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3.III.1 Introduction

In this chapter we give a personal view on the role of a statistical consultancy unit, especially one within a university. Both of us work in universities where, besides research, we do consultancy work, and this enables us to explore the issue from an inside point of view. This work is an updated and revised version of Does and Zempléni (2001).

Statistical consultancy can mean anything from resident experts within departments to a dedicated bureau or consultancy unit. Why is there a need for consultancy

units? Why cannot the engineers or other local experts solve their own problems? One reason is that problems that occur randomly in time may be solved more readily by someone with an external viewpoint. But our main point is that theory and methods are constantly developing and a university-based group is more likely to be able to keep up with research. This may not be obvious to those with the problems, since the ubiquity of statistical packages creates the illusion that anybody can find the correct answers to problems. Unfortunately, the results from statistical packages are not always correct; the obvious choice is not always the best one to choose from the abundance of available methods, and people may not see the need to check analytical conditions.

So it is necessary to promote the services of the consultancy unit, and this is a tricky issue because it is knowledge rather than a product that has to be sold. Probably one of the best ways to make potential users aware of the existence of the consultancy unit is to put on a special course, which may show the benefits of consulting the unit.

The next question may be: what is the difference between university-based and other consultancy units? The distinction may be blurred because university-based units are quite often transformed into general business enterprises, and then the same personnel and approach are to be found in both types of unit. Rather than become enmeshed in detail concerning these differences, this section confines its investigation to university-based consultancy units.

Minton and Freund (1977) suggested that a consultancy unit located within a statistics or mathematics department probably has the most advantages – for example, recent advances in statistical methodology can be applied if needed and, in return, service courses are revitalised by the consultancy problems. But before explaining our point of view on the role a consultancy unit can play at the host university, we give a brief summary of the available literature on statistical consultancy units.

There is an extensive literature about university-based statistical consultancy units, containing valuable information about such centres at universities in the United States; see Boen (1982) and the references therein, or Khamis and Mann (1994) for a more recent review. The existence of these units is based on the fact that statistics is a special science, as its methodology is used in almost all other sciences and its use is booming in industry (see Bacon, 1999). There are several examples showing that an informal 'service' provided by members of staff to colleagues is not effective. An organisation is needed for performing excellent consultancy.

The literature about European practice is more sparse. Some examples of successful university-based consultancy units are presented in Zempléni (1997). Does (1999) is a recent paper with many examples of research problems initiated by consultancy work.

Within the university, statistical consultancy units can be either commercial, charging a viable rate for their work, or non-commercial, working for no extra

payment. We have found more examples of non-commercial (or mostly non-commercial) units than commercial ones; see Carter *et al.* (1986) and Khamis and Mann (1994) for examples. That does not prove that there are only a few commercial units – it could be the case that their consultants are too busy conducting a commercially viable business to disseminate their experiences. A nice example of a self-supporting unit is presented by Boen (1982) in the area of biometrics. Our aim is to add new examples from Europe, where we observe differences in traditions.

An important point is that consulting activities are not usually supported by the traditional university evaluation system, in which research is considered the most important activity (several grants and personal rewards depend on the research activities of the given department), followed by teaching – but in this case quite often the quantitative characteristics are more important than the qualitative ones. Consultancy services – provided to colleagues from other departments or to interested people from the outside world – are considered far less important. This being the case, the establishment of a consultancy unit does not only have the usual organisational difficulties, but there is a danger that the participants themselves will be unsure about their preferences and so the consultancy work might be done less enthusiastically and effectively. In Section 3.III.2 we give a list of differences between commercial and non-commercial units, which should be taken into consideration when deciding whether to establish a unit of either type. Section 3.III.3 summarises the opportunities and the problems when a commercial consultancy unit is already in operation. We summarise both sections in the form of a table. Section 3.III.4 contains our examples, showing how we tried to overcome the observed difficulties when establishing consultancy units in the Netherlands and in Hungary. Section 3.III.5 gives our conclusions.

3.III.2 Comparison of commercial and non-commercial statistical consultancy units

In practice, different traditions at universities have resulted in certain departments or faculties having their own experts in statistics. It is quite clear that such local experts are not able to cover all possible statistical consultancy needs. So there is often a unit (either formal or informal) within the department of mathematics or statistics serving the needs of other departments and/or industry.

There are two main types of such statistical consultancy units: the non-commercial unit, serving mainly the needs of the other faculties of the university; and the commercial unit, which is open to clients both from inside and outside the university on a fee-for-service basis. These pure, extreme cases are rare: often one finds mixtures with emphasis on either the non-commercial or on the commercial aspects.

3.III.2.1 Finance

The most important (and probably the most decisive) question when thinking about starting a consultancy unit is the following: is the university (or any other institution) in a position to offer long-term support to the statistical department (or analogous unit) for providing statistical consulting services to other departments or not? As can be seen from the literature (see Carter *et al.*, 1986), the mission statements of non-commercial units emphasise the positive effect of consultancy on teaching and research. But consultancy is of course a time-consuming activity, so the participating members of staff should get a reduction in their teaching load (financed by the host university). This non-commercial type of unit is less stressful for the members of staff if there is little pressure from the clients for very strict deadlines.

On the other hand, if there is no – or only limited – direct financial support available from the host university, then the unit needs to be self-supporting. There are examples (see below and Zempléni, 1997) where the commercial unit not only became self-supporting, but succeeded even in providing financial support to its faculty and/or university.

The different financial status also has an important effect on the scientific merits of the projects undertaken. If one is responsible for keeping to the annual budget of a commercial unit, then there is strong pressure to obtain income even if the project is not interesting from a scientific point of view. Such pressure is rare in the case of non-commercial units.

The pricing policy is also different for the two types of units: the non-commercial unit is not so heavily dependent on making profits, so there is a possibility to apply flexible charges, depending on the project and the client. On the other hand, commercial units cannot afford to incur losses, so usually a fixed price per consultant per day is charged.

3.III.2.2 Personnel

There are some important points about the skills to be possessed by the members of staff which should also be taken into consideration when thinking about starting a statistical consultancy unit.

Different clienteles require different communication skills: if one only deals with university graduates (which is usually the case for a non-commercial unit), it tends to be easier to achieve respect and to make oneself understandable. However, when communicating with people from the shop floor of a manufacturing company, one has to possess the skills of a good facilitator (see Snee, 1996; see Section 3.II above).

Moreover, the commercial unit has to have a competent head, who is capable not only of understanding the statistical or technical nature of the problems and estimating the difficulty of the projects, but also of managing the whole unit. This requires the skills of an entrepreneur, because he/she has to negotiate project

fees and details with other managers. These skills are rarely found in statisticians from a university, and recruitment from outside is not an easy task. The lack of a suitable manager is often the reason for rejecting the idea of establishing a commercial unit.

The organisation, planning and documentation of the work are also different for the two types of units. At a non-commercial unit, in the worst case, the scientific reputation of the author is at risk. To be a consultant at a commercial unit involves taking more responsibility, since in this case legal consequences can follow erroneous advice. Hence the work – and the responsibilities – should always be documented during the whole process of working on a project, (see Kirk, 1991). There is a related question of deadlines. Whilst in the case of non-commercial units the deadlines are rarely strict, this is not so for projects of the commercial consultancy units.

3.III.2.3 Operational structure

As the consultancy units are usually part of the department of mathematics or statistics, the rules of the university apply. Some peculiarities are worth mentioning. For instance, the commercial consultancy unit should have a well-chosen name in order to be distinguishable from the 'old-fashioned' academic department.

Usually, there is no need for major investment when it is decided to start a consultancy unit and, if the consultants already have positions in the department, the financial risk is limited. However, this comfortable situation has its dangers, too: if the head of the unit does not have enough motivation or skills to arrange new contracts, then there is no future for the commercial unit. The non-commercial unit does not need to be so well managed, as the clients usually come on their own initiative.

If the commercial unit is successful, after a few years in operation the unit's growth makes it possible for the university to relax control. Hence, the unit gains more independence. In this case the host department/faculty can create a supervisory board controlling the policy of the unit and the use of the accumulated profit, but not its everyday life.

3.III.2.4 Typical projects

Examples from the practice of the Institute for Business and Industrial Statistics of the University of Amsterdam (IBIS UvA) in the Netherlands show (see below) that the total involvement approach in projects is effective (see Marquardt, 1979). Here the consultant is actively involved in the complete trajectory, from project formulation through understanding the processes, recognizing the possible problems, implementing the practical solutions and checking the results to the post-project follow-up. In such cases the power of statistics can be fully utilized.

Even with projects in other sectors, such as health care, knowledge about the motivation and the expectations of the client are vital for the consultancy work

to be effective. A deep understanding of the background is needed so that the suggestions are useful and realizable.

Although the above-mentioned type of participation in projects would of course be useful in the case of non-commercial units as well, usually the consultants can afford to allocate only a limited amount of time to the clients. So there is little hope for total involvement, which needs months or sometimes even years of continuous work. This lack of time results in the situation that even the formulation of the project and agreement on the outputs are not always done.

As statistical theories and methods are expanding, it is almost impossible for a person to be familiar with the most recent trends in more than one field of application. So specialization is needed (especially in the case of a commercial unit): either the unit itself concentrates on a specific subject (industrial statistics in the case of IBIS UvA; see below) or the specializations of the senior members of staff define the limits of the consultancy. For a non-commercial unit, there is more flexibility in choosing projects; one reason for this may be a much looser time schedule which allows time for research.

Table 3.III.1 gives a summary of the above mentioned issues.

Table 3.III.1 Comparison of commercial and non-commercial units.

Aspect	Commercial units	Non-commercial units
Financial status	Self-supporting	Supported by the host university
Pricing	Fixed (based on working days)	Flexible
Clients	Both internal and external	Mostly internal
Skills needed	Professional, managerial and communicational	Professional
Responsibility	Legal	Scientific
Selection of projects	Not always possible	Important
Method of work	Written contracts, policy statements	Informal agreements
Operational structure	Independent management	Possibly within the department
Project areas	Usually specialised	May be more diverse
Typical project depth	Total involvement	Clinic-type

3.III.3 Opportunities and problems when running a commercial consultancy unit

Let us investigate the main points related to running a commercial consultancy unit

3.III.3.1 Research

Even in the case of commercial units, the university background should never be forgotten. Consultancy projects will provide the consultants with challenging research problems; for a wide range of examples, see Does (1999).

It is emphasised even in some earlier papers (see Marquardt, 1979) that the level of statistics applied in industry and science has become highly sophisticated. Often suitable procedures for non-standard situations can only be developed by a PhD-level consultant. It is the task of the head of the unit to encourage the publication of the results. Usually, it is not a major problem to get permission from clients to publish the results achieved in a scientific journal. However, it is surprising that these results are not always accepted as an achievement comparable to the (not always really applicable) methodological papers. The promotion and extension of the use of statistical methods to other disciplines are important goals of applied statistics (cf. Carter *et al.*, 1986). One should be aware of the danger of accepting any client only because of financial considerations: if there are only trivial problems involved in the consultancy projects, the consultant might feel overqualified for the work.

3.III.3.2 Teaching

The teaching aspect of consultancy requires that the consultant should possess the ability to communicate the statistical knowledge to the clients, who might have a very different statistical background. This ability is also important when delivering service courses to students of other faculties. The wide range of projects that staff members work on provide excellent examples for illustrating teaching.

On the other hand, a busy consultant might not have enough time to deal with the problems of individual students. It might also cause tensions if the consultant is the supervisor both of his PhD student's thesis and his consultancy work (cf. Boen, 1982).

3.III.3.3 Computing

A recent activity, which is heavily related to modern applied methods in statistics, is the use of computers. There are completely different attitudes towards this area. Some university members of staff are leading figures in non-commercial software development (R being the most widespread example, but there are other examples such as the BUGS package for carrying out Markov chain Monte Carlo analysis). These non-commercial packages are often developed through non-commercial consultancy units. On the other hand, commercial units are more time-conscious, so even if they develop their own procedures, they are rarely published. If they put more effort into their software development, it is more often for an (at least partially) commercialised product, as in the case of some teaching or simulation software (such as SIMUL8). Even in this case the large amount of time spent on the development and marketing of such products may not be effective enough to

ensure large sales. So best practice seems to be to relate the software development to the projects, and any sales will be an added bonus.

3.III.3.4 Career

If the applied research of the consultant is recognised by the university, then career opportunities are no worse than for other university staff members who have mainly published papers in (theoretical) statistical journals. In addition, a consultant has extra options, being an entrepreneur as well as a scientist (through the 'total involvement' in the projects, and because practical experience has been acquired in team work and managerial skills – see Marquardt, 1979). This ensures that he is a strong candidate for management positions in industry or research institutes.

This is of benefit for the consultant himself, but it causes a major problem for the head of the unit: he must be able to keep the experienced employees (at least for a while), as too high a level of turnover of consultants causes problems in operating the unit. One way to avoid this is to give the consultants competitive salaries which are on a level with statisticians who work for private consultancy companies. This – together with the above-mentioned research opportunities and the relative freedom of working at a university – will hopefully be enough to solve the problem. However, this might cause tension between the lower-paid university staff and the consultants of the commercial unit, which can be resolved in two ways: first, the host department should also gain from the existence of the unit (usually some percentage of the income is handed over); second, participation in the unit's work should be made possible for other members of staff as well.

Table 3.III.2 gives a summary of this section.

Table 3.III.2 Opportunities and possible problems related to a commercial consultancy unit.

Aspect	Opportunities	Problems/dangers
Research	Real-life problems; possible (joint) publications also in non-statistical journals	Limited time is left for research; less scientific recognition
Teaching	Real-life examples for courses	Less time for individual work with (under)graduates
Computing	Case-related products, possible earnings	Too much time spent on development
Career	Entrepreneurial, communicational skills learned	Slower procedure of promotion

3.III.4 Units in europe

In this section we give some brief examples from Portugal and Great Britain (information by personal communication or from the internet) and present our own experience in two European countries (the Netherlands and Hungary) with rather different economic and scientific backgrounds.

An interesting mixture of commercial and non-commercial activities is carried out by GEPSI, a Portuguese research group, with main activities in the area of process and systems engineering. This mixture is partly due to the interdisciplinary nature of their main fields of interest, which range from engineering to chemistry, with statistics not playing a leading role. This group of leading scientists and active young members of staff have been extremely successful in applying for research grants – together with companies from the chemical industry and, in particular, the paper industry.

Another successful unit is the Medical Statistics group at Lancaster University. Pharmaceutical companies are often important clients of consultancy groups, as their statisticians are not always in a position to provide the most appropriate solutions to the practical problems arising at their companies.

Another British university, Reading, offers a wide range of training especially in agricultural research institutes, to animal health clients, public sector bodies, environmental organisations and developing world projects. The last is a main speciality of the unit. By using external funds to support projects in the Third World, the university is unique and its mission is to provide knowledge where it is most sparse and worthy of appreciation.

3.III.4.1 The Netherlands

The Institute for Business and Industrial Statistics of the University of Amsterdam (IBIS UvA) has been operational since 1 May 1994. It was able to start as a commercial statistical consultancy with a two-year start-up grant from the Faculty of Mathematics and Computer Science. From the outset the unit was sufficiently successful that the grant was not necessary.

The services that are provided deal with implementing statistical process control (see Does *et al.*, 1999) and related quantitative quality programs such as Six Sigma (see Van den Heuvel *et al.*, 1997; Hahn *et al.*, 1999), quality improvement (as a part of total quality management) courses and general statistical consultancy. Currently, there are seven enthusiastic consultants employed (four full-time senior consultants and three part-time senior consultants) three of whom are also professors in the Department of Mathematics. To support and constantly improve the consulting activities, IBIS UvA aims to:

- contribute to scientific research in business and industrial statistics on an international level (for overviews, see Does and Roes, 1996; Does, 1997, 1999);
- promote the application of industrial statistics in all relevant parts of society.

IBIS UvA has developed a comprehensive package of training courses and workshops. These involve statistical process control, Six Sigma, measurement system evaluation, design of experiments, statistically robust design, Taguchi methods, and Shainin – Bhote techniques. These workshops are strongly based on the broad and hands-on expertise available within IBIS UvA.

The customers of IBIS UvA cover a wide range of products and services: from low-volume to mass production; from industry to health care. The IBIS UvA approach has helped its customers to achieve lower costs, higher productivity and better quality.

From 1994 until 1997 IBIS UvA was part of the Department of Mathematics. The host university charges 5 % of the consultancy unit turnover and a fixed price of €3500 per consultant for housing. An extra 7 % of the turnover is paid for use of the faculty infrastructure. The total profit in the period from 1994 to 1997 was about €250 000, which was allocated into a fund. This fund can be used for sabbatical leave and for initiating research in industrial statistics.

In 1998 IBIS UvA became a private company, wholly owned by a holding company which controls all the university's commercial activities. The profits of IBIS UvA are now divided into three equal parts: one going to the holding company, one to the Department of Mathematics and one to IBIS UvA. The current situation allows IBIS UvA to keep the consultants' salaries at a level comparable to those of staff in other professional consultancy bureaux. This really was necessary in order to retain the employees. During the last five years the unit has made a profit in excess of €1 million.

3.III.4.2 Hungary

At Eötvös Loránd University, Budapest, in a traditionally theoretical department in probability and statistics, applied statistics in teaching became more important in the 1980s, when new insurance companies needed young mathematicians. Soon after this, however, there were heavy cuts in the universities' budgets and the number of staff fell by nearly 20 %, and even the daily life of the faculty became impossible without the aid of several grants (research projects or other development funds).

The support of the European Union was obtained in the form of a Joint European Project grant during the years 1995 to 1997 for gaining the knowledge and information needed to be able to create a successful consultancy unit. The Universities of Amsterdam (the Netherlands), Dortmund (Germany), Göteborg (Sweden), Lisbon (Portugal) and Sheffield (Great Britain) were involved in this project. At most of these universities there is still a statistical consultancy unit; see Zempléni (1997) for an overview.

The above-mentioned economic need motivated the choice for a commercial unit rather than a non-commercial one. The members of staff are university graduates and students of the department, so a balance between consultancy and other duties needed to be found – it was achieved within the first few years. Accounting

and legal advice is given by the university, enabling the members of the unit to concentrate on the professional part of their work. Over 20 % of the project value has to be paid to the university and an additional 6 % to the host department. This service cannot be cheap. Thus the quality of the work and the reputation of the university have to be a factor when winning clients. This has been the case and, since its formal establishment in 1998, there have been several consultancy contracts fulfilled with a total value of nearly €30 000.

An additional gain for the unit was the successful participation in different national calls for applied projects (in the area of hydrology, for example) as well as the signing of major research contracts with insurance companies (risk analysis). The unit has been able to finance the studies of some PhD students, an important factor when the state is not in a position to give grants even to the best students. However, the status of the unit has not been changed, it has no full-time employees, and the projects are tackled by members of staff and the graduate students.

Another feature is the role of the unit in teaching. The courses taught by the active members of the unit are more application-oriented, with more emphasis on the problems they face during the solution of real-life problems. In addition, courses are held at different companies mostly not as the unit's own projects, but with unit members as teachers for other – mostly non-statistical – consultancy companies.

3.III.5 Conclusion

In most cases there is a need for a university-based statistical consultancy unit which is able to encourage valuable applied statistical research and can provide students with practical training. There is an option for such a unit to be commercial or non-commercial, which depends mostly on the university's willingness to finance this consultancy activity.

If the commercial route is chosen, then one can expect more problems with financial and legal administration, and one should be aware of the danger of being overrun by high budgetary expectations. The example of IBIS UvA has shown that it is possible to overcome these difficulties and to accumulate not only a substantial profit but also scientific recognition.

In the developing economies of central and eastern Europe one cannot expect such a quick expansion, but the need for advanced statistical applications is increasing, so it is worth being prepared for the challenges.

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