LIKERT SCALES

1.General

In the fields of Market Research, Public Opinion polling, and the Humanities in general, multi-thematic questionnaires that primarily use qualitative characteristics (variables) for their analysis are a long-standing tradition.

However, the responses received are typically processed using classical statistical methods, where parameters such as means, variances, and standard deviations are calculated for each question separately. When multivariate Data Analysis methods are used, Principal Components Analysis (PCA) is commonly applied to the data.

The collected data include questionnaire responses where individuals are asked to state a degree of acceptance or rejection for a series of opinions based on a graded scale, known as a Likert scale.

For example, if in a study we are interested in the opinion of internet users regarding whether their use of the internet affected their mood, then question Q1={User opinion on the effect of internet use on their mood} is a qualitative ordinal variable and could take the form shown in Figure 1.

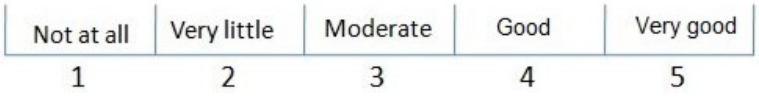

Figure 1

Figure 1: Graduated Likert-type scale according to the direction of the values on the real number axis R.

Of course, the respondent can mark with a circle the degree corresponding to level of agreement on the questionnaire, or place an X, as shown in Figures 1a and 1b.

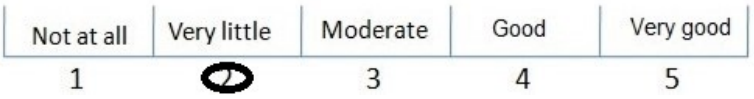

Figure 1a

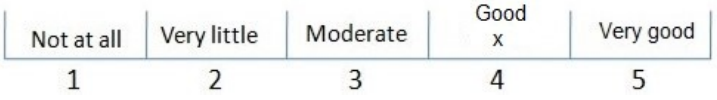

Figure 1b

Some use Likert scales with the conceptual direction moving from positive to negative emotion, and the corresponding scores in a direction opposite to that of real numbers (Figure2).

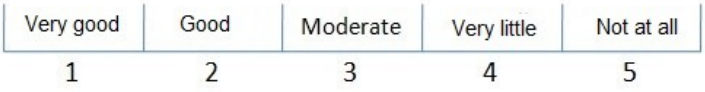

Figure 2

Another form of Likert scale design is the Agreement-Disagreement scale with only four levels.

Figure 3

In this case, the respondent is '**forced**' to provide an answer that does not accept the neutral 'Neither agree nor disagree' option, which corresponds to the value 3 on a 5-point scale .It should be noted that scales can be 3-point, 7-point, or even 10-point, depending on whether a brief or more detailed view of the respondent's opinion is desired."

2. Creation of a data table

If, for example, a questionnaire contains 7 questions (Q1,…Q7) where 100 internet users state their degree of agreement for each question using 5-point scales Likert as in Figure 1, then the data table T(100,7) submitted for analysis would have the following form.

Table 1: Data evaluation table with scores from Likert-type scales

ind	**Q1**	**Q2**	Q3	**Q4**	**Q5**	**Q6**	**Q7**
I1	**3**	**4**	**2**	**2**	**3**	**4**	**1**
I2	**1**	**2**	**1**	**3**	**4**	**2**	**3**
.							
.							
.							
I100	**2**	**2**	**4**	**5**	**3**	**4**	**3**

However, data processing using classical statistical methods requires the variables used by the analyst to be **quantitative**, whether continuous or discrete. These variables, as defined by statistical science, are characterized by the fact that **quantitative measurement scales** are used to measure their values. This stands in contrast to Likert-type ordinal scales, which are used for categorical variables that are considered **qualitative**. In qualitative variables, instead of recording values from a quantitative scale, the number of responses given for each level of the variable is recorded, noted as the **frequency** of occurrence for that level.

Furthermore, in these types of scales, when **quantified**, there is no classic zero point (the origin of the scale), while the **pseudo-values** assigned to each level (e.g., from 1 to 5) are not represented by units of measurement, as is always the case with the value scales of quantitative variables. Consequently, calculating the mean and standard deviation is meaningless. Additionally, these scales are often incorrectly assumed **to be potentially continuous** and to have equal intervals between their levels.

This means that for a question such as «How do you find the quality of product A», a scale with the following levels could be used: «Bad», «Moderate», «Good», «Very

Good», «Excellent», with the pseudo-values 1, 2, 3, 4, 5 assigned to these levels respectively.

Such a mapping is considered misplaced because, since there are no units of measurement that strictly define the distance between 1 and 2, or between 2 and 3, the impressions held by two different consumers regarding «Bad», «Moderate», and «Good» are most likely to be completely different. More specifically, the sentiment of two consumers can in no way be identical when distinguishing between «Bad», «Moderate», and «Good» quality, as this is shaped by different factors for each individual. One such factor could be the varying degree of influence from the product's advertising.

Consequently, the subjectivity of an individual's rating on a question is inevitable; therefore, the **proximity - similarity** between two people who answer the same question with the same rating is something to be **investigated rather than an a priori given.**

For Javeau M. (1978), the failure of those who treat qualitative scales as quantitative is not only considered an arbitrary proportionality of categorical variables, but also a «**skillful trick**» for data coding.

For the aforementioned reasons, it is considered appropriate to analyze such data using methods that do not alter the nature of the variables, but instead allow for processing based on Mathematical science and, more specifically, Linear Algebra. The method for analyzing such tables—as already analyzed in detail in other links of the website **www.pylimad.gr** (Navigation/ Brief presentation of Data Analysis methods)—is primarily Correspondence Analysis, where **respect for the nature of the data** is indisputable.

The following example will present the step-by-step process of analyzing questionnaires that include evaluation scales. The goal is to make clear the significant difference that exists in processing such questionnaires between classical methods and Correspondence Analysis, the method for qualitative variable analysis of the French School founded by French professor J.P. Benzecri (1932-2019).

3. Evaluation of three criteria for the purchase of a product

Let’s assume the following question is posed to 401 consumers:

«Could you evaluate product "X" based on the following criteria? »

(A 3-point Likert scale is used for educational purposes).

A respondent's answer may take the following form:

Ind	Moderate	Good	Very good
Quality	X		
Price		X	
Packing		X	

or the same response, based on the 3-point Likert scale, may have the form:

Quality	1
Price	2
Packing	2

Or, the form

Quality			Price			Packing		
Moderate	Good	Very Good	Moderate	Good	Very Good	Moderate	Good	Very Good
x				x				x

Or, finally, the form

Ind	Moderate	Good	Very good
Quality	(1)	2	3
Price	1	(2)	3
Packing	1	(3)	3

Observation: The researcher's inspiration can lead to the design of other forms of data collection based on the Likert scale.

Let's assume that 401 consumers were asked to evaluate product 'X'. Regardless of the form in which the consumers' answers were collected, the analyst will eventually create a two-dimensional data table for analysis, in the form presented in Table 2.

Table 2: Part of data table

Ind	Quality	Price	Packing
I1	1	2	2
I2	2	1	3
….	….	….	….
….	….	….	….
I401	2	3	1

Note: The responses of the 401 respondents are coded as I1, I2, ..., I401

A) If the analyst first wishes to simply examine which rating level consumer opinion converges toward for each of the three criteria, they must use the procedure provided by the MAD software: Edit / Multidimensional / Evaluation Tables / Conversion of (IxJ) table to contingency table. This creates the contingency table to which Correspondence Analysis will be applied**.**

Table 3: Table of contingency table

Ind	Moderate (1)	Good (2)	Very good (3)	
Quality	131	100	170	401
Price	60	279	62	401
Packing	20	142	239	401
	211	521	471	1203

The cell (PRICE,-2-)=279 means that the criterion PRICE was evaluated by 279 respondents.

3.1. The results of the analysis

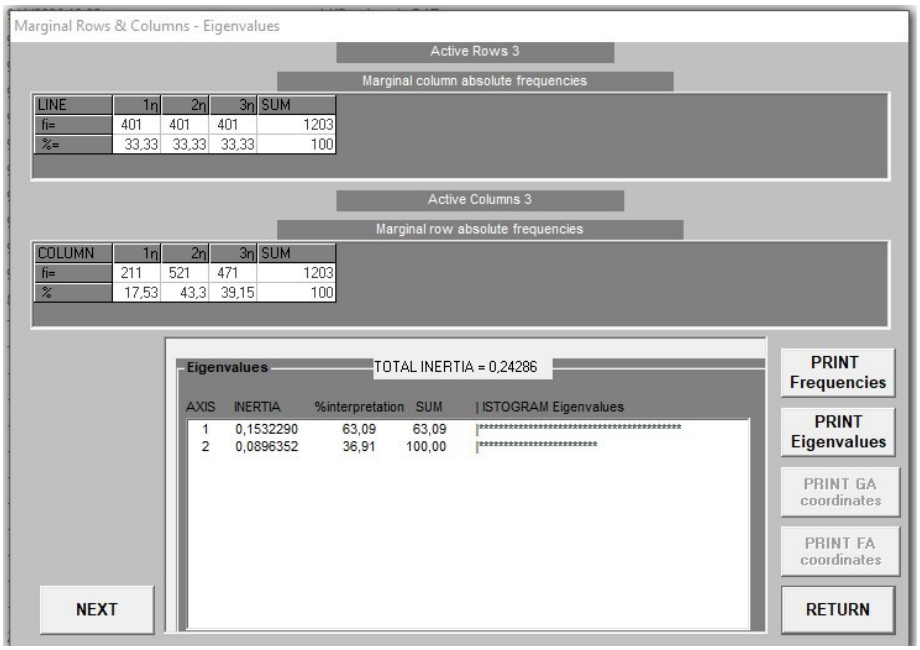

Figure 4

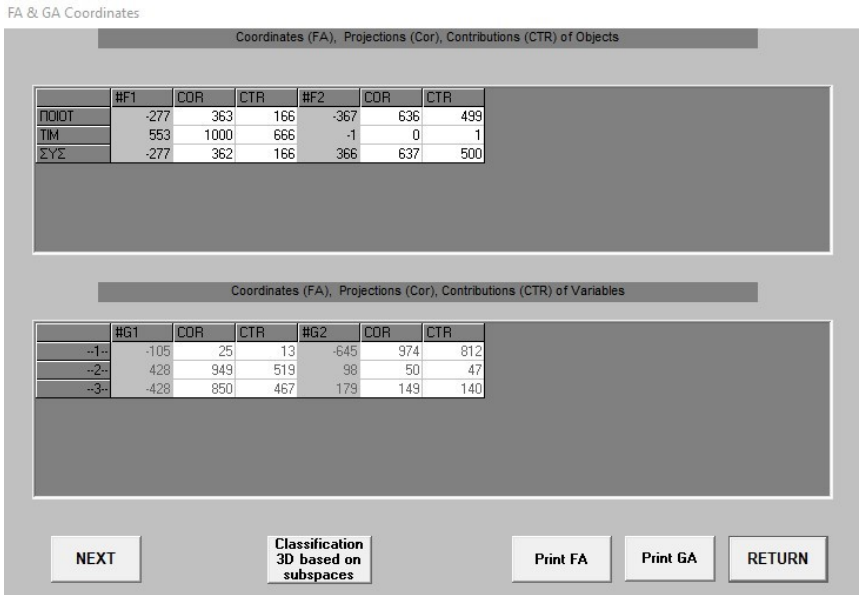

Figure 5

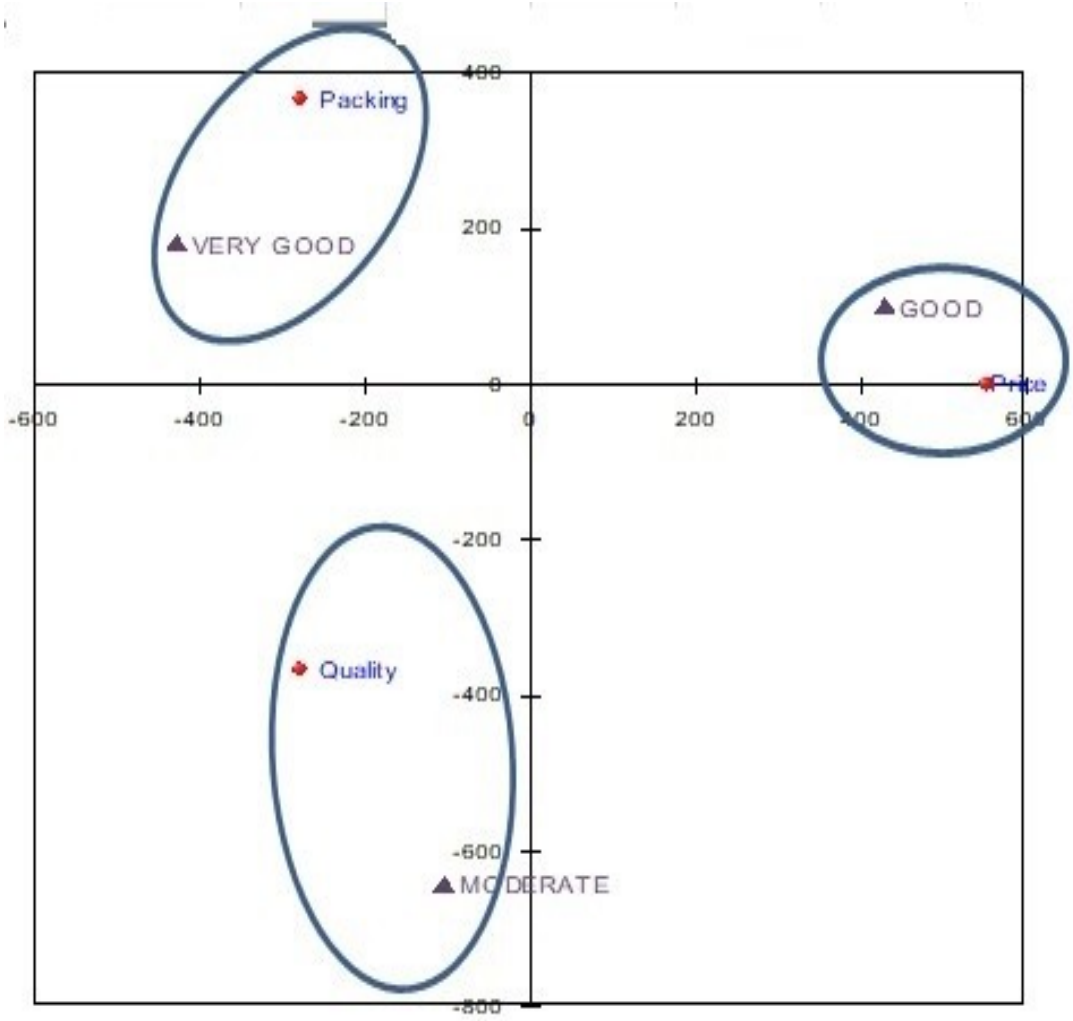

Figure 6: 1x2 Factorial level

3.Conclusion

From the 1x2 factorial level which represents 100% of the information provided by table 3, it is found that the respondents evaluated the Packaging as Very Good , the Price as Good and the Quality as Moderate.

4. Evaluation of the services offered by the International Hellenic University to students

754 students of the five departments (D1,….D5) participated in the survey, who were asked to answer nine questions. Specifically one of the questions asked concerned 12 criteria (Q1….Q12) . with which they were asked to evaluate the factors that affect their studies, such as logistical infrastructure, secretarial support, cleanliness of premises, transportation and others.

4.1 Processing of the 12 evaluation criteria

For each of the 12 criteria, a 5-point Likert scale was used in the form of:

Not at all→1 Very little→2 Moderate→3 Very→4 Too →5

- **Q1:** determines the level of student satisfaction regarding the quality of the **Program of study**.
- **Q2**:determines the level of student satisfaction regarding **teaching methods**.
- **Q3:** determines the level of student satisfaction regarding the quality of **textbooks**.
- **Q4:** determines the level of student satisfaction regarding the quality of **course notes**.
- **Q5:** determines the level of student satisfaction regarding the **library**.
- **Q6:** determines the level of student satisfaction regarding **classrooms**.
- **Q7:** determines the level of student satisfaction regarding **laboratory facilities**.
- **Q8:** determines the level of student satisfaction regarding **cafeteria services**.
- **Q9:** determines the level of student satisfaction regarding **administrative/secretariat support**.
- **Q10:** determines the level of student satisfaction regarding **catering/dining services**.
- **Q11:** determines the level of student satisfaction regarding the **cleanliness of the premises**
- **Q12:** determines the level of student satisfaction regarding **transportation**.

Note: The 12 criteria are marked in bold.

Below is a portion of the table of answers for all questions:

Table 7: Part of the data table

IND	Q1	...	Q8	Q9	Q10	Q11	Q12
I1	3	....	2	1	5	1	2
I2	4	...	5	1	3	3	1
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
I754	4	...	4	0	3	3	4

Note 1: Where I1, I2 etc. refers to the answers of the 1st, 2nd etc. student.
Note 2: The value 0 corresponds to the answer: Don't know/No answer (DK/DA).

The table 8 presents the mean scores of the responses for each criterion by department**.**

Table 8: Average value of the 12 criteria for each School

INT	D1	D2	D3	D4	D5
Q1	2.78	2.94	2.91	2.94	2.86
Q2	2.79	2.95	2.89	2.82	2.77
Q3	2.83	2.42	2.39	2.73	2.34
Q4	3.01	2.45	2.52	2.68	2.52
Q5	3.22	3.11	3.28	2.76	3.22
Q6	2.47	2.78	2.23	2.77	2.73
Q7	3.01	2.82	2.73	3.04	3.03
Q8	2.73	2.75	2.60	2.49	2.91
Q9	2.30	2.67	2.73	2.60	1.99
Q10	3.14	3.16	2.85	3.03	3.24
Q11	2.35	2.48	2.47	2.52	2.82
Q12	2.59	2.85	2.88	2.53	2.92

By applying the nearest relative method (KARAP method) to the data in table 8 (after previously multiplying the values by 100), the following table 9 is created:

Table 9: Classification of the 12 criteria using the KARAP method

D1	D2	D3	D4	D5
Q3	Q1	Q5	Q6	Q8
Q4	Q2	Q9		Q11
Q7	Q10	Q12		

While then following the method of Generalized Ascending Hierarchical Classification by creating three classes, the following findings emerge:

a) The three classes formed by the five Departments based on the criteria that mainly influence their studies are the services:

1. The class with the greatest homogeneity of criteria consists of the Departments of D2 and D3.

2. The class with the Schools of D1and D4 follows

3. While the third consists exclusively of the School of D5

b) Regarding the criteria that mainly satisfy the students of each Department separately, they are, on the one hand

For D1 (Business & Economics**)**

- Q3: **Quality of textbooks**
- Q4: **Quality of lecture notes**
- Q7:**Laboratory facilities**

For D2 (Health & Welfare Professions**)**

- Q1: **Quality program of studies**
- Q2:**Teaching methods**
- Q10: **Catering / dining services**

For D3 (Agricultural Technology**)**

- Q5: **Library**
- Q9: **Secretariat / Administrative support**
- Q12: **Transportation**

For D4 (Technological Applications**)**

- Q6: **Classrooms**

For D5 (Food Technology & Nutrition**)**

- Q8: **Cafeteria services**
- Q11:**Cleanliness of premises**

The application of the **Generalized Ascending Hierarchical Clustering** method, by requesting the formation of three (3) classes, produces the following **dendrogram**.

This diagram simultaneously illustrates the classification of the Departments and the primary satisfaction criteria of their students.

The dendrogram follows

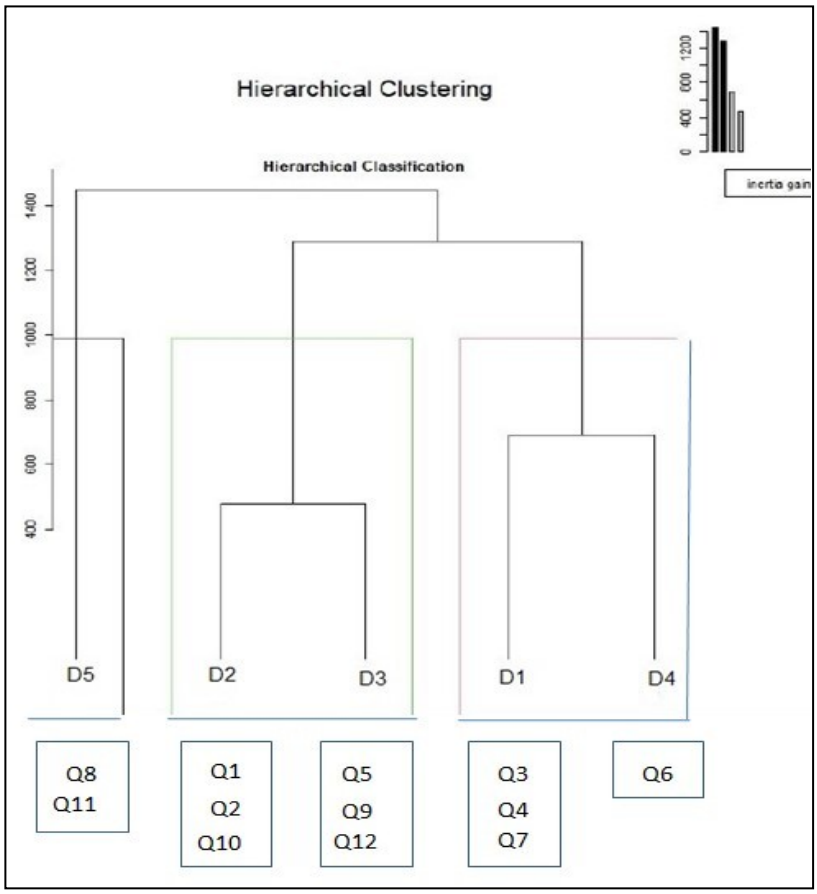

Figure 7: Dendrogram of GAIC in three classes of the data of table 8

Note: The analyses were performed with the original software of Dr. Dimitrios Nik. Karapistolis MAD (**Méthodes d' Analyse des Données)**

BIBLIOGRAPHY

1. BENZECRI J.P & F (1980) Pratique de l' analyse des données Ed. Dunod Paris
2. KARAPISTOLIS D.(2022) Multidimensional Statistical Data Analysis (in Greek)
3 KARAPISTOLIS D. (2024) Hierarchical Classification Manual (in Greek)
4. Software MAD. Site www.pylimad.gr