Identifying Peer Institutions Using Cluster Analysis

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ABSTRACT

The New York Institute of Technology's (NYIT) School of Management (SOM) wishes to develop a list of peer institutions for the purpose of benchmarking and monitoring/improving performance against other business schools. The procedure utilizes relevant criteria for the purpose of establishing this peer group by way of a cluster analysis. The resulting outcomes suggest five schools that the SOM intends to use for this purpose. The analysis can be extended to also determine the SOM competitive set as well as aspirant schools.

Keywords: Management; Quantitative Methods; Analysis; Education

INTRODUCTION & LITERATURE REVIEW

Towards the attainment and maintenance of professional accreditations such as those administered by the Association to Advance Collegiate Schools of Business (AACSB) and the Quality Assurance Authority for Education and Training (QAAET), the SOM at NYIT wishes to identify with a peer group of schools/colleges of business. Establishing this peer group will allow the SOM to validate its competitiveness and relevance in those communities within which it delivers its academic programs. One commonly utilized methodology, and that which is employed here, is Cluster Analysis, which is a means of separating schools into similar or homogeneous groups on the basis of the selected empirical measures (Johnson, 1967). In applying this methodology, the SOM has identified dimensions/institutional characteristics that result in the creation of a homogeneous subset representing its peers.

Cluster Analysis has been commonly employed historically within academic institutional research as it allows for multiple criteria to be chosen and evaluated against potential peers and aspirants (i.e. cases) to determine the strongest groupings within a universe of cases considered. For example, the US Law School Admission Council/Law School Admission Service (http://www.lsac.org/) has used, among other techniques, a cluster analysis study to ascertain its peers. SUNY Albany[1] employed a cluster analysis of peer institutions to examine requisite funding requirements and performance measures. While there are numerous clustering methods available such as Q-mode factor analysis, multidimensional scaling, and latent class analysis, a hierarchical cluster analysis method has been employed here because it is appropriate for smaller samples. In addition, hierarchical methods are robust and avail themselves to user friendly software, making this an accessible methodology to a wide variety of researchers across a variety of fields[2]. This is not to suggest that alternative benchmarking methodologies are underutilized. For example, survey analyses are also commonly employed, such as that developed jointly by The Wharton School, Emory University, and The Monitor Group and utilized at Penn State (Smeal College of Business Administration and the School of Information Sciences and Technology) to identify which e-business models are employed successfully in industry[3].

[1]Szelest, B. P. (1996) "In search of peer institutions: Two methods of exploring and determining peer institutions," Proceedings of the Annual Conference of the Northeast Association for Institutional Research (Princeton, NJ). (ERIC Document Reproduction Service No. ED432186)

[2] *Kolsky, J. (1997) Interpreting Cluster Analysis: Interpreting Results from Cluster Analysis. CAMO: http://www.camo.com/rt/Resources/infodoc/Interpreting_Cluster_Analysis.html*

[3] http://www.smeal.psu.edu/cdt/ebrcpubs/papers/benchmark/ebizquestionnairesummary.pdf ;

The selection of peer (and aspirant) organizations for benchmarking is not limited to an academic setting. For example, financial organizations such as MetLife utilize benchmarking against peers to support their employee benefit policies[4] and actively maintain a benchmarking tool online. Zacks SEC Compliance Service Group utilizes "peer group selection as an important factor in compensation and company performance evaluation"[5]. NASA and the US Navy engage in benchmarking of safety practices aboard manned spacecraft and submarines[6]. In the hospitality sector, benchmarking against peers has been used for measuring the efficiency of hotel chain managers (Morey and Dittman, 2003)[7]. The governmental sector, specifically, the National Achieves and Record Administration, have created and utilized questionnaires to identify relevant factors for the purpose of identifying and implementing best-practice record keeping requirements in new systems design[8]. In many cases company sponsored whitepapers are also available that highlight the importance of benchmarking against peers (Dumford, 2008)[9]. Recent applications for cluster analysis include its application to online delivery services such as Facebook.com to cluster people into different groups and track weights of friendships, influencing the effectiveness of news feed and content delivery towards that from "people they are closer with"[10], and internet auctions, related to the heterogeneity of price evolution in eBay auctions.[11]

The manuscript proceeds as follows. Section 2 provides a brief overview of the methodology, the dataset development, and variable selection. The results, conclusions and implications for future research are presented for the NYIT-SOM in section 3.

METHODOLOGY

Inherent to the hierarchical cluster analysis approach is the development of criteria for comparison between schools. Hence the first step of this procedure was to consider which institutional characteristics should be used to narrow down the universe of institutions, which is extensive and includes many institutions that are fundamentally different from New York Institute of Technology. The resulting group is referred to as the preliminary set. Once established, the clustering analysis implements selection criteria to establish the subset of this preliminary set that are considered peer schools, or those that are highly comparable to the NYIT-SOM (target school).

Nominal variables were used as institutional criteria, and included institutional level, institutional control, postsecondary/Carnegie classification and Title IV indicators, and religious affiliation; each readily accessible in IPEDS[12]. As an example, the NYIT SOM offers four year degree programs in addition at Master's level programs, is a private and not-for-profit institution, a Title IV postsecondary institution, and is non-religiously affiliated. Additional detail concerning how these four criteria were employed, to narrow the universal set to a preliminary set, is presented in Appendix A. The resulting preliminary set includes 714 schools. One additional screening factor was subsequently employed, narrowing the set according to its accreditation status with the AACSB. That is, schools that had not attained AACSB accreditation were removed from the preliminary set. This is a common approach for identifying peer schools when pursuing AACSB accreditation[13]. A final preliminary set of ninety eight schools

[4] http://whymetlife.com/downloads/MetLife_Benchmarking_Report.pdf ; http://whymetlife.com/benchmarkingtool/

[5] Zacks SEC Compliance Service Group; Zacks Investment Research: http://nt8.zacks.com/zackscharts/page.aspx?code=faq

[6] http://www.hq.nasa.gov/office/hqlibrary/ppm/ppm13.htm

[7] Morey, R. C. and Dittman, D. A. (2003) "Evaluating a hotel GM's performance: a case study in benchmarking, *Cornell Hotel & Restaurant Administration Quarterly*, V.44 (October 2003), pp. 53-59.

[8] http://www.archives.gov/records-mgmt/pdf/bpa-benchmarking-appendix-b.pdf ; http://www.archives.gov/records-mgmt/pdf/bpa-benchmarking-appendix-b.pdf

[9] Dumford, S. (2008) "Benchmarking : How to Make the Best Decisions for Your Practice," Nuesoft Technologies Inc: http://www.nuesoft.com/pdf/white-paper-benchmarking.pdf

[10] http://www.forbes.com/sites/kashmirhill/2010/10/07/mark-zuckerberg-talks-about-facebooks-co-efficient-in-the-least-creepy-way-possible/

[11] Jank, W. and Shmueli, G. (2009) "Studying Heterogeneity of Price Evolution in eBay Auctions via Functional Clustering," *Handbooks in Information Systems*, V.3, Adomavicius and Gupta (Editors), Emerald Group Publishing: http://www.rhsmith.umd.edu/faculty/wjank/AuctionProfiling-AlokBook.pdf

[12] Integrated Postsecondary Education Data System; U.S. Department's National Center for Education Statistics (NCES): http://nces.ed.gov/ipeds/

[13] The Benchmark of Quality for Business Education Worldwide; Initial Accreditation Handbook by AACSB: http://www.aacsb.edu/accreditation/initial_accreditation_handbook.pdf

obtains, provided in Appendix B.

Towards implementing the hierarchical cluster analysis to narrow the preliminary set and create the cluster groups the appropriate selection variables used to characterize the schools were established by utilizing inputs gathered from:

1) Questionnaires/feedback distributed and collected among students of different universities as well as employers;
2) Similar studies conducted elsewhere;
3) Communication with other schools including Adelphi University, Colombia University and New York University; and
4) The NYIT-SOM Dean, Business Advisory Board, Student Advisory Board, Faculty and Administration.

Appendix C lists the nineteen selection variables chosen result of the consensus of the aforementioned sources. The collection of data for each of the nineteen selection variables across the 98 schools in the preliminary set included surveying data from the AACSB, IPEDS, US News and World Report, Business week for B-schools, Peterson's Four Year College Guides, among others

Methodology for analysis followed an established "between-linkage," or "average linkage" approach, incorporating Minkowski measures to define the degree of similarity between both individual cases and also individual cases and clusters, as clusters are formed. In general, the following formula applies in determining the distance between two cases/points, *s* and *t*, each having *n* attributes:

$$d_{st} = \sqrt[p]{\sum_{j=1}^{n} \left| x_{sj} - x_{tj} \right|^p}$$

The reader will note that for $p = 1, 2$ the aforementioned formula results in the rectilinear and Euclidean distances, respectively. For the purpose of this analysis, we chose to employ the rectilinear distance.

The methodology proceeded as follows: (a) each case, which is associated by its own distinctive vector in *n*-space (e.g. *n* selection variables), is compared, pairwise, with each other case by calculating the Minkowski distance, (b) A first cluster is created by grouping together the two cases from the $n \times n$ resulting proximity matrix that represents the minimum distance, (c) the pairwise comparison between this resulting cluster and all other cases (or other clusters) is recalculated, and (d) the proximity matrix is revised and steps (b) – (d) are repeated. That is, the hierarchical approach continues to compare, on a pair-wise basis, all remaining cases and clusters, identifying the two most similar observations that are not in the same cluster and combining their clusters. The methodology is also agglomerative, under which cluster continues to expand until no two clusters fall within a pre-specified tolerance distance, at which the procedure terminates. The final agglomeration schedule also provides correlation coefficients.

The size of the cluster that is desired is determined by the project manager. For example, an institutional research unit at a University might suggest that a peer group of at least 5 to 6 schools be established. Hence as an alternative to setting the threshold for the agglomeration of clusters, the analysis might proceed until an ex-ante declared cluster size is reached including the target school.

The methodology is facilitated by available in software packages, such as SPSS, which is utilized for this analysis. Figure 1 is a variable input screen; Figure 2 is a methodology screen where the user specifies the method of analysis, distance measure and standardization. Results of the analysis are typically displayed in a dendogram, shown in Figure 3.

RESULTS, CONCLUSIONS AND IMPLICATIONS FOR FUTURE RESEARCH

As noted earlier, data for the analysis was extracted from IPEDS, US News and World Report and AACSB database tools. The initial preliminary set included 714 Universities when filtered for institutional level, institutional control, details regarding religious affiliation, postsecondary and Title IV institution indicator. Further elimination schools that did not hold AACSB accreditation resulted in a final preliminary set of 98 universities that were considered in the hierarchical cluster analysis. The cluster analysis then returned five (5) peer schools, which are shown in Appendix D.

As a result of this analysis the NYIT-SOM will extend its effort towards utilizing data from its peer schools as benchmarks to guide its continuous development effort. This includes setting targets for performance, prioritizing its efforts towards those areas where improvement is required, and ascertaining how organizational strengths and opportunities might be used to develop distinctive competencies to strengthen its position in the competitive set of schools and market.

This methodology can be easily adapted to meet the needs of other Universities and Colleges. In addition, adaptations can also result in extensions to this study when choosing aspirant schools or the competitive set of schools.

AUTHOR INFORMATION

Dr. Boronico holds the Ph.D. in Operations Research from the Wharton School of Business at the University of Pennsylvania. He previously attained the Bachelor of Science degree in Mathematics and the Master of Science Degree in Mathematics, Operations Research specialization, at Fairleigh Dickinson University. He currently serves as the Dean of the College of Business at the School of Management at the New York Institute of Technology, and holds the rank of Professor. Previous appointments include serving as the Dean of the Christos M. Cotsakos College of Business at William Paterson University, where he successfully led the College to its attainment of AACSB accreditation (2004).

He is an active member of *INFORMS* and the *Decisions Sciences Institute*. He serves on the editorial board and is an ad hoc reviewer for numerous academic journals, and has published over thirty five manuscripts in peer-reviewed academic journals, including *Production and Operations Management*, *Omega*, and the *European Journal of Operations Research*. He is a co-author of *Computer Simulation in Operations Management* and the editor of *Studies in the Strategy and Tactics of Competitive Advantage: Management in the New Millennium*. He is a member of *MENSA* and has consulted for the United States Postal Service and State Highway Authorities. E-mail: jboronic@nyit.edu

Shail S.Choksi, raised in Gujarat, India, started an E-commerce business at age of 16 and was youngest Information Technology consultant for State Government in India. He received Rajiv Gandhi award for youngest achiever in IT, "Rajiv Gandhi Rastriya Ekta Samman" from All India National Unity Conference and nominated for Godfrey Philips Bravery Award for outstanding achievement in innovation. He earned Bachelor in Commerce with Accountancy specialization from Gujarat University (India) and MBA with Finance specialization from New York Institute of Technology. He is the founder of Indian Graduate Students Association (IGSA) in NYIT and also received an award for Outstanding Service to MBA. E-mail: schoksi@nyit.edu

APPENDICES

Appendix A: Preliminary Group of Universities – Institutional Characteristics

A) Level of Institution (NYIT - 4 Years or higher): A classification of whether an institution's programs are 4-year or higher (4 year), 2-but-less-than 4-year (2 year), or less than 2-year.

B) Institutional Control (NYIT - Private not-for profit institution): A classification of whether an institution is operated by publicly elected or appointed officials or by privately elected or appointed officials and derives its major source of funds from private sources.

- Public institution - An educational institution whose programs and activities are operated by publicly elected or appointed school officials and which is supported primarily by public funds.
- Private not-for-profit institution - A private institution in which the individual(s) or agency in control receives no compensation, other than wages, rent, or other expenses for the assumption of risk. These include both independent not-for-profit schools and those affiliated with a religious organization.
- Private for-profit institution - A private institution in which the individual(s) or agency in control receives compensation other than wages, rent, or other expenses for the assumption of risk.

C) Postsecondary and Title IV institution indicator (NYIT - Title IV postsecondary institution):

- Title IV postsecondary institution
- Non-Title IV postsecondary institution
- Title IV NOT primarily postsecondary institution
- Non-Title IV NOT primarily postsecondary institution
- Non-Title IV postsecondary institution that is NOT open to the public; or
- Institution is not active in current universe

D) Religious Affiliation (NYIT - No Religious Affiliation): either Religious Affiliation or No Religious Affiliation

Appendix B

Final preliminary set of 98 schools
Adelphi University, School of Business
Adolfo Ibanez University, School of Business
Alfred University, College of Business
American University in Cairo, School of Business
American University of Beirut, Olayan School of Business
American University, Kogod School of Business
Ashridge
Asian Institute of Management, Office of the President of the Institute
Babson College, School of Management
Bentley University, McCallum Graduate School of Business
Berry College, Campbell School of Business
Boston University, School of Management
Bradley University, Foster College of Business Administration
Bryant University, College of Business
Butler University, College of Business Administration
Carnegie Mellon University, Tepper School of Business
Case Western Reserve University, Weatherhead School of Management
Claremont Graduate University, Peter F. Drucker and Masatoshi Ito Graduate School of Management
Clark University, Graduate School of Management
Columbia University, Columbia Business School
Cornell University Department of Applied Economics and Management
Cornell University, Samuel Curtis Johnson Graduate School of Management
Dartmouth College, Tuck School of Business at Dartmouth
Denver, University of, Daniels College of Business
Drake University, College of Business and Public Administration
Drexel University, Bennett S. LeBow College of Business
Duke University, Fuqua School of Business
Emory University, Goizueta Business School
Fairleigh Dickinson University, Silberman College of Business
FundacaoGetulio Vargas, Sao Paulo, Escola de Administracao de Empresas de Sao Paulo
George Washington University, School of Business
Hartford, University of, Barney School of Business
HHL-Leipzig Graduate School of Management
Hofstra University, Frank G. Zarb School of Business
IMD International Institute
INCAE Business School
Instituto de Estudios Superiores de Administracion (IESA)
Instituto Tecny de Est Super de Monterrey-Monterrey, Grad School of Bus Admin & Leadership-EGADE
Instituto Tecnologico Autonomo de Mexico (ITAM), Academic Division of Admin and Accounting
Ithaca College, School of Business
Jacksonville University, Davis College of Business
Korea University, Korea University Business School
Lehigh University, College of Business and Economics
Long Island University-CW Post Campus, College of Management
Marist College, School of Management
Meredith College, School of Business
Miami, University of, School of Business Administration
Monmouth University, School of Business Administration
Monterey Institute of Int'l Studies, Robert L. and Marilyn J. Fisher Grad School of Int'l Bus
Nagoya University of Commerce and Bus, NUCB Graduate School
New York Institute of Technology, School of Management
Northeastern University, College of Business Administration
Northwestern University, Kellogg School of Management
Pace University, Lubin School of Business

Quinnipiac University, School of Business
Rensselaer Polytechnic Institute, Lally School of Management and Tech
Rice University, Jesse H. Jones Graduate School of Business
Richmond, University of, Robins School of Business
Rider University, College of Business Administration
Robert Morris University, School of Business
Rochester Institute of Tech, E. Philip Saunders College of Business at RIT
Rochester, University of, William E. Simon Graduate School of Business Administration
Roger Williams University, Gabelli School of Business
Rollins College, Roy E. Crummer Graduate School of Business
Simmons College, School of Management
Southern California, University of, Marshall School of Business
St. John Fisher College, Ronald L. Bittner School of Business
Stanford University, Graduate School of Business
Stetson University, School of Business Administration
Strathclyde, University of, Strathclyde Business School
Suffolk University, Sawyer School of Management
Tampa, University of, John H. Sykes College of Business
Temple University, Fox School of Business and Management
Thunderbird, School of Global Management
Tulane University, A. B. Freeman School of Business
Tuskegee University, Andrew F. Brimmer College of Business & Information Science
Union Graduate College, School of Management
Universidad de Los Andes, School of Management
Vanderbilt University, Owen Graduate School of Management
Vlerick Leuven Gent Management School
Wake Forest University-Babcock, Babcock Graduate School of Management
Wake Forest University-Schools of Business
Washington and Lee University, Williams School of Commerce, Economics, and Politics
Washington University in St. Louis, Olin School of Business
Western New England College, School of Business
Widener University, School of Business Administration
Worcester Polytechnic Institute, Department of Management
Yale University, School of Management

Appendix C

19 selection variables for Hierarchical Cluster analysis	
1	Full Time Equivalent
2	Faculty with Ph.D.
3	Total B school enrollment
4	Tuition
5	Operating budget
6	Full Time Faculty
7	SAT MATH 25
8	SAT MATH 75
9	SAT Writing 25
10	SAT Writing 75
11	SAT Reading 25
12	SAT Reading 75
13	Student-Faculty Ratio
14	Under Graduate Students Total
15	Under Graduate Full Time Students
16	Graduate Full Time Students
17	Under Graduate Part Time Students
18	Graduate Part Time Students
19	GMAT

Appendix D

	Final set of 5 peer schools
1	Drexel University's LeBow College of Business
2	Pace University's Lubin School of Business
3	Hofstra University's Frank G. Zarb School of Business
4	University of Denver's Daniels College of Business
5	Suffolk University's Sawyer Business School

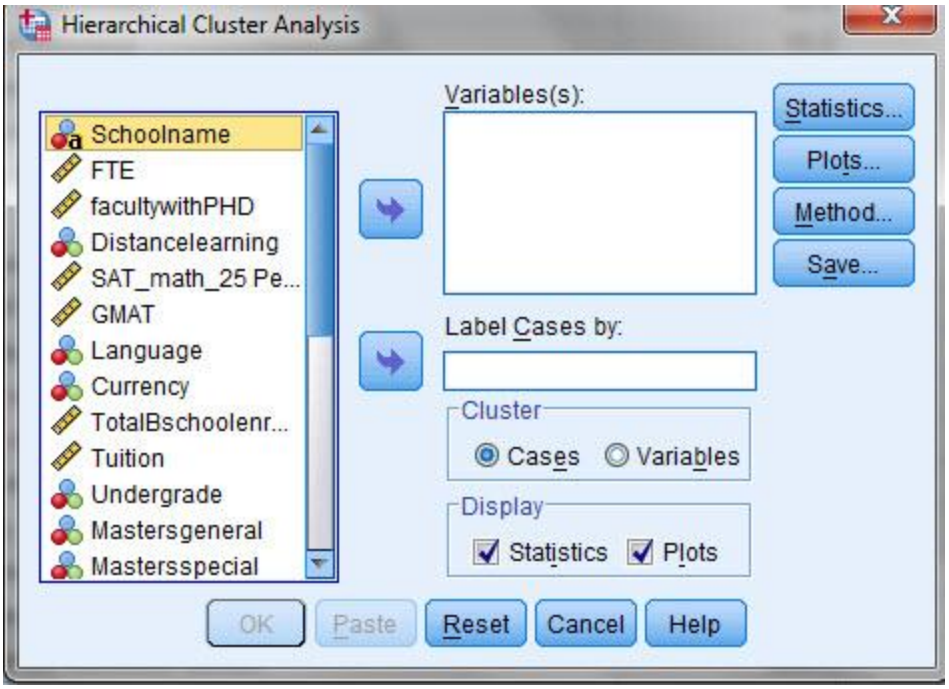

Figure 1: Screen for variables input in SPSS

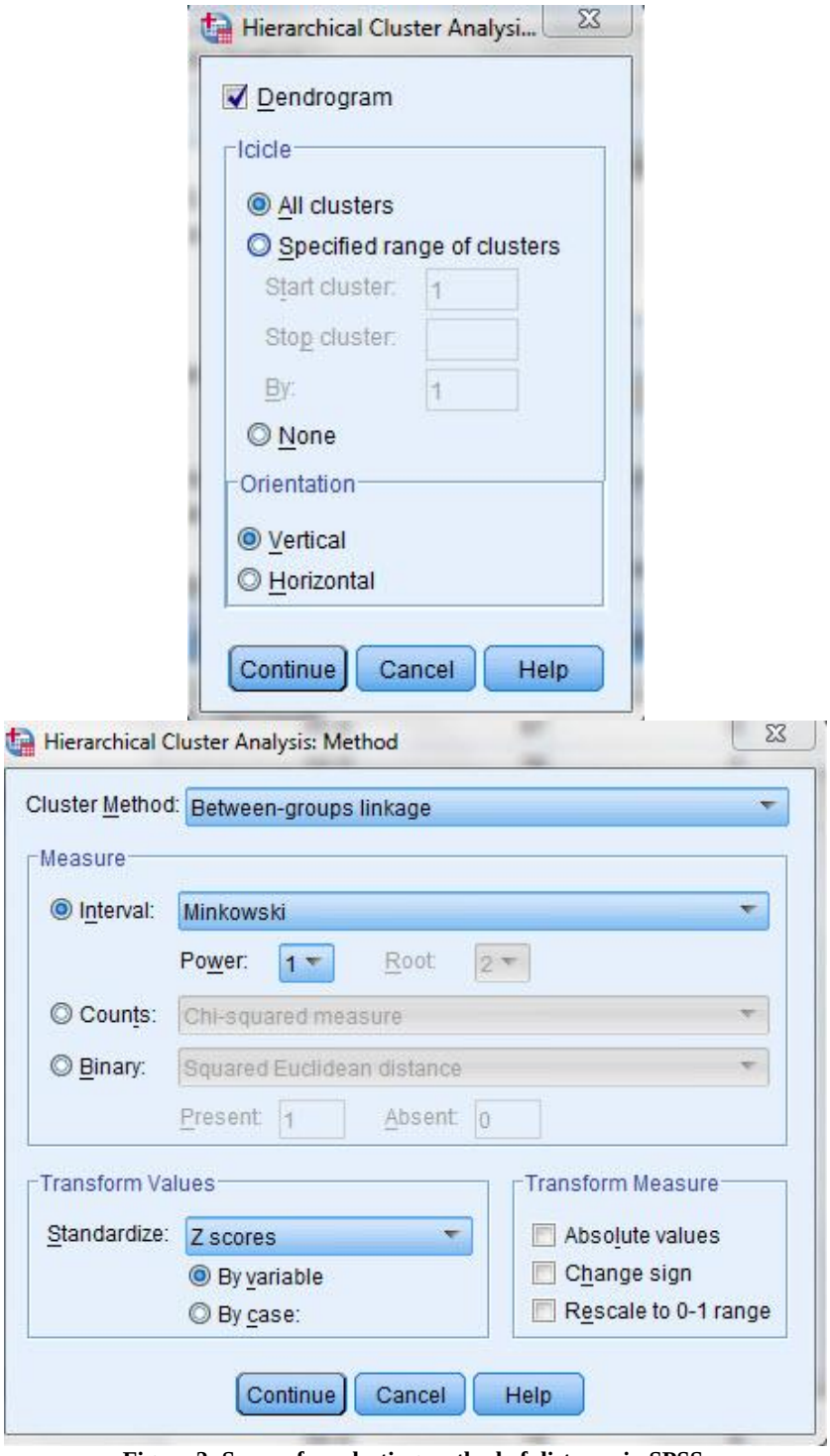

Figure 2: Screen for selecting method of distance in SPSS

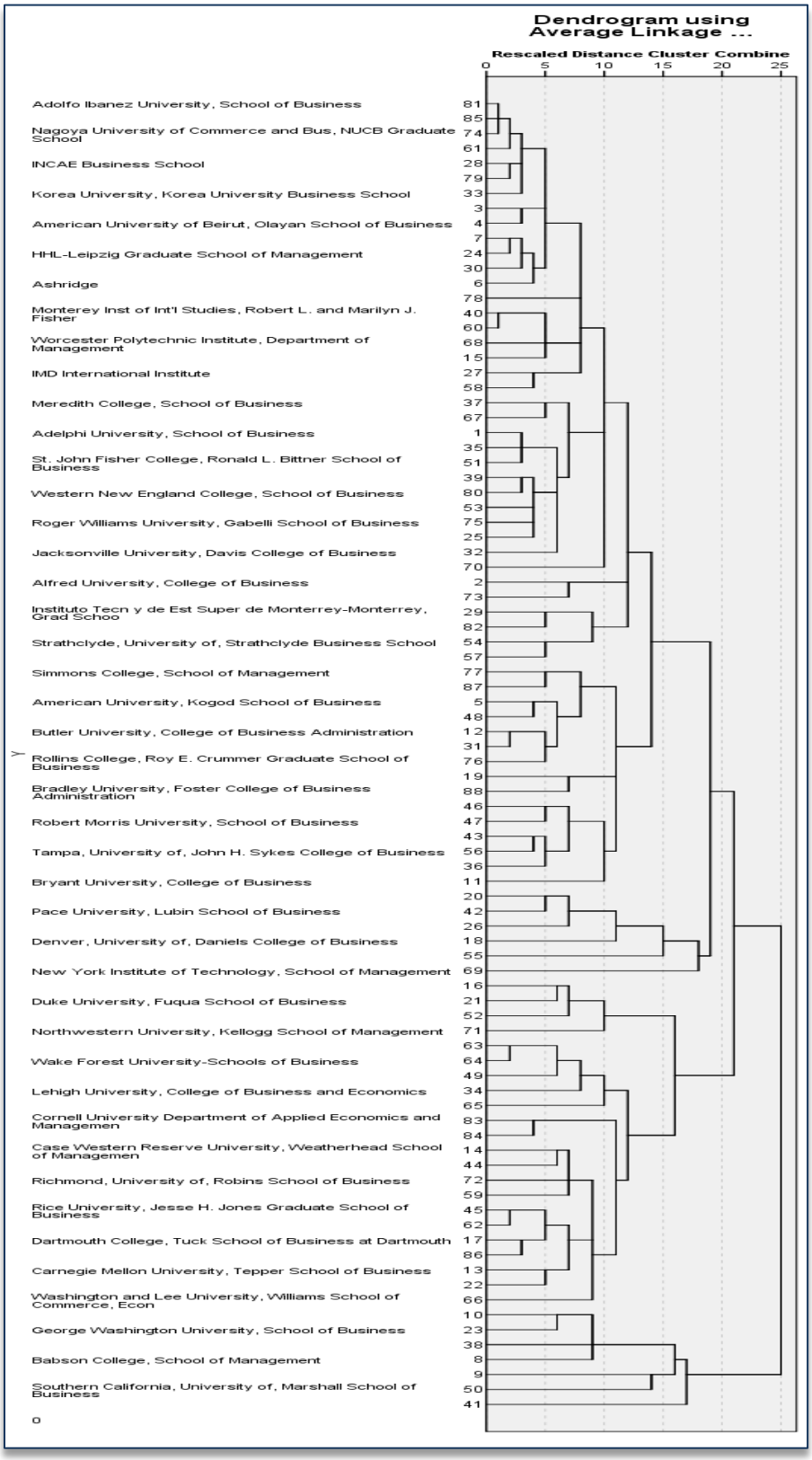

Figure 3: Dendogram

NOTES

