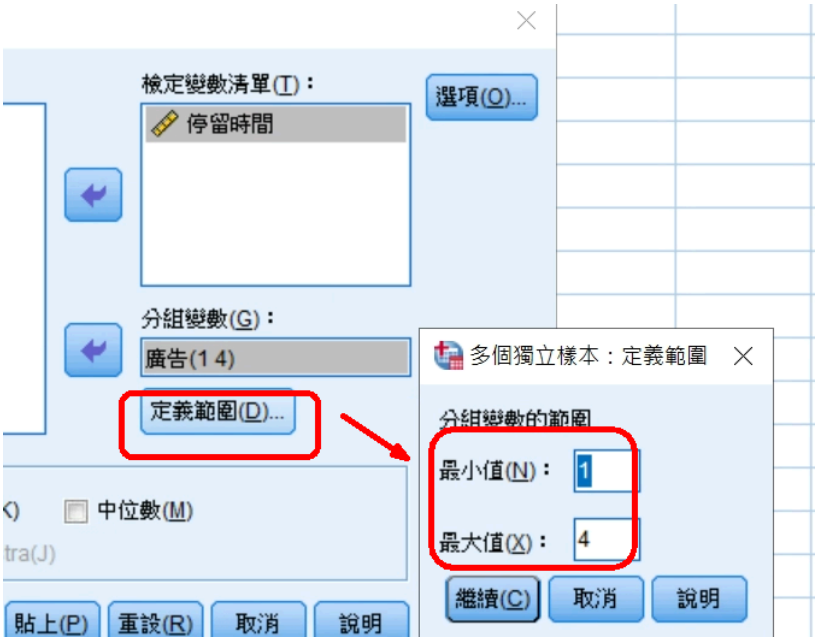
1. **Open SPSS and load the data**
2. **Select Analysis Method**
   - Click Analyze → Nonparametric Tests → Legacy Dialogs → K Independent Samples.



3. **Select Variables**
   - **Test Variable List: Select the continuous variable to be compared (e.g., scores, measurements).**
   - **Grouping Variable: Select the variable used to distinguish categories (e.g., different groups).**



4. **Set Grouping Variable**
    - Click Define Range, enter the minimum and maximum values of the grouping variable.



5. **Select Kruskal-Wallis Test**
    - In the Test Type section, check Kruskal-Wallis H.

How to Interpret SPSS Kruskal-Wallis Test Results

- **Test Statistics Table:**
  - **Kruskal-Wallis H Value: Test statistic.**
  - **df (degrees of freedom): k - 1 (number of groups minus 1).**
  - **Asymp. Sig. (Significance p-value):**
    - **p > 0.05: Indicates no significant difference between groups (cannot reject the null hypothesis).**
    - **p ≤ 0.05: Indicates that at least one group is significantly different from the other groups.**

Kruskal-Wallis 檢定

等級

	廣告	N	平均等級
停留時間	廣告1	150	255.71
	廣告2	150	218.13
	廣告3	150	202.66
	總計	450	

檢定統計量[a,b]

	停留時間
卡方檢定	13.205
自由度	2
漸近顯著性	.001

Conclusion: Because the significance p-value is 0.001 < 0.05,

So it means: at least one group is significantly different from the other groups

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Supplementary Explanation

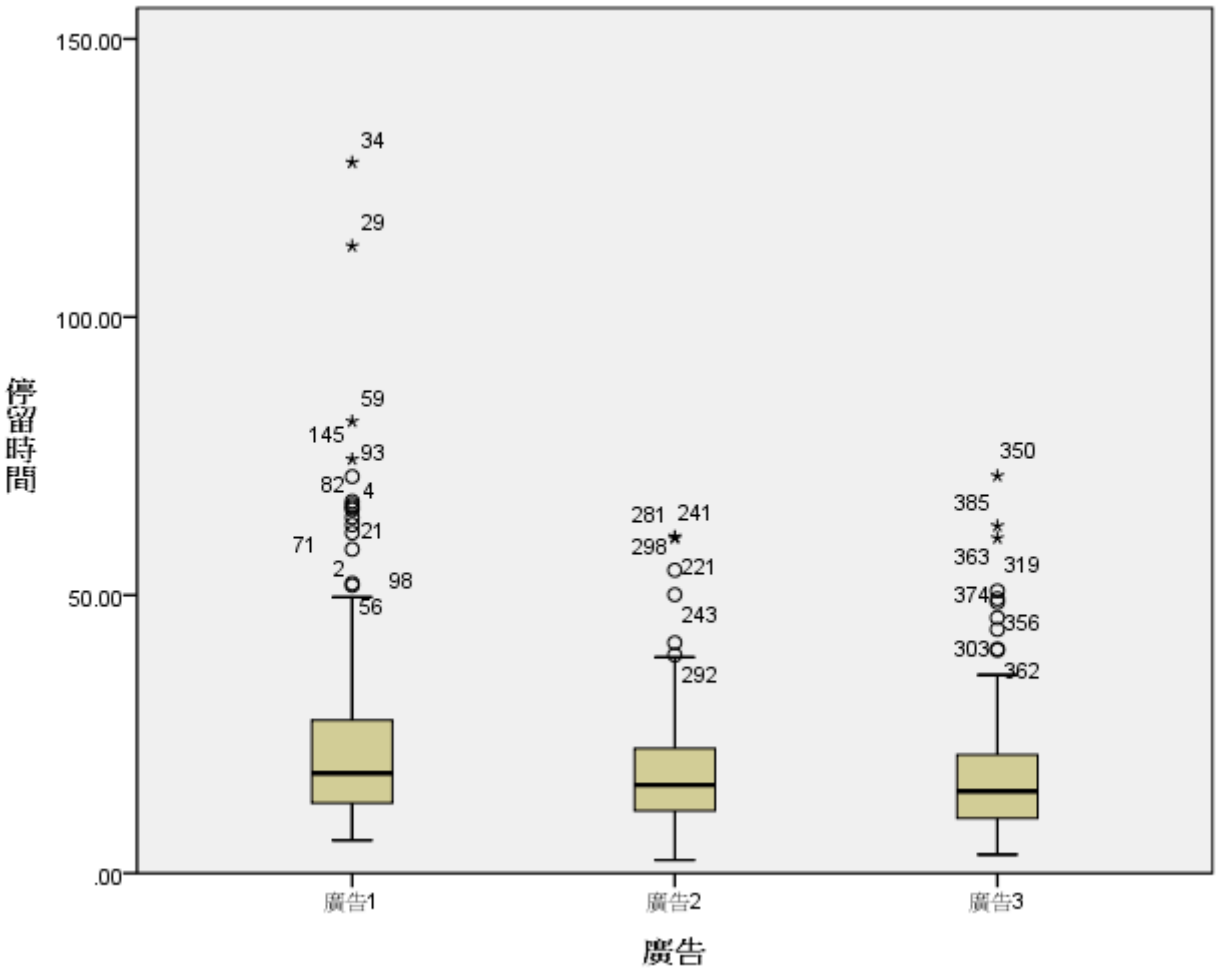
- **Post-hoc Comparison:**
  - If the Kruskal-Wallis test result is significant ($p \leq 0.05$), Dunn's test or Mann-Whitney U test (with Bonferroni correction) can be further used to compare the differences between two groups.

(6). [Concept]: The [post-hoc test: Dunn's test] after the Kruskal-Wallis test is not provided in SPSS, and the school's SPSS version is an old version (version 23), which cannot provide alternative methods. Other new versions of SPSS have alternative methods.

📌 各版本簡要概覽：

版本	發佈年份	重點特色
SPSS 23	2015	穩定版本，支援 Python 和 R 插件（需安裝 R Essentials）
SPSS 24	2016	提升圖形功能，改善介面
SPSS 25	2017	增加 ROC 曲線、Bayesian 檢定等
SPSS 26	2019	支援更多非參數檢定與資料轉換
SPSS 27	2020	加入多重分析功能與新版圖表介面
SPSS 28	2021	支援新版資料視覺化、強化報表
SPSS 29	**2022~至今**	支援 Python 3.10、增強 ML 模型、多語言介面、內建更多現代統計模型

(7). [Drawing]: Box Plot



(8). [Drawing]: Bar Chart