

Relevance of Multivariate Analysis in Management Research

Dr. Sateesh Kumar Ojha*

Abstract

Often we receive misled conclusion in the research if properly variables are not analyzed. In different functional issues of management it is very essential that all the latent and observed variable are properly understood so management decisions will be relevant and effective. The objective of this paper is to investigate the use of different multivariate tools for analyzing in the management research : applied or basic. The sources of data is primary as well as secondary. The primary includes the observation of different research articles of the proceedings of different conferences. And the secondary includes different publications related to multivariate analysis. The study has revealed the reasons of not using such tools of research. The preliminary finding reveals that most of the researches do not use such analytical tools in a comprehensive manner. Carelessness in design while fixing the design aspect is the main reasons of not using appropriate design.

Keywords : Multivariate Tools, Factors, Variables

1. Introduction

The information age has resulted in masses of data in every field. Despite the quantum of data available, the ability to obtain a clear picture of what is going on and make intelligent decisions is a challenge. When available information is stored in database tables containing rows and columns, Multivariate Analysis can be used to process the information in a meaningful fashion. To a competent analyst multivariate analysis is an essential tool to simplify the mass of chaotic data, and provide them in a suitable graphical presentation which can be impossible from one to one tabulation. Research has indicated multivariate analysis as a useful tool for examining critical aspects of the competitiveness of industrial sectors [Lipovatz et al., 2000]. Multivariate thinking is a body of thought processes that illuminate the interrelatedness between and within sets of variables. Corporate competitiveness is the synergy effect of many factors so calls for multivariate analysis in place of bivariate and univariate analysis [Častek et al., 2013]. The essence of multivariate thinking rises to expose the inherent structure and meaning revealed from the variation of the sets of variables through application and interpretation of various statistical methods. A large numbers of variables need to be analyzed at a time of making business decisions, more the information are understood greater the business has opportunity to make appropriate decisions. For example marketing is the key function of any business that devote on knowing customers. Under-

standing consumers is most complicated job because what consumers like, how consumers are affected, how they make decisions etc are determined by many factors, like age, sex, qualification, experience, maturity level, family background, peer group, location, etc. to set the business to address these consumers also very tough. Similarly HR function has to manage a large number of attributes of large number of individuals, knowing their strength and weaknesses. It has to minimize the effect of weakness and optimize the strength of individuals to treat them as an important and most valuable assets of business. Satisfaction of external customers are possible if the business understands internal customers. An individual in the organization is guided by various direct and indirect measures. Operation in the other hands must produce and deliver the goods and services considering quality, costs and speed. A large number of the activities must be selected out of the many variables and arrange them in a value chain that business become successful to attain the competitive position by reducing costs, increasing speed and meeting the quality defined by customers. Finance functions on the other hands have to serve all the business activities by reducing costs and increasing returns of the investments. It has to manage cost centers and revenue centers which are composed of many variables and cost drivers.

The role of research in the business is very high. Research describes the current activities as why it is being done, and projects for the best future considering all elements and their values.

It decides where and what are to be controlled. It describes about variables which are seen and injected in the system to bring possible changes and there occur different unseen variables that affect the result which are called factors or constructs. Multivariate analysis assumes that anything that come out in the society or the system it is because of many variables and factors injected purposely or unintentionally, they are to be known, and induced or controlled while making administrative decisions so that desired objectives can be achieved.

2. Objective

Objective of this paper is to assess the use of multivariate analysis in business research and decision making and reveal the status of the use of multivariate analysis in such proceedings.

3. Method

The method adopted is review of literature and reviews of research design of 338 research articles presented in different proceedings of managements. Such proceedings and journals were randomly selected from some international

conferences. They are :

4. Review of Literature

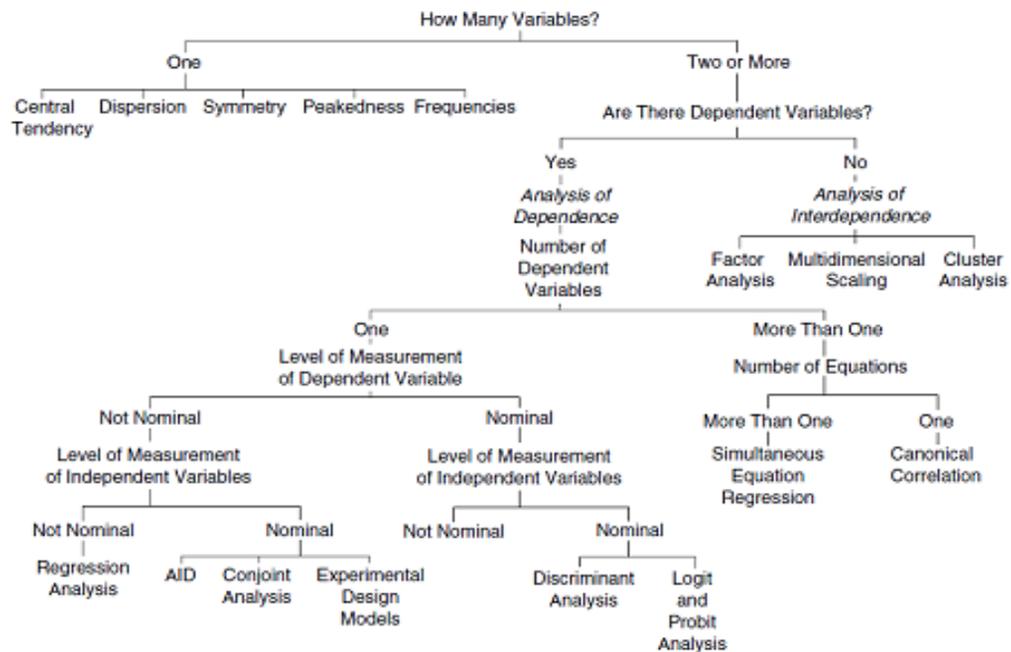
Many researchers in their research have indicated the use of multivariate analysis will be dominant analytical method in the future research [Chandra and Menezes, 2001; Hair et al., 1998]. In quantitative analysis three types analysis are used : univariate analysis, bivariate analysis and multivariate analysis. There are two different groups of techniques in multivariate data analysis known as-dependency techniques and interdependency techniques. The former consist of techniques in which a variable or a set of variables is identified as the dependent variable that is being predicted or explained by other variables, identified as the independent variables. Multiple regressions are an example of a dependency multivariate technique. In contrast, in the case of interdependency techniques there is no single variable or set of variables identified as being independent or dependent. Interdependency techniques involve the simultaneous analysis of all the variables in the set. Factor analysis is one example of an interdependent technique.

<Table 1> Research Design Reviewed

Indian institute of Technology (IIT International Conference proceedings) Roorki, India	138
Institute of management studies, IMS (books from selected article of International Conference Ghaziabad)	28
ITAM proceedings [korean Data Based Society]	23
Nepalese Academy of Management (Proceeding of international conference)	35
Birala Institute of Technology BIT proceedings	114
Total articles	338

〈Table 2〉 Major Multivariate Tools and their Uses

Major multivariate tools	uses
correlation	Is used when the intent is simply to assess the possible linear relationship between the DV and the IVs [Villamorán, 2007].
Regression analyses	Regression analyses are sets of statistical techniques that allow one to assess the relationship between one dependent variable (DV) and several independent variables (IVs) [Villamorán, 2007]. The beta coefficients (weights) are the marginal impacts of each variable, and the size of the weight can be interpreted directly multiple regressions is often used as a forecasting tool.
Conjoint Analysis	Predicting choice behavior when product or service involves a relatively high resource commitment and tends to be “analyzable” by the purchaser (e.g., banking or insurance services, industrial products) [Smith and Albaum, 2010]
Factor analysis	A set of techniques for finding the underlying relationships between many variables and condensing the variables into a smaller number of dimensions called factor [Smith and Albaum, 2010].
Correspondence Analysis	Correspondence analysis is often used in positioning and image studies where the researcher wants to explore the relationships between brands, between attributes, and between brands and attributes [Smith and Albaum, 2010]. the marketing researcher may want to identify (a) closely competitive brands, (b) important attributes, (c) how attributes cluster together, (d) a brand’s competitive strengths, and most importantly (e) ideas for improving a brand’s competitive position [Whitlark and Smith, 2001]
Cluster Analysis	The usual objective of cluster analysis is to separate objects (or people) into groups such that we maximize the similarity of objects within each group, while maximizing the differences between groups. Cluster analysis is thus concerned ultimately with classification, and its techniques are part of a field of study called numerical taxonomy [Sokal and Sneath, 1963; Aldenderfer and Blashfield, 1984]. Cluster analysis can also be used to (a) investigate useful conceptual schemes derived from grouping entities; (b) generate a hypothesis through data exploration; and (c) attempt to determine if types defined through other procedures are present in a data set [Aldenderfer and Blashfield, 1984]
Multivariate Analysis of Variance	Mean differences between groups on the separate scales provide information and clues as to how the groups can be described separately. The multivariate analysis of variance answers the important question of whether patterns of differences involving both groups and scales are present and what the levels of significance are in terms of chance expectations [Haupt and Allen, 1965]
Canonical Variate Analysis	(CVA) is a widely used method for analyzing group structure in multivariate data. CVA can be interpreted as a special case of canonical correlation analysis where one set of variables consists of group indicators [Gittins, 1985]
Multivariate meta-analysis	Multivariate meta-analysis model that jointly synthesizes the multiple endpoints and obtains all the pooled results collectively [Gleser and Olkin, 1994; Houwelingen et al., 2002].
Multidimensional Scaling (MDS)	Exploratory technique, it is useful in examining unrecognized dimensions about products and in uncovering comparative evaluations of products when the basis for comparison is unknown.
Structural Equation Modeling	Structural equation modeling (SEM) examines multiple relationships between sets of variables simultaneously. This represents a family of techniques, including LISREL, latent variable analysis, and confirmatory factor analysis. SEM can incorporate latent variables, which either are not or cannot be measured directly into the analysis. For example, intelligence levels can only be inferred, with direct measurement of variables like test scores, level of education, grade point average, and other related measures. These tools are often used to evaluate many scaled attributes or to build summated scales.
Discriminant Analysis	Discriminant analysis is used to create classifications of people based on a variety of characteristics, such as whether the person is an “outdoors” person or do-it-yourselfer, and then determine which classification the person being surveyed fits into based on how his responses match up.
Logistic Regression Analysis	Sometimes referred to as “choice models”, this technique is a variation of multiple regression that allows for the prediction of an event. It is allowable to utilize nonmetric (typically binary) dependent variables, as the objective is to arrive at a probabilistic assessment of a binary choice. The independent variables can be either discrete or continuous.
Probit analysis	Probit Analysis is a type of regression used with binomial response variables. It is very similar to logit, but is preferred when data are normally distributed. It differs from logit because it is used when data are normally distributed [Finney, 1952].



〈Figure 1〉 A Glimpse on Multivariate Analysis

Some common software for handling MVA

Analytica : Analytica is a powerful, stand-alone application for visual quantitative modeling. Analytica offers a comprehensive array of statistical functions for analyzing sample data including standard mean, variance, skewness, percentiles, correlations, with built in graphics to visualize uncertainties using density functions, cumulative functions, probability bands, and viewing the underlying sample. Analytica Optimizer adds powerful solvers for linear, quadratic, and non-linear optimization.

SPSS : Statistical Package for the Social Sciences (SPSS) can help find new relationships in the data and predict what will likely happen next. Watch IBM's free statistics video demo to learn how to easily access, manage and analyze data sets-without previous statistics experience; vir-

tually eliminate time-consuming data prep; and quickly create, manipulate and distribute insights for decision making. user friendly software and perfect for any statistical analysis

Plug & Score Modeler : Plug & Score Modeler is easy-to-use credit scorecard development software. Key features : data preparation and analysis, automatic scorecard creation, monitoring and validation of scorecards using a set of pre-defined reports. Reject Inference with automated and manual inference methods. Automated binning based on chi-square and manual binning based on WOE, estimating a correlation coefficient for each pair of dataset variables. Work with several validation datasets. Credit risk professionals and consultants who need a convenient tool for developing credit scoring models.

MaxStat : MaxStat is easy-to-use and affordable software for scientific data analysis. Statistical analysis is done in three simple steps within a single dialog window. MaxStat guides user with little experience in their statistical analysis. Other features are the easily understandable way to interpret the results and making high-quality graphs. MaxStat includes a complete word processor, and it's the place to store notes and reports with your data analysis and graphs.

Statwing : Statwing is an easy-to-use statistical tool. Expert users work 5x faster in Statwing than they would in Excel or statistical tools like R or SPSS, and novice users can get as much insight out of their data as an expert data analyst. Statwing's modern, intuitive interface chooses statistical tests automatically, then reports results in plain English. You have to try it to see how much better statistical analysis can really be. Our ideal customer is quantitatively savvy, but not deeply skilled in statistics. Most of our users are either frequent Excel users looking to level up, or dissatisfied users of other stats tools.

Minitab 17 : The car you drive. The medicine you take. The bank you use. The device or computer you're looking at right now. Chances are that all of them have been developed or improved using Minitab. Minitab is the leading statistical software used for quality improvement and statistics education worldwide. More than 90% of Fortune 100 companies, and more than 4000 colleges and universities, use Minitab to graph and analyze their data.

SAS Statistics : SAS statistics provides a wide range of statistical software, ranging from traditional analysis of variance to exact methods and dynamic data visualization techniques. almost every sector of the economy including energy and power, environment, education, health and pharma, defense, software and technology, financial services, and aerospace

Statistica : Data mining, statistical analysis, enterprise quality control, and web-based analytics software.

Stata : This statistical software is a complete, integrated statistical software package that provides everything you need for data analysis, data management, and graphics. Stata is not sold in modules, which means you get everything you need in one package. And, you can choose a perpetual license, with nothing more to buy ever. Annual licenses are also available. Stata is distributed in more than 200 countries and is used by hundreds of thousands of professional researchers in many fields of research. <http://www.stata.com/why-use-stata/who-uses-stata>.

Statistix : Statistix is an intuitive, easy statistical program designed by researchers for researchers. Comprehensive but not intimidating, Statistix offers basic and advanced statistics in one inexpensive package. Researchers at universities, government agencies, and corporations.

Unistat : A statistical software package featuring a statistics add-in for Excel data analysis, charting and presentation-quality reporting. Re-

searchers at universities, government agencies, and corporations.

Meghastat : A statistical software package featuring a statistics add-in for Excel data analysis, charting and presentation-quality reporting. Researchers at universities, government agencies, and corporations.

xlstat : Variety of tools to enhance the analytical capabilities of Excel, making it the ideal for data analysis and statistics requirements.

Coheris SPAD : It is a data mining and predictive analytics software, uses company data to anticipate risks, identify opportunities and optimize the different business operations.

R and S-plus : The last two applications, R and S-Plus, have nearly identical command-line syntax, but the latter is more GUI-oriented. The two programs started out the same. S-Plus was developed into a commercial product that can handle large amounts of data, while R focuses more on small data samples and is more appropriate for university researchers, particularly those interested in computational statistics.

5. Results

In this part a review of some proceedings so some universities were done to find what design they use. The result is presented in <Table 3>.

On the review of the design of 338 articles, it is found that 135 (40%) were found to use qualitative design, and 203 (60%) used quantitative

<Table 3> Proceedings and Used Design

IMS proceeding [2015]		
Research design		
Qualitative	17	61%
Quantitative	11	39%
A. Univariate/bivariate	7	25%
B. Multivariate	4	14%
	28	100%
IIT proceedings [2015]		
Research design		
Qualitative	54	39%
Quantitative	84	61%
A. Univariate/bivariate	56	41%
B. Multivariate	28	20%
	138	100%
ITAM proceeding [15th of 2015]		
Research design		
Qualitative	7	30%
Quantitative	16	70%
A. Univariate/bivariate	13	57%
B. Multivariate	3	13%
	23	100%
Nepalese Academy of Management [2015]		
Research design		
Qualitative	21	60%
Quantitative	14	40%
A. Univariate/bivariate	9	26%
B. Multivariate	5	14%
	35	100%
BIT proceedings [2015]		
Research design		
qualitative	36	32%
quantitative		68%
A. Univariate/bivariate	56	49%
B. Multivariate	22	19%
	114	100%

designs. Even in 203 quantitative designs, 155 (46% of the total) were found to use univariate analysis and 48 (14% of the total) used multivariate analysis. This means the numbers of researches using multivariate analysis is low.

6. Discussion

Comparatively researches conducted in the country have methodologically not quantitative. The analysis of proceedings of ITAM proceedings shows it is comparatively more quantitative than others of the sampled. Birala Institute of Technology's proceedings are also mostly quantitative. It is followed by IIT; IMS and NAMs proceedings are 61%, 39% and 40%. The argument is put here that for the best researches of all designs should be balanced. The ITAM proceedings seem to be 70% quantitative and 30% qualitative in design. The ratio of design of researches of IMS on qualitative and quantitative is 61% and 39%. IIT proceedings have the ratio of quantitative and qualitative 61% and 39%. It is 60% qualitative and quantitative in the case of Nepalese Academy of Management. The fields that call for deeper analysis are consumer and market research, quality control and quality assurance across a range of industries such as food and beverage, paint, pharmaceuticals, chemicals, energy, telecommunications, etc., process optimization and process control and research and development. When researchers in the field of social sciences like to go into deeper analysis of variables, then they are found to use multivariate analysis. The main reason for growing interest on multivariate analysis is development of dozens of statistical software. This software has capability of analyzing a large number of variables. So interpreting becomes easy too. Traditionally research believes in two types of variables-independent and dependent and researchers use one way interaction where-

as multivariate analysis permits two way analyses assuming that they are interdependent, for instance education and social economic status are interdependent because one helps others. For instance quality education leads to rise in social economic status and social economic status offers better education.

There are varieties of methods developed in multivariate analysis to understand the variables and their nature. Both extensive and intensive analysis is possible at a time. It has shifted on the focus to individual factors taken singly to relationship among variables.

As has already been discussed the reasons of being multivariate analysis popular is the invention of computer software and fast processing capability of computer CPU along with the structure of human knowledge and emphasis of differences sciences including to use multivariate analysis. Equally responsible factor for this is the cooperation between computer scientists and statisticians.

Large number of organizations are established each year, large number of decisions are to be made by these organizations. Out of these, limited numbers that is below 30% sustain and grow, and out of the large number of decisions, few give effective impacts. The reasons behind these are the bases of decisions not realizing fully the need of analysis of the factors and variables concerning them. Highly skilled people and highly advanced statistical software, and fast processing computers are essential for these. Organization of developing countries cannot afford these.

Mostly organizations do not allocate research budget to undertake research activities.

7. Conclusion

Business requires decision with correctly analysed and synthesized information about customer, supplier, manufacturing plants and ingredients, market conditions, internal and external resources available. Greater supports for the business is possible only when information supplied are valid, Valid information come from the research done with proper designing and appropriate analysis of data through multivariate analysis.

References

- [1] Aldenderfer, M. S. and Blashfield, R. K., Cluster analysis, Beverly Hills, CA : Sage, 1984.
- [2] Castek, O., Blazek, L., Pudil, P., and Somol, P., "Comparison of the Multivariate and Bivariate Analysis of Corporate Competitive-ness Factors Synergy", *VŠB-TU Ostrava*, Vol. 16, 2013, pp. 67-77.
- [3] Chandra, S. and Menezes, D., "Applications of Multivariate Analysis in International Tourism Research : The Marketing Strategy Perspective of NTOs", *Journal of Economic and Social Research*, Vol. 3, No. 1, 2001, pp. 77-98.
- [4] Finney, D. J., Ed. Probit Analysis, Cambridge, England, Cambridge University Press, 1952.
- [5] Gittins, R., Canonical analysis : A Review with Applications in Ecology, Berlin : Springer Verla, 1985.
- [6] Gleser, L. and Olkin, I., Stochastically Dependent Effect Sizes. In : The Handbook of Research Synthesis, Cooper, H., Hedges, L., eds, Russell Sage Foundation : 1994, New York, pp. 339-355.
- [7] Hair, J. F. Jr., Anderson, R., Tatham, R., and Black, W. C., Multivariate Data Analysis (5th ed.). Upper Saddle River, NJ : Prentice Hall, 1998.
- [8] Haupt, T. D. and Allen, R. M., "A Multivariate Analysis of Variance of Scale Scores on the Sex Inventory, Male Form", *Journal of Clinical Psychology*, Vol. 22, No. 4, 1966, pp. 387-395.
- [9] Houwelingen, H. C. V., Lidia R. A., and Stijnen, T., "Advanced Methods in Meta-analysis : Multivariate Approach and Meta-regression", *Statistics in Med*, Vol. 21, 2002, pp. 589-624.
- [10] Lipovatz, D., Mandaraka, M., and Mourelatos, A., "Multivariate Analysis for the Assessment of Factors Affecting Industrial Competitiveness : The case of Greek food and Beverage Industries", *Applied Stochastic Models in Business and Industry*, Vol. 16, No. 2, 2000, pp. 85-98.
- [11] Smith, S. M. and Albaum, G. S., An Introduction to Marketing Research, 2010.
- [12] Sokal, R. R. and Sneath, P. H. A., Principles of Numerical Taxonomy, San Francisco : Freeman, W. H., 1963.
- [13] Villamorán, E. P., "Multivariate Data Analyses : Multiple Regressions Applied in Educational Research", 10th National Convention on Statistics (NCS), EDSA Shangri-La Hotel, October 1-2, 2007
- [14] Whitlark, D. B. and Smith, S. M., "Using Correspondence Analysis to Map Relationships : It's Time to Think Strategically about Positioning and Image Data", *Marketing Research*, Vol. 13, No. 3, 2001, pp. 22-27.

■ Author Profile



Dr. Sateesh Kumar Ojha

Dr. Sateesh Kumar Ojha is the only professor who maintained his first position at his all appointments from Assistant administrator, Assistant

lecturer, Lecturer, Associate Professor, and Professor in Faculty of Management, Tribhuvan University, Nepal. Dr. Ojha was born on October 16, 1956. He completed his graduation in Mathematics, Business Education, Public Administration, Accounting, and Curriculum and Evaluation. He did Ph.D in Human Resource Management in 1996. He has been teaching Research Methodology, Multivariate Analysis, Human Resource Management, Organizational Behaviour, and Business Environment Strategic Management in Graduate and Post Graduate level for 30 years. He has supervised more than ten Ph.D Students, and more that 100 Master level Students. He has published more than 70 publications in different national and international journals and conference proceedings. He has served as panel expert for Ph.D program of different reputed Indian Universities. He has been serving as a trustee of social organizations, like Satya Sai Institution in Nepal. These days he is doing research in Human Resource Management, and Application of Multivariate Analysis in Business Research. He is an active Executive Member of IT Applications and Management Society.