POLITICAL SCIENCE RESEARCH METHODOLOGY

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INTRODUCTION TO RESEARCH METHODOLOGY

This is an area where there is considerable disagreement on the definition of concepts, and what is right and wrong. Accordingly, you should read widely and critically; never assume that you need to accept every concept and every assertion. You will probably be able to find an exception to every rule (see Feyer bend, 1975, for an extreme version of this principle).

These notes are intended as a brief overview of the main issues. It is important that you read in more depth on the specific issues of particular concern to you. For example, if you intend to conduct some interviews or a questionnaire survey, it is important that you consult a suitable source of guidance on surveys, interviews and questionnaires – eg Saunders et al (2003), Robson (2002), Easterby-Smith et al (2002).

I will use the word "method" for a specific research method such as a questionnaire survey. The word "methodology" refers to the study of methods in the same way as "psychology" is the study of the psyche. A research "strategy" is the overall approach to the project - which may include the use of several methods.

The word "research" in this context covers everything that academic researchers do: the gathering of information about the world, the discovery and creation of theories and models to make sense of this information, reviewing and collating research done by others, as well as conceptual, mathematical and computational analysis.

Strategies for research projects

The strategy for carrying out a research project is largely a matter of common sense. It is important not to let jargon and technicalities obscure this. (I am using the term strategy here in the sense of a general answer to the question "How do I go about research?" - taking all aspects into account. You will find other authors may use the term in a slightly different sense.)

A simple basic strategy for any research project is:

1 Decide what you want to achieve - the aims of the project, or the questions it will answer.

2 Decide how you are going to achieve these aims or answer these questions - the design of your research project. (Most aspects of research tend to take longer than anticipated, so it is important to plan the timescale carefully to take this into account.)

3 Carry out the research, analyse the results and state the conclusions and (if appropriate) recommendations.

4 Check that you have in fact achieved the aims of the project. If you have not, work out your excuses, try again, or pretend that you were really trying to do something else - ie change your aims to fit what you actually did.

One difficulty with this is that you may not know exactly what you want to achieve at the outset. This may only become clear as the research progresses. Similarly, the appropriate methods (step 2) may only become clear as the research evolves. In general, it is best to plan your research in advance as far as possible, but it is clearly important to be flexible.

Research aims or questions

Sometimes the research aims or questions are quite clear. More typically, a research project may start from a fairly fuzzy problem or area of concern; it is then necessary to decide on a clear focus by formulating some more definite aims or questions - although you may change your mind about these as discussed above. This process of achieving a focus is often not easy and deserves care (see Saunders et al, 2003, Chapter 2). *It is almost always better to focus on a limited area so that you can do a thorough job, rather than having a broad focus with inevitably superficial results.*

It is normal to include a section on the background context of the research project. As well as details of the real world issues the project tackles, you may also wish to discuss the academic background and your personal motivation. (Your personal aims for doing the project - perhaps to pass the course and acquire a marketable skill - are, of course, distinct from the research aims of the project.)

The focus for your research project, its goals, can then be formulated in any of the following ways:

* Question(s) to be answered: eg *What is the best quality strategy for ABC Company?*
* Aim(s) (or objectives) to the achieved: eg *To devise the best quality strategy for ABC Company.*
* A hypothesis or hypotheses to be tested: eg *Strategy X is the best strategy for ABC Company.*

Aims and questions are more or less equivalent. Whether you express your goals as a list of aims or as a series of questions does not matter much.

My preference would be for questions because questions lead to answers which can be written down in a research report, whereas aims may be wider than this. For example, the aim "to increase profits" is not an appropriate aim for a research project because the output is not research. This is a business aim not a research aim. The corresponding research aim would be to *find out* how best to increase profits. On the other hand, Saunders et al (2003) recommend objectives because they "lead to greater specificity" (p. 25).

However, in general, I would advise you against formulating the aims of your project as a series of hypotheses to be tested. Testing hypotheses in management is more difficult than it may appear, and the results of the research become a simple list

of True/False statements - which may be boring for readers!

Despite this, it may be useful to have an *informal* hypothesis - eg TQM is helpful - to guide your research. Then you can formulate some more detailed aims spelling out which aspects of the helpfulness of TQM that you wish to investigate.

You may also have hypotheses you wish to test as a part of addressing your research aims. For example, you may wish to test the hypothesis that there is no difference in effectiveness between two procedures.

It is often helpful to have a series of questions (or aims), which may be broken down into a hierarchy - for example:
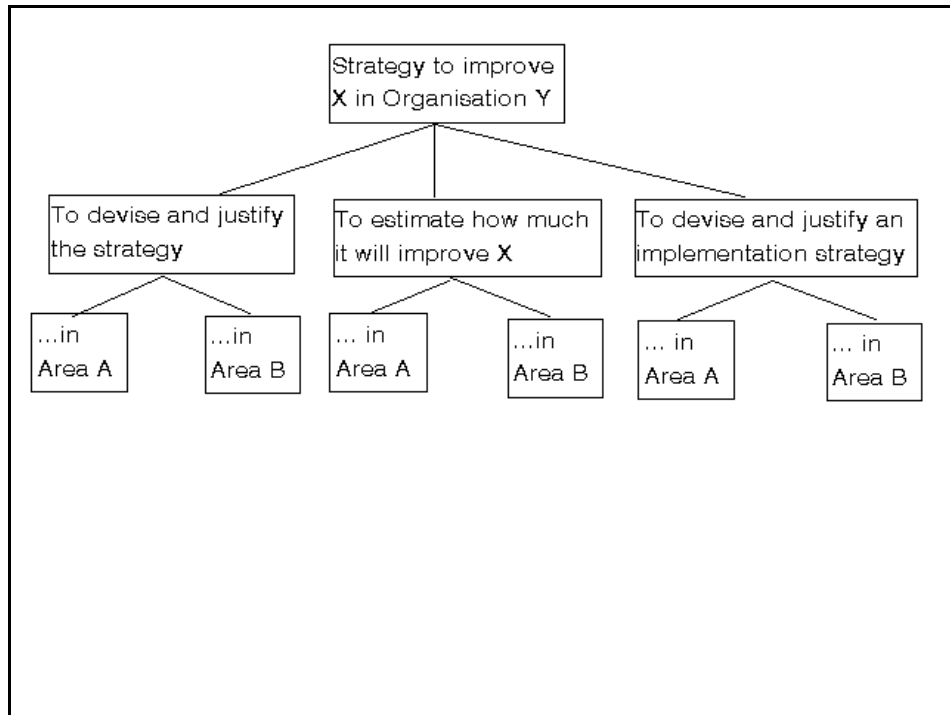
This diagram shows the fairly vague topic "Strategy to improve X in organisation Y" broken down into three more specific objectives. This is a typical general aim for a Masters degree project: X might stand for quality, profitability, marketing or employee job satisfaction, for example. Each of these objectives is then applied to two areas of the organisation. There may be more areas to consider, but the diagram indicates that this project is only concerned with two of them.

A diagram such as this (based on Keeney, 1992) should be helpful for clarifying and structuring your aims (or objectives, or questions). It is also helpful for checking that your proposed research methods are likely to be adequate for meeting your aims (or answering your research questions). We'll return to this below.

The research aims or questions should
* be unambiguous and clear;
* be coherent, and reasonably challenging but not too ambitious;
* make the scope of the research clear (will it refer to one company or be broader, for example?);
* clarify the meaning of any key terms used;
* refer to practical or theoretical outcomes;
* be listed near the start of the project repory.

Try to envisage the sort of conclusions which you might expect to arrive at. Then ask yourself:
* Are you likely to be able to get the evidence to justify these conclusions?
* Are the conclusions worth the effort. Put yourself in the position of a critic who says, simply, "So what?".
At the end of the project report, you should have a clear section explaining how you have achieved the aims (or answered the questions) laid out near the beginning.

General issues concerning research: philosophy, etc

The first point to be made is that the outcomes of a research project (the answers to the questions posed by the researchers) may be of a wide variety of different types. The possibilities include:

*   *Universal laws of the type which are common in natural science.* (Eg E=mc^2. TQM always improves profitability.) Such laws are very rare, or perhaps non-existent, in management. They are not a realistic aim.
*   *Statistical conclusions.* (Eg 60% of TQM implentations fail. On average, on-the-job training is more effective that class-room training.) These are common outcomes of management research. It is obviously very important to specify the scope of the research (what training in which industries?) and the exact meaning of key terms (on-the-job, classroom, effective).
*   *Detailed analyses of particular situations (case studies).* Eg a detailed case study of a TQM implementation which failed might be useful for understanding the causes of failure and so avoiding them elsewhere.
*   *Conceptual frameworks.*
*   *Mathematical and other models.*
*   *Recommended procedures or methods.*

Can you think of any other possibilities?

Understanding the present, predicting the future, and improving the future

Research projects may seek to *understand and explain the present and past situation*, to *predict the future situation*, or to recommend how to *improve the future situation* (sometimes called "prescriptive" conclusions), or a combination of all three.

For example, consider a research project which aims to find the best quality strategy for a particular company. This might start by developing an *understanding* of the existing problems in the company, and the effectiveness of the various possible quality strategies in use in the industry. This understanding may range from a simple catalogue of problems to a deeper explanation of the sources of the problems and the effectiveness of the various quality strategies.

The next step might be to *predict* (roughly) the impact of the various possible strategies. These predictions would be based on the understanding of the existing problems and the effectiveness of the various possible strategies.

These predictions can then be used to decide which strategy is likely to be best in the sense that it will *improve* the company's performance more than the others. The research is aimed at understanding, prediction and improvement, but improvement is, of course, the main goal.

Unfortunately, most discussions of research methods in management are based fairly closely on similar discussions about the natural and social sciences - which aim to understand and predict, but not to improve. This means that the aim of making improvements tends to be ignored in philosophical discussions. Ulrich (1983, p. 15) claims that "there is no adequate philosophical basis" for this type of research. This is serious because the logical basis of recommending improvements is very different from the logical basis of understanding or predicting.

There are two important differences. The first is that if a change is made, the new situation will be different from the existing situation, and so difficult to research directly. It is difficult to study the impact of a new idea which has not been tried! There are a number of ways round this difficulty: the use of experiments, action research and modelling (see below), and studying (for example) other organisations which have tried the new idea. (This is not possible, of course, if the idea is really new.)

The second point about making recommendations about what an organisation ought to do to improve performance is that this obviously presupposes some *value judgements*. These are "subjective estimates of worth" (*the Pocket Oxford Dictionary*, Clarendon Press, 1996): ie assertions about how things are valued, or about what is good and what is bad, and about which goals an organisation or individual should strive for. Different groups in an organisation, or different stakeholders, may, of course, arrive at different value judgements, and different recommendations about what should be done.

It is important to try to be as explicit as possible about the basis of these value judgments. Where the value judgments depend on several different criteria, it may be helpful to indicate how each quality strategy (or whatever) scores against each criterion by means of an "options by criteria matrix". (See also Robson, 1993, chapter 7 on "Evaluations", and Keeney, 1992.)

Both of these points - the fact that the research has to study hypothetical situations, and has to be based on value judgments - mean that research which seeks to improve situations fits uneasily into the crude idea of the scientific method known as positivism - to which we turn next. (Despite this, "management science" is perhaps the main source of prescriptive management research!)

Positivism and phenomenology, and similar distinctions

Positivism is the view that research should be scientific in a fairly crude sense. The reality researched is viewed as external and objective, and the methods used should be "value-free" and, as far as possible, quantitative. (There are many different versions of positivism. The confusion is exacerbated by the fact that much of modern physics is far closer to phenomenology than positivism as it is usually understood, and some branches of management science have a lot to say about values.)

Phenomenology "stems from the view that the world and 'reality' are not objective and exterior, but that they are socially constructed and given meaning by people" (Easterby-Smith et al, 1991, page 24, citing Husserl, 1946). This leads on to a style of research that involves detailed interviews and other interactions with the actors involved in a situation, and appreciating, but not necessarily predicting, the different perspectives and choices people adopt. It typically involves an in-depth study of a small sample of people which attempts to understand the experience of these people "from the inside" - ie in terms of their subjective experience. The researcher is inevitably not independent of the situation under study, which may mean that different researchers come to different conclusions. (Does this matter?)

A phenomenological analysis is typically mainly qualitative in character rather than quantitative, and deterministic or statistical conclusions tend to be shunned in favour of a thorough analysis of a small number of cases - which may, of course, illustrate possibilities which could occur elsewhere. Positivistic research, on the other hand, typically involves larger samples, which produce more reliable statistical generalisations but at the cost of a shallower understanding "from the outside" - ie in terms of externally defined variables.

It is not helpful to regard this as an either-or choice. Any useful research is likely to draw on *both* objective facts and subjective experiences, and to use both qualitative and quantitative methods of analysis.

There are other related concepts and distinctions - hard and soft (Rosenhead, 1989);, and positivism and social constructionism (Burr, 1995, Easterby-Smith et al, 2002). The terms "quantitative" and "qualitative" are often used as umbrella terms for the two ends of the spectrum.

The meaning of many of these terms is rather hazy, so it is important to define what you mean when using them.

The degree of generality

Einstein's famous equation $E=mc^2$ refers to all the matter in the universe at any time. It is perfectly general.

At the other extreme the aim of devising the best quality strategy for QRW Ltd., Emsworth, England in 1997 refers to one particular company at one particular time.

Obviously, other things being equal, the more general the research is the more useful it is. However, other things rarely are equal. In fields like management, general theories are often too vague to be helpful in specific situations, and they are also far harder to set up. For this reason, *it is usually a good idea to make your aims fairly specific - ie relating to one organisation or sector or country.* However it may be worth adding a subsidiary aim to generalise your conclusions more widely (particularly if you are considering getting another job or want to publish your findings).

Theories: building, testing, amending and using

The word *theory* means different things to different people. I think that anything which goes beyond a straight listing of the facts should be counted as a theory. This includes explanatory frameworks, generalisations, recommendations, mathematical models, etc. All useful research involves theory in some form - there is a note on the meaning and role of theory in the appendix.

Sometimes, the aim of the research is to develop theory from scratch. This is the *inductive* approach: trying to derive generalisations and explanations from the data you collect. In its pure form the researcher tries to forget any preconceptions and just let the data "speak". You will find suggested tactics for this in books on research methods, and in more detail in Miles and Huberman (1994).

The other extreme style of research involves starting with a theory, or hypothesis, and then testing it. The theory may come from other researchers, or it may be a hunch or a conjecture. This is the hypothetico-deductive approach to research. Karl Popper is an influential advocate of this style of research (see Popper, 1978, or one of the many commentaries on Popper's views).

It is very important that the theory should be very clearly defined. For example "Women are more intelligent than men" could not be properly tested without defining intelligence in numerical terms, specifying which women the hypothesis refers to, and whether it refers to average intelligence levels. Popper (1978) has stressed the importance of the hypotheses being testable: he claims that the theories of Marx and Freud are useless because their hypotheses cannot be tested.

In practice, the best approach is often in the middle: a bit of induction, and a bit of testing theory. The result may be an amended theory, or a theory adapted to a particular situation, or conclusions about the value (or otherwise) of the theory in a particular context.

Sometimes a research project will make use of a theory developed by other researchers, without trying to test or amend it. For example, research into profitability and employee empowerment might make use of measures of profitability and empowerment - which are themselves theories.

The theories which play a part in your research are an important aspect of the project. You should discuss these theories, and their role in your research, carefully.

Politics and ethics

The political issues surrounding access to data, and the impact of the results also need considering. Will you have access to the data you need? Do you have to give guarantees of confidentiality and if so does this matter? What if your conclusions are not to the liking of key stakeholders?

Similarly, there are sometimes ethical dilemmas in research. These are obvious in medical research where, for example, it is obviously unfair to withhold what is considered the best treatment in order to set up a controlled experiment. In management research, withholding benefits from a comparison or control group may also be considered unfair. More generally, except in very special circumstances, it is considered unethical to mislead people involved in research, to subject them to stress, to invade their privacy, and so on. If interviewees are promised they will not be identified in research reports, it is obviously unethical to fail to do this.

Research design

Having decided on the aims to be achieved the next stage is to design your research: in other words devise a plan for achieving the aims. Much of the most successful research uses a variety of different methods. It is best to start without too many preconceptions concerning the best approach.

There are three possible sources of information for research:
1 Empirical sources: gathering information from the real world. This may be *primary data* that you have gathered yourself, or *secondary data* gathered by someone else - eg published statistics or company documents.
2 Literary sources: gathering information from published books and papers, and from the internet (see Stein, 1999).
3 Conceptual analysis: analysing the meanings of concepts and their implications. (Mathematical analysis and model building are conceptual in that they are concerned with working out the detailed implications of assumptions.)

Almost all projects make some use of all three - *but the emphasis is usually on empirical methods*. However, your research report should always include a review of relevant research by others (the "literature review"); and your research will also inevitably depend on a framework of concepts (a "conceptual framework") which should be carefully analysed and justified. What do you mean by "quality", "competitive" or whatever other terms are important for your research?

Empirical methods

Empirical research usually involves making choices in four areas:
1 Are you going to study the existing situation, or are you going to do an experiment or a "quasi-experiment" - ie change something and see what effect it has? Experiments and quasi experiments are particularly useful for gathering support for recommendations.
2 What sort of sample are you going to take? Large sample, small sample or study of a single case?
3 Are you going to use a standard theory or framework (and if so which?), or are you going to develop your own theory? In either case, theories are important (see appendix).
4 How are you going to gather the empirical data? The possibilities include: written questionnaires, interviews, observation, "participant observation", document and data archive analysis, the internet, etc. Can you think of any others?
All of these choices deserve very careful consideration. Don't forget that you will probably use different approaches for different parts of your research.

There are also some other possibilities which do not fit neatly into this framework (eg computer simulation, role plays). *The*

important thing is to be flexible and use a variety of methods to achieve your aims.

The following subsections describe five general patterns of research design: surveys, experiments and quasi-experiments, case studies, action research, and modelling. These may overlap - a model may be built from a case study or a survey, or an action research project may make use of a survey - and there are certainly other possibilities.

You should not be restricted by these: good research generally uses a combination of these patterns as well strategies which do not fit neatly into any of them.

Surveys

A survey involves the collection of information from a (usually fairly large) number of "units". These units may be people, or organisations, or towns, or families, or departments, etc; the information collected may be of any kind - eg financial information or opinions in the case of surveys of people, or information about numbers of employees and organisational structures in the case of a survey of organisations. A survey provides a snapshot of the situation as it is at a particular time, usually with a view to analysing patterns and trends applying to the group as a whole. Most surveys are based on a *sample* of the *population* of interest (see notes on sampling below). Surveys often use questionnaires to collect data, but interviews or observation may sometimes be preferable. Many people seem to assume that an Masters degree project has to include a questionnaire survey but this is *not* so; do *not* use a questionnaire survey if it is not the appropriate method for your purposes. Further reading in any book on research methods.

Experiments and quasi-experiments

Surveys provide a way of finding out about the present situation and what has happened in the past. However, there are two major difficulties with simply monitoring what is happening now and what has happened in the recent past.

The first difficulty is that it may be difficult to disentangle cause and effect. There is apparently (Huff, 1973, p. 84) a strong and positive correlation between the number of babies born into families in Holland and Denmark and the number of storks' nests on the roofs of their houses. Does this suggest that the storks are in fact responsible for the babies? Obviously there is a more plausible explanation - big families have big houses which provide more space for storks to nest. However, you cannot make reliable inferences about which factor is the underlying cause from the correlation observed. To test the hypothesis about storks increasing the number of babies, you would need to do an experiment - perhaps encouraging more storks to nest to see if the number of babies born increases. You need to *control* the relevant variables (eg size of houses, age and gender of occupants) so the comparison is a fair one.

The second difficulty is that things that have not happened cannot be investigated. If the best solution is a combination of circumstances that have never arisen, no survey will ever find it.

The best way round these difficulties is to design an experiment. This involves changing something and then measuring the effect that this change has. The simplest design for an experiment is the "post-test only two group design" (Robson, 2002):

1   Set up an experimental and a comparison (control) group using random assignment.

2   The experimental groups gets the "treatment"; the comparison group gets the "comparison treatment". It is important to ensure that the two groups get roughly the same amount of attention - otherwise there is a possibility that any observed difference may be due to the "Hawthorne effect". This is named after a famous experiment in which it was discovered that any treatment - including reversing a previous treatment - brought improvements because it indicated that the experimenter was taking an interest in the people involved.

3   Give "post-tests" to see what the effect of the treatment is.

More complex designs are of course possible (see Robson, 2002). The random assignment is important to reduce the likelihood of some factor other than the "treatment" being responsible for any observed improvement. The results of an experiment are then usually analysed by means of a *statistical hypothesis test* (see below).

Experiments are widely used in medicine, psychology, and to a lesser extent in education. In management, it is often impossible to follow a rigorous experimental design so *quasi-experiments* are often used instead. Quasi-experiments are defined by Campbell and Stanley (1963) (cited by Robson (2002), p. 133) as

> "a research design involving an experimental approach but where random assignment to treatment and comparison groups has not been used."

For example, the success of an organisation using a particular type of quality management system may be compared with an organisation which does not use this type of system, or with the same organisation before the system was implemented. In either case the "treatments" (quality system or no quality system) were not allocated at random, so there is the (strong) possibility that some other, uncontrolled, variable is responsible for any differences found. For this reason, Robson (2002) does not recommend either of these designs, preferring more elaborate designs (see Robson, 2002, pp. 136-146 for details).

The important thing is to be as sure as possible that the lack of randomisation in quasi-experiments is not likely to affect the validity of the results.

Case studies and small sample research
It often seems more useful to undertake a detailed study of an individual case, or of a small sample of cases, than to do a superficial study of a larger sample. The cases may be individual people, organisations, neighbourhoods, projects, events of various types, etc. It is important to be clear about the purpose of the case study. Is it intended to be typical of something more general, or to be a case of particular interest from some specific point of view?

It is also important to make sure that your approach is systematic, and that you give adequate attention to developing a suitable conceptual framework and list of research questions. Case studies normally use multiple sources of evidence (eg interviews, observations, document analysis, etc), and should aim for a detailed ("in depth") understanding of the chosen case(s).

Further reading: Yin (1994).

Action research
Traditional science seeks to keep the researcher separate from the researched and their aims and values in the interests of "objectivity". Action research is the name given to research which seeks to integrate theory development and data collection with action in the sense of improving the process being studied. The action researcher would typically be an active participant in the process. The obvious danger here is that the particular interests of the researcher / actor will encourage a biased perspective: clearly you must try to reduce the likelihood of this happening. (A counterargument to this starts from the assertion that there is no such thing as an unbiased perspective, just different biases ....)

 There are different variants and interpretations of action research. One simple possibility would be:
1 Study the existing situation
2 Plan how improvements could be made.
3 Carry out these improvements and analyse their effects and success. (This step may be a quasi experiment.)
4 Study the new situation.
5 Go back to step 2, etc, etc.
It is obviously important to ensure that the researcher's involvement in the process does not compromise the validity of the results.

Modelling
Management science researchers often seek to set up a *model* of, for example, a stock control system, or a series of cash flows, or a project. Models are also important in many other areas including, for example, finance and "softer" disciplines such as marketing. Harding and Long (1998) summarise 45 of these management models. Modelling is not treated as a standard type of research in most texts on research methods - you will need to consult books such as Pidd (1996 or 2003).
Pidd (1996, p. 15) defines a model as
       an external and explicit representation of part of reality as seen by people who wish to use that model to understand, to change, to manage and to control that part of reality.

Models may be physical, mathematical or computer based. They are useful if experimenting directly with reality is too difficult, costly or time-consuming. They are typically set up on the basis of empirical data and a "common sense" analysis of how the situation "works". Models are always simpler than reality: it is important to consider the appropriate degree of simplification.

The steps in a typical modelling project are:
(1) build the model;
(2) check its accuracy and/or usefulness and adjust if necessary;
(3) use the model to understand, change, manage, control...
    Further reading: Pidd (1996) chapter 1.

A general design for a typical Masters degree project
Many (but by no means all) projects fit the following pattern:
Aim: To find a good strategy to "improve" X in org Y
Method
(1) Survey/case studies of Org Y to investigate problems and opportunities
(2) Survey/case studies to see how other organisations do X and which approaches work well

(3) Based on (1), (2), the literature, and perhaps creative inspiration and consultations within the organisation, devise a strategy likely to improve X

(4) Try/test/pilot/monitor the proposed strategy

Linking methods to research aims or questions

To ensure that your methods are firmly linked to your research questions (or aims), it is a good idea to draw a diagram which links each research question with the methods you plan to use to answer it.

In the diagrams below, the lines without arrows indicate the breakdown of the research aims. The arrows indicate that the box at the start of the arrow is a means to help achieve the box at the end of the arrow. The arrows only indicate that a method will *help* with the aim or method it points to, not that it will solve the problem completely. The dotted arrow is intended to signify that the help involved is likely to be slight. (This notation is due to Keeney, 1992).
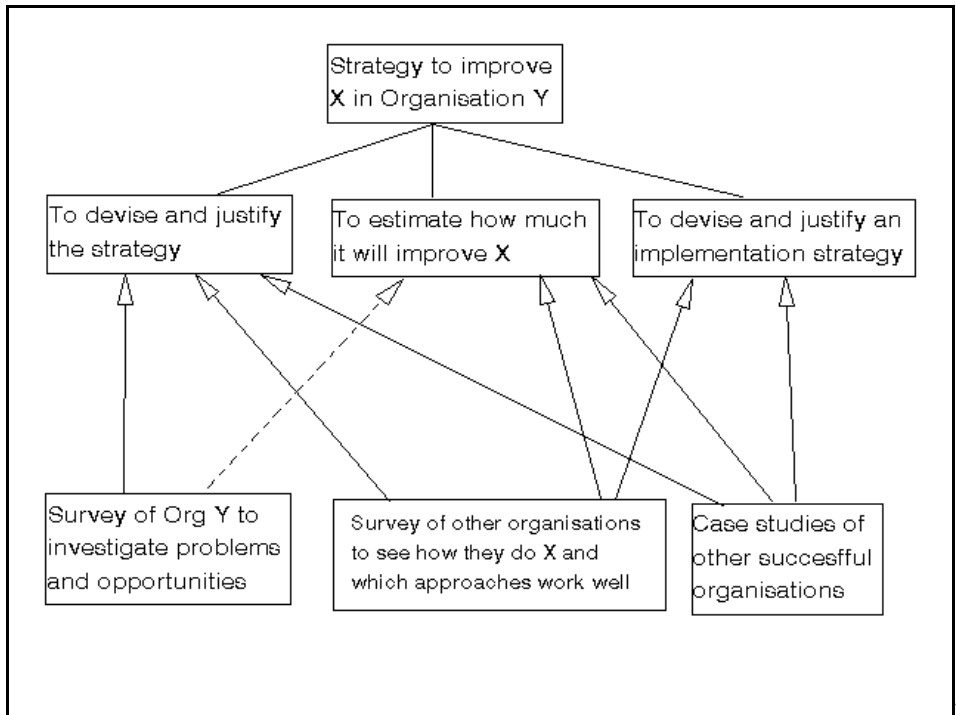
This diagram should help you to ensure that the methods you are proposing are likely to be sufficient. This is a matter of judgement, obviously. You need to check each aim carefully. In this example, the lack of methods drawing on data from Organisation Y for assessing the improvements from the proposed strategy, and for devising and justifying the implementation strategy, suggests that this plan is not adequate. You are likely, for example, to need some input to the implementation strategy from Organisation Y. The next diagram shows a possible improvement.
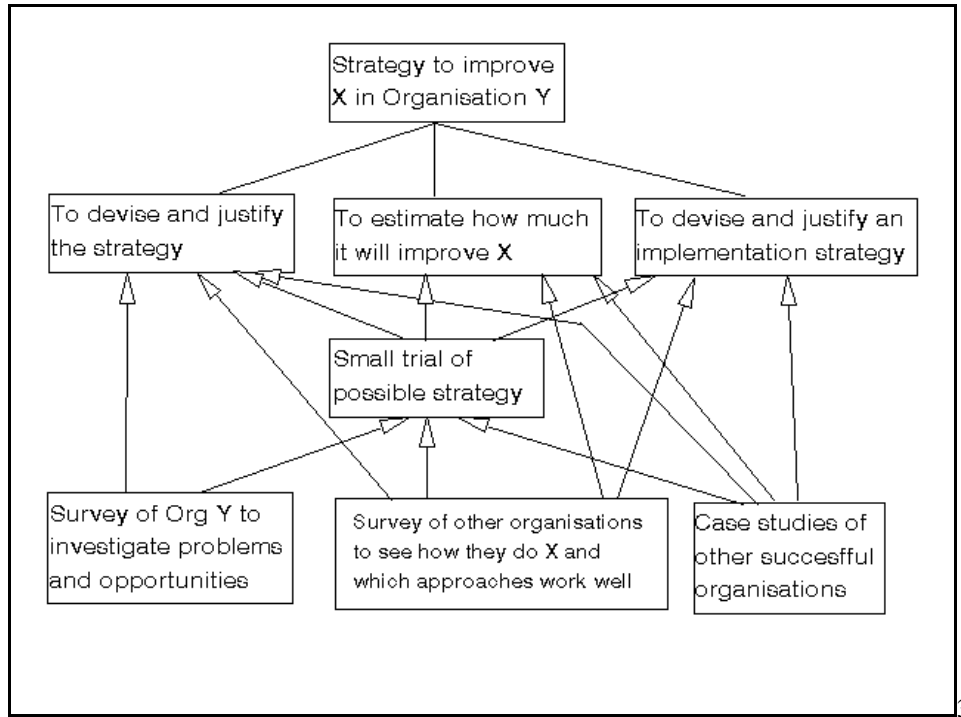
Data collection methods

There are many sources of data which you should consider - see the section on Empirical methods above). This section contains very brief notes on interviews and questionnaires, and also on sampling, *which is important whatever you decide to do.* For more detailed help, is *essential* to consult a textbook or other source of advice.

Interviews

These could play a part in surveys, or case studies, or experiments, or action research. They usually allow you find out about the topic of interest in more depth than a questionnaire, because people are likely to give more detail when talking than when writing, and it is possible to ask questions to probe points of particular interest. It is however necessary to be organised: use a list of questions and prompts and decide how you are going to record the answers. Telephone and group interviews are other possibilities to bear in mind. Above all, remember that the idea is to get a deep understanding of the issues in question.

*   Write a plan or schedule for the interviews, but treat it flexibly and be prepared to modify it if appropriate. What are you going to ask and how? Don't forget that interviews are particularly useful for open-ended questions.
*   You will probably want to probe some responses for more detail. Some such probes can be in the interview plan, but obviously as you do not know what the interviewees will say, you cannot cover all eventualities.
*   It is a good idea to record the interview so that you can quote interesting bits in the write-up. You must ask interviewees for their permission, of course. If a recording is not possible, you will obviously need to make very detailed notes.
*   Don't forget to think about putting interviewees at ease.
*   With interviews there may be a danger that the interviewer influences the interviewee. Does this matter and what can you do about it?

Questionnaires

Many books and articles give advice on questionnaires: *you should consult one at an early stage because designing good questionnaires is far more difficult than it may look.* It is essential to test the questionnaire and the proposed method of analysis by means of a pilot survey before the final questionnaires are sent out.

When designing questionnaires consider:
*   Exactly what do you want to find out?
*   Why should people fill it in? (Anonymity, confidentiality? Reward for returning it?)
*   Will they tell the truth?
*   Length and sequence of questions
*   Wording: avoid leading, long, complicated questions asking several things, incomprehensible, unanswerable, silly, rude, annoying questions....
*   The covering letter explaining who you are and what the research is for.

There are three main types of questions you can ask in a questionnaire:
*   Closed questions asking for a category. (Which department are you in? - tick the appropriate box.) Be careful to ensure you have thought of all the categories; you should usually have a box at the end for *Other - please specify.*
*   Closed questions asking for a number. (How old are you? Questions asking respondents to rate their agreement with a series of statements on a 1 to 7 scale.)
*   Open ended questions. (What do you think of … ?) The responses may either be coded for analysis (in which case it may be better to use a closed question in the first place), or simply read and used for quotations and as a means of coming to understand the respondents.)
Particularly with closed questions you need to cater for respondents who do not know the answer. You don't want to force them to make up an answer!

Remember that designing a good questionnaire is much more difficult than it looks.

Common Problems with questionnaires:
*   Low response rate (What should you do about this?)
*   Too much information to analyse
*   Inconclusive answers
*   You only find out what people want to (and can) tell you

Finally, ask yourself, are you sure you need a questionnaire? Would you fill it in yourself? If not, why not think again?

Sampling
We often talk about analysing data (figures, etc) and drawing graphs of data as if we were interested in the data for its own sake. Usually this is not the case. Usually we are interested in our data because of what it tells us about a wider situation. So, for example, an opinion poll might ask 1000 voters how they are going to vote in the next election: the assumption being, of course, that the voting pattern of the electorate as a whole will be similar.
        The first step is to decide exactly where our interests lie. *Population* or *universe* are terms used by statisticians for the group comprising all the instances in which we are interested. It is important to be very clear about the exact nature of the population. For example:
*   employees in an organisation
*   employees in all similar organisations
*   all the transactions which may be carried out by a software system (now and in the future)

        If the population is large or infinite we will need to use a *sample*: ie a subset chosen as far possible to be *representative* of the population as a whole. *It is important in all investigations, quantitative and qualitative, large scale and small scale, to be careful about the choice of a sample.*
        Even when it is apparently possible to look at every member of the population - ie to carry out a *census*, the benefits may not be real. In one survey of applications of "100% inspection" (Oakland, 1986, p 50), 17% of defects on PCB's were missed, and 25% on chest X-rays (where a defect may represent a case of TB). The problems in each case were that the necessity to check everything meant that the job was done quickly and carelessly. It is often a good idea to take a fairly small sample and investigate this carefully.
        In addition, populations are often slightly wider than is apparent at first sight. We might, for example, consider all the transactions performed by a computer system in the past week as our population; however a more useful perspective might be to think of these transactions as a sample of the possible transactions for which the system is designed. This raises the question of whether the past week's performance is likely to typical or representative.

From the point of view of ensuring representativeness, two problems may arise in sampling:
1   The method of selecting the sample may lead to an inevitable *bias* (even with large samples). It is often surprisingly difficult to obtain an unbiased sample.
2   Even if the method of selection does not lead to bias, inevitable random variations may mean that the particular sample chosen is unrepresentative in some way. This is known as *sampling error*, and its size can be analysed by statistical methods: eg the 3% error often quoted for surveys of electors' voting intentions with samples of around 1000 is based on a 95% statistical confidence interval (Wood, 2003). Conversely, the theory can be turned round to tell you how large a sample is necessary for a given degree of accuracy.
Methods of sampling can be divided into *probability sampling* (where the idea is to try to ensure that the sample is representative by controlling the probability of each individual being chosen), and *non-probability sampling* (which does not use this principle). Four important methods of sampling are:

Probability sampling:

1   *Random sampling*: sample chosen so that every member of the population has an equal chance of being selected, and every member of the sample is chosen independently of every other member. It also means that the sample is chosen without allowing the investigator's (possibly subconscious) preferences to influence the choice. *This is the standard on which most statistical theory is based*. To produce a random sample it is necessary to have a numbered list of the population - this list is known as a *sampling frame*. Then the sample is chosen by drawing random numbers (see below) and selecting the corresponding members of the population as the sample.

2   *Stratified sampling*: population divided into "strata" and a random sample of appropriate size taken from *each* of the strata. If done properly this should yield a slightly lower sampling error but the difference is often very small. It is generally only worth doing if it easy to do or you want to compare results by stratum. You should also bear in mind that your sample will suffer if you only take a few of the strata. For example, if you base a sample of workers on just three companies, this sample will obviously not encompass as much variety as it would if you took a wider sample of companies.

Non-probability sampling:

3   *Purposive sampling*: the researcher's judgment is used to choose individuals which are thought to be typical or of special interest. It is often a good idea to choose small samples (eg for case studies) in this way; for larger samples, the random or stratified methods are likely to produce more representative results.

4   *Opportunity or convenience sampling*: taking the sample that you can get. This is effectively working backwards: the problem then is deciding on the population to which the results can be generalised.

As a general principle random sampling is best for large samples (say 12+), whereas purposive sampling is suitable for small samples. Remember that the final sample may be smaller than you anticipate because of non-return of questionnaires, etc.

Random numbers (produced by a spreadsheet)

2569 9114 7079 2209 3867 0793 6977 3720 1510 2765 4074 5878 5759 2317 4575 6224 1399 7161 6903 6414
1792 5956 1543 3127 4895 2861 6714 0676 0635 7399 3420 7827 2116 7672 1573 0632 5594 1149 9320 2288
7634 6464 2378 6759 9738 1734 1063 2848 6489 8750 1189 5490 7826 0818 9196 5858 4586 4792 1260 6522
1039 9930 7971 2092 8076 5686 8511 2598 8687 7479 9436 0699 8264 1735 6532 0860 6313 6132 7005 7045
1183 5183 6472 8021 5716 7222 7773 5886 7473 3033 8900 2384 8255 9014 1209 8897 2828 1461 7399 0623
8927 3789 2030 1993 1094 7274 3554 2439 4360 1900

Trustworthiness or credibility

What makes research *trustworthy*? Why should you believe or accept the conclusions? The concepts of *validity, reliability, objectivity, triangulation* and *statistical hypothesis testing* are all relevant to this issue. The most general concept is validity.

As well as being trustworthy, research should, of course, also be *relevant* and *useful*. Readers should not be left asking "So what?".

Validity

Validity refers to the extent to which the results are valid - ie true or well grounded. Gill and Johnson (1991, p 161) distinguish three types of validity:

1.   Internal validity is the extent to which the conclusions regarding cause and effect are warranted.

2.   Population validity is the extent to which conclusions can be generalised to other people, or other organisations, or other sampling units. This is a matter of ensuring that samples are likely to be representative (see the notes above).

3.   Ecological validity is the extent to which conclusions might be generalised to social contexts other than those in which data has been collected.

There is also ...

4.   The extent to which operational definitions or indicators (eg defect rates as a definition of quality; IQ tests as a measure of intelligence) reflect the concept they are trying to capture.

Reliability

This refers to the consistency of the research method. For example would you get the same answer if you repeated the research with a different sample, at a different time, or with different observers or judges? Suppose, for example, your research involves coding responses to an open-ended question on a questionnaire. You should check a sample of codes by bringing in a second researcher. You could then indicate the reliability of the coding scheme by saying that the two coders agreed on the code given to 95% (or whatever) of responses. This provides the reader with a simple assessment of how reliable this aspect of the research is.

Objectivity

This term refers to the extent to which research reflects the reality of the "objects" (including people) under study, as opposed to the subjective experience of the researchers or observers. In practice, the method for checking whether an observation or assessment is objective is to see if different observers agree: if they do it is objective, if they do not it is subjective in the sense that it depends on the subjectivity of particular people. Physical measurements like weight or time are objective because different observers will agree readily, whereas assessments of the quality of a meal are more likely to be subjective.

Some would say objectivity is essential; other would say that it is meaningless or impossible in many contexts. Do you think it is sensible to talk about the objective quality of a meal? On the other hand if you are interested in the amount of scrap produced, it seems sensible to get as objective a measure as possible.

Triangulation

Checking your conclusions by other methods. For example, if questionnaire results suggests that particular managers are not motivated by money, this could be checked by interviewing the managers, and by observing their behaviour (or records of their behaviour) when offered financial incentives.

Statistical hypothesis tests

These provide a way of deciding if the evidence is strong enough. Examples are the "t test", analysis of variance (ANOVA) and the "Chi square test". These tests are mathematically complex, and are very frequently misunderstood and misinterpreted. Despite this they are useful and widely used. *Statistically significant* means that the data *cannot reasonably be attributed to chance alone (ie to the accident of the particular sample chosen)*. A significant result *signifies a real effect* (and not just a sampling accident). The significance level tells us how strong the evidence is - with the lower levels indicating stronger evidence.

For example, the results below (McGoldrick & Greenland, 1992) come from a survey on the service offered by banks and building societies:

Aspect of service	*Banks' mean rating*	*Building Society's mean rating*	*Level of significance (p)*
Sympathetic/understanding	6.046	6.389	0.000
Helpful /friendly staff	6.495	6.978	0.000
Not too pushy	6.397	6.644	0.003
Time for decisions	6.734	6.865	0.028
Confidentiality of details	7.834	7.778	NS
Branch manager available	5.928	6.097	0.090

The data was obtained from a sample of customers who rated each institution on a scale ranging from 1 (very bad) to 9 (very good.). The above six dimensions are a selection from the 22 reported in the paper. The evidence is strongest in relation to the first two variables and weakest in relation to the least one. The *p* values in the final column of the table give the estimated probability of obtaining the results which were actually observed, or more extreme ones, *if there is really no difference between banks and building societies*. (There is a fuller explanation at http://userweb.port.ac.uk/~woodm/nms/test.doc .)

NS means not significant - which in this table means that the *p* value is greater than 0.1. The lower the *p* value the more convincing the evidence for a real difference between banks and building societies./

In many contexts (including the example above) "confidence intervals" provide an alternative method of analysis - which may be more useful and user-friendly (Gardner and Altman, 1986; Wood, 2003).

Data analysis

There are many methods of analysing data. You should read up those that are appropriate to your particular study.

At one extreme is statistical analysis. The steps here are:

1   Decide what you are going to measure. Check that the proposed measurements are valid and sensible. If appropriate check the reliability of your measurements.

2   Produce diagrams and/or tables to show the values of your measurements and the relationships and differences between them. It is more difficult than it might appear to design tables and diagrams which are clear and unambiguous - ask someone else to check!

3   If appropriate, do statistical hypothesis tests or work out confidence intervals to indicate the likely effects of sampling error. (You may need help here.)

At the other extreme, the analysis of tapes of interviews, or open-ended questions in questionnaires, might simply consist of listening to the tapes, or reading the questionnaire responses, to try to understand the situation. The report of the research would then include direct quotations (in "…") from the interviews, or the questionnaires, as evidence for the assertions put forward.

The weakness of this last style of research is that the particularly passages quoted may give an unrepresentative impression. The suspicion may be that the researcher has chosen the quotes that confirm her (or his) prejudices. Clearly this type of analysis needs to be backed up by some further evidence. It is, however, a very useful method of providing a detailed analysis of certain possibilities. For example, a researcher investigating the use of a software package might find one individual using it in a particularly innovative manner: a detailed analysis of this one instance may be interesting because it illustrates what is possible - although it is in no sense representative of the population as a whole.

To use interview data, or data from open-ended questions on questionnaires, to obtain more quantitative information about the frequency with which phenomena occur, or the strength of relationships, it is usually necessary to devise a *coding scheme* (see Saunders et al, 2003). This can be used to give quantitative results on the percentage of individuals in each category, or the number of times particular things are mentioned. These results can then be analysed statistically like any other quantitative results.

One issue to consider when analysing "softer" data from interviews and participant observation studies is the extent to which the conclusions should "emerge" from the data without the researcher imposing his or her preconceptions. This is the *grounded theory approach* (see Saunders et al, 2003; Robson, 2002). Various methods have been proposed for achieving this – eg analytic induction (Saunders et al, 2003, 397-8; Robson, 2002, p. 322).

Whatever you do it is important to consider the validity and reliability (see above) of your final conclusions.
Further reading: Miles and Huberman (1994).

Types of measurement
Variables may be *numerical* (eg salary), *ordinal* (ie a rank - eg Manchester United's position in the league was 2nd), or *category* variables (eg male or female, make of car, etc). Take care not to manipulate results in ways that do not make sense. For example there is little point in coding a category variable (eg make of car) by the numbers 1, 2, 3, 4, etc and then taking the average - it won't mean anything.

Numerical scales can be further subdivided into *ratio* and *interval* scales. Ratios make sense in ratio scales but not interval scales. For example it makes sense to say that one man earns twice as much as another (earnings is a ratio scale), but it does not make sense to say that a temperature of 20 degrees Celsius is twice as hot a temperature of 10 degrees since temperature is not a ratio scale; the zero point is arbitrary - the equivalent Fahrenheit temperatures are 50 and 68 which are not in the same ratio.

Computer software
The most useful type of package is a spreadsheet. Excel is particularly good because of the wide range of statistical functions and procedures which it incorporates. Put each record (individual from a sample) in a separate row with field headings at the top. For example:

NAME	SEX	HEIGHT	WEIGHT
Bill	M	1.47	132
Susan	F	1.91	
Mandy	F	1.45	38

Avoid the temptation to include fancy formatting, to leave rows to improve spacing, etc. Any frills you include may cause problems when you try to analyse your data.

If any data is missing (eg Susan's weight) leave the cell blank. Do not enter 0. Yes/no is best coded as 1 for yes and 0 for no; then the average of the column will give you the proportion answering yes.

You may be able to do all your analysis with a spreadsheet. Don't forget that spreadsheets will sort data. If you want to see how males differ from females, you can sort the data on this field. Spreadsheets are also good for working out averages, drawing bar charts and other diagrams, etc.

However, if the statistical analysis you need is at all complex, it may be worth transferring the data to a statistical package such as SPSS (Statistical Package for the Social Sciences).

Further reading: Wood (2003) contains brief notes on the use of Excel and SPSS for analysing data.

Writing the report
A standard layout is:
* Abstract
* Acknowledgments (if any)
* Contents
* Introduction (including background and context - this would normally lead on to the aims in the next chapter)
* Aims of the project (what you intend to achieve)
* Literature review (*briefly* and *critically* reviews *relevant* previous research and discusses its relation to your study)
* Research design or method (what you did and why)
* Investigation results and analysis (may be split into several chapters)
* Conclusions and recommendations (possibly two chapters). You should also discuss the limitations of the research and possibly include suggestions for future extensions.
* References (must follow one of the standard formats)
* Appendices (supporting material to which readers may want to refer – eg questionnaires, examples of interview transcripts)

However, many projects are not standard so you should feel free to adjust this pattern if appropriate.

Whatever the structure of your report, you should, as far as possible, ensure that readers can check your analysis to see if they accept your conclusions (put details in appendices). Above all, please ensure that the report is clear, concise and does not exceed the permitted length.

It is important to describe and discuss all important aspects of your empirical research: details of questionnaire surveys and interviews, software used, methods of analysis, and so on. The reader should be able to follow what you did, and how you derived your conclusions. This should enable the reader to decide how trustworthy your research is, and perhaps repeat it in another context. Remember that if your research is well designed and competently carried out, this should be clear from the report.

All books and other sources should be clearly referenced using one of the standard styles. There is a leaflet on this available from the library, but you may find it easier to copy the style used in a particular academic paper. In my view the easiest style is to refer to works in the text by the author's name and the date of publication only - for example, Plato (1956) - and then to list the publications in alphabetical order of authors' names at the end. Every reference you give in the text should appear in the list of references at the end - check for Plato (1956) in the references at the end of this document. (The date is the date of the *publication* of the version to which you referred; obviously Plato did not write in 1956.) Notice that books and journal articles are mixed up in this list of references; otherwise you would not know which list Plato (1956) is in. Note also the style of book and journal articles (eg Thorpe and Moscarola, 1991) in this list of references.

The critical attitude
One of the distinguishing characteristics of good research is that as much as possible is subjected to critical analysis. You should question as much as possible. If the objective of the project is to derive a "good" strategy for a particular purpose, what does "good" mean? Who says and how do you know? Why is this method appropriate? What are the potential flaws with this method and how did you try to overcome them? What are the main weaknesses of your research, and other research in the field? *Try and anticipate and answer all possible criticisms of your research.*

Publishing your research
If you think your project deserves a wider audience you should consider publishing it in a journal or in some other format. Ask your supervisor for advice.

Checklists when starting a project … and finishing it
These are my suggestions for checking your initial project proposal:
1 What output do you expect? Write down some examples of the sort of conclusions and recommendations you might expect at the end of your project.
2 So what? Is the world - or at least part of it - going to be a better place once these conclusions and recommendations have been reached?
3 Are you likely to be able to get the right data, and enough data, to justify these conclusions. What if a key stakeholder doesn't like your results, conclusions or recommendations? Have you access to all the information you need? Will the information be sufficiently accurate and reliable?
4 Are the aims challenging but not so ambitious as to be impossible with the limited resources (time, etc) at your disposal? It is often a good idea to have a fairly restricted focus that is analysed in depth.
5 Are your research methods appropriate to achieve the aims? If you have, say, three aims, you must make sure that you have considered the methods for achieving all three of them.

And at the end of the project you should check that:

1   Your research aims, literature, analysis and conclusions are clearly linked together. It is important to be very clear about how your conclusions and recommendations follow from your analysis, and achieve the aims you set yourself at the start.

2   Remember that you are reporting a research project. It should be clear from your write-up that you have done some useful, systematic and rigorous research. Make sure that you give enough detail for this to be clear.

3   Finally, check that your written project satisfies the requirements in the guidelines you have been given.

References

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[29]. **APPENDICES**

A note on "theory"

A "theory" is defined by the *Concise Oxford Dictionary* as a "supposition or system of ideas explaining something, esp. one based on general principles independent of the particular thing to be explained." This clearly hinges on the meaning of "explain" - which is defined as "make intelligible".

According to Russell (1961, p. 52), the word theory is derived from an Orphic word which can be translated as "passionate sympathetic contemplation"; at first sight this is very different from the modern meaning but in fact it fits well with the ethos of, for example, the research method of participant observation.

Theory is often contrasted with "facts" and what happens "in practice". A fact is "a thing that is known to have occurred, to exist or be true", and "in practice" means "when actually applied, in reality". A theory is thus a system of ideas which *explains* something, or makes it *intelligible*, whereas facts and practice are simply the reality of what happens. (However, the physicist, Sir Arthur Eddington, dismisses the common assumption that facts are more certain than theory in physical science: "You should never believe any experiment [fact] until it is confirmed by theory" - quoted in The *Guardian*, January 7, 1993).

To give a concrete example, it might be a fact that a firm's sales have increased by a particular amount. A theory to explain this might be the assertion that the increase in sales is the result of improved quality in the products sold. The system of ideas which forms this theory is the fact that quality levels have improved, and the assertion that, in these circumstances, improved quality is likely to lead to increased sales. The theory is useful because it gives us a means of predicting when sales are likely to rise and so of increasing sales in new situations. A list of facts and of what happens in practice may be interesting; however to predict and control in new situations, theory is needed. This reason for going beyond facts and a simple description of practice, to theory, seems, to me, unanswerable.

According to Quinn, Mintzberg and James (1988) "theories are useful because they shortcut the need to store masses of data ... it is easier to remember a simple framework ... than to remember every detail you ever observed" (p. xviii). However, this misses the most important function of theory which is to help cope with *new* situations which you have not yet observed.

However, even apart from this reason for using theory as a means of going beyond the given facts, theory is necessary for defining the "facts". The above example depends on a way of measuring quality. This can be done in various ways - by reported defect rates, by customer satisfaction, or by some other means. Obviously, we need a system of ideas defining quality before we can even claim to detect an increase. The required theory might be formal academic theory, or it might be provided by "common sense". But in either case it is still a theory. The same is true of many other "facts": profitability can only be defined by reference to theories of accounting, facts about organisational structures can only be defined by reference to the appropriate theories. Even a simple questionnaire designed to elicit an attitude or an opinion depends on the theory that people give true (or valid or meaningful) answers to such questions. (This is often a rather dubious theory.) In all these cases the facts are defined by the underlying theory. The facts cannot even exist without the theory, and different theories are likely to give rise to different facts. Whether this applies to all facts, or just some facts, is an issue which need not concern us here. The important thing is that it applies to many facts of interest to management researchers.

This means that the use of theory is inevitable and it is clearly important to use the best theory for the purpose in hand.

Types and levels of theory

Part of the difficulty in discussing theory is that the single term encompasses a very broad range. Examples of theories are the simple assertion that an improvement in quality led to an increase in sales (see above), theories about how quality can be measured and monitored, mathematically based theories such as the model for calculating the economic order quantity, the theory that specifying objectives clearly increases the chances of a project succeeding, the theory that there are particular categories of organisation, and, on a much more ambitious scale, the theory of total quality management (Oakland 1989). These are all theories in the sense above. They are all useful for defining the facts and for providing explanations about, for example, what to do in given situations.

Theories may differ in their source: some come from academic publications, while others may be derived from common sense. They differ in their level of generality. They differ in the sense in which they "explain" things: sometimes the explanation leads to a prediction (following the TQM way will lead to improvements in quality which will lead to increases in sales); sometimes it merely categorises the possibilities - which is an essential prerequisite for understanding and managing a situation. Theories may be stated in formal mathematical terms or in informal terms, which allow or even encourage differing interpretations. Theories differ in many other ways. But they are all theories.

The problem for the researcher is that of choosing, creating, or adapting, the best theory for the purpose in hand. It is important to investigate all the possibilities and make the selection carefully.

Theories may be wrong or inadequate

Scientists tend to think of the current theory as the "truth". However, even the history of physical science indicates that this is likely to be a very limited perspective: there are many old "truths" - the earth being the centre of the universe, atoms being unsplittable, matter indestructible - which have been replaced by contradictory new "truths". In management, few, if any, theories command respect from everyone. Theories of management are much more obviously fallible and for this reason should not be taken too seriously.

Conclusions

What is the relationship between theory and management research? I think that the discussion above demonstrates that:

1   Theories are necessary as a background for a research project to define the concepts and terms in which the research is phrased. Denying this does not make it less true; it just means that the implicit theories underlying the research will be unacknowledged, uncriticised, and, very likely, quite unsuitable for the job.

2   The only useful aim for research is to make a contribution to theory, since a simple list of facts or practices is of little use.

The following seem to me to be the possible types of contribution:

    (a)   Demonstrating that an existing theory applies to a particular situation and showing how it can be used in this situation: for example an application of TQM theory X to Organisation Y.

    (b)   Modifying, elaborating or extending an existing theory: for example demonstrating that TQM theory X, when applied to organisations of type Y, needs modifying in a particular way.

    (c)   Creating a new theory.

    (d)   Demonstrating that an existing theory is wrong or useless.

(The reader should bear in mind that the theory presented here, about the role of theory in management research, is as fallible as any other theory and should be not accepted uncritically. It represents my analysis; others may disagree.)

An example to show the analysis of questionnaire data

The questionnaire was to obtain feedback from students on a course. It comprised one question asking for the student's tutorial group (GP - an "independent variable"), 21 questions asking for ratings of different aspects of the course on a 1-7 scale (the "dependent variables"), and two open ended questions which were analysed separately. The data was entered in a spreadsheet, and then the analysis was carried out using SPSS (Statistical Package for the Social Sciences). Refno was a reference number written on each questionnaire to identify it.

    SPSS was used to produce histograms, means and standard errors for each of the 21 questions, and a breakdown of the scores by tutorial group and an analysis of variance to assess the significance of these results. It could also give other statistics such as standard deviation, skewness, kurtosis, minimum, maximum, etc. There were a total of 66 pages of output of which one is below. (A lengthier questionnaire or a more detailed analysis can easily result in hundreds of pages of output.)

    It would also be possible to use a spreadsheet to do some, if not all, of the analysis.

Top left of data spreadsheet

Refno	GP	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
1	11	1	4	4	4	2		3	1
2		2	1	3	1	4	4	4	4
3		5	4	4	4	3		5	3
4	4	4	5	5	6	6		5	5
5		3	2	4	2	4		3	2

(Note that missing data is indicated by leaving the cell blank.)

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	10	49.3789	4.9379	2.4055	0.0227
Within Groups	43	88.2693	2.0528		
Total	53	137.6481			

Group	Count	Mean	95 Pct Conf Int for Mean		Minimum	Maximum
Grp 1	3	6.333	4.8991 To	7.7676	6.0000	7.0000
Grp 2	3	4.333	2.8991 To	5.7676	4.0000	5.0000
Grp 3	5	3.400	.5415 To	6.2585	1.0000	6.0000
Grp 4	3	4.333	-.8379 To	9.5045	2.0000	6.0000
Grp 5	3	3.000	-1.9683 To	7.9683	1.0000	5.0000
Grp 6	11	3.636	2.7722 To	4.5005	2.0000	6.0000
Grp 7	8	4.500	3.5008 To	5.4992	2.0000	6.0000
Grp 8	4	3.000	.0949 To	5.9051	1.0000	5.0000
Grp 9	7	2.142	1.3107 To	2.9750	1.0000	3.0000
Grp10	4	3.500	1.9088 To	5.0912	2.0000	4.0000
Grp11	3	3.666	-.1280 To	7.4613	2.0000	5.0000
Total	54	3.685	3.2453 To	4.1251	1.0000	7.0000