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The use of statistical methods by MBA graduates in South African management and its implications for curriculum design

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With this study we aim to identify the degree of penetration of statistical methods in South African management. Consequently, that section of the management population with past exposure to quantitative methods is targetted. Thus the target population was all MBA alumni from South African Business Schools operating in South African companies. A response rate of 27% (408 usable responses) was achieved. The findings of this study correlate highly with those of a similar survey conducted in the United Kingdom in 1991. In addition to reporting these findings, we also sought to examine the implications of these results on future statistical methods course planning. We recommend a change in teaching strategy to promote greater utilization of this discipline in practice.

Met hierdie studie word gepoog om die mate waartoe statistiese metodes onder Suid Afrikaanse bestuur gebruik word, te identifiseer. Die studie was gemik op die gedeelte van die bestuurspopulasie wat reeds in 'n MBA-program aan kwantitatiewe metodes blootgestel was. Die steekproefpopulasie was dus alle MBA-alumni van Suid Afrikaanse Bestuurskole wat by Suid-Afrikaanse maatskappye werksaam is. Altesaam 27% (408 bruikbare antwoorde) antwoorde is ontvang. Die bevindinge van hierdie studie korreleer gunstig met dié van 'n soortgelyke studie wat in 1991 in Brittanje gedoen is. Nie alleen word die resultate van hierdie ondersoek gerapporteer nie, maar met hierdie studie word ook oorweging geskenk aan die implikasies van die bevindinge vir toekomstige beplanning van kursusse in statistiese metodes. Veranderings in onderrigstrategie word aanbeveel om die gebruik van toepaslike tegnieke aan te moedig.

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Introduction

Quantitative methods has been an integral component of every academic management education programme for at least two decades in South Africa and even longer in Europe, Britain and the United States. It is appropriate that each management discipline should subject itself to periodic self-appraisal to confirm or reassess its relevance to the management education process. Quantitative methods is no exception. However, only two studies to assess the current status of the discipline within South African management (Wegner, 1983 and Juritz, Money, Affleck-Graves & Du Toit, 1988) have been reported in the past decade. A further rationale for undertaking another study in South Africa is the fact that a similar study by Naudé, Stray & Wegner (1991) amongst *United Kingdom management* has recently been completed and would serve as a useful basis for comparison for the South African experience.

This study serves *two* broad *purposes. Firstly*, it aims to identify the level to which quantitative methods have been integrated into management decision making in South Africa and *secondly*, it examines the implications of these findings for future quantitative methods course planning in South African management education.

This study differs from almost every other study into quantitative methods practices in management by focussing only on *that section of the management population with past exposure to quantitative methods* through an MBA programme. Thus the target population was all MBA alumni from South African Business Schools operating in South African companies. This removes one of the commonly identified factors for non-implemetation namely, *ignorance of the discipline* from the study.

Literature review

In the early seventies Vandell (1970: 5) identified *quantitative analysis* and *electronic data processing* as two powerful emerging forces in management. It is a *fait accompli* that the computer revolution has happened over the past two decades. However, studies exploring the extent to which *quantitative methods* thinking has penetrated the domain of management decision making have generally reported less dramatic developments. Some of these more recent studies are reviewed here.

The studies which are reported differ widely in their *sampling methods, choice of techniques,* and *questionnaire design*. Consequently, it will not be possible to draw firm conclusions about the scale of penetration of quantitative methods into decision making in mainly American and European management. However, certain patterns can be detected and these will be highlighted. All studies reviewed below will be examined from the following points of view: (i) the identification of the *most frequently used techniques; (ii) the percentage* of techniques examined which are in *frequent use;* and (iii) the identification of *hinderances* which inhibit the further use of quantitative methods in management practice. This study will focus only on *statistical methods* as a subset of the broader range of Quantitative Methods discipline.

While not representing the management profession, the results of a survey carried out amongst members of the Institute of Statisticians (Pridmore & Reese, 1988) provide an insight into the *most frequently used techniques* by professional statisticians. In *decreasing order of usage levels*, the top 50% of techniques employed are *data collection and presentation, experimental design and analysis, hypotheses testing, time series and forecasting* and *surveys and opinion polls*. In a recent joint United Kingdom-Europe study (involving Denmark and Greece), Wisniewski, Jones, Halikias, Bourantas, Kristensen & Ostergaard (1990: 18) found that *extensive use* was reported by the 93 respondents across the three countries of the following statistical methods with respondent frequencies greater than 25%: *basic statistics* (65%), *simulation* (38%), *smoothing methods* (38%), *regression* (37%), *inventory control* (25%), and *quality control* (25%). Of interest, in terms of statistical techniques, respondents were *least familiar* with a range of *multivariate* and *non-parametric methods* (1990: 20). Only *six of the 27 techniques* examined are used regularly by 25% or more of responding companies. Usage patterns of statistical methods in the USA have been researched by Kathawala (1988). He reported on 226 responses of a survey of large manufacturing firms, service organizations and small businesses in the USA. The five top ranked techniques, in terms of regular usage, were identified as follows: *forecasting* (72%), *statistical sampling* (45%), *simulation* (44%), *regression analysis* (35%), and *ANOVA* (35%). This study by Kathawala was a replication of an earlier study by Green, Newson & Jones (1977) which reported that the most frequently used techniques were *sampling* (50%), *stock control* (45%), *regression* (42%), and *time series* (40%).

In terms of the *number of techniques in frequent use*, the 1977 study of Green *et al.* reported that only *25%* of the responding companies had *frequent or extensive* use of 7 of the 19 quantitative methods examined; and 9 out of 19 were not used by over 60% of the responding companies (Kathawala, 1988: 982). Kathawala's finding was more pessimistic. His study found that only *7 out of the 28 techniques* surveyed are listed as being frequently or extensively used by 25% or more of the responding companies. Altogether 11 out of the 28 techniques are largely unused by over 60% of the responding firms (1988: 984). Kwathawala concluded that the results are far from satisfactory in terms of *increased penetration* of quantitative methods into American management decision making. In a second recent survey reported in the USA, Coccari (1989) surveyed small and medium-sized manufacturing firms. He concluded that *forecasting methods 'seem to have a broader appeal than other quantitative techniques'* (1989: 72).

The *South African* management community has only been surveyed twice in the past ten years. The 1983 study by Wegner reported that, of the 165 Johannesburg Stock Exchange companies who responded, *descriptive statistics* (52%) and *forecasting methods* — including regression and time series — (53%) were the most widely known and used methods. Only between 20% and 32% of respondents reported using *inferential statistics* and *simulation* on a periodic to regular basis (1983: 122). Fewer than 10% of all respondents reported using any other technique on a regular basis. In 1988 the second study — based on 42 responses — was reported by Juritz, Money, Affleck-Graves & Du Toit (1988) on the use of statistics in South African Commerce and Industry. They found that *routine use* was made of graphical display and data summary by 80% of respondents, *basic statistical methods* by 70% of respondents, and *forecasting methods* by 60% of respondents. Only 40% of respondents reported *routine use* of *analysis of variance, regression analysis, time series*, and *quality control methods*. Other statistical methods such as *survey sampling, contingency tables, multivariate techniques* and *non-parametric methods* were reported as routinely used by a minority of respondents which ranged from 20% down to 5% (1988: 62).

Summarized in Table 1 are the six studies reported above and a pattern that has evolved in recent times is highlighted. *Data collection* and *graphic display* (which includes *basic statistics)* has emerged from the six studies reported as the *most frequently used* (i.e. 50% to 80%) set of statistical methods. Only *moderate usage* (i.e. between 30% and 50% overall) is reported for most of the remaining techniques

Table 1 Comparison of usage frequency of statistical methods from six studies (1977–1990)

Statistical techniques	IoS (1988)	Juritz *et al.* (1988)	Kathawala (1988)	Green *et al.* (1977)	Wisniewski (1990)	Wegner (1983)
Basic statistics & graphical display	1*	80%	—	—	65%	52%
Experimental design	2	40%	35%	—	—	—
Inferential methods	3	70%	—	—	—	33%
Forecasting methods	4	40–60%	72%	40%	38%	54%
Sampling	5	—	45%	50%	—	—
Quality control	—	40%	—	—	25%	—
Regression analysis	—	40%	35%	42%	37%	54%
Simulation	—	—	44%	—	38%	32%
Inventory control	—	—	—	45%	25%	27%

* The Ios study only *ranked* the *top 50% of* techniques most frequently used.

listed in Table 1. Almost all other *statistical* methods not listed in Table 1 do not appear to be in common use (i.e. regular usage levels below 10%).

In addition to *usage analysis*, a further major component of most studies into quantitative methods applications focuses on the *identification* of *hinderances* which inhibit the further penetration of these methods into management practice. All three US studies established that amongst the *top-ranking* barriers were: *the benefits of using techniques are not clearly understood by managers*, and *managers lack knowledge of quantitative techniques* (Green *et al.*, 1977; Kathawala, 1988; Coccari, 1989). Of the 15 ranked order of barriers listed by Kathawala (1988: 987), the majority of the *top order* barriers relate largely to a *lack of knowledge* and *confidence* and can be described as mainly *human-oriented hinderances*. The lower rank order barriers relate to mainly *technical* hinderances such as *lack of data*, *cost* and *computing difficulties*. In the 1983 study reported by Wegner (1983: 122), the *lack of understanding by the line manager* and *inadequately trained personnel for implementation* were cited as the two primary reasons by responding companies for reporting either *no* usage or *very limited* usage of quantitative methods in decision making. Wegner concluded that '*70% of all the problems associated with the application of these techniques are attributed to the human element*' (1983: 122).

Lack of management support and *no established support group* within the organization were the top two reasons given by UK respondents in the Wisniewski (1990) study.

There is general concensus amongst researchers that *human-oriented factors* are the most significant barriers to more *widespread* use of statistical methods in management. A disturbing observation is that this barrier has not diminished over the years. It was reported in the mid-1960s by Vatter (1967) and still features *high* on the list of *hinderances* in the 1990s. It is also a *inter-country* phenomena. It is as prevalent in the USA as it is in the UK and South Africa.

Empirical findings

In this section the findings of a survey conducted in 1992 amongst *Business School management graduates* operating in South African companies are presented. The MBA alumni lists of the four major RSA Business Schools, namely the University of Cape Town, Witwatersrand University, University of South Africa, and Stellenbosch University were used as the sampling frame. These alumni account for over 90% of all South African MBA graduates annually. A mailed questionnaire identical to the one used in the Naudé, Stray & Wegner (1990) study conducted in the United Kingdom was used. A response rate of 27% (408 usable responses) was achieved using a clustered random sampling approach.

Of the 408 responses, 256 (63%) identified themselves as *users* and 152 (37%) as *non-users* of *quantitative methods*. The UK study (Naudé *et al.*, 1991) reported that 66% of respondents used statistical techniques, while 34% did not. More than a quarter of the South African *non-users* (28%) envisaged employing *statistical methods* in the future. The *most common* reasons given for *non-use* were '*lack of need*' and '*non relevance to job or company activity*'. It should be noted that in this study only the explicit use of statistical methods in management practice will be examined. An aspect which is not explored in this study, but which could form the basis for further research, is the extent to which *non-users* may implicitly apply statistical reasoning in their decision making.

To establish if *non-response bias* exists, the profile of responses between identified *users* and *non-users* as classified by *management level*, *functional area*, and *economic sector* were examined. These profiles are shown in Table 2.

For *both users* and *non-users*, the majority of respondents were *top management* (about 60%) and about *one-third* were *middle management*. No difference in profile exists. In terms of *functional area*, *general management* (*users* 43%, *non-users* 50%) were the largest representative group in both categories. All the major functional areas in management are also well represented as shown in Table 2. A good cross-section of *economic sectors* are represented with a slight bias towards *Retail/Banking* (*users* 14%, *non-users* 15%), *Engineering*, *Chemicals/Energy*, *Construction* and *Consultancy* (each approximately 10% representation).

Table 2 Profiles of users and non-users by management level, functional area and economic sector

	Percentages of users (n=256)	Percentages of non-users (n=152)
Management level		
Top	58	64
Middle	36	32
Junior	6	4
Functional area		
General management	43	50
Marketing/sales	11	18
Finance/accounting	9	12
Production/operations	10	5
Human resources	6	3
Computer support	11	5
Other	10	7
Economic sector		
Metal and mining	7	7
Chemicals/energy	10	10
Pharmaceuticals	4	3
Engineering	10	14
Textiles/paper	6	4
Food/drink	6	3
Construction	8	11
Transport	4	3
Retailing/banking	14	15
Printing/publishing	1	1
Consulting	12	11
Public service	2	3
Education	2	1
Computer services	3	5
Other	11	9

While marginal differences were noted in the spread of *users* versus *non-users* across the major *functional areas* and *economic sectors*, these differences do not appear to be significant.

Since the percentage of *non-user* respondents is relatively large in terms of the response sample (i.e. almost 40%), *non-response bias* from *non-users* would appear to be minimal. In addition, the similar *user* and *non-user* profiles across *management levels*, *functional areas* and *economic sectors* indicate that a representative cross-section of South African management with quantitative methods exposure have been surveyed through the sample.

User awareness

The remainder of the empirical findings relate to the 256 *user* responses. The first question asked of *users* of statistical methods was their *level of awareness* of a range of statistical techniques. The techniques are separated into High, Moderate and Low awareness categories in Table 3. The equivalent awareness levels for the United Kingdom study are also shown together with a rank ordering of techniques by *awareness levels*.

In Table 3 the view is confirmed that there is *high awareness* (above 80%) of the *introductory statistical methods* as expected given the nature of the sampling procedure, and *moderate to low awareness* of the *intermediate* and *specialist interest* statistical techniques.

An almost *identical* rank ordering of techniques in terms of *awareness* is found between the RSA and UK *user respondents*. However, the awareness levels for techniques in the specialist areas, such as *quality control*, *experimental design models* and *non-parametric tests* appear significantly lower in the UK study than amongst SA *user respondents*.

Table 3 Respondent awareness of statistical techniques

Statistical method	Awareness RSA (n=256) %	Rank	UK (n=420) %	Rank
High awareness				
Data collection and presentation	100	1	98	1
Forecasting models	96	2	92	3
Regression and correlation	94	3	92	4
Probability analysis	92	4	95	2
Hypothesis testing	84	5	78	6
Confidence intervals	84	6	81	5
Moderate awareness				
Sample survey design	77	7	74	7
Index numbers	65	8	56	9
Contingency tables	63	9	60	8
Low awareness				
Multivariate models	53	10	50	10
Quality control	51	11	36	11
Experimental design model	46	12	18	13
Non-parametric tests	42	13	34	12

Usage levels

The *usage level* of each of 13 statistical techniques were guaged on a *5-point semantic differential scale* from '*none*' (0) to '*extensive*' (4). The mean *usage level* of each technique is shown in Table 4 and is a measure of *the intensity of usage*. The techniques have been classified into *high*, *medium* and *low usage levels*.

Indicated in Table 4 is the fact that there is generally *low usage* amongst the *256 user respondents* for the majority of the statistical techniques examined. The only exceptions are the techniques of *data collection and presentation (mean usage* = 2.95) which shows *high usage*, and the *moderate usage* of predictive techniques such as *forecasting models* and *regression and correlation*. An almost similar pattern is found amongst UK user respondents.

The mean usage levels of Table 4 measure the *intensity of usage*. To explore the *frequency of usage*, respondents *ranked* the three *most often used* techniques. Frequency is expressed as a percentage of the number of respondents who *ranked a technique in the top three* relative to the number of respondents *aware* of the given technique. Refer to Table 5.

Data collection and presentation methods enjoy the highest usage both in terms of *intensity* (mean score = 2.95) and *frequency* (by 92% of users). Predictive type models such as *forecasting models* and *regression and correlation* show a *moderate* level of application both in terms of *intensity* and *frequency of usage* (approximately 50% of users make use of these techniques frequently). The remainder of the techniques show *low* and *infrequently use*. Frequent usage of these

Table 4 Mean usage levels — South Africa and the United Kingdom

RSA	Mean usage UK (n=256)	(n=420)
High usage		
Data collection and presentation	2.94	3.01
Moderate usage		
Forecasting models	1.80	1.66
Regression and correlation	1.63	1.14
Low usage		
Probability analysis	1.18	1.13
Index numbers	1.12	1.26
Sample survey design	1.02	1.10
Confidence intervals	1.00	0.85
Quality control	0.92	0.72
Contingency tables	0.82	1.01
Hypothesis testing	0.66	0.67
Multivariate models	0.44	0.76
Experimental design models	0.38	0.34
Non-parametric tests	0.36	0.40

Table 5 Most frequently used techniques

Statistical method	Frequency of use
Data collection and presentation	92%
Forecasting models	57%
Regression and correlation	50%
Probability analysis	23%
Sample survey design	22%
Index numbers	22%
Quality control	18%
Confidence intervals	14%
Contingency tables	12%
Hypothesis testing	7%
Multivariate models	6%
Experimental design models	4%
Non-parametric tests	4%

latter techniques is confined to only a small percentage of respondents which range from 4% to no more than 23% of respondents (refer to Table 5).

As a pointer to the future use of statistical techniques, respondents were asked to identify the *top three* techniques considered to have *potential* for further application. Indicated in Table 6 is the percentage of respondents who consider that *more frequent usage can* be made of a given technique in their decision-making domain. The responses are expressed as a percentage of the number of respondents who were aware of the particular technique.

The three techniques which currently enjoy the *most frequent usage* currently, namely *data collection/presentation, forecasting models* and *regression analysis* tend also to be amongst the techniques which are considered to have *greater potential for further usage*. There is also a perception amongst respondents that the *less used* techniques of *probability analysis* and *quality control* have potential for more frequent usage in the future. Currently these latter two techniques are used frequently by only approximately 20% of respondents.

Techniques which currently have *little* usage (i.e. mean usage is below 1.0 as seen in Table 4) such as Sample Survey Design, Index Numbers, Contingency Tables, Multivariate Models, Quality Control, Experimental Design Models, Non-Parametric Tests, are considered *not* to have much potential for further application. The UK study findings are very similar to the above findings as seen from Table 6.

Table 6 Techniques warranting more frequent usage

	RSA		UK
	No.	%	%
Greater potential for further usage			
Forecasting models	143	58	54
Probability analysis	108	46	41
Data collection and presentation	109	43	53
Regression and correlation	87	36	32
Quality control	43	33	22
Lesser potential for further usage			
Confidence intervals	43	20	26
Sample survey design	31	16	20
Hypothesis testing	33	15	19
Multivariate models	15	11	10
Non-parametric tests	11	10	3
Experimental design models	12	10	15
Contingency tables	14	9	13
Index numbers	8	5	13

Benefits

The perceived importance the *256 user respondents* attached to statistical methods as a *decision support* function in management decision making is clearly indicated in Table 7. Between 60% and 70% of respondents see the role of statistical methods as *enhancing their decision-making capabilities*. This perception is shared by the UK management respondents as reported by Naudé *et al.* (1991: 453).

Inhibiting factors

The *most significant barrier to greater usage* is a *human* constraint. From Table 8 it can be seen that over 40% of the *256 user respondents* (42%) see the *lack of statistical knowledge of their management colleagues* as *the* major inhibiting factor. This limits the ability of respondents to communicate effectively using statistically based reports. This is also a significant factor highlighted by the UK report (33%). The *second most important* inhibitor in *both* this study and the UK study is a *technical factor* of the *lack of appropriate data*. Altogether 35% of South African respondents and 28% of UK respondents identified it as a problem area.

Technical problems rated more prominently than *human problems* overall in this study. The *lack of consultative/ technical support* (29%) and the *lack of appropriate statistical software* (28%) appear to be more important inhibitors than the *human* factors of *colleagues' lack of confidence in statistical methods* (20%) and *respondent's own lack of confidence* (13%). In contrast, the UK study found that *human* barriers were marginally more significant

Table 7 Benefits derived from using statistical techniques

Factors	RSA (n=256) %	UK (n=420) %
Greater confidence in final decision	68	52
Deeper analysis of problem possible	68	60
Reduces subjective jugdement	66	60
Improves problem understanding	61	60
Decision justification made easier	55	57
Other	15	11
No benefits	0	0
Total number of mentions (excluding *No benefits)*	853	

Table 8 Barriers to greater usage

	Percentage RSA (n=256)	UK (n=420)
Factors — Human		
Colleagues' lack of statistical knowledge	42	33
Colleague's lack of confidence in statistical methods	20	20
Respondent's own lack of confidence in statistical methods	13	12
Factors — Technical		
Lack of appropriate data	35	28
Lack of consultative/technical support	29	18
Lack of appropriate software	28	19
Inadequate access to computer facilities	9	9
Other	22	13
No hinderances	16	21
Total number of mentions (excluding *No hinderances)*	506	

than *technical* barriers. At least 16% of user respondents saw *no hinderances* to their further usage of statistical methods.

It is worth noting that the percentage of respondents who identify with the *inhibiting factors* (between 20% and 40%) are *significantly fewer* than the percentage of respondents who identify with the *benefits* of using statistical methods (between 55% and 70%). A similar trend existed in the UK findings.

Available support systems

The *lack of appropriate statistical software* was cited as an *inhibiting factor* by almost 28% of respondents. Established in Table 9 is the *usage level* of a selection of commonly available statistical software packages.

It is clear that the majority of user respondents (91%) rely on a *spreadsheet* and to a lesser extent on a *database* package (44%) for their statistical analysis. Neither of these packages are custom-made statistical systems, although *spreadsheets* have a limited number of basic statistical functions. *Statgraphics* is the most frequently used general-purpose statistical package, but only by 22% of user respondents. The low usage of established statistical software systems confirms the finding that users perceive there to be a *lack of appropriate statistical software* (refer Table 8).

The *lack of consultative/technical support* was also identified in Table 8 as a significant inhibiting factor. This study found that *only 33%* of user respondents *have access* to some form of *statistical support unit* within their organization. The majority of user respondents (64%) do believe that there is a need for a *statistical support unit* or *consultant* to whom they can refer for statistical advice.

Educational pointers

The *second objective* of this study was to examine the offerrings of statistical topics in South African management education programmes. In this regard, Statistics courses directed at management students should endeavour to address topics considered relevant by the end-user community.

Table 9 Percentage of respondents using statistical software packages

Software packages	Percentage (n=256)
BMDP	0
SAS	13
SPSS/SCSS	6
MINITAB	0
GENSTAT	3
STATGRAPHICS	22
LOTUS 123/spreadsheet	**91**
DBASE III +/other database	44
Other	15

As an aid to course design, respondents were requested to indicate the appropriate location in an *applied statistics course* for each of 13 topics. Table 10 reflects the percentage of respondents who classified each topic as either *core*, an *elective*, or to be *excluded* from an *applied business statistics* programme.

From Table 10, it would appear that there is *no single statistical technique* that the clear majority of user respondents (over 90%) wish to see excluded from a Statistical Methods course for managers.

The statistical methods which are considered fundamental by over 75% of user respondents and should be taught in a *core* statistical methods course are: *data collection and presentation* (96%); *probability analysis* (83%); *regression and correlation* (79%); and *forecasting methods* (76%). There is more support for *confidence intervals* (66%); hypotheses testing (61%) and *sample survey design* (48%) techniques to be covered in a *core* course rather than as an *elective*.

Table 10 Statistical methods course content

	Topic classification (n=256)			
	Core	Elec-tive	Ex-clude	No opinion
	(% of respondents)			
Preferred core topics				
Data collection and presentation	96	3	0	1
Probability analysis	83	14	0	3
Regression and correlation	79	16	0	5
Forecasting models	76	20	0	4
Confidence intervals	66	22	2	10
Hypothesis tests	61	32	0	7
Sample survey design	48	36	3	14
Preferred elective topics				
Contingency tables	34	44	5	17
Index numbers	33	42	8	16
Quality control	30	49	5	16
Non-parametric tests	22	51	7	20
Experimental design models	19	52	11	18
Multivariate models	9	31	5	55

There is clearer evidence to suggest, by examining Table 10, that the techniques of *contingency tables analysis; index numbers; quality control; non-parametric tests; experimental design models;* and *multivariate models* should be offered as electives. There was a large *non-response* (55%) to the course positioning of topics on *multivariate models*. This can be ascribed to the relative recent introduction of these topics into management education programmes and hence the lack of knowledge of what these topics entail by a significant proportion of user respondents.

Discussion and conclusions

In this study it was established that over 60% (63%) of management respondents used some form of statistical analysis in their decision-making domain. A similar level of penetration (67%) was reported in the UK study by Naudé *et al.* (1991). *Frequent* and *wide-scale* usage of statistical methods is limited to only three areas, namely *data collection and presentation, forecasting models* and *regression and correlation*. The remainder of statistical techniques surveyed had both *low regular usage*, and a small user base. The potential for future frequent usage appears limited to those statistical methods which are *currently* frequently used, in particular, *forecasting models*. Only *probability analysis* and *quality control* from amongst the list of infrequently used methods, are considered to possess greater potential for future frequent use. Further research on usage levels could correlate the strategic importance of management decisions with the prerequisite need to employ statistical methods.

It is not possible to conclude about relative changes in the usage level of statistical techniques over time due to varying sampling procedures, choice of techniques and methods of analysis employed in earlier studies cited. However, a comparison between Table 1 (Summary of previous studies: 1977–1990) and Table 5 (1992 Study) indicates consistent usage of a core of statistical techniques (*descriptive statistics and display methods, regression analysis* and *forecasting methods).* The balance of the statistical methods remain largely underutilized. Notwithstanding the significant proportion of users (60% to 70%) who derived benefits from the use of statistical methods, the *difficulties* encountered (by up to approximately 40% of users) and lack of greater *benefit* awareness (by between 30% and 40% of users) demand that further attention be paid to minimizing these obstacles on the one hand, and promoting the benefits on the other.

The most notable reason for this situation is *still human orientated*, namely a *lack of knowledge* and consequently *confidence*, by a user's *colleagues* with whom they need to interact in the exchange of statistical information. Technical issues also play a significant role as barriers to greater usage. The three most significant technical barriers are: the *lack of appropriate data*, the *lack of consultative/technical support*, and the perceived *lack of appropriate statistical software*. These issues are clearly inter-related. A *consultative/technical support* service could serve to familiarize users with suitable statistical software packages and advise on the design of databases to reduce the likelihood of data not being available in the format and quantity required for specific statistical analyses. Such support services would consequently promote confidence in the use and interpretation of statistical information. Thus, by addressing the lack of statistical *consultative/technical support services* within organizations, it may well be possible to contribute significantly to the greater utilization of statistical methods within management decision making.

These findings also have significant implications for statistics educators in the field of management education. In this study it was found that all respondents agreed that an appreciation of statistical methods in any management education programme is necessary. The question then becomes one of how to 'package the product' to promote greater utilization in practice. For managers to become users of statistical methods, the instructional modes employed must promote *competency* and demonstrate *relevance*.

According to Simms & Sauser (1985: 51), management students, in particular MBA's, have been criticized for possessing knowledge, but failing to display *competency* which is the skill of applying what has been learnt. This points towards a need to re-appraise the *instruction modes* employed in promoting statistical expertise amongst management students. The oft quoted reason of *a manager's lack of confidence* in applying these techniques is clear evidence that less than appropriate learning methods have been used in the past. Greater emphasis should possibly be placed on *andragogic* learning principles which encourage self-discovery. Extensive use of assignments and practical projects promote competency rather than *knowledge acquistion* only. While the lecture method is useful for imparting basic knowledge of statistical methods, greater emphasis should be placed on the *practice* of statistics *during* the learning process. This should promote confidence in the understanding and use of techniques as well as expose students of management to the wide spectrum of application areas and hence also demonstrate *relevance*.

The discipline of *applied* statistics must be seen in the context of *decision support*. In order for managers to integrate statistical thinking into the *decision-making process*, statistical methods and reasoning must be closely integrated with functional management disciplines. This could be done either by introducing statistics concepts within a functional discipline, or designing a Statistical Methods programme which is *applications*-driven instead of technique-driven. A further suggestion is the offering of specialist electives which focus on statistical methods relevant to specific functional areas. Thus, increased statistical usage may result from both a change in *instruction mode* and *material orientation*.

Curriculum design need also be examined in the light of factors identified in Table 8 as limiting greater usage of the discipline in practice. Following from the significant number of users who are restricted by the lack of appropriate data, management education programmes should include material on the *organization and structuring* of data capturing systems as part of a statistical methods programme. Statistical courses should include, as a *core* component, a section on *data requirements* for different statistical methods and *data collection* techniques to acquire the needed data. This

practice may result in managers developing and implementing *database structures* within their decision domains to ensure that the required data for statistical analysis is available when required. This section should be integrated with computer-related database systems. It is also clear from the findings in Table 9 that users are unfamiliar with statistical software packages. By adopting *andragogic* instructional modes, familarization with available statistical software would be an integral component of such learning methods.

The discipline of statistics has much to offer management as an effective decision-support service, but there is still much that needs to be done by educators in statistics to promote greater usage of the discipline in management. This study sought to provide pointers in this review process.

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