

Multidimensional scaling in tourism literature

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ABSTRACT

This paper makes a structured review of 64 travel and tourism journal articles published from 1975-2014 applying the multivariate analytical technique called multidimensional scaling (MDS). MDS originates from psychometrics and by the middle of the 1970's the technique was also well established in marketing. Typical themes of tourism studies applying MDS are destinations, positioning and image. The result of the literature review is illustrated in MDS diagrams containing both the references themselves and the characteristics of these references as object points. The uptake of MDS in tourism studies is compared to other techniques, specifically correspondence analysis and structural equation modelling. The literature review is supplemented by a previously unpublished example of the usage of MDS, namely the position of country destinations in the regions of the German tourism market. MDS diagrams can indicate which destinations are competitors, but competitors are at the same time potential partners.

Key words: multidimensional scaling; tourism; destinations; positioning; image.

1 Introduction

During the first half of the 1970's, interest in the data visualisation technique, multidimensional scaling (MDS), had spread from psychology or psychometrics, marketing research and general marketing into tourism, and studies applying multidimensional scaling were presented at travel and tourism research conferences (Mayo & Scott, 1971; Anderssen & Colberg, 1973; Mayo, 1973). Ritchie & Beliveau (1974) also drew attention to the potential of the technique by stating in a Journal of Travel Research article that "newer techniques (such as multidimensional scaling) employed in new product development and product positioning in other areas could be usefully applied" in travel and tourism research.

By 1975, the first travel and tourism journal article applying MDS was published (Mayo, 1975). Now, about 40 years after Mayo (1975), and about 25 years since the first review article on MDS in tourism (Fenton & Pearce, 1988), it seems appropriate to take stock and see how MDS has fared in tourism since the outset, both in its own right and compared to a couple of other techniques. *Thus, the purpose of this article is to give an overview of the themes of tourism studies applying MDS, with an emphasis on journal articles published during the period of 1975-2014.* As an illustration of the wide applicability of MDS, the review itself is presented in MDS diagram formats. A previously unpublished example of the application of MDS will be provided, namely the position of country destinations in the regions of the German travel market.

According to Kruskal & Wish (1978), multidimensional scaling refers to a class of techniques, which use proximities among any kind of objects as input. Carroll, Arabie & Hubert (2005), define multidimensional scaling (MDS) as "a family of models and methods for representing stimuli or other objects as points in multidimensional space based on proximity (e.g., similarity or dissimilarity) data and relying on the principle that distances (usually, but not necessarily, Euclidean) in that space are related via a simple (usually linear or monotonic) function of the proximities." In order to lend meaning to the name multidimensional scaling, it can be noted that each of the multiple object points in MDS diagrams can be thought of as dimensions, hence the name multidimensional scaling, whereas the graphical visualisation is represented in a low-dimensional space, typically in two dimensions, or three at most. Descriptions of MDS can be found in advanced marketing research textbooks such as those by Green & Tull (1978) pp. 459-477, or other editions of the same book, including the 2nd edition (Green & Tull, 1970); the 1st edition from 1966 did not include any explicit mentioning of multidimensional scaling. A description of current computer programs for running multidimensional scaling analyses can be found in Borg, Groenen and Mair (2013), which also covers the basics of MDS, or in the manuals of major analytical program packages, for example Meulman & Heiser (2013) and earlier editions.

Important foundations of multidimensional scaling can be attributed to Torgerson (1952), who acknowledged earlier work, including Richardson's (1938), generally from the field of psychology. Shepard (1962) described a computer program capable of doing multidimensional scaling analysis, and offered to make the program available to those who wished to use it. Kruskal (1964), who published his work within the field of psychology or psychometrics, like both Torgerson and Shepard, emphasised MDS based on ranking scales (non-metric ordinal data). However, the scales can also be metric such as rating scales or categorical (nominal scales). Following a *Journal of Marketing Research* article (Green & Carmone, 1969) comparing three different computer programs available at the time, Green & Carmone (1970) wrote a book specifically on "multidimensional scaling and related techniques in marketing analysis." Thus, by 1970, MDS was well on its way into marketing research in general, and from then on it was only a question of time, until the technique would be applied in a travel and tourism research context, see the next section for more information. Paul Green (1975) wrote a review or state of the art of MDS in the general marketing field article, which probably fuelled the uptake of the technique.

In the context of Geographical Analysis, one of the fields somewhat related to tourism, Gould (1969) generated mental maps of the states of the USA, based on a survey, asking respondents to rate and to order the states in terms of preferences as places for living. This is parallel to stated preferences for places as tourist destinations. Respondents found it easier to order or rank the states rather than to give points on a rating scale, but both approaches could be used for generating perceptual or mental maps, somewhat similar to geographical maps. Subjecting nations, which may also be tourism destinations, to MDS studies was done as early as 1970 (Wish, Deutsch & Biener, 1970). None of the mentioned studies were published in a travel or tourism journal, the first of which was founded in 1968 (*Journal of Travel Research*).

2 Applications of MDS in tourism studies

In a paper at the 2nd Travel and Tourism Research Association (TTRA) conference, according to the available abstract, Mayo & Scott (1971) discussed two pilot study applications of multidimensional scaling dealing with air carrier images and destination images, respectively. This was followed two years later by a second conference paper, this time solely by Mayo (1973). At the same conference Anderssen & Colberg (1973) also presented a paper applying MDS, specifically about perceptions of Mediterranean destinations, according to Fenton & Pearce (1988). Mayo (1975) was the first to conduct a study applying multidimensional scaling published in a travel and tourism journal, specifically in the context of the attitudes of tourists toward 10 areas, including National Parks, as vacation destinations. The result was illustrated in a three dimensional graph which included an ideal point. Next, in the very first issue of the first volume of the *Journal of Hospitality & Tourism Research*, Renaghan (1976) described an application of multidimensional scaling in a study of 10 fast food restaurant brands assessed on 14 attributes. The result was illustrated in a graph of two dimensions, which was considered to be enough to limit stress, while solutions of three or more dimensions were considered to be very difficult to visualise. Goodrich (1977; 1978) comprised nine vacation areas, seven of which were in the USA, and 10 attributes. In the former study only the vacation areas were plotted in a graph of two dimensions, while in the latter study the nine destinations were plotted along with the ten attributes in a graph of two dimensions.

The 1980's saw tourism journal articles applying MDS to themes like culture (Kemper, Roberts & Goodwin, 1983), positioning of destinations countries (Husbands, 1983), and positioning of 12 European destination countries, each assessed by 10 attributes (Haahti, 1986). Kemper, Roberts & Goodwin (1983) combined MDS with a clustering technique to group 50 tourist items. A three dimensional solution was illustrated by a series of three graphs, each in two dimensions. The first article reviewing the use of MDS in tourism was written by Fenton & Pearce (1988). Fenton & Pearce (1988, p. 236) were optimistic when they stated that multidimensional scaling "can be used to test hypotheses." In the normal meaning of "testing hypothesis" this has generally not been done in tourism studies by MDS alone, but only by means of supplementary techniques. The 1980's finished with a study on destination images by Gartner (1989), utilising MDS, which remains one of the most cited articles applying "multidimensional scaling" in tourism, see for example, scholar.google.com, along with Baloglu & Brinberg (1997), see the next section. The study by Gartner (1989), which was based on a survey using rating scales, included a MDS diagram showing 15 image attributes and four destinations.

During the 1990s, the published studies applying MDS included the themes of tourist attractions (Fodness, 1990), tourism image assessment (Reilly, 1990; Yiannakis & Gibson, 1993), re-positioning of casino hotels – in Las Vegas (Shoemaker, 1993), positioning of city destinations (Mazanec, 1995), attributes and preferences of hotel food and beverage products (Hong-bumm Kim, 1996), cruises and other holiday types (Moscardo et al., 1996), images of destinations (Baloglu & Brinberg, 1997), user pays strategies in nature-based tourism settings (Burns, 1997), tourists' information search (Fodness & Murray, 1998), perceived attractiveness of destinations (Hong-bumm Kim, 1998), residents' attitudes towards tourism at selected destinations (Lawson, Williams, Young & Cossens, 1998), interest of clusters of potential travellers in Olympic sports (Chalip, Green & Velden, 1999), destination images (Jenkins, 1999, mentioned MDS, but did not actually apply), and vacation styles at an European destination (Zins, 1999).

During the decade 2000-2009, the two main themes of studies applying MDS techniques were positioning (at least six studies) and image (at least four studies). The six positioning studies were on destination positioning (Orth & Turecková, 2002; Kim & Augusa, 2005; Kim, Guo & Agrusa, 2005), relative positioning of destination countries Gursoy, Baloglu & Millar, 2008;

2009), positioning of cities based on online search terms (Wolk & Wöber, 2008), and positioning of online travel agencies (Kim, Kim & Han, 2007). The four studies published 2000-2009 involving image dealt with destination image (MacKay & Fesenmaier, 2000; Murphy, 2000), residents' attitudes to and images of destination development (McNicol, 2004), and image and destination choice (Hong, Kim, Jang & Lee, 2006). Two studies were related to information, namely information search behaviour (Gursoy & Chen, 2000), patterns of information services on hotel websites (Zafiroopoulos et al., 2008). Two studies focused on tourist roles (Foo, McGuiggan & Yiannakis, 2004; Yfantidou, Costa & Michalopoulos, 2008).

Additional studies published 2000-2009 applying MDS included the themes of environmental perceptions and sense of responsibility in tourism (Hashimoto, 2000), destination avoidance and inept destination sets (Lawson & Thyne, 2001), branding (Cai, 2002), categories of visitors' activities (Eftchiadou, 2002), cruise passengers' perceived values (Petrick, 2003), hospitality management competencies and hospitality education (Steed & Schwer, 2003), determination of hotel quality dimensions (Tamagni, Micheli & Zanfardini, 2003), hiking experiences (Chhetri, Arrowsmith & Jackson, 2004), competitive group analysis in local transport (Gimeno & Vila, 2007), customer expectations and attributes of a restaurant's lounge (Christodoulidou, Kincaid & Erdem, 2007), and finally tourists' landscape perceptions and preferences (Fyhri, Jacobsen & Tømmervik, 2009).

Using MDS, in combination with other techniques, Ray Green (2005), who published in a non-tourism journal, studied the perceptions by local residents of tourism development. Outside of the domain of tourism journals, air passenger flows between 28 European metropolitan urban regions was analysed by Burns et al. (2008) using SPSS PROXSCAL; Ahmed & Miller (2007) used the same variant of a MDS program in an analysis and visualisation of the road transportation system of a city.

From 2010 on, the main themes in studies applying MDS has been positioning (at least five studies) and image (at least four studies). The positioning studies dealt with country destinations based on the Travel and Tourism competitiveness Index (Kayar & Kozak, 2010), positioning of countries based on online search terms (Mazanec, 2010), positioning of countries based on time-series of seasonal/monthly bed-night statistics (Marcussen, 2011b), positioning USA in the outbound Chinese travel market (Li et al., 2012), and positioning strategies of airlines (López-Bonilla & López-Bonilla, 2013). The image theme included focus on destination images (Zins, 2010), measuring pictorial and verbal city destination images (Pezenka & Buchta, 2012), positioning of casinos - in Macao (Wong & Wu, 2013), and affective image positioning of hotels - in Las Vegas (Ro, Lee & Mattila, 2013).

Additional tourism studies from 2010 on, applying MDS focused on competitiveness of destinations - at the country level (Leung & Seyhmus, 2013), determinants of tourist spending (Marcussen, 2011a), perceptions of tourism experiences (Ribeiro, 2012), generational theory and tourism consumer behaviour (Li, Li & Hudson, 2013), and identification of authority groups among popular wine blogs (Vrana et al., 2013).

Although not in tourism journals, Lozano & Gutierrez (2011) did an efficiency analysis of 25 EU member states as tourist destinations, applying MDS, and Chen et al. (2013) used MDS in a study of cultural landscape groups, based on photos. Toma & Linca (2013) applied MDS in combination with cluster analysis in a mapping of rural mountain tourism destinations. - A summary of the tourism studies published in tourism journals can be found in Table 1. The corresponding MDS diagram is shown in Figure 1.

Table 1. Selected characteristics of 64 tourism studies published from 1975-2014 applying multidimensional scaling (MDS).

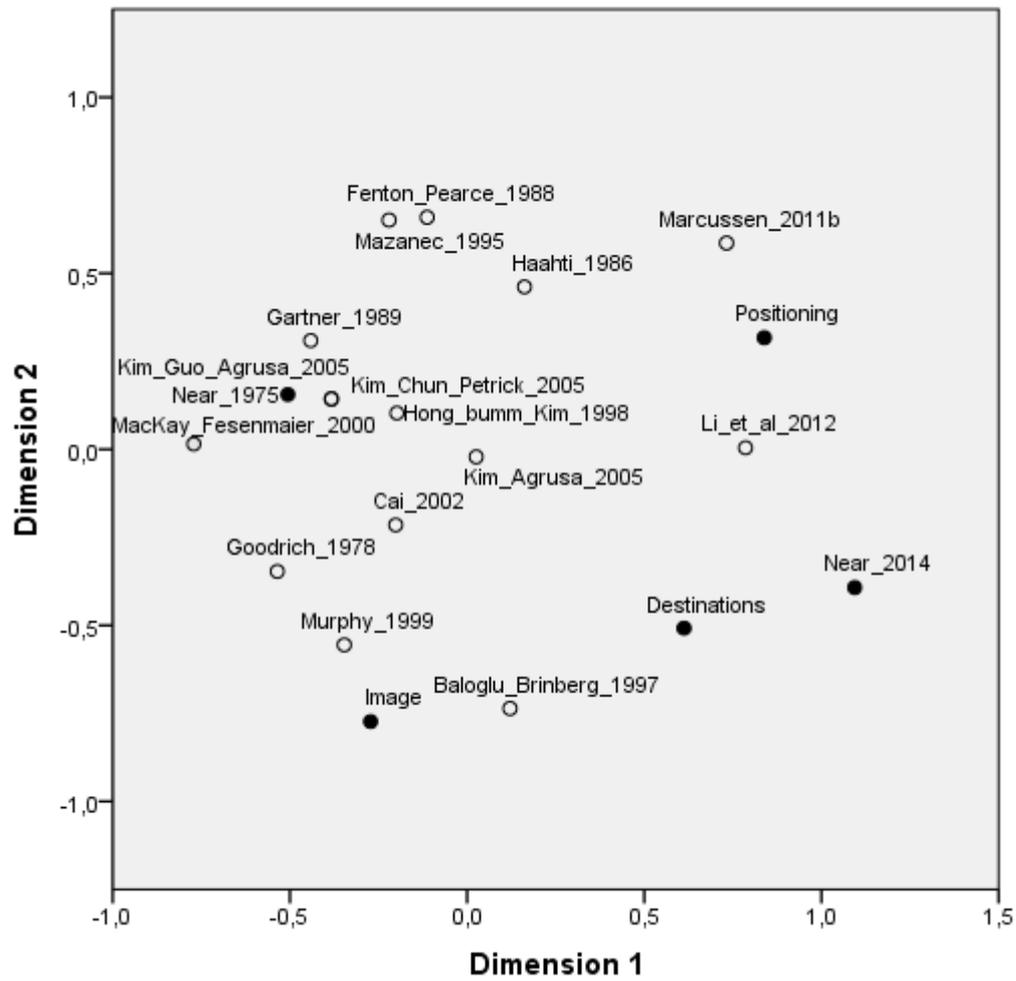
Authors	Themes	Year	Near_2014	Near_1975	Destinations	Image	Positioning	Hotels_food	Information_and_web	JTR	ATR	TM	PROXSCAL	Count
Mayo_1975	National parks	1975	0	39	1	1	0	0	0	1	0	0	0	1
Renaghan_1976	Restaurants	1976	1	38	0	1	0	1	0	0	0	0	0	1
Goodrich_1977b	Regions	1977	2	37	1	0	0	0	0	1	0	0	0	1
Goodrich_1978	Regions	1978	3	36	1	1	0	0	0	1	0	0	0	1
Husbands_1983	Destination choices	1983	8	31	1	0	1	0	0	0	0	0	0	1
Kemper_et_al_1983	Activities, attractions, se	1983	8	31	1	0	0	0	0	0	1	0	0	1
Hahti_1986	Positioning of countries	1986	11	28	1	0	1	0	0	0	1	0	0	1
Fenton_Pearce_1988	Review	1988	13	26	0	0	0	0	0	0	1	0	0	1
Gartner_1989	Destinations and activiti	1989	14	25	1	0	0	0	0	1	0	0	0	1
Fodness_1990	Attractions	1990	15	24	0	0	0	0	0	1	0	0	0	1
Reilly_1990	Destination image	1990	15	24	1	1	0	0	0	1	0	0	0	1
Shoemaker_1993	Hotels	1993	18	21	0	0	1	1	0	0	0	0	0	1
Mazanec_1995	Cities	1995	20	19	1	0	1	0	0	0	0	0	0	1
Hong_bumm_Kim_1996	Food & beverage	1996	21	18	0	0	1	1	0	0	0	0	0	1
Moscardo_et_al_1996	Cruising	1996	21	18	0	0	1	0	0	0	0	0	0	1
Baloglu_Brinberg_1997	Destination images	1997	22	17	1	1	0	0	0	1	0	0	0	1
Burns_1997	Nature based tourism	1997	22	17	1	0	0	0	0	0	0	0	0	1
Chalip_et_al_1998	Events	1998	23	16	0	0	1	0	0	0	0	0	0	1
Fodness_Murray_1998	Information search	1998	23	16	0	0	0	0	1	1	0	0	0	1
Hong_bumm_Kim_1998	Destinations	1998	23	16	1	0	0	0	0	0	1	0	0	1
Lawson_et_al_1998	Residents' attitudes	1998	23	16	1	0	0	0	0	0	0	1	0	1
Jenkins_1999	Destination images	1999	24	15	1	0	0	0	0	0	0	0	0	1
Murphy_1999	Destination image	1999	24	15	1	1	0	0	0	0	0	0	0	1
Zins_1999	Vacation styles	1999	24	15	1	0	1	0	0	0	0	0	0	1
Hashimoto_2000	Environmental perceptio	2000	25	14	1	0	0	0	0	0	0	0	0	1
MacKay_Fesenmaier_2000	Destination image	2000	25	14	1	1	0	0	0	1	0	0	0	1
Lawson_Thyne_2001	Destinations	2001	26	13	1	1	0	0	0	0	0	0	0	1
Cai_2002	Branding	2002	27	12	1	0	0	0	0	0	1	0	0	1
Orth_Turecková_2002	Destination positioning	2002	27	12	1	0	1	0	0	0	0	0	0	1
Petrack_2003	Cruising	2003	28	11	0	0	0	0	0	0	0	0	0	1
Tamagni_et_al_2003	Hotels	2003	28	11	0	0	0	1	0	0	0	0	0	1
Chhetri_et_al_2004	Nature based tourism	2004	29	10	1	0	0	0	0	0	0	1	0	1
Foo_et_al_2004	Tourist roles	2004	29	10	0	0	0	0	0	0	1	0	0	1
McNicol_2004	Residents' attitudes	2004	29	10	1	1	0	0	0	0	0	0	0	1
Green_R_2005	Residents' attitudes	2005	30	9	1	0	0	0	0	0	0	0	0	1
Kim_Agrusa_2005	Destination positioning	2005	30	9	1	0	0	0	0	0	1	0	0	1
Kim_Chun_Petrack_2005	Destination positioning	2005	30	9	1	0	1	0	0	0	0	1	0	1
Kim_Guo_Agrusa_2005	Destination positioning	2005	30	9	1	0	1	0	0	1	0	0	0	1
Hong_et_al_2006	Destination images	2006	31	8	1	1	0	0	0	0	0	1	0	1
Christodoulidou_et_al_2007	Restaurants	2007	32	7	0	0	1	1	0	0	0	0	0	1
Jimeno_Vila_2007	Cities, transport	2007	32	7	0	0	1	0	0	0	0	0	0	1
Kim_Kim_Han_2007	Online travel agenices	2007	32	7	0	0	1	0	1	0	0	1	0	1
Pan_Ryan_2007	Gender	2007	32	7	1	0	0	0	0	1	0	0	0	1
Wolk_Wöber_2008	Cities	2008	33	6	1	0	0	0	0	0	0	0	1	1
Yfantidou_et_al_2008	Tourist roles	2008	33	6	1	0	0	0	0	0	0	0	1	1
Zafiropoulos_et_al_2008	Hotel websites	2008	33	6	1	0	0	1	0	0	0	0	0	1
Fyhri_et_al_2009	Nature based tourism	2009	34	5	1	0	0	0	0	0	0	0	0	1
Gursoy_et_al_2009	Destination positioning	2009	34	5	1	0	1	0	0	0	0	0	0	1
Tsai_2009	Destination images	2009	34	5	1	1	0	0	0	0	0	0	0	1
Kayar_Kozak_2010	Destination positioning	2010	35	4	1	0	1	0	0	0	0	0	0	1
Mazanec_2010	Destinations online	2010	35	4	1	0	0	0	0	1	0	0	0	1
Zins_2010	Destination images	2010	35	4	1	1	1	0	0	0	0	0	0	1
Marcussen_2011a	Destinations, spending	2011	36	3	1	0	0	0	0	0	0	0	1	1
Marcussen_2011b	Destination positioning	2011	36	3	1	0	1	0	0	0	0	0	1	1
Ilona_Christian_2012	Destination images	2012	37	2	1	1	0	0	0	0	0	0	0	1
Li_et_al_2012	Destination positioning	2012	37	2	1	0	1	0	0	0	0	0	0	1
Ribeiro_2012	Perceptions of experienc	2012	37	2	0	0	0	0	0	1	0	0	0	1
Leung_et_al_2013	Destination positioning	2013	38	1	1	0	1	0	0	0	0	0	0	1
Li_Li_Hudson_2013	Generational theory	2013	38	1	1	0	0	0	1	0	0	1	0	1
Ro_et_al_2013	Hotels	2013	38	1	1	1	1	1	0	0	0	0	0	1
Vrana_et_al_2013	Wine blogs	2013	38	1	0	0	0	1	1	0	0	0	0	1
Wong_et_al_2013	Casinos	2013	38	1	1	0	1	1	0	0	0	0	0	1
Yin_Jen_et_al_2013	Residents' attitudes	2013	38	1	1	0	0	0	0	0	0	0	0	1
Chiang_et_al_2014	Generational theory	2014	39	0	1	0	0	0	1	0	0	0	0	1
Total, 64 articles on MDS					48	14	22	9	5	13	7	6	4	64

interpretation, especially in cases with relatively many (i.e., more than 20) object points. The MDS variant PROXSCAL from IBM SPSS Categories has been applied throughout this study.

The 75 object points in Figure 1 represent 64 articles (circles) and 11 selected aspects of these (black dots). The 11 selected aspects are object points representing the first and the last year, 1975 and 2014; the five destination themes, image, positioning, hotels-casinos-restaurants, information/web; and the three journals: Journal of Travel Research, Annals of Tourism Research and Tourism Management. The 11th reference point in Figure 1 represents a certain variant of a MDS program, i.e., PROXSCAL found in SPSS Categories from 1999 on. Articles which comprise one or more of the same aspects are positioned relatively close to each other by the MDS program, given the coding of the variables in the data matrix, which in this case consists of 64 selected rows (one for each article) and 64+11=75 variables (columns). Among the 64 articles, 48 concerned the theme destinations, 22 positioning, and 14 concerned the theme image, 9 hotels, casinos, restaurants, food/wine, 5 contained information and the Internet. Thirteen references were from Journal of Travel Research, 7 from Annals of Tourism Research, and 6 from Tourism Management.

An object point in the MDS diagram of Figure 1 represents each variable. The horizontal dimension reflects time, i.e., the year of publication, with the eldest articles to the left, and the most recent ones to the right. Apart from the different aspects, references in one article to others in the included articles also helps to position the object points in relation to each other. In the coding, references in a given article to other studies are recorded in the columns. In effect, the references from other writers to specific studies appear in the rows. In Figure 2, the minimum sum of references from and to other articles is five. In both Figure 1 and Figure 2, the horizontal axis, dimension 1, can largely be interpreted as the time line, which is suitable for the MDS analysis of the result of the literature review. Since there are several references to and/or from each article in Figure 2, the diagram could have been generated even without any of the five reference points. In Figure 2, Kim, Guo & Agrusa (2005) and Kim, Chun & Petrick (2005) occupy the same position, so one of the 20 object points is "double." Obviously, rather than studies, the object points of Figure 1 and 2 could have been specific destinations, brands or other objects.

Figure 2. Multidimensional scaling diagram with 15 selected tourism studies applying MDS and 5 descriptors.



Note: Objects: 15+5=20. Dispersion accounted for: 0.9627.

3 Multidimensional scaling (MDS) and other techniques

Correspondence analysis (actually multiple correspondence analysis, MCA for short) is related to factor analysis and is also similar to multidimensional scaling (MDS). Both MCA and MDS can be used to visualise data in the form of perceptual maps, typically a graph in two dimensions, but sometimes in three dimensions. Correspondence analysis works on categorical data, but so can MDS. Indeed, MDS can be run on datasets only consisting of categorical data. Therefore, in some cases where MCA is used, MDS may have been used instead. For an introduction to both techniques, see chapter nine, "Multidimensional Scaling and Correspondence Analysis" in Hair et al. (2010) or similar textbooks.

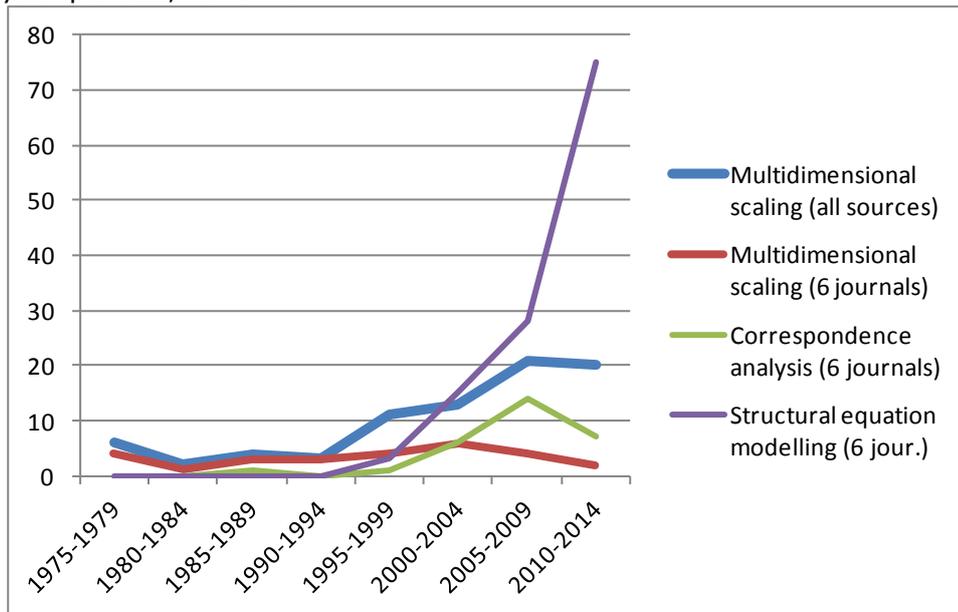
The most cited article on correspondence analysis in travel and tourism journals is written by Calatone et al. (1989), who tackled the issue of multiple origins, multiple destinations and multiple attributes in the context of tourist market communication and positioning. A series of studies involving Chen, which utilise correspondence analysis, have been published (Chen, 2000; Guesoy & Chen, 2000; Chen, 2001; Chen & Uysal, 2002). Based on a large survey, Chen (2000) did a correspondence analysis covering travellers from three different European countries, four different travel purposes and 12 different information sources. A diagram in two dimensions showed how the $3 \times 3 = 9$ segments related to the 12 information sources. Chen (2001) did a study on Korean outbound travellers' destination images by using correspondence analysis. Chen (2001) included six destinations (different parts of the world) and 12 attributes or image assessment criteria, which were plotted jointly in a scatter diagram of two dimensions. Chen & Uysal (2002) did a market positioning analysis in which 10 American states were positioned in relation to each other and in relation to 17 attributes. Arimond & Elfessi (2001) used multiple correspondence analysis followed by cluster analysis in the context of tourist market segmentation. Beldona, Morrison & O'Leary (2005), used correspondence analysis in a study of six online shopping motives and eight pleasure products, distinguishing between high and low user skill levels. Kim & Morrison (2005) used MCA - in combination with other techniques - and illustrated the effect on the image of Korea of a major sport event by different demographic characteristics.

Since MCA, just like MDS, is a descriptive technique, Chen & Uysal (2002) supplemented their MCA analysis by logistic regression analysis, to detect cognitive variations between American states as competing destinations. Indeed, many MDS studies supplement the descriptive or explorative diagrams by other techniques capable of testing hypothesis. Pan, Chon & Song (2008) analysed hundreds of travel trade articles and uncovered tourism trends. The results were visualised by means of correspondence analysis. Pan & Ryan (2009) also conducted content analysis utilising correspondence analysis. Further studies utilising correspondence analysis have investigated generational preferences for trip planning resources (Chaing et al., 2014), destination image (Hsu & Song, 2012; Pratt, 2013), and stars as hotel quality indicators (Nunez-Serrano et al., 2014). Richards & van der Ark (2013) applied MCA in a study of dimensions of cultural consumption among tourists and showed that market segments can be visualised.

Until and including part of 2014, in the six major tourism journals (Tourism Management, Journal of Travel Research, Annals of Tourism Research, Tourism Analysis, Journal of Travel & Tourism Marketing, and Tourism Economics), a total of 27 articles mentioning "multidimensional scaling," 29 articles mentioning "correspondence analysis" and 121 articles mentioning "structural equation modelling" in the title, abstract or key words were published. Figure 3 illustrates how these numbers are spread by five-year periods over the last 40 years. SEM includes both covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM). CB-SEM is the traditional and most commonly used variant of SEM, while PLS-SEM is less restrictive with regard to data assumptions and has found its way into tourism literature (e.g., Asaker, Huang & Hallak, 2012). Most of the travel and tourism journal studies applying MCA or Structural Equation Modelling (SEM) have been published in this century, unlike tourism

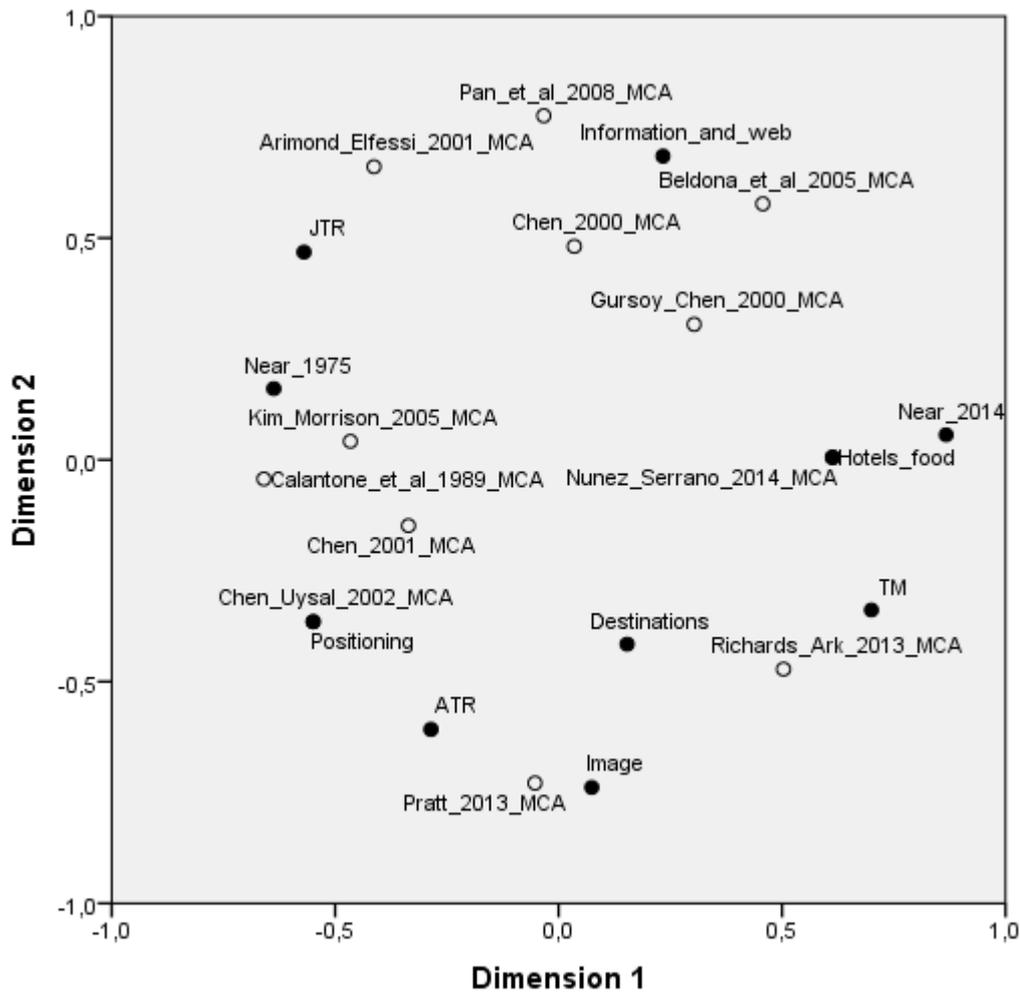
studies applying MDS, which originated in the 1970's. Since the second half of the 1990's the number of studies applying MDS have been higher in other journals than in the previously mentioned six selected travel and tourism journals.

Figure 3. Number of articles on multidimensional scaling (MDS) in tourism overall, and on MDS, correspondence analyses and structural equation modelling in six selected journals by 5-year periods, 1975-2014.



By 2014 the accumulated number of published tourism studies applying correspondence analysis matches those applying multidimensional scaling. Figure 4 shows how the cited tourism articles applying correspondence analysis are positioned in relation to each other. The main focus of this paper is on multidimensional scaling and therefore no attempt is made to make an exhaustive review of all the tourism articles that have applied correspondence analysis.

Figure 4. Multidimensional scaling diagram with 12 tourism studies applying correspondence analysis and 10 descriptors.



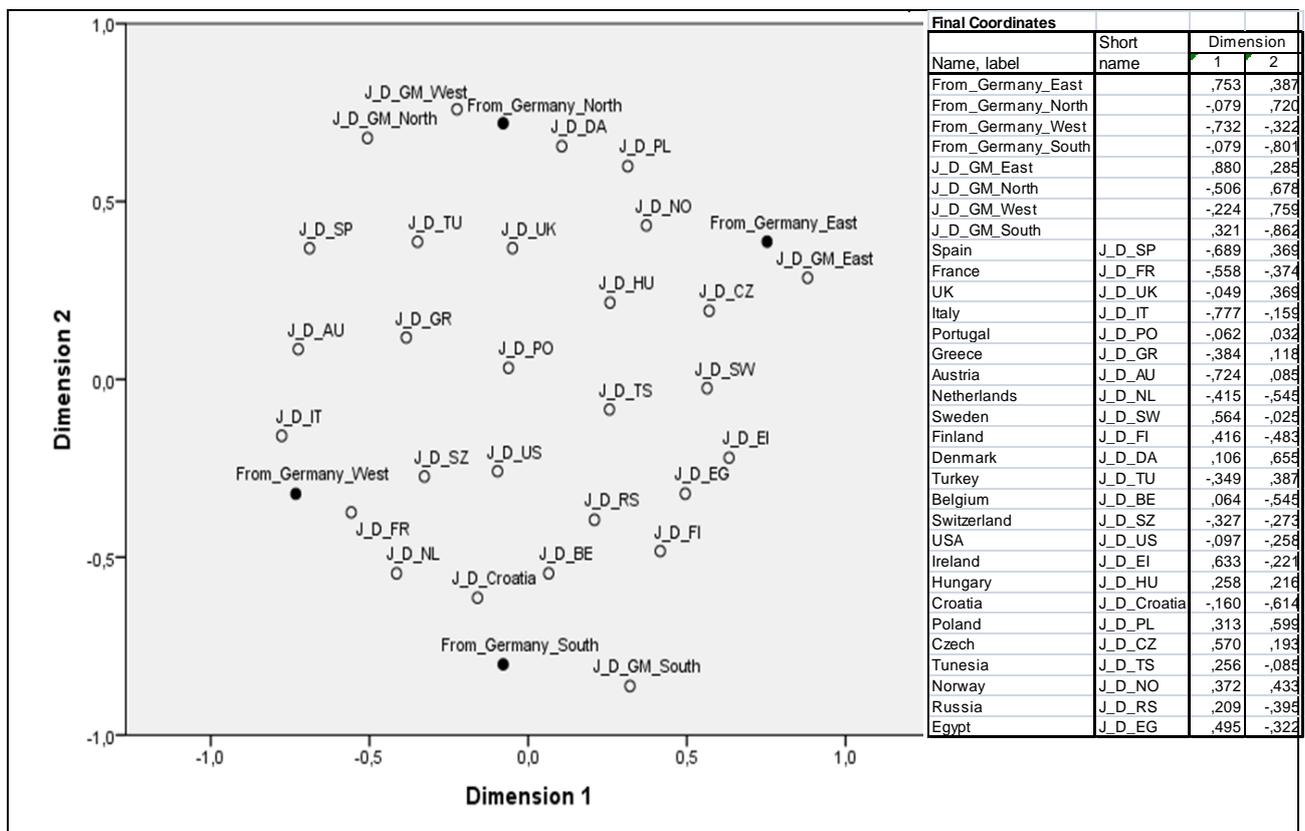
Note: Objects: 12+10=22. Dispersion accounted for: 0.9191.

4 Example of MDS: Positioning of country destinations in the regions of the German tourism market

Positioning analyses is one of the main application areas for MDS in tourism studies. The below MDS diagram illustrates how 24 different foreign country destinations and 4 domestic destination regions tend to be chosen by overnight tourists originating from the east, north, west and south parts of the German tourist market for journeys of at least 5 nights in duration. The dataset consists of 37,579 journeys of at least 100 km generally with at least one night of overnight stay undertaken by German tourists (travellers). Unfortunately, the data is not recent, but for illustrative purposes it will do. At least to some extent, travel patterns are rather stable over long periods of time, and, in any case, annual changes (such as a gradual shortening in the length of stay) may be tracked based on aggregated data published by Eurostat, national statistical authorities, and the German Travel Association, to which readers in need of up to date aggregated data and trends are referred. The survey was completed in

2002 as part of an EU-project finished in 2004 called DATELINE, Design and Application of a Travel Survey for Long-distance Trips Based on an International Network of Expertise. The survey can be considered a forerunner to some of the current harmonized Eurostat data on travel and tourism. Results from the German portion of the utilized survey can be summarised as follows: 74% of journeys had holiday as the purpose, 20% private, 6% business; 59% travelled by car; 20% of journeys lasted up to three nights while the average length of stay was 9.7 nights; average distance to the destination was 930 km (one way); average party size was 3.24; 30% came from east (the new states of Germany), 18% from north, 30% from west, 23% from south of Germany; and 43% travelled in June, July or August. One previously published study (Marcussen, 2011a) has utilized the same survey, but it did not include any MDS application.

Figure 5. Position of 24 country destinations and 4 domestic destinations in 4 origin regions of the German tourist market.



Note: Objects: 28+4=32. Dispersion accounted for (DAF): 0.8579.

The abbreviation "J_D_" in Figure 5 stands for journey destination. The initial configuration of the objects in the MDS diagram was not entirely satisfactory, since north was down and south was up. This was changed easily, by multiplying the Y-coordinates by -1. Furthermore, the positions of the object points were refined (recalculated by means of trigonometry) so that "from north" was placed exactly above "from south," i.e., with identical X-coordinates (dimension 1), but with the relative position of the object points and the proportion of dispersion accounted for unchanged. Figure 5 can be interpreted as follows: those from southern Germany tend to stay in southern Germany, if travelling domestically for a journey. Those from northern Germany tend to go to northern or western Germany, if travelling domestically; and those from eastern Germany tend to stay in eastern Germany for domestic travelling even with overnights stays. Those from western Germany are less likely to stay in

Germany, but are more likely to choose foreign destinations, like Italy, France, the Netherlands, Austria or Switzerland. Croatia is a relatively popular destination for those from southern Germany, as a driving destination. Spain, Turkey and the UK are relatively popular destinations among travellers from the north and west of Germany, as flying destinations. Denmark and Poland are relatively popular destinations for Germans from the north, while the Czech Republic, Norway and Sweden are relatively popular destinations among tourists from the east of Germany. More distant destinations like the United States and Russia appear to be more likely to be visited by tourists from the south and the west of Germany than from the north and the east. Obviously, distance plays a great role in destination choice, most notably for driving destinations. Which destinations that appear to be competing, is also reflected in Figure 5. For foreign destinations, the nearest competing destination is typically a nearby domestic destination. Those foreign destinations, which appear to be the nearest competitors, are typically neighbouring countries or countries neighbouring the same part of the origin market, in this case Germany. This holds true for typical driving destinations. For flying destinations, typically destinations are further afield, the nearest competitors are also visible in Figure 5, e.g., Spain, Turkey, Greece, Portugal, Tunisia and Egypt. All in all, MDS diagrams, certainly for illustrating positioning of tourist destinations either overall or in specific markets or regions of specific markets, are capable of summarising a lot of information in a meaningful and potentially useful way.

5 Conclusion

In multidimensional scaling analyses, the object points or variables are multiple, hence the name multidimensional scaling, whereas the number of dimensions in the graphical representation is typically limited to two dimensions, or three dimensions at most. Methodologically, MDS is not a probability model, and therefore it cannot be used to test hypotheses. If hypotheses need to be tested, other methods must be applied, either instead of or as a supplement to MDS. In recent years, structural equation modelling (SEM), has become popular, not least in tourism related studies. Unlike MDS, SEM allows for the testing of hypotheses. However, in studies of the relative positions or images of comparable destinations MDS is a commonly used and useful tool. Perhaps, because of its origin in psychology and psychometrics, non-metric MDS has been frequently used, as in the case in marketing research and in tourism research. But in the latter two disciplines, or certainly in the context of tourism studies, rating scales and categorical (nominal) scales are actually more commonly used and therefore metric MDS is more relevant than non-metric MDS in most tourism related studies. When applying MDS techniques and programs, it is not necessary to compare each variable directly with each of the other variables, for example destinations, or journal articles. Instead, each object of interest (destination, or journal article) can be assessed by a scale such as a 1-5 rating scale (i.e., an interval scale), or 0-1 classifications (nominal scales). The MDS program, in relation to the assessment dimensions, then positions each object of interest. In this way the objects of interest are also positioned in relation to each other, although they have only been compared indirectly. Drawing a parallel to the classical MDS example of using distances between US cities as a basis for constructing a MDS diagram, the indirect or alternative way of positioning objects of interest in relation to each other would be to use the coordinates of each city instead of the distances between the cities as input. Obviously, if objects of interest (such as destinations) are assessed on many different dimensions, compromises will need to be made, minimising stress, if the positioning of destinations or other objects of interest is to be illustrated in a normal two-dimensional graph.

Technically, i.e., by the use of trigonometry, it is possible to change the position of the object points, without changing their distance to the origin and to each other, for example so that the "time line" or another central dimension such as the east-west dimension would become exactly horizontal (or exactly vertical for the north-south dimension). This can be done by recalculating the positions of all the object points, and then read the new positions into the

graphical facility of the MDS program or into a separate graphics program. Also, some MDS programs allow for the turning of diagrams including MDS diagrams 90, 180 or 270 degrees by clicking an icon. Obviously, simple manipulations can be undertaken such as turning the X axis or the Y axis 180 degrees by multiplying the X coordinates or the Y coordinates by -1 and then rereading the coordinates of the object points into the graphics interface.

Segmentation appears to be a common theme in studies applying correspondence analysis (see for example, Arimond & Elfessi, 2001 and Richards & Ark, 2013), whereas segmentation is not a typical theme in studies applying multidimensional scaling. Apart from this, the themes in tourism studies applying the two techniques are similar and both produce visualisations of data.

The applications of MDS in tourism studies are wide ranging and fairly numerous. Now, however, the usage of structural equation modelling, a technique capable of testing hypotheses, in tourism studies far exceeds the number of studies using MDS and MCA combined. MDS has its advantages as well, though, such as ease of use and interpretation and its ability to simultaneously and instantly illustrate the proximity of all variables. A MDS diagram may indicate which destinations are similar, and thereby competitors. However, competing destinations, within or across national boundaries, are also potential partners. Similar destination may join forces on a selective basis, for example at international tourism fairs (such as International Tourismus Börse in Germany, ITB Berlin), or at online platforms, in order to jointly become more visible in national, international or global market places.

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