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CHOICE OF ELECTIVE COURSES AT IMA
- An Application of Factor Analysis

by

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Indian Institute of Management
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To

Chairman (Research)
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Technical Report

Title of the report Choice of Elective Courses at IIMA - An Application of Factor Analysis

Name of the Author M. Raghavachari and Y P Sabharwal

Under which area do you like to be classified? P&QM Area

ABSTRACT (within 250 words)

The report is based on a study made to find the factors influencing the choice of elective courses by the second year students of IIMA. The statistical technique of Factor Analysis has been used to identify the factors.

Please indicate restrictions if any that the author wishes to place upon this note none

Date 2/17/74

M. Raghavachari
Signature of the Author

CHOICE OF ELECTIVE COURSES AT IIMA
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1. Course Structure of PGP at IIM

The Post Graduate Programme at IIM is a two year programme. All the First Year courses are compulsory and cover basic functional areas along with basic disciplines which are useful in making management decisions. The Second Year courses provide an opportunity to continue to some extent the broad range of subjects and to pursue special interest to a far greater extent. All the Second Year courses, with the exception of a two-term Business Policy course, are, therefore, elective. A knowledge of the factors that affect the choice of these elective courses is envisaged to be of immense value to the faculty offering courses in Second Year as well as First Year of the Programme.

2. The Present Study

What Makes You Choose Your Courses? is the title of the survey conducted to identify the principal factors that affect the choice of the courses by the participants of the Programme in Second Year. Intuitively it is felt that participants make reference to factors such as: career plan; previous background; effort required in completing the course; professor's role and image of the course. However, neither the order nor the extent of importance could be assigned to these factors on intuitive basis. Accordingly, a scientific study based on the Principal Component Method of Factor Analysis was undertaken, with the participants of the 1972-74 batch as respondents to the questionnaire discussed below, during the third term of the academic session 1973-74.

3. What is Factor Analysis?

Factor Analysis is one of the statistical methods for the study of multivariate data. The method arose in providing mathematical models for the explanation of psychological theories of human ability and behaviour. The method has since been applied to many other areas. The chief aim of factor analysis is to attain scientific parsimony or economy of description of data.

Two aspects are relevant to the study of multivariate data, viz. examine the system with a view to know the underlying structure; and fit an appropriate model for the underlying structure. A simple model for the system for which n observations $x_{ij} = j=1,2,\dots,n$ have been made on each of the variables x_i would be the structural relationship

$$x_i = \sum_{k=1}^m a_{ik} F_k, \quad i=1,2,\dots,p; \quad m \leq p,$$

i.e. we assume that the variables are linear combinations of the m factors F_k , where usually m is considerably smaller than p . The coefficients a_{ik} are called "factor loadings." Unlike a regression model, here F_k are not fixed.

The model as such is undetermined, and we need to devise "rules" for determining the factor loadings a_{ik} and the factors F_k . As noted above, F_k are not observable. Several methods are now available for determining a_{ik} . For details we refer to Harman [3], Table 6.1, p.108 where an overview of the different methods along with their distinguishing characteristics is presented. Each of these methods assumes a criterion e.g. maximal reproduction of correlations or maximum contribution to the sum of the variances of the p variables. The factor loadings a_{ik} are then uniquely determined by the statistical methods. For each factor the factor loadings are ranked against the variables. The major factors are then identified together with the total amount of variation they account for. This leaves us with a model that fits the empirical data, within the bounds of accuracy embedded through the criteria set up.

The usefulness of factor analysis in empirical investigations, however, largely depends upon the investigator's success in identifying the factors with intuitively interpretable entities. The statistical analysis carried out upto this point would suggest that the system envisaged to be described by p variables can be described in terms of only m new hypothetical ones. A practical identification of the new variables (factors) requires these to be named. For this purpose sufficient knowledge is necessary of the physical systems which has generated the data. Factor analysis is a statistical tool which works as an exploratory instrument. Identification or naming the factors essentially remains extra-statistical in character, though the ranking methods come handy in carrying out this exercise.

This introduction to factor analysis as a statistical method would be incomplete without a reference to the choice of variables x_i . A rational choice of the variables in generating empirical data is no doubt the starting point of any study; and this is well appreciated. Besides the choice of variables, the question of scale also requires attention. The results of factor analysis are not invariant under change of scale. Kendall and Stuart [5] demonstrates this point through an

example of meteorological data. We will be content here by pointing out that whether scaling, e.g. standardization - as is customarily the case to reduce all the variables to equal importance - is desirable or not is to be decided on considerations other than statistical.

Heavy computation work is a general characteristic of statistical analysis of multivariate data. Use of factor analysis is no exception. However, advent of electronic computers and the availability of standard codes has rendered it possible to use this technique in several areas, e.g. marketing [1,2,6,7], meteorology [5] and motor insurance [4]. Bibliography in Harman [3] includes references to many more applications of factor analysis to other areas, e.g. medicine, urban systems and economics.

4. The Questionnaire

Eighteen variables were devised to get information. A list of these variables is given in Exhibit I. These were randomly arranged in the questionnaire and put in the form of a booklet instead of a single sheet to ensure to a great extent mutual independence in the scoring of various variables by a respondent. A six point scale was provided to avoid 'central-tendency' on the part of the respondent. It was decided to administer the questionnaire to all the participants on the campus during the third week of February, 1974. Out of a total of 116 participants, 90 were contacted, and a check against the enrollment list indicated that no section of the 'population' was ill-represented.

5. The Correlation Matrix and Other Calculations

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The Library Program JACOBI/the IIM Computer Centre was modified to compute the first and second order moments and the correlation matrix at the first instance. Subsequent part of the Program computed the corresponding Eigen values for the correlation matrix and the corresponding Eigen vectors and the factor loadings. For economy of space we reproduce here only two tables, viz. The Correlation Matrix, Exhibit 2 and Rankings of Factor loadings, Exhibit 3.

6. Identification of Factors

As an aid to identifying the Principal Factors, the variables were ranked, Exhibit 3, according to a_{ij} , $i=1,2,\dots,18$ from highest positive to highest negative. A reference to this exhibit suggests the following:

- (a) PROFESSOR'S ROLE is the most relevant factor in a participant's choice of elective courses in the Second Year of the Programme. This accounts for 20.40% of the total variation in the data.
- (b) EFFORT REQUIRED ON THE PART OF THE PARTICIPANT is the next Principal Factor. This conclusion is based on the consideration that variables number 3,4,9,10,12,13 and 15 are splits of the effort (or convenience) required on the part of the participants in completing the course. Variation explained by this factor is 13.86% of the total.
- (c) CAREER PLAN is the third Principal Factor, explaining 9.12% of the total variation.
- (d) EXTERNAL IMAGE OF THE COURSE AND INDIVIDUAL'S OWN ASSESSMENT OF THE COURSE are the next two Principal Factors. These explain respectively 7.83% and 6.63% of the total variation.

The above five Principal Factors taken together explain 57.84% of the total variation in the data. No breakthrough was possible in identifying further factors. For other factors the ranks for the various variables are, however, reported for the sake of completeness, and readers are invited to seek some suitable factors from these data.

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JAR = Journal of Advertising Research, U.S.A.

Exhibit 1: The Questionnaire

Title: WHAT MAKES YOU CHOOSE YOUR COURSES

Preface: Your name will NOT be divulged to any one and DATA will be used absolutely for research purposes only.

We are investigating the factors that influence the choice of courses in the FINAL YEAR I of the Post Graduate Programme at IIMA.

Below are listed 18 variables. Please read them FAST; and mark (x) on the SCALE provided.

The 6 points (1,2,...,6) on the scale have the following meaning:

1. Not at all relevant
2. Least relevant
3. Little relevance
4. Moderately relevant
5. Substantially relevant
6. Most relevant

Variables:

1. Future need for the type of skills and/or knowledge that the course will impart.
2. Seniors' acclamation about the course.
3. Friends are taking the course.
4. Number of Examinations and Quizzes.
5. Professor's attitude and grading policy.
6. Your ability to gain the skills and/or knowledge of your own as and when need for these may arise.
7. Title of the course
8. Chance of a better job
9. Amount of project work required
10. Level of abstraction of the course material
11. Prospective employers expect you to have taken the course.
12. (Subjective) Probability of succeeding in the course
13. Time Schedule for the sessions
14. Professor's effectiveness in handling the course
15. Effort required in organizing the course material
16. Past training and/or specialization
17. Your own career plan.
18. Your own experience about the subject matter while in the First Year of the Programme.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.000																	
2	.2147	1.0000																
3	.0621	.2261	1.0000															
4	-.0279	.0999	.1516	1.0000														
5	-.0736	.1358	.1051	.4704	1.0000													
6	-.1179	-.1085	.0376	.0407	.0511	1.0000												
7	-.0954	.0272	.2370	.1147	.2054	.0513	1.0000											
8	.0076	.0459	-.1338	-.0074	.0958	.1263	.3440	1.0000										
9	.1418	.0677	.0959	.3513	.2415	.0025	.1449	.1888	1.0000									
10	.0403	.1954	.0695	.1753	.2275	.1334	.0885	.1738	.0488	1.0000								
11	.0204	.0814	-.0105	-.1556	.1290	.1487	.2524	.3435	.0525	.2034	1.0000							
12	.0000	-.0419	.0720	.2082	.3278	.0998	.0076	.0332	.0517	.1572	.1581	1.0000						
13	-.0903	-.0358	.2668	.3865	.1976	-.1347	.1452	-.1649	.1315	.1466	-.0291	.2147	1.0000					
14	.2310	.2990	.1139	-.0232	.2151	.1774	.0693	.1825	.1863	.0706	.2416	.1285	.2031	1.0000				
15	.0989	.0713	.0236	.1724	.2202	.1021	.1802	.2419	.1619	.2557	.2607	.0894	.3269	.1974	1.0000			
16	.0869	.1373	.0417	-.0034	.0682	.1966	.0621	.0952	.1685	.0655	.1545	-.0021	-.0021	.1016	-.0006	1.0000		
17	.2067	.1310	-.1535	-.0984	-.0174	.0003	-.1100	.1025	-.0390	.0124	.2000	.0904	.0819	.4319	.0363	.2310	1.0000	
18	-.0259	.2486	.0069	-.1375	.2406	.0806	.1345	.3496	.1590	.0513	.2986	.1249	-.1522	.4112	-.0279	.2201	.2813	1.00
Mean	5.33	3.18	1.80	2.51	3.20	4.76	2.58	4.18	5.98	3.33	3.70	3.07	2.18	4.88	2.99	3.90	5.46	4.59
Var																		
ance	5.111	1.6351	.9378	1.6943	1.6045	1.2069	2.3106	1.8351	1.6351	2.3773	2.3211	2.1511	1.8945	.9739	1.8554	2.0456	.6036	.997

Exhibit 3: Rankings of Factor Analysis

S. No.	Variable	Ranks for the various factors																	
		1	2	3	5	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Future need for the type of skills and/or knowledge..	18	11	18	9	3	1	6	8	18	1	12	15	7	8	6	6	9	-
2	Seniors' acclamation about the course	13	10	18	3	17	14	7	17	15	16	9	14	12	14	13	18	15	-
3	Friends are taking the course	17	4	14	1	18	13	2	2	5	6	7	4	16	7	12	1	3	-
4	Number of examinations and quizzes	11	1	10	6	4	15	10	14	7	13	2	13	15	2	7	8	18	-
5	Professor's attitude and grading policy	1	3	8	10	6	16	11	12	12	15	5	17	1	4	15	9	1	-
6	Your ability to gain the skill and/or knowledge..	16	12	6	11	2	6	1	4	10	17	8	10	11	6	4	16	11	-
7	Title of the course	5	9	2	2	12	5	12	1	9	4	4	7	5	12	11	17	6	-
8	Chance of a better job	6	15	1	7	7	7	13	14	12	12	3	12	17	17	9	2	12	-
9	Amount of project work	9	5	11	4	4	1	3	18	11	4	11	18	2	10	9	14	13	5
10	Level of abstraction of the course material	8	8	5	14	11	10	3	18	17	9	6	1	3	10	3	5	7	-
11	Prospective employers expect you to have taken the course	2	17	4	12	15	12	8	9	8	5	15	11	8	1	18	12	17	-
12	Subjective probability of succeeding in the course	10	7	7	17	8	18	5	6	16	2	14	6	14	18	16	14	10	-
13	Time schedule for the sessions	12	2	12	16	16	4	14	5	3	7	11	8	6	13	2	11	16	-
14	Professor's effectiveness in handling the course	3	13	15	13	13	7	13	3	13	18	15	5	2	15	17	3	14	-
15	Effort required in organizing the course material	4	6	3	15	14	2	9	16	6	14	17	18	18	11	5	7	4	-
16	Past training and/or specialization	14	14	13	8	5	11	4	15	1	3	10	16	4	16	10	4	13	-
17	Your own career plan	15	16	17	18	9	8	15	10	2	8	1	3	15	5	9	15	2	-
18	Your own experience about the subject..	7	18	9	5	10	17	16	7	11	10	16	9	9	5	1	10	8	-