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PLANNING A PRODUCT FOR TOURING DESTINATIONS THROUGH THE USE OF SPATIAL MATHEMATICAL ANALYSIS

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Abstract: Mathematical models provide spatial analysis to help complex decision-making and can be successfully applied to product planning in tourism. This paper presents a case study, and suggests one process by which planning agencies may evaluate the railway stations in the Northern Greece network. Six geographical points of distinction are identified for promotion based on linear-nearest neighbor analysis and the connectivity index. A functional diagram evaluates each point based on infrastructure, natural and cultural attractions. Finally, these indicators suggest marketing considerations, which may lend support to Management or stakeholders' discussions to maximize the geographic points.
Key words: Linear-nearest neighbor analysis, connectivity index analysis, regional assessment of natural and cultural potential, place marketing management, touring tourism.

Sažetak: PLANIRANJE PROIZVODA DESTINACIJA KRUŽNIH PUTOVANJA POMOĆU PROSTORNE MATEMATIČKE ANALIZE. Matematički modeli omogućuju prostornu analizu kako bi se pomoglo složenom postupku odlučivanja i mogu se uspješno primjenjivati za planiranje proizvoda u turizmu. Ovaj rad prikazuje analizu pojedinog slučaja i predlaže proces pri čijem planiranju agencije mogu procjenjivati kolodvore u željezničkoj mreži sjeverne Grčke. Za promociju na bazi analize linearnog najbližeg susjedu i indeksa povezanosti utvrđeno je šest geografskih točaka razlikovanja. Funkcijska shema ocjenjuje svaku točku na temelju infrastrukture i prirodnih i kulturnih aktivnosti. Zaključno ti indikatori predlažu marketinško promišljanje što bi pružilo podršku menadžmentu ili nositelju interesa kod diskusija oko maksimiziranja geografskih točki.
Ključne riječi: Analiza linearnog najbližeg susjedu, analiza indeksa povezanosti, regionalna procjena prirodnog i kulturnog potencijala, menadžment marketinga mjesta, turizam kružnih putovanja.

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1. INTRODUCTION

1.1 Linear-Nearest Neighbor Analysis (LNNA)

Designers and developers can use the LNNA tool to measure how technical, natural and cultural resources may be optimized along a linear network, as with a railway line (Smith 1993).The assessment can locate the most valuable geographical points by calculating variables such as distance, cost of travel, and time of travel between points. Pimder and Witherick (1975), building on the research of Clark and Evans in 1954, adapted random distribution analysis in a limited area, to develop geographical analysis along a linear path.

The mathematical expression of LNNA is given by the following formula:

$$dr = 0.5\,[L/(n-1)], \quad (1)$$

where:
dr = the theoretical distance between the points in a random distribution of points.
L = the length of the line, and
n = the total number of points of investigation

$$do = E\ \text{(the closest distances between the geographical points on the line)}/n \quad (2)$$

In other words, *do* refer to the middle observed distance between points.
From (1) and (2), one can estimate the ratio of the linear analysis of nearest -neighbor analysis:

$$L\,Rn = do/dr, \quad (3)$$

LRn is an indicator of statistical control based on the linear nearest-neighbour analysis (LNNA). With the *LRn* ratio, LNNA describes the distribution of random points in space and whether they are uniformly dispersed or clustered in space. Randomness is measured by *LRn* equals 1 *(LRn = a 1.00)*. A value of zero (*LRn = 0.00)* meanwhile defines ideal clustering where as a value of 2 (*LRn = 2.00)* describes ideal distribution. *LRn* values are tested by significance graphs (Pinder and Withcrick, 1975) and are justified in evaluations of natural obstacles in a region, or measuring a region's accessibility.

1.2 A Report concerning the Supplementary Techniques of the LNNA Relating to Issues of Spatial Analysis and Administration

1.2.1 Connectivity Index Analysis (CIA)

The CIA is a theoretical technique based on graphs originally proposed by mathematicians and widely known as graph theory (Taylor, 1977). CIA is just one of six such visual techniques that comprise *graph theory* analysis, and measures in terms of *the gamma index* (γ). CIA is easy to use and recommended for land-planning tourism analysis (Smith, 1993). Its application provides useful estimates concerning the level of access in the studied region and is calculated by the following mathematical formula:

$$\boldsymbol{\gamma = L/3(P\text{-}2)} \qquad \textbf{(4)}$$

where:
L = the total number of direct links between geographical points.
P = the total number of points under examination.

γ, then, is the statistical ratio of the number of activities or existing links between each pair of geographical points in the network to the total number of points under investigation. If γ=0 then the systems of points of analysis do not present any links between these points. If γ=1, then the system presents a complete structure with all possible links between the points of analysis. The CIA technique compliments LNNA by providing figures that measure access from and toward the geographic points along the linear network, and applies readily to the evaluation of road and railway links.

1.2.2 Functional Diagrams

The functional diagrams can be particularly useful in measuring the relation between natural, artificial and cultural touring resources. The resources can be grouped when they record similarities at a functional level. Gunn (1988) clarified two distinct groups of attractions. “Long stay” tourism or “longer stay” tourism like touring circuits. When investigating road and railway links or a combination of both, for instance, analysis would reveal function of points in space. With LNNA, the analyst can offer suggestions to functional questions such as inquiries about access, combining resources and accessibility in organizing touring tourism.
The case that follows examines the proposed model of tourism for roadside scenic areas. Model A (Roadside scenic areas) is tied to a railway network, confined to a linear dimension and capped in a dynamic framework that attracts visitors with natural and cultural resources; Regional Assessment of Potential is the protocol for evaluating such a touring region (Gunn, 1988). The rating incorporates natural, cultural and technical factors such as: water and water life, topography, soils and geology, vegetative cover, wildlife and pests, climate and atmosphere, aesthetics, existing attractions, industries and institutions, history, ethnicity, legends, service centers and transportation access. In Model A, 25 nearby natural and cultural attractions were selected (with a maximum radius distance of 20 kilometers) along the Thessalonika – Alexandroupoli Railway Line. Similar research was conducted by Vasiliadis and Kobotis (1999) for the region of Macedonia, Northern Greece.

1.2.3 Place or Destination Marketing Management

Modern planning of touring activities must also follow Place Marketing analysist as proposed by prominent writers (Kotler et. al., 1993). Such a review audits the first two levels of activity and appraises the merits of a region.
For instance, Place marketing management reveals, which attractions and infrastructures could entice, target visitors. Spatial analysis is then carried out by official authorities and enterprises (Kotler et. al., 1993), «at the planning group level» in collaboration with local or regional governments. Calculations take into account relevant marketing factors that affect local citizens' expectations, as well as targeted

visitors. It should be noted that natural, artificial and cultural resources must follow the specific demands and needs of the market to positively influence the viability of a destination (Gunn, 1988).

1.2.4 Conjoint Analysis (CJA)

The development of a destination depends on the attractions offered, and how they are perceived by visitors (Kotler et.al., 1993). Conjoint Analysis (CJA) is a technique that can be used to appraise various attractions, taking into account the demands and needs of the consumers.
Mathematicians specializing in psychology proposed CJA in the 1960s. They aimed to quantify individuals' subjective preferences into empirical variables (Shepard, 1957, 1962; Luce and Tukey, 1964; Kruskal, 1965). Researchers adopted CJA studies in sectors such as marketing, transport and health. CJA proved useful with problems in cognitive object of Marketing, and is regarded suitable for effective product planning (Urban and Hauser, 1980). In the 1970s, researchers (Green and Rao, 1971; Green and Devita, 1973; Green and Srinivasan 1978; Green and Wind, 1975) determined consumer choice by evaluating subjective characteristics of a product as defined by various groups of buyers. The technique was particularly effective in formulating strategies in the planning of new products and services. Pullman (Pullman et. al., 2002) validated the influence of CJA on product placement in strategic marketing, on improvements to productive brands, and invoice competition. In Austria, Mazanec applied CJA to measure the disposal of popular products (Mazanec, 1976). For the tourism industry, meanwhile, Goldberg (Goldberg et. al. 1984), Teare (Teare et. al., 1994), and Wind (Wind et al., 1989) published researches related to hotels. In the early years of the 21st Century, the technique was applied to multimedia platforms through the Web and included ski centers (Dahan and Hauser, 2002).

2. APPLYING LNNA IN THE TRADITIONAL RAILWAY NETWORK

A railway network in a given geographical region can be surveyed to evaluate potential touring resources. Examples show how rational administration and marketing of tourism resources along a railway network can enhance the touring quality of a region. The Durango-Silverton Narrow Gauge in Colorado (Gunn, 1988) Railways is one such model.

A hypothesis for the case investigation study

The following analysis investigates the tourism market along a railway line, when a combination of geographical points, natural and cultural prospects, and technical infrastructures can be identified. Existing railway stations can advertize such resources by informing visitors about local products or existing road links to attractions. Mathematical techniques, like the LNNA and CIA, can evaluate the virtue of such stations in economic terms, and identify the most attractive ones within the distribution. In this case study, spatial analysis helps develop a strategy to maximize the appeal of natural and cultural characteristics to visitors. In technical terms, mathematical models calculate spatial location of groups, consisting of a combination of geographical points referring to existing stations and nearby attractions.

2.1. The distribution and analysis of point patterns along the railway line

The railway line extends from the station of Thessalonika to the station at Alexandroupoli (Dedeagats) at a distance of about 437 kilometers, coordinated by 43 traditional stations, all of which were built in the year 1896 (Kalemkeris, 2000). It is the main line in Northern Greece, and crosses three administrative regions, i.e, Central Macedonia, Eastern Macedonia and Thrace.

Table 1: Linear Nearest Neighbor Analysis (LNNA) of the traditional railway stations of the wider study area

Near pairs of points	Distances between the near points (in cm)
Passenger station THESSALONICA-1	0.5
1-2	0.6
4-3	0.8
3-4	0.8
6-5	0.8
5-6	0.7
8-7	0.5
7-8	0.5
8-9	0.7
9-10	1.3
12-11	1.3
11-12	1.3
14-13	1.0
15-14	0.5
14-15	0.5
15-16	1.2
16-17	1.2
17-18	1.2
20-19	0.7
19-20	0.7
20-21	0.8
23-22	0.6
22-23	0.6
23-24	0.8
24-25	1.5
27-26	0.5
26-27	0.5
27-28	0.6
28-29	1.3
31-30	1.3
30-31	1.3
31-32	1.9
34-33	0.4
33-34	0.4
34-35	1.1
37-36	1.2
36-37	1.2
39-38	0.9
40-39	0.4
39-40	0.4
ALEXANDROUPOLI-41	0.3
	Σ=34.8 cm

d_o= 34.8/41= 0.8 cm
d_r= [0.5 (47.3/40)]= 0.5x1.2= 0.6 cm,
$\boldsymbol{LR_n}$= d_o/d_r= 0.8/0.6= **1.3** cm (=**uniform spacing**)

The distances and nearby distances among 41 points of a railway line were calculated using a centimeter (cm) scale. The total length of the line was L=43.7 cm. Based on (3) the numerical ratio LRn was estimated to be 1.3 cm (Table 1). According to the significance graph testing value of *LRn* (Pinder and Whitherick, 1975), the distribution of traditional stations along the network approaches the situation of uniform spacing. This structure as distributed supports touring tourism development.

2.2 Investigating the Links of the Nearby Traditional Stations and Natural - Cultural Attractions along the Railway Line

CIA was used to investigate the links of the nearby traditional stations. The system of points included 41 traditional stations and 66 geographical points of natural and cultural attractions (P=107) (Figure 1). Also, the railway and road accesses - links between the points were calculated to 42 and 93, respectively (L=135). According to formula (4) and Figure 1, indicator =0.43, which investigates the possible combinations of links between the points. The investigating system of points of analysis can be characterized as lower than the medium level of links (i.e. 0.50), thus it presents fewer links between its points. This can be justified after observing the traditional stations in Figure 1, as Hrisos (S18), Serres (S17), Skotousas (S16) and Kirkis (S38). These stations along the railway network do not present links with any of the 66 natural and cultural attractions. After a careful observation of the CIA diagram, six linking groups were identified along the railway line of investigation (Figure 1). Appropriate functional diagrams of touring activities were then developed on the six groups (i.e., touring tourism functional diagrams: the model A, for the roadside scenic areas) by applying model A on the first group of geographical points (Cluster 1; Figure 2). The development of the touring circuit must also be investigated. Gunn (1988, 1997) suggests that touring tourism is related with activities as visiting historical, archaeological and natural attractions of various geographical regions.

Figure 1: Connectivity Index Analysis of the traditional rail stations (S1-S41) and natural and cultural attractions (A1-A26)

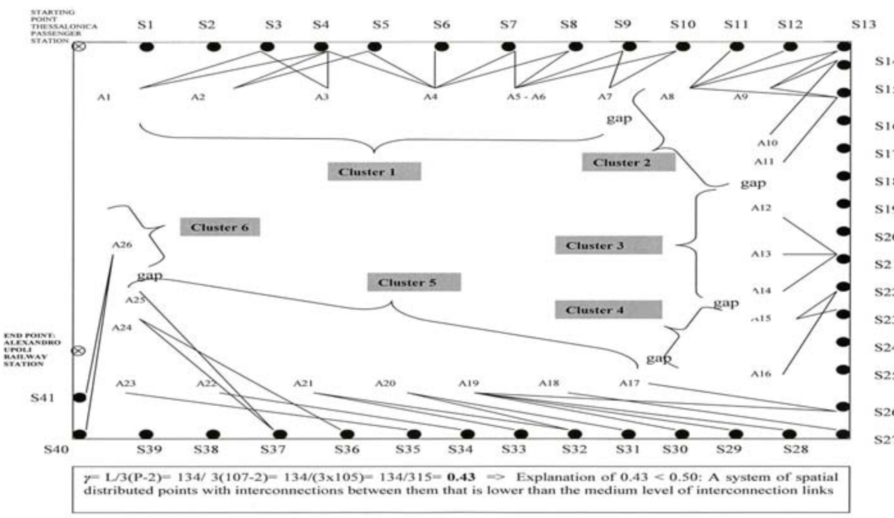
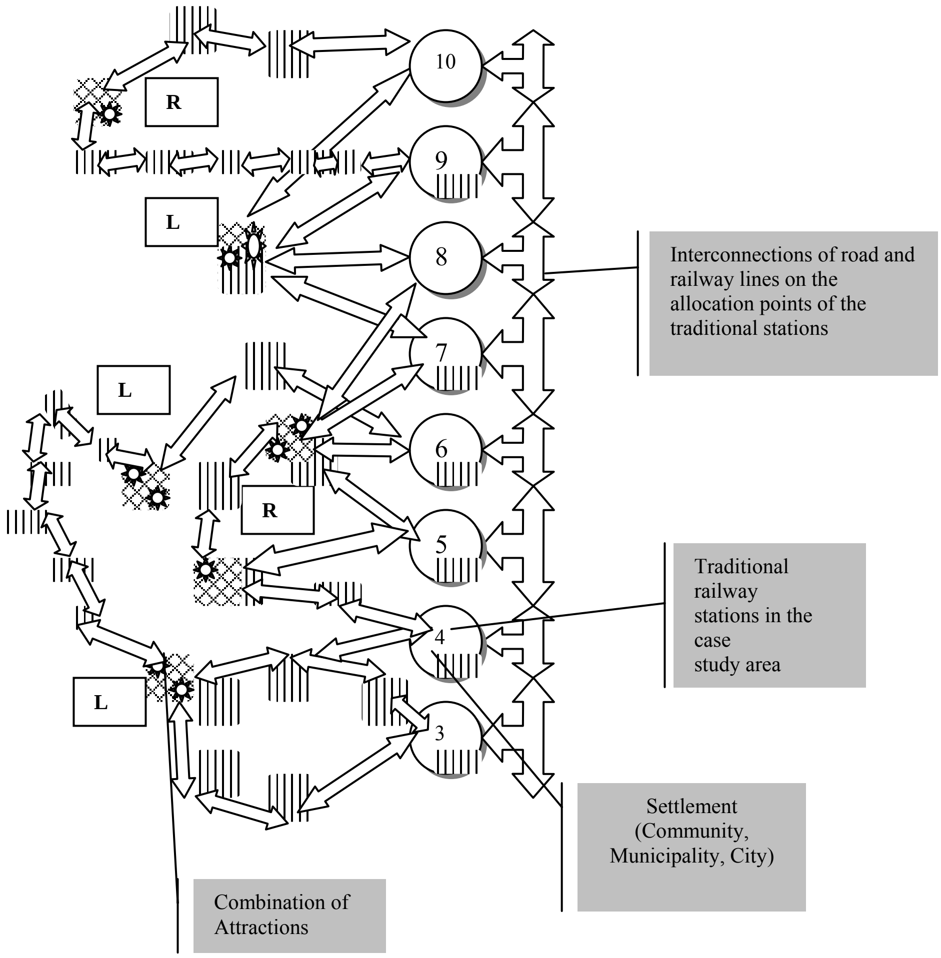


Figure 2: Functional Diagram Analysis in spatial cluster 1, according to Gunn's "Model A" about touring circuit spatial functions (Gunn 1997, Model A)



Explanation of symbols:

Settlement

Combination of Attractions

Attraction

Interconnections of road and railway lines on the allocation points of the traditional stations

Traditional stations in the railway network

Direction of the tour side

R, L — Orientation symbol: To the Right or Left side of the Railway station

Railway stops and attractions are included (Figure 2). The information concerning Cluster 1 can be used to develop a plan of touring tourism referring to relevant geographical regions (Godart, 2003).

3. CONCLUSIONS AND MANAGERIAL IMPLICATIONS

3.1 Discussion of the Spatial Analysis Results

Mathematical analysis supports investing in the region studied based on spatial distribution of points and functional relations between these points in the stated railway network. A potential problem that may hinder the planning process is determining the probable total value of geographical runs (i.e., trips). Since products are not only produced or planned in isolation but must follow demands of customers, consumption can nevertheless be promoted based on benefit and value (Green and Srinivasan, 1990).

The Japanese manager Konosuki Matsushita characteristically stressed that point (Fortune 1997): "Don't sell customers goods that they are attracted to. Sell them goods that will benefit them." (Make sure quote is correct – see http://www.sawtoothsoftware.com).

In these instances, visitors did choose destinations according to value. Based on mathematical analysis, a product to attract visitors is proposed. Competitive advantages (Chrzan and Orme, 2000; Huber, 1997) can determine a region's value based on alternative (competitive) choices-preferences when more than two product choices are offered.

The present analysis, therefore, can refer to more than two alternative geographical runs (i.e. trips). Figure 3 presents an indicative card of proposed choices concerning traditional railway stations of Cluster 1 (Pilon, 1998). The card can be used for further research aiming to evaluate the relative usefulness of each average visitor in the sample analysis. The visitors' choices would be represented by the value of each proposed offering combined with the runs recommended per railway junction in each group of observable runs.

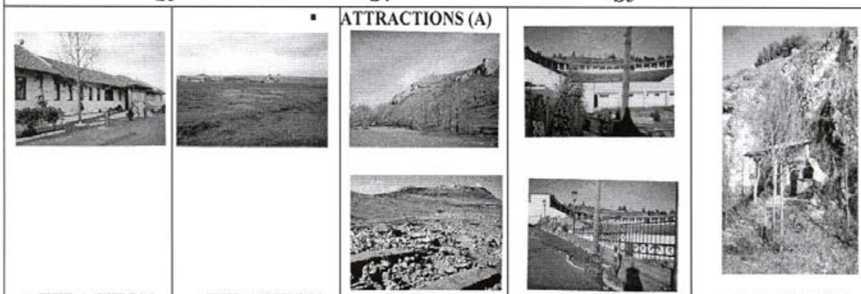
Figure 3: A sample card model of a choice for determining visitor's value

WHICH WAY YOU WOULD PREFER?

- **TRADITIONAL RAILWAY STATIONS (S)**

S3	*S4*	*S5*

- **ATTRACTIONS (A)**



ATTRACTION	ATTRACTION	ATTRACTION	ATTRACTION	ATTRACTION
A.1.1	*A.1.2*	*A.2*	*A3*	*A4*

If you intend to make a daily excursion with a company of relatives or friends that combines the use of train and rented car witch one of the following would you select?

	1 Tour way **A** (From station S3 to the Attractions A1.1-A2)	2 Tour way **B** (From station S4 to the Attractions A1.1, A1.2-A4)	3 Tour way **C** (From station S5 to the Attractions A3 and A4)	4
Traditional arrival station:	S3	S4	S5	None: I would not choose any of them
Attractions:	A1.1, A1.2, A2	A1.1, A1.2, A2, A3, A4	A3, A4	
Price of the rail ticket and renting of a car :	0.60+18=18.60€	0.65+18=18.65€	1.30+18=19.30€	
Duration of tour (one-way):	1.10' hours	1.34' hours	0.40' hours	

Suppose you selected daily tour "C". What lead you to this choice?

	3 Tour way "**C**" (From station S5 to Attractions A3 and A4)	***CYCLE THE NUMBER THAT EXPRESSES THE MOST IMPORTANT CHARACTERISTIC FOR YOUR CHOICE***
Traditional arrival station:	S5	1
Attractions:	A3, A4	2
Price of the rail ticket and renting of a car :	1.30+18=19.30€	3
Duration of tour (one-way):	0.40' hours	4

Suppose that you have to pay extra money for the daily tour "C". What would be the total sum of money that would you be willing to pay, taking in to consideration the most important characteristic for you?

I am willing to pay up to ____________ €

3.2 Managerial Implications

The proceeding analysis conforms to the alternative strategy for product segmentation proposed by Datta (1996). According to segmentation, the sectional efficiency to supply a given market must be assessed and compared. Federal and local authorities, which are responsible for planning and administering tourism regions, must necessarily evaluate sustainable strategies of resources (e.g. attractions, road and railway infrastructure) to satisfy customer needs.

Specifically, local authorities can draw useful results by answering such questions as:

- How do consumers choose specific runs (i.e. trips) from all possible attractions available to them with the network, and how do they perceive these attractions?
- What is the segmentation profile of the market in relation to value-attractiveness and attraction?

Using CJA in combination with spatial valuations, tourism planners can quantify the characteristics of a touring product along a network where prices and value of runs (trips) in current or future markets may be reasonably projected. In addition, the conjoint technique along may provide competent strategies for sustained development. For example, the variation and differentiation of a region, the development (growth) of a product or a market may be valued. Regional authorities through such quantitative indicators may assess the quality of each region to visitors. Finally, the value of touring products may be adjusted according to the targeted visitors' demands**.**

REFERENCES

Chrzan K. and Orme B. (2000), "An Overview and Comparison of Design Strategies for Choice-Based Conjoint Analysis", Sawtooth Software-Research Paper Series, Sequim, USA

Dahan E. and Hauser J.R. (2002), "The virtual customer", The Journal of Product Innovation Management, Vol. 19, pp. 332-353

Datta Y. (1996), "Market Segmentation: An Integrated Framework" Long Range Planning, (6) 797-811

Godart J. M. (2003), "Beyond the Trip Planning Problem for Effective Computer-Assisted Customization of Sightseeing Tours", In Frew A.J. and Hitz M. and O'Connor P. (eds.)

'Information and Communication Technology in Tourism' (2003), Springer Wien-New York, p.170

Green P.E. and Srinivasan V. (1990), "Conjoint analysis in Marketing - New developments with implications for Research and Practice", Journal of Marketing, Vol. 54 (October), pp. 3-19

Green P. E., and Rao V. R. (1971), "Conjoint Measurement for quantifying judgmental Data", Journal of Marketing Research, Vol.8, pp. 355-363

Green P.E. and Devita M.T. (1973), "A complementarity model of consumer utility for item collections", Journal of Consumer Research, Vol. 1, pp. 56-67

Green P.E. and Srinivasan V. (1978), "Conjoint measurement in consumer research: Issues and Outlook", Journal of Consumer Research, Vol. 5, pp.103-123

Green P. E. and Wind Y. (1975), "New way to measure consumer's judgments", Harvard Business Review, Vol.53, pp. 107-117

Goldberg S. M., Green P.E. and Wind Y. (1984), "Conjoint analysis of price premiums for hotel amenities", Journal of Business, Vol. 57 (1) 111-132

Gunn C. (1988), "Vacationscape –Designing Tourist Regions", VNR, New York, 2nd edition, pp. 42-155

Gunn C. (1997), "Vacationscape –Designing Tourist Regions", VNR, New York, 3rd edition, pp.49-69

Hauser J.R. Shugan S.M. (1980), „Intensity measures of consumer preference", Operation Research, 28 (2) 278-320

Hauser J.R. and Simmie R. (1981), "Profit maximizing perceptual positions: an integrated theory for the selection of product features and price", Management Science, 27 (2) 33-56

Huber J. (1997), "What we have learned from 20 years of Conjoint Research", Sawtooth Software-Research Paper Series, Sequim, USA

Kalemkeris Chr. (2000), "The Trains in North Greece Space (1871-1965)", Reprotime Publications, Thessaloniki, Greece, pp. 2-166

Kotler P., Heider D.H. and Rein I. (1993), "Marketing Places", Free Press, New York, USA. pp. 19-134

Kruskal J. B. (1965), "Analysis of factorial experiments by estimating monotone transformations of the data", Journal of Royal Statistical Society, Series B (27) 251-263

Luce, R. D. and Tukey J. W. (1964), "Simultaneous conjoint measurement: a new type of fundamental measurement", Journal of Mathematical Psychology, 1 (1) 1-27

Mazanec, J. (1976), "Die scheatzung des beitrags einzelner produkteigenshaften zur markenpreaferenz als problem der polynomishen verbundmessung, arbeitspapiere der absatzwirtschaftlichen institute der wirtschaftauniversiteat Wien", Orac Verlag, Vienna

Pilon T. L. (1998), "Extensions to the Analysis of Choice Studies", Sawtooth Software – Research Paper Series, Sequim and Swatooth Software – Research Paper Studies, Choice-based Conjoint Technical Paper, Sequim, USA

Pinder D.A. and Witherick M.E. (1975), "A modification of nearest-neighbour analysis for use in linear situations", Geography 60, pp.16-23

Pullman M. E., Moore W.L. and Wardell D. G. (2002), "A comparison of quality function deployment and conjoint analysis in new product design", The Journal of Product Innovation Management, Vol. 19, pp. 354-64

Shepard R. N. (1957), "Stimulus and response generalization: a stochastic model relating generalization to distance in psychological space", Psychometrika, 22 (4) 325-45

Shepard R. N. (1962), "The analysis of proximities: multidimensional scaling with an unknown distance function", Psychometrika, 27 (2) 125-40

Smith, L.S.J. (1993), "Tourism Analysis", UK: Longman, pp. 210-212

Taylor P. J. (1977), "Quantity methods in geography", Houghton Mifflin Company, Boston, Mass. pp.58-65

Teare R., Mazanec J. A., Welch S. C. and Calver S. (1994), "Marketing in Hospitality and Tourism- A Consumer Focus", Cassell, Great Britain, pp. 123- 189

Urban G. L. and Hauser J. R. (1980), "Design and Marketing of New Products", Englewood Cliffs, N.J, Prentice Hall, pp. 25-256

Vasiliadis Ch. and Kobotis A. (1999), "Spatial Analysis- an application of nearest-neighbour analysis to tourism locations in Macedonia", Tourism Management No. 20, 141-148

Wind J., Green P., Shifflet D. and Scarbrough M. (1989), "Courtyard by Marriott: Designing a hotel facility with consumer-based marketing models", Interfaces. 19(1), 25-47