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The fifth edition of *Research Methods for Construction* is the ideal textbook for advanced undergraduate and postgraduate students embarking on a research project, at bachelors, masters or doctoral level, in construction, surveying, architecture, civil engineering, and other built environment disciplines.

Richard Fellows is Emeritus Professor of Construction Business Management, Loughborough University, UK. He is an experienced quantity surveyor and in his academic career has taught at several universities in the UK and other countries. His research interests concern economics, contracts and law, and the management of people in construction - especially cultural issues as drivers of behaviour and performance. He was a founder and for many years was joint coordinator of the CIB group, W112 - Culture in Construction. Richard is an editor of a leading construction journal and frequent reviewer of papers for international conferences and journals.

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FIFTH EDITION

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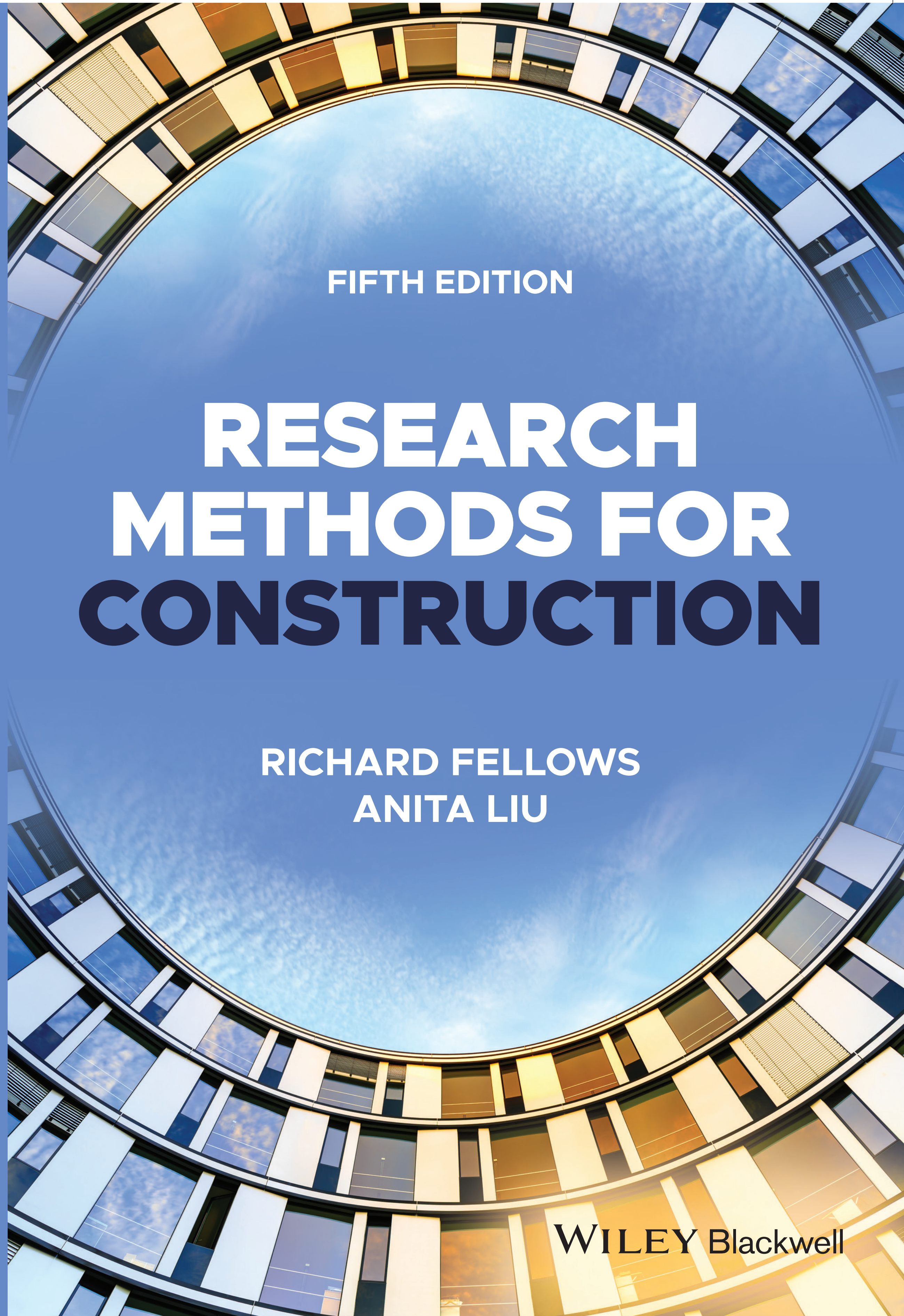

FIFTH EDITION

RESEARCH METHODS FOR CONSTRUCTION

RICHARD FELLOWS
ANITA LIU

WILEY Blackwell

Research Methods for Construction

Fifth Edition

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Anita Liu graduated from the University of Reading. She returned to Hong Kong to work in a quantity surveying consultancy, for the Hong Kong government, and for a major contractor before moving into academia. She obtained an MSc and a PhD from the University of Hong Kong. Anita was Chair Professor of Commercial Management and Quantity Surveying at Loughborough University and, subsequently, was Head of Department and Professor in the Department of Real Estate and Construction at the University of Hong Kong and joint co-coordinator of CIB W112: 'Culture in Construction'. She has obtained many research grants from different awarding bodies, including ESRC (United Kingdom) and RGC (Hong Kong) projects, and has presented papers at many international research conferences. She publishes widely in a variety of leading journals, is a regular reviewer for international journals and research awarding bodies, and is a member of several editorial boards. Anita has been chairperson and a member of committees and boards in various professional institutions in Hong Kong S.A.R., China, Asia Pacific, and the United Kingdom.

Preface to the Fifth Edition

Again, we are very grateful to our friends and colleagues who have taken the time and trouble to give us critical and constructive feedback on previous volumes of this book. That feedback has been invaluable in developing this fifth edition, along with our continuing endeavours in our own research and reviewing and editing the work of others for various journals. For this edition, our reviewing and journal editing has provided important and fascinating insights into how research in construction, especially management and economics, is developing.

As the field of construction is quite young as an academic discipline (or domain), most researchers borrow theory from other, more established fields – physics, chemistry, economics, psychology, sociology, (general) management, etc. Such widespread practice raises a number of very important issues regarding the content of the theories, the contexts in which they have been and are to be used, and the methodologies and the methods of research employed (see Fellows and Liu 2020). Hence, a new section on Theory Borrowing has been included.

The internet and IT generally are, virtually, ubiquitous so that communications are enhanced greatly and researchers have ever more ready access to documented knowledge. Of course, issues of validity and reliability are, commensurately, of great importance, and given the volume of, allegedly, 'fake news', rigour of evaluation has never been more required.

The other enduring concern over computing is the sheer power of calculation that renders complicated, intricate, and extensive calculations usable by all. Whilst that is, undoubtedly, a huge potential benefit, like many benefits, there is a notable associated potential problem too – most often manifested as a lack of discussion and justification of the use of analytic methods, and no concern for their limitations and appropriateness in the context of the topic under study – essentially, no more than 'I've found a sophisticated technique and I'm going to use it to impress others'. That, almost always, does not work.

Such problems aside, concerns over contexts are fundamental. Most theory that we use in construction research is borrowed from other disciplines and contexts so, the basic issues are whether, how and to what extent does the theory apply in the particular construction context under investigation, and how it should be modified to be more suitable. That may be extended to ask whether a set of theory derived from the particularities of construction is more appropriate? Those concerns have prompted enduring debate in general management over the applicability of Western theory to China or whether a Chinese theory of management should be fostered. Context is vital to the content of theory as well as its environment of applications.

The enhanced attention to the contexts of research is reinforced by the need for all researchers to consider the population(s) from which data are drawn and how those data have been obtained – usually, through some form of sampling. The decisions regarding methodology and methods are fundamental cognitive processes and so, are subject to potential influences and biases. Hence, not only is Axiology important but also are the pragmatic examinations of how people think and decide. Those aspects are addressed in specific sections on Sensemaking and Motivated Reasoning as well as specific consideration of deterministic and stochastic thinking and the issues being addressed by Complexity Theory.

Much of this revised edition of our book has been re-structured around the 'Research Cascade' figure (Chapter 3) which depicts a flow in research from the 'question', via philosophy, paradigms (perspectives/lenses), data gathering, and analysis techniques, to drawing conclusions and evaluating limitations; ethical concerns pervade the process – most notably regarding privacy and accessibility, and presentations as reports and oral forms are addressed.

Our warmest thanks go to Paul Sayer and his colleagues at Wiley Blackwell for all his help, encouragement, and, especially, hard work in managing us and the entire production process – no mean feat, especially in the novel and hugely difficult environment that prevailed – we are most grateful.

We hope that the revisions and additions in this edition are interesting and useful in articulating the numerous components of and approaches to research. It is always refreshing to debate with colleagues and to reflect on how the field has developed and continues along its dynamic path. If our small contribution helps you, if only to prompt more questions, then we have been successful.

Enjoy your journey of discovery.

Reference

Fellows, R.F. and Liu, A.M.M. (2020). Borrowing theories: conceptual and empirical considerations. *Construction Management and Economics* 13 (7): 581–588.

Anita Liu
Richard Fellows
Hong Kong; December, 2020.

Part I

Producing a Proposal

1

Introduction

The objectives of this chapter are to:

- introduce the *concept of research*
- provide awareness of different *classifications of research*
- outline the essentials of *theories and paradigms*
- discuss the various *research styles*
- introduce *quantitative, qualitative, and triangulated approaches*
- consider *where*, and how, *to begin*.

1.1 The concept of research

Chambers English Dictionary defines research as:

- a careful search
- investigation
- systematic investigation towards increasing the sum of knowledge.

For many people, the prospect of embarking on a research project is a daunting one. However, especially for people who are associated with a project-oriented industry, such as property development, building design, construction or facilities management, familiarity with the nature of projects and their management is a significant advantage. Dr Martin Barnes, an ex-chairperson of the Association of Project Managers (APM), has described a project as a task or an activity which has a beginning (start), a middle, and an end that involves a process which leads to an output (product/solution). Thus, getting married is a project but staying married is not a project! Staying married is a process. Despite the situation that much research is carried out as part of a long-term

Research Methods for Construction, Fifth Edition. Richard Fellows and Anita Liu.

'rolling' programme, each individual package of research is an entity which is complete in itself, while contributing to the overall programme.

Indeed, any work which assists in the advancement of knowledge, whether of society, a group or an individual, involves research; it will also involve enquiry and learning.

1.1.1 Research: a careful search/investigation

Research can be considered to be a 'voyage of discovery', whether anything is discovered or not. In fact, it is highly likely that some discovery will result because discovery can concern the process of investigation as well as the 'technical subject' (the topic of investigation). Even if no new knowledge is apparent, the investigation may lend further support for existing theory.

What is discovered depends on the question(s) or topic which the research addresses, the patterns and techniques of searching, the location and subject material investigated, the analyses carried out and, importantly, reflection by the researcher on the results of the analyses in the context of the theory and literature, the methodology and the methods employed. The knowledge and abilities of researchers and their associates are important in executing the investigative work and, perhaps more especially, in the production of results, discussion of them, and the drawing of conclusions. Being open-minded, self-aware and as objective as possible is vital for good research.

1.1.2 Research: contribution to knowledge

The Economic and Social Research Council (ESRC) defines research as '… any form of disciplined inquiry that aims to contribute to a body of knowledge or theory' (ESRC 2007). That definition demonstrates that the inquiry must be designed and structured appropriately and that it is the intent of the inquiry which is important (to distinguish from casual inquiries) rather than the outcome *per se*.

The Concise Oxford Dictionary (1995) provides a more extensive definition of research as 'the systematic investigation into and study of materials, sources, etc. in order to establish facts and reach new conclusions'. Here the emphasis lies on determining facts in order to reach new conclusions – hence, new knowledge. The issue of 'facts' is not as clear, philosophically speaking, as is commonly assumed, and will be considered later.

The dictionary continues: 'an endeavour to discover new or collate old facts, etc. by the scientific study of a subject or by a course of critical investigation'. Here there is added emphasis on the method(s) of study; the importance of being both scientific and critical is reinforced.

Therefore, research comprises *what* (facts and conclusions) and *how* (systematic; scientific; critical) components. Being critical, even sceptical, rather than merely accepting is vital; evidence to support assertions, use of methods, production of findings, etc. is essential. '… critical analysis questions the authority and objective necessity of the normative framework that is taken for granted … also challenges the adequacy of … accounts … ' (Willmott 1993: 522). Further, it is concerned to '… situate the development and popularity of ideas and practices … in the material and historical contexts of their emergence and application … ' (*ibid*: 521).

The history of the nature of investigations constituting research is paralleled by the continuum of activities undertaken in a modern research project – description, classification, comparison, measurement, establishing (any) association, determining cause and effect (Bonoma 1985). 'Studies toward the description end of the continuum might be associated more frequently with *theory building*, whereas those near the cause-and-effect end are more frequently used for theory disconfirmation [testing]' ([..] added, *ibid*: 201).

Traditionally, the essential feature of research for a doctoral degree (PhD – Doctor of Philosophy) is that the work makes an original (incremental) contribution to knowledge. This is a requirement for a PhD, and many other research projects make original contributions to knowledge also. A vast number of research projects synthesise and analyse existing theory, ideas, and findings of other research, in seeking to answer a particular question or to provide new insights. Often, such research is referred to as scholarship; scholarship forms a vital underpinning for almost every type of research project (including PhD). However, the importance of scholarship is, all too often, not appreciated adequately – it informs and provides a major foundation upon which further knowledge is built, for both the topic of investigation and the methodology and methods by which investigations may be carried out.

Despite its image, research is not an activity which is limited to academics, scientists, etc.; it is carried out by everyone many times each day. Some research projects are larger, need more resources and are more important than others.

Example

Consider what you would do in response to being asked, 'What is the time, please?'

Having heard and understood the question, your response process might be:

- look at watch/clock
- read time
- formulate answer
- state answer ('The time is … ').

In providing an answer to the original question, a certain amount of research has been done.

Clearly, it is the research question, issue or problem, that drives the research. However, considerable skill is required to frame (articulate the essentials of) the problem to be investigated. In framing a research question, it is important to clarify whether the question is a 'mystery' or a 'puzzle' – i.e. is it a real-world question (mystery) involving unknowns and uncertainties, or is it a 'small world' question (puzzle) involving well-known variables and processes as risks (occurrences governed by stationary probability distributions) (Kuhn 1996; Kay and King 2020). Methodology, method(s), data, etc. are determined to best suit answering the question validly, accurately, and reliably. It is dangerous to adopt a method and then to hunt for questions and problems to which the method may be applied – it may not be (very) suitable and so, lead to difficulties and dubious results.

1.1.3 A learning process

Research is a learning process … perhaps the only learning process.

Commonly, teaching is believed to be the passing on of knowledge, via instructions given by the teacher, to the learner. Learning is the process of acquiring knowledge and understanding. Thus, teaching exists only through the presence of learning and constitutes a communication process to stimulate learning; teaching is 'facilitation of learning'. If someone is determined not to learn, they cannot be forced to do so, although they may be persuaded to learn through forceful means.

1.1.4 Contextual factors affecting research

Research does not occur in a vacuum. Research projects take place in contexts – of the researcher's interests, expertise and experiences; of human contacts; of the physical environment, etc. Thus, despite the best intentions and rigorous precautions, it seems inevitable that circumstances, purpose, and constraints will impact the work and its results (a 'Hawthorne effect' or a 'halo effect'). The fact that research is being carried out will, itself, influence the results, as described in the Hawthorne investigations of Elton Mayo (1949) and noted in the writings of Karl Popper (1989) on the philosophy of research. Research is never a completely closed system. Indeed, much research is, of necessity, an *open* system which allows for, and accommodates, adaptability (e.g. exploratory studies; processual research).

As research is *always* executed in context, it is important to consider the contextual factors, the *environmental variables*, which may influence the results through their impacting on the data recorded. (Environmental variables and constructs are fundamental, express concerns of institutional theory; Scott 1995; Oliver 1997.) Such environmental variables merit explicit and detailed consideration in tandem with the *subject variables* – dependent, independent, and intervening (see Fig. 1.1) – of the

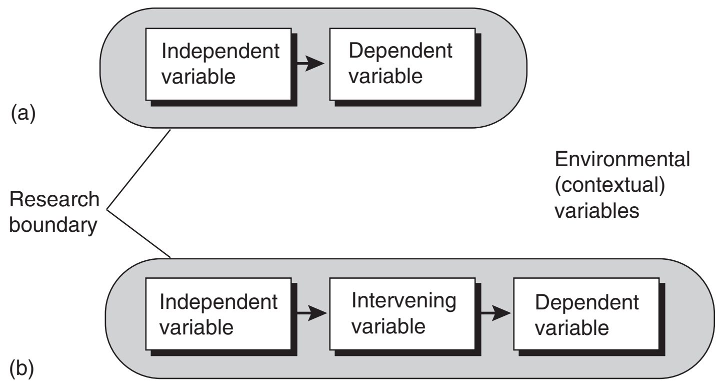

Figure 1.1 'Causality chain' between variables (see also Fig. 4.2, p. 141).

topic of study. The choice of methodology/methodologies is important in assisting identification of all relevant variables, their mechanisms, and amounts of impact.

Example

Consider Boyle's Law. Boyle's Law states that, at a constant temperature, the volume of a given quantity of a gas is inversely proportional to the pressure upon the gas, i.e.

$$V \propto \frac{1}{P}$$

$$PV = \text{constant}$$

Laboratory experiments to examine Boyle's Law attempt to measure the volumes of a particular quantity of gas at different pressures of that gas. The temperature is the contextual/environmental variable, to be held constant, the pressure is the independent variable and the volume is the dependent variable (following the statement of Boyle's Law). The researcher's breathing on the equipment which contains the gas may alter the temperature (otherwise constant) slightly, and it will influence the results, though, possibly, not enough to be recorded. In such cases, the uncontrolled effects of environmental variables which impact the results so that the relationship found is not in strict compliance with the statement of Boyle's Law, are denoted 'experimental error'.

Boyle's Law, like the other gas laws, strictly applies to a perfect gas only but, for many 'practical' purposes, all gases conform to Boyle's Law. For this reason, the purpose of the research is likely to be an important determinant of how the experiment is performed and to what level of accuracy. Considerations, such as those noted in respect of Boyle's Law experiments, lead to research being classified as pure research and applied research. Slightly different views classify studies as either research or development whilst the purpose of a study often leads to academics' work being classified as research or consultancy. Ultimately, such categorisations may prove insignificant – knowledge should be improved continuously in quantity and quality and applied for advancing society, including the advancement of knowledge.

1.2 Classifications of research

1.2.1 Pure and applied research

Frequently, classification of research is difficult, not only due to the use of 'fuzzy' definitions but, more importantly, because the research occurs along a continuum. Whether the common classifications are meaningful and helpful is another concern. At one end of the continuum is 'pure' or 'blue sky' research such as the investigation of laws of nature, etc., whilst at the other, applied research is directed to end uses and practical applications. Most academics are encouraged to undertake research towards the 'pure' end of the spectrum whilst practitioners/industrialists tend to pursue developmental work and applications. Of course, particularly in contexts like construction, the vast majority of research is a combination of ‘pure’ and ‘applied’ research – of theory and applications. Both are vitally important.

Essentially, development and applications (innovations) cannot exist without the basic, pure research while pure research is unlikely to be of great benefit to society without development and applications. Unfortunately, much snobbery exists within the research and development sectors – those who work in one sector all too often decry (or fail to value) the contributions of others who work in different sectors. Fortunately, the advances of Japanese industry and many individual organisations which recognise and value the synergetic contributions of the various sectors of the research spectrum are prompting a change in attitude (synergistic continuous improvement) such that research and development activities are recognised as being different and complementary – each with particular strengths, approaches, and contributions to make.

Often, the difference concerns the questions to be addressed rather than the approaches adopted. Pure research is undertaken to develop knowledge, to contribute to the body of theory which exists – to aid the search for ‘truth’. Applied research seeks to address issues of applications: to help solve a practical problem (the addition to knowledge is more ‘incidental’ than being the main purpose). The (not always material) distinction may be articulated as being that pure research develops scientific knowledge and so asks ‘is it true?’ whilst applied research uses scientific knowledge and so asks ‘does it work?’

Commonly, research, especially applied research (located towards the developmental end of the research spectrum), involves solving problems. A simple dichotomous classification of types of problem is:

(1) *Closed* (ended) problems – simple problems, each with a correct solution. The existence of the problem, its nature, and the variables involved can be identified readily. Such problems are common, even routine, and so, can be dealt with easily (often via heuristics/routines) to give the single correct solution. The problems are ‘tame’; sometimes called ‘puzzles’.
(2) *Open* (ended) problems – tend to be complex; the existence of the problem may be difficult to identify, the situation is likely to be dynamic and so, the variables are difficult to isolate and relationships between them are difficult to determine. Finding a solution is hard and may require novel ideas (e.g. through ‘brainstorming’). It may not be (very) evident when a solution has been reached and many alternative solutions are likely to be possible. Such problems are ‘wicked’, ‘vicious’ or ‘fuzzy’ and may well concern/involve insight; sometimes called ‘mysteries’.

Clearly, most problems requiring research for their solution are likely to be open ended. However, in solving problems, there are many sources of and types of influence (bias) which may impact the people involved – not least, the approaches adopted for solving and the solutions determined for closed-ended problems.

1.2.2 Quantitative and qualitative research

The other primary classification system concerns the research methods adopted (for collection and analysis of data) – broadly, quantitative and qualitative research.

Quantitative approaches adopt 'scientific method' in which initial study of theory and literature yields precise aims and objectives with proposition(s) and hypotheses to be tested – conjecture and refutation may be adopted, as discussed by philosophers such as Popper (1989) and so, tend to be *explanatory*. In qualitative research, an exploration of the subject is undertaken, sometimes without prior formulations – the object may be to gain understanding and collect information and data such that theories will emerge and so, tends to be *exploratory* (as exemplified in *grounded theory*; Glaser and Strauss 1967). Thus, usually, qualitative research is a precursor to quantitative research. In an 'advanced' body of knowledge, where many theories have been developed and laws have been established, quantitative studies of their applicabilities can be undertaken without the need to determine theories and such afresh, thereby avoiding, 'reinventing the wheel' for each new study. Thus, Harrison *et al*. (2007: 1234) suggest that '… qualitative research methods work best for developing new theoretical ideas and making interpretations of a theory or a phenomenon's significance; quantitative research is directed toward identifying general patterns and making predictions'.

The typology of Edmondson and McManus (2007) indicates appropriate methodologies according to the extent of development of research in a discipline. Research in construction is relatively 'nascent' or 'intermediate' in maturity and in matching to the fieldwork context. Hence, accentuation of exploratory studies using qualitative methods (rather than hypothesis testing and quantitative methods which are appropriate for mature disciplines/domains) is appropriate to foster the development of construction-specific knowledge. Quantitative studies in construction usually 'borrow' theory (and methods) from other, more established disciplines.

Generally, quantitative approaches provide 'snapshots' and so, are used to address questions such as what, how much, how many? Thus, the data, and results, are instantaneous or cross-sectional (e.g. compressive strength of a concrete cube; number of firms in an industry; market price of an item; content of an Architect's Instruction). Qualitative approaches seek to find out why things happen as they do, to determine the meanings which people attribute to events, processes, and structures. Many qualitative studies use data regarding people's perceptions to investigate aspects of their social world; others seek to 'go deeper' to address people's assumptions, prejudices, etc. to determine their impacts on behaviour and, thence, (organisational/project) performance.

The fundamental issues in designing any research, and so, underpinning the selection of quantitative, qualitative, or combination approaches, concern the research question, and constraints and, perhaps most particularly, what is to be measured and the requirements of validities and reliability.

Sometimes, qualitative research is assumed to be an easy option, perhaps in an attempt to avoid statistical analyses by persons who do not excel in mathematical techniques. Such an assumption is seriously flawed – to execute a worthwhile research project using qualitative methods can be more intellectually demanding than if quantitative methods had been employed. The use of qualitative methodologies should not be assumed to be a 'soft option'.

Irrespective of the nature of the study, rigour and objectivity are paramount throughout. Drenth (1998: 13) defines objectivity as '… the degree to which different observers or judges are able to record the data in the same manner. Judgement or classification of data in scientific research should not be substantially influenced by the subjectivity of the observer'. Thus, it is helpful if all the researchers agree the definitions of terms, metrics for collecting the data and the related protocols. Commonly, qualitative data, which are subjective (such as obtained in opinion surveys), can and should be analysed objectively, often using quantitative techniques. However, one should not lose sight of the richness which qualitative data can provide and, often, quantitative data cannot (see Van Maanen 1988). Triangulation – the use of qualitative and quantitative techniques together to study the topic – can be very powerful to gain insights and results, to assist in making inferences and in drawing conclusions, as illustrated in Fig. 1.2.

Research requires a systematic approach by the researcher, irrespective of what is investigated and the methods adopted. Careful and thorough planning are essential and, especially where large amounts of data are collected, rigorous record-keeping is vital – in the study of theory and previous work (literature) as well as in the field work.

The impact of the researcher must be considered, both as an observer or an experimenter, whose presence will impact the data collected and the results derived, and through whom bias may be introduced in data collection, analyses, and inferences. Such biases may be introduced knowingly – to investigate the subject from a particular viewpoint – or, more usually, unknowingly, perhaps by asking 'leading questions'. Normally, the impact of the researcher and of the execution of the research should be minimised through careful research design and execution; rigorous documentation and 'writing up' are vital and must specify the perspective/paradigm adopted (and rationale for its adoption).

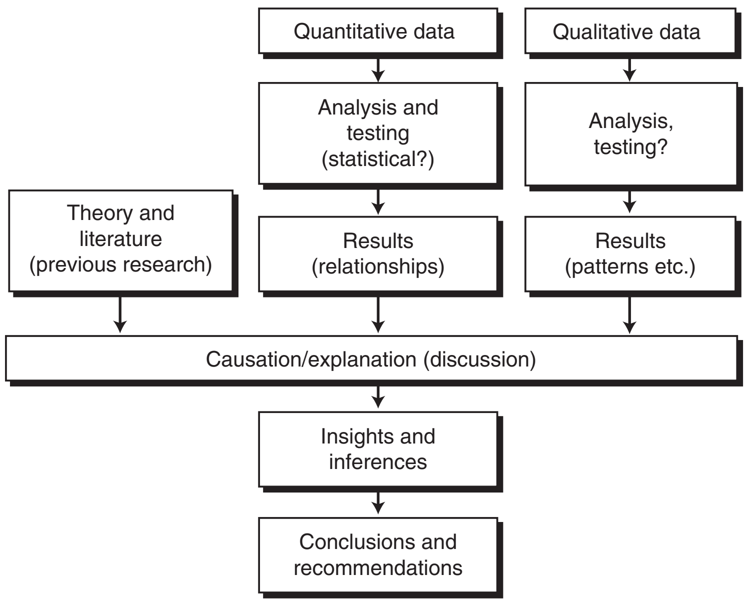

Figure 1.2 Triangulation of quantitative and qualitative data.

Example

Consider the question, 'Do you not agree that universities are underfunded?' The phrasing, 'Do you not agree that … ', suggests that the respondent ought to agree that universities are underfunded and so, asking such a 'leading' question is likely to yield more responses of agreement than if the question were phrased more objectively/neutrally.

The question could be phrased much more objectively, 'Do you believe that universities are:

(1) funded generously, or
(2) funded adequately, or
(3) funded inadequately?'

Even phrasing the question in that way, although removing the 'agreement bias', is incomplete as it assumes that all the respondents have a belief about the topic – some may not and so, a fourth possibility of 'no opinion' should be included. Unfortunately, that additional possibility also allows respondents to opt out of expressing their opinion!

Additionally, the sequence in which alternative response options appear may influence the frequency of the selection of each one.

Tsoukas (1989: 551) cautions that ' … qualitative is a type of evidence rather than a research design' which, by analogy, applies to quantitative studies too.

1.2.3 Other categories of research

Further categorisation of types of research accords with the purpose of the research (question) as set out next.

- Instrumental – to construct/calibrate research instruments, whether physical measuring equipment or as tests/data collection (e.g. questionnaires; rating scales). In such situations the construction, etc. of the instrument is a technological exercise; it is the evaluation of the instrument and data measurement in terms of meaning which renders the activity scientific research. The evaluation will be based on theory.
- Descriptive – to systematically identify and record (all the elements of) a phenomenon, process or system. Such identification and recording will be done from a particular perspective and, often, for a specified purpose; however, it should always be done as objectively (accurately) and as comprehensively as possible (this is important for later analysis). The research may be undertaken as a survey (of the population identified – usually, employing sampling) or as case study work. Commonly, such research is carried out to enable the subject matter to be categorised.
- Exploratory – to test, or explore, aspects of theory (if any is applicable). A central feature is discovery of processes, etc., sometimes through the use of propositions/hypotheses. A proposition or a hypothesis may be set up and then

tested via research (data collection, analyses, interpretation of results). More usually, a complex array of constructs or/and variables is identified by the research and propositions/hypotheses are produced as the research output to be tested by further research.

- Explanatory – to answer a particular question or explain a specific issue/phenomenon. Propositions/hypotheses are used and, as the situation is known better (or is defined more clearly), theory and literature can be used to develop the hypotheses which the research will test. Also, this could be a follow-on from exploratory research which has produced hypotheses for testing.
- Interpretive – to fit findings/experience to a theoretical framework or model; such research is necessary when empirical testing cannot be done (perhaps due to some unique aspects – as in a particular event of recent history, e.g. 'the Asian financial crisis of 1997'). Interpretivism is founded on the '… assumption that human understanding and action are based on the *interpretation* of information and events by the people experiencing them … ' (Gioia and Chittipeddi 1991: 435). The models used may be heuristic (using 'rules of thumb') – in which variables are grouped to (assumed) relationships – or ontological, which endeavour to replicate/simulate the 'reality' as closely as possible.

A further categorisation of research concerns what is being investigated – product, process, or both. Research in construction includes all three categories; research into structural integrity is product oriented (e.g. strength properties of materials), construction management research tends to be process oriented (e.g. organisational culture of construction firms) or both process and product (e.g. the impact of different procurement approaches on project performance and on project management performance). Van de Ven (1992: 169) identifies a process as '… a sequence of events that describes how things change over time'.

1.3 Theories and paradigms

Usually, research is distinguished from other investigations, searches, and enquiries by being 'scientific'; traditionally regarded as adoption of the 'scientific method'. Scientific method is 'a method of procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses: *criticism is the backbone of* ***the scientific method*** *[in plural]: the process is based on presently valid scientific methods*' (Oxford English Dictionary 2013). *Today, the concept of scientific method embraces quite diverse approaches and interpretations – to the extent that different sciences (natural, social,* etc.*) tend to use different methods, leading to the conclusion that there is* ***no single*** '***scientific method***'***.*** *However, traditionalism remains strong in that some empiricists and positivists refute any approach which does not conform to the traditional concept as being* '*unscientific*'*!*

Essentially, research, as a cognitive process, comprises a logic of discovery and the (subsequent) validation of discoveries – to promote refinement and further discovery. Unfortunately, some researchers may be unaware of their underlying ontological,

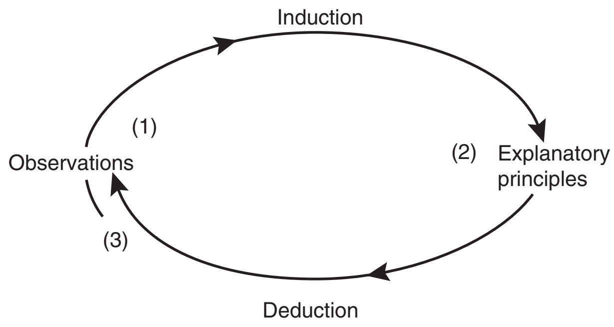

Figure 1.3 Aristotles inductive–deductive method (*Source*: Losee (1993)).

epistemological, and axiological beliefs and assumptions (which are founded in culture and early upbringing – see, n.b., Hofstede 2001) or, otherwise, do not express those underpinnings in research reports and debates The ontological, epistemological, and axiological bases of research are fundamental as they inform all research activities – notably, developing and using theory, which denotes what elements in the world are relevant to the topic of investigation and how those elements are related to each other and to context (Van Maanen *et al*. 2007). Such judgements of relevance and relationships are determined by axiology (the values of those persons involved – especially the researcher).

Losee (1993: 6) depicts Aristotle's inductive–deductive method for the development of knowledge as shown in Fig. 1.3. He notes that, 'scientific explanation thus is a transition from knowledge of a fact [point (1) in the diagram] to knowledge of the reasons for the fact [point (3)]'. Notably, abductive reasoning had not been identified at the time Aristotle lived.

1.3.1 Development of knowledge

Popper (1972, 1989) argues that scientific knowledge is different from other types of knowledge because it is falsifiable rather than verifiable; tests can only corroborate or falsify a theory, the theory can never be proved to be true. No matter how many tests have yielded results which support or corroborate a theory, results of a single test are sufficient (provided the test is valid) to falsify the theory – to demonstrate that it is not always true. The more general application for acceptability in scientific investigation is shown in Fig. 1.4.

Different philosophies consider that scientific theories arise in diverse ways. Cartesians, who hold a 'rationalist' or 'intellectual' view, believe that people can develop explanatory theories of science purely through reasoning, without reference or recourse to the observations yielded by experience or experimentation. Empiricists, maintain that such pure reasoning is inadequate, it is essential to use results and knowledge (experience) from observation and experimentation to determine the validity or falsity of a scientific theory. Kant (1934) noted that the scope of peoples' knowledge is limited

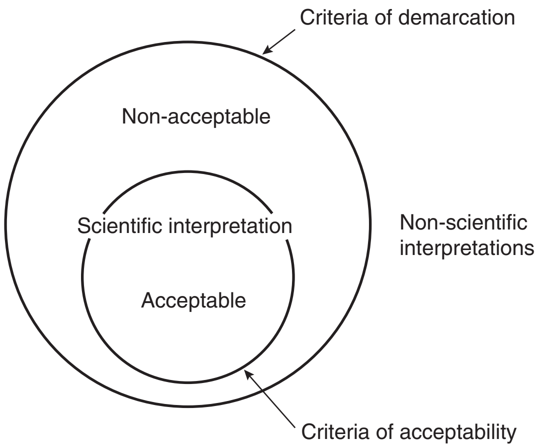

Figure 1.4 Depiction of the approach to the advancement of knowledge, as advocated by Galileo (*Source*: Losee (1993)).

to the area of their possible experience; speculative reason beyond that, such as attempts to construct a metaphysical system through reasoning alone, has no justification.

Nagel (1986) suggests that the scientist adopts a 'view from nowhere' which implies the possibility of total objectivity and that phenomena exist totally independently of any observer. Conversely, Kuhn (1996: 113) notes that 'what a man sees depends both upon what he looks at and also upon what his previous visual–conceptual experience has taught him to see' (as employed in sensemaking, Weick 1995 – how people determine meaning).

Tauber (1997) observes that, as science has evolved, so the notion of what constitutes objectivity has changed such that different branches of science require/employ different standards of 'proof'.

Dialectic, a development of 'trial and error', can be traced back to Plato who employed that method of developing theories to explain natural phenomena and followed this by a critical discussion and questioning of those theories; notably whether the theories could account for the empirical observations adequately. Essentially, Plato's approach builds on the dialectical method employed by Socrates who adopted the approach of questioning everything, and everyone who professed to have knowledge, from the perspective of knowing nothing. The intent was to reveal both the extent and the limitations of existing knowledge by revealing assumptions, contradictions, and gaps.

As science developed specialisms, it separated into quite individual subject areas (e.g. chemistry, physics), a tradition which has extended and is, largely maintained; studies in such fields of individual specialisation produce what has become known as Mode 1 knowledge (Gibbons *et al*. 1994). Mode 1 knowledge production occurs to extend the amount of human knowledge *per se*, irrespective of any applications; emphasising the discovery of 'universal laws'. Since the latter part of the twentieth century, partly due to funding pressures, research has moved towards more attention to applications (addressing problems of industry and practice – the 'real world') and, in so doing, has embraced multi- and cross-disciplinary working; that, more applied, research produces Mode 2 knowledge (Gibbons *et al*. 1994) which is quite particular and context-bound. Recently, Mode 3 knowledge production has emerged (Carayannis and Campbell 2012) that asserts that knowledge coexists and so, through multidisciplinary working at various levels, diverse knowledge is co-developed; in Mode 3, innovation for application of knowledge is emphasised through a quadruple helix approach involving university, industry, government, and public. Triple helix learning and innovation comprises university, industry, and government, while quintuple helix is university, industry, government, public, and environment.

Commonly, scientists offer theories as tentative solutions to problems; the theory is criticised from a variety of perspectives; testing the theory occurs, by subjecting vulnerable or criticised aspects of the theory – notably, any and all assumptions – to the most severe tests possible. The dialectic approach, following Hegel and discussed by authors such as Rosen (1982), is that a theory develops through the dialectic triad – thesis, antithesis, and synthesis. The theory advanced initially is the thesis; often, it will provoke opposition and will contain weak points which will become the focus of opposition to it. Next, the opponents will produce their own counter-theory, the antithesis; there may be several antitheses. Debate and testing will continue until recognition of the strengths and weaknesses of the thesis and of the antithesis are acknowledged and the strengths of each are conjoined into a new theory, the synthesis. This is likely to regenerate the cycle of dialectic triad.

Stinchcombe (2002) postulates an alternative framework for the development of theory. The framework comprises three mechanisms that, usually, occur in the sequence of '(1) Commensuration, or the standardization of theoretical constructs, definitions or processes that enable comparison across theorizations; (2) evangelism, or the zealous conversion of adherents to a particular theoretical or methodological stance, and (3) truth-telling, or critical tests that can detect the most veridical theories in a particular field' (Glynn and Raffaelli 2010: 362).

History, of course, has a role to play as it is likely to be influential, especially qualitatively, on how people think and behave in developing, criticising, and interpreting theories. Popper (1989) uses the term 'historicism', whilst Clegg (1992) employs 'indexicality' to consider history's impact how people understand, interpret, and behave. Indexicality is a person's understanding of terms which is determined by that person's background, socialisation, education, training, etc. Marx's broad view was that the development of ideas cannot be understood fully without consideration of their historical context(s), notably the conditions and situations of their originator(s). It is possible to explain both formal social institutions (such as the UK parliament, the Sorbonne, the Supreme Court of USA, the Tokyo stock exchange, or the Royal Institution of Chartered Surveyors) and informal social institutions (such as friendship groups), by examining how people have developed them over time.

As domains and disciplines mature, in terms of research relating to them, the research tends to progress through the chronological frameworks, noted above. Research in construction is relatively nascent and so, draws on more established research disciplines (materials science, chemistry, physics, economics, psychology, etc.). In determining how to progress research, Glynn and Raffaelli (2010: 390) advise that 'A research strategy of compartmentalization treats different theoretical perspectives within an academic field as fairly independent of one another, more as stand-alone silos of thought. Essentially, compartmentalization reflects incommensuration across theoretical boundaries … , or the absence of a commonly shared standard for theoretical evaluation or integration. The result is that different theoretical perspectives are neither compared nor combined in meaningful ways'. Such an approach is particularly detrimental to a field such as construction in which aspects of various, diverse disciplines are integrated for good practice; unfortunately, the 'silo' perspective may be emphasised in research funding of narrowly defined programmes which, often, focus on solving particular (industry-based) problems.

However, Glynn and Raffaelli (2010: 392) also note that 'Theoretical integration can result from commensuration … which enables comparison and consolidation across theories and, in this, can result in the kind of cumulative knowledge that grows in explanatory power over time … ' – an important component of organisational learning and learning organisations.

Commonly, research, first uses theory to inform the study – to help identify the constructs and variables and relationships between them, the boundary of the research, and the nature and content of the environment. In an active capacity, research seeks to generate theory (which 'occurs when the inquiry's design produces formal and testable research propositions') (Lee *et al*. 1999: 164), to elaborate theory (' … when pre-existing conceptual ideas or a preliminary model drives the study's design' to test the theory or/and to develop it further) (*ibid*), or to test theory (' … when formal hypotheses or a formal theory determines the study's design', as in replicating an experiment, or examining the applicability of a theory in a new context) (*ibid*).

1.3.2 Testing a theory

A *theory* is a system of ideas for explaining something; the exposition of the principles of science. Bacharach (1989: 498) provides an amplified definition' … a theory may be viewed as a system of constructs and variables in which the constructs are related to each other by propositions and the variables are related to each other by hypotheses. The whole system is bounded by the theorist's assumptions … '. In particular, ' … a theory … makes its assumptions clear and empirically testable' (Mir and Watson 2001: 1170). Notably, 'The primary goal of a theory is to answer questions of *how, when,* and *why*, unlike the goal of description, which is to answer the question of *what*' (Bacharach 1989: 498).

Constructs are 'terms which, though not observational either directly or indirectly, may be applied or even defined on the basis of observables' (Kaplan 1964: 55) – such as an index number; e.g. BCIS Tender Price Index, or BCIS Building Cost Index. However, Suddaby (2010: 354) cautions that ' … different research traditions … have different interpretations of how constructs are constituted and how they should be used … '. A variable is an observable entity which may assume two or more values (Schwab 1980) – such as the individual constituents of an index number; e.g. the price (at a specified date) of a tonne of 15-mm rebar.

Popper (2002: 9) notes four approaches to testing a theory:

- 'The logical comparison of the conclusions among themselves, by which the internal consistency of the system is tested.

- The investigation of the logical form of the theory, with the object of determining whether it has the character of an empirical or scientific theory.
- The comparison with other theories, chiefly with the aim of determining whether the theory would contribute a scientific advance should it survive our various tests.
- The testing of the theory by way of empirical applications of the conclusions which can be derived from it'.

In particular, science provides rules for how to formulate, test (corroborate/falsify), and use theories. However, all theories share the concern that the testable propositions/hypotheses that flow from them are impacted by two sets of assumptions – contextual assumptions (regarding what is being observed and measured), and conceptual assumptions (regarding the researcher(s) and the philosophy, methodology, and methods adopted).

Boolean logic states that concepts are polar in nature – they are either true or false. However, scientific theories are not of that form; they are not always well defined, and so it is appropriate to consider a theory as being accepted due to the weight of supporting/confirming evidence (until falsified); rather akin to fuzzy logic. The value or usefulness of a theory may not be demonstrated by the use of probability alone; such probability must be considered in conjunction with the information contained in the theory. Broadly based, general theories may be highly probable but vague, due to their low information content (generic) and so, difficult to falsify; whilst precise or exact theories, with a high information content (specific), may be of much lower probability and so, quite easy to falsify – due to their narrow scope of applicability. Theories with a high information content tend to be much more useful, which leads Blockley (1980) to require that appropriate measures to corroborate theories should be designed such that only theories with a high information content can achieve high levels of corroboration.

Tests (empiricism) can only corroborate or falsify a theory, as noted by Lakatos (1977). Losee (1993: 193) outlines Hempel's (1965) notion of three stages for evaluating a scientific hypothesis:

(1) 'Accumulating observation reports which state the results of observations or experiments;
(2) Ascertaining whether these observations confirm, disconfirm, or are neutral toward the hypothesis; and
(3) Deciding whether to accept, reject, or suspend judgement on the hypothesis in the light of this confirming or disconfirming evidence'.

Husserl (1970: 189) asserts that 'the point is not to secure objectivity but to understand it'.

Traditionally, scientific theories must be testable empirically. If a theory is true and one fact is known, often, another can be deduced. For example: if a theory states 'all clay is brown' and a sample provided is known to be clay, the deduction is that the sample will be brown. Provided the general statement of the theory is correct, in this case that all clay is brown, the deductive reasoning to go from the general statement to the specific statement, that the sample of clay is brown, is valid. However, discovery of clay which is a colour other than brown will falsify the general theory and so, require it to be modified, if not abandoned. Hence, the deduction is 'safe', given corroboration of the theory/hypothesis, but it does not allow knowledge to be advanced.

There are three major forms of inference by which people draw conclusions from data (facts); alternatively these are regarded as forms of reasoning – deduction, induction, and abduction.

In deductive inferences, what is inferred is necessarily true provided the premises from which the inference is made are true; thus, the truth of the premises guarantees the truth of the conclusion. For example, all clays are cohesive soils; this sample of soil is London clay; therefore, London clay is a cohesive soil (a necessary inference).

Inductive inferences may be characterised as those inferences that are based on statistical data only. Commonly, the data are in the form of observed frequencies of occurrences of a particular feature in a prescribed population. For example, 95% of type 'X' projects over-run on final cost by 10%; this is a type 'X' project; therefore, this project will (strictly, is 95% likely to) over-run on cost by 10% (not a necessary – but a statistically likely – inference).

Inductive reasoning – from the specific example to the general statement – is not valid (without the statistical caveat – perhaps in the form of confidence intervals).

Abductive inferences are similar to inductive inferences but without a (strict) basis in statistical data – they may be quite subjective. For example, most construction managers in the United Kingdom are male; Al is a construction manager in the United Kingdom; therefore, Al is male (not a necessary – but a highly likely – inference).

A *hypothesis* is a supposition/proposition made, as a starting point for further investigation, from known facts. (However, in formal research terms, a *proposition* concerns *constructs* and relationships between them whilst a *hypothesis* concerns *variables* and relationships between those – see Chapter 5.) Induction is useful to yield hypotheses; for example, by inspecting a variety of samples, it may be hypothesised that all clay is brown. Thus, whilst the hypothesis remains corroborated rather than falsified, deductions can be made from it. Advances are made by use of induction. As knowledge advances, hypotheses may require qualifying statements to be appended to them – such as that all clay of a certain type and found in a given location, is brown – such auxiliary statements lend precision by raising the information content of the hypothesis or theory.

Thus, deductive reasoning occurs within the boundaries of existing knowledge (and may reinforce those boundaries), whilst inductive reasoning is valuable in extending or overcoming boundaries to current knowledge but should be employed with due caution – scientifically, through the use of hypotheses to be tested. Thus, Orton (1997: 422) notes that 'Deductive research rhetorics tend to proceed from theory to data (theory, method, data, findings), while inductive research rhetorics tend to proceed from data to theory (method, data, findings, theory)'.

Abductive reasoning, as formally developed by C. S. Pierce, 'is the process of forming an explanatory hypothesis. It is the only logical operation which introduces a new idea' (Pierce 1903: 216; cited in Suddaby 2006: 639). Dubois and Gadde (2002) employ abductive reasoning to develop a method which they call 'systematic combining' which '… is a process where theoretical framework, empirical fieldwork, and case studies evolve simultaneously, and is particularly useful for development of new theories' (p. 554). In a grounded theory context, Suddaby 2006: 639) notes that it is termed '"... analytic induction," the process by which a researcher moves between induction and deduction while practicing the constant comparative method'.

Abduction commences from an unexpected situation (a surprise, given prevailing knowledge) that gives rise to speculations about the situation, its causes, and effects; the reasoning, then, '... works backward to invent a plausible world or a theory that would make the surprise meaningful' (Van Maanen *et al*. 2007: 1149). More specifically, abduction comprises '... (1) the application of an established interpretive rule (theory), (2) the observation of a surprising – in the light of the interpretive rule – empirical phenomenon, and (3) the imaginative articulation of a new interpretive rule (theory) that resolves the surprise' (Alvesson and Kärreman 2007: 1269).

Exceptions to established general principles are called *anomalies* – instances in which the theory fails to provide a correct prediction of the particular reality. The presence of an anomaly usually promotes re-examination of the general principles/theory and, following further detailed investigation and use of the dialectic triad, the modification of the theory so that all the known instances are incorporated correctly.

The *fallacy of affirmation* occurs when certain observations apparently lead to particular conclusions regarding further relationships which appear to follow from the observations. However, without investigation of the validity of those conclusions on the basis of logical theory and empirical observation, false and misleading conclusions may ensue.

For example:	Fact (1) Some penguins are flightless birds
	Fact (2) Some penguins are chocolate biscuits
False conclusion:	Some flightless birds are chocolate biscuits

Finally, theories must be evaluated – for use in research and in application to practical situations. Criteria for evaluation include internal consistency, validities, logic of content and structure, organisation of the theory's content and relationship to the existing body of (other) theory, clarity and parsimony, and reliability.

Although scientific advances are grounded in the notion that 'observation trumps theory', such grounding is dependent upon the validity and reliability of the observations – the data collected and analysed (including the analytic techniques and any model employed).

1.3.3 Paradigms

A *paradigm* is a theoretical framework which includes a system by which people view events (a lens). The importance of paradigms is that they operate to determine not only what views are adopted, but also the approach to questioning and discovery – which leads Mir and Watson (2000: 941) to describe a paradigm as '... a characteristic set of beliefs and perceptions held by a discipline ... '. Inevitably, the set of beliefs and perceptions, are important in that they impact on any study, thus, 'Within a subjective paradigm [especially], such as the interpretive, interests and biases become central. They need to be declared ... ' to facilitate understanding of the findings ([ ] added, Williamson 2002: 1391). Those interests and biases are likely to be embedded in the assumptions underpinning a study and so, it is essential that the assumptions are expressed to facilitate their examination, interrogation, and consideration of effects.

Hence, much work concerns verification of what is expected or/and explanation of unexpected results according to the adopted, current paradigms. However, as progressive investigations produce increasing numbers and types of results which cannot be explained by the existing paradigms' theoretical frameworks, paradigms are modified or, in more extreme instances, discarded and new ones adopted – the well-known 'paradigm shift'.

Normally, the advance of knowledge occurs by a succession of increments; hence, it is described as evolutionary. Only rarely are discoveries made which are so major that a revolutionary advance occurs. Often, such revolutionary advances require a long time to be recognised and more time, still, for their adoption – such as Darwin's theory of evolution. Hence, in terms of scientific progress, a theory which is valid at a given time is one which has not been falsified, or one where the falsification has not been accepted. Whilst objectivity is sought, research does have both cultural and moral contents and so, a contextual perspective, especially for social science research, is important in order to demonstrate and appreciate the validity of the study.

Kuhn (1996: 37) asserts that '… one of the things a scientific community acquires with a paradigm is a criterion for choosing problems that … can be assumed to have solutions …. A paradigm can … insulate a community from those socially important problems that are not reducible to the puzzle form because they cannot be stated in terms of the conceptual and instrumental tools the paradigm supplies'.

In 'High paradigm fields … there is "shared theoretical structures and methodological approaches about which there is a high level of consensus" (Cole 1993, p 112, cited in Pfeffer 1993, p. 599); low paradigm fields lack such consensus and, instead, proliferate varieties of theories and methods about which there is little agreement' (Glynn and Raffaelli 2010: 362). Thus, it is usual for newer, emerging fields to be low paradigm – they use (borrow) theories and methods from more established fields to aid their own investigations. Construction is such a field.

Generically, a diverse array of paradigms of research are in use, the taxonomy being: positivism, realism (direct; critical), interpretivism, constructivism, transformationalism, postmodernism, and pragmatism. Essentially, the paradigms diverge on the basis of the nature of 'reality' – how reality exists, and how and why it may be observed; positivism regards reality as independent of an observer and observation, interpretivism regards reality and observation as inseparable/integrated, and pragmatism focuses on the usefulness of the outcomes of observation.

1.3.4 Positivism

Positivism originates in the thinking of Auguste Comte (1798–1857). It recognises only non-metaphysical facts and observable phenomena and so is closely related to rationalism, empiricism, and objectivity. Positivism asserts, in common with one branch of the Cartesian duality, that there are facts which can be observed and measured by an observer, which remain uninfluenced by the observation and measurement. Thus, in '… classical positivism … a scientific theory was meaningful if, and only if, its elements could be empirically examined using objective data' (Alvarez and Barney 2010: 560). Clearly, there is a strong relation to quantitative approaches.

However, the presence of 'facts' independent of the observer, and the feasibility of totally objective and accurate observation are being challenged increasingly (e.g. 'halo' effect, 'Hawthorne' effect, Heisenberg's uncertainty principle). Whilst certain facts are, indeed, likely to exist independently of observation, this may be relevant and true as regards the 'natural world' only – the natural laws of the universe. Inevitably, observation and measurement affect what is being observed and measured (such as the issues involved in experiments to measure the temperature of absolute zero). Further, what is to be observed and measured, by whom, how, when, etc. are all determined by human decisions. Measurement may not be accurate for a variety of reasons, such as parallax, instrument error, etc. (See Fellows and Liu 2000 for a discussion relating to pricing construction projects.)

In apparently separating reality of the natural world from those who attempt to observe and measure it, scientific positivism maintains the Cartesian duality to (supposedly) yield consistency of perception – the same inputs under the same circumstances yield the same outputs/results – the principle of replication and the research criterion of reliability.

Thus, Chia (1994: 797) contrasts positivist and Kantian approaches as 'Positivist theories … maintain that … laws and principles are empirically discoverable, while Kantian theory insists that the basic categories of logic, time and space are not "out there" but are inherent constituents of the mind'.

1.3.5 Interpretivism

Interpretivism may be regarded as an antithesis of determinism. While determinism asserts that each and every event or situation is the necessary and inevitable (direct) consequence of prior events and situations, interpretivism argues that reality is relative and so, there can be many different, valid realities; the task of research is to interpret and understand those realities rather than to determine cause – effect relationships for general, predictive purposes.

The interpretive paradigm is particularly valuable for research in management (and other social arenas) by indicating that reality is constructed by the persons involved (social constructivism). Thus, one person's reality, derived by observations and perceptions and modified by socialisation (upbringing, education, and training), is likely to be different from another's. Therefore, truth and reality are social constructs, rather than existing independently 'out there' and so, researchers should endeavour to determine truth and reality from the participants' collective perspective(s) – to see things through their eyes (as in ethnographic research). Such determination is likely to require extensive discussion with the participants, in order to achieve agreement on the representation (description) of their truth and reality and subsequent, further discussion to verify that the researcher's representation is correct. Further, symbolic interactionists argue that truth '… results from both the act of observation and the emerging consensus within a community of observers as they make sense of what they have observed' (Suddaby 2006: 633).

As the interpretive paradigm is more likely to feature in qualitative studies (although it is applicable to quantitative research also), there is a risk of influence (bias) by powerful participants who may be either individuals or groups. Therefore, the impact of social structure should be considered, including the perspective of *structuralists*, who argue that structure is fundamental to how society operates and to the determination of its values and customs. This may, of course, be 'interactive cycling' as societal values help to determine social structure, which then impacts on values, and so on.

Knowledge, then, may be regarded as constituting reality with a human component in that it is what, perhaps only for a time and place, counts as reality in being accepted as such by individuals or the population. Science is a mechanism for establishing and refining knowledge, as noted previously, but with a focus on validation – itself a human process.

Tauber (1997: 3) notes that 'science is indeed a social phenomenon, but a very special one, because of the constraints exerted by its object of study and its mode of analysis'.

Pickering's (1992: 1) view is that 'scientific knowledge itself had to be understood as a social product'. That perspective is echoed by Pettigrew (1997: 338–339) who asserts that 'Actions are embedded in contexts which limit their information, insight and influence … the dual quality of agents and contexts must always be recognised. Contexts are shaping and shaped, actors are producers and products … interchange between agents and contexts occurs over time and is cumulative'.

The objectivity requirement of scientific positivism requires that the knowledge of the observer is excluded. If personal knowledge (Polanyi 1962) – including intuitions and insights – are actually excluded, questions arise as to how investigations are instigated, how they are carried out, and how conclusions are formulated. If we assume that investigations – research projects – do not just happen by pure chance but are initiated by cognitive motivation (e.g. career development), then decisions (human, goal-directed actions) are taken to answer the basic investigative questions. Further, such motivational drives are determined by society and are likely to reflect and to perpetuate current perspectives of proper investigation of subjects and methods, often by use of 'immunising strategy' involving only incremental, evolutionary change. Revolutions require bold challenges (Kuhn 1996) – such as that of Galileo.

Golinski (1990: 502) notes that the choices made by scientists and their managers ' … are constrained by their aims or interests and by the resources they select to advance them'.

Perhaps it is more useful that the most suitable approaches to investigation, including the various forms of testing, are applied with rigour so that knowledge advances by employing models of maximum usefulness – following the high information content approach advocated by Blockley (1980). Such advances of science accept the roles of all types of inputs and testing – indeed, give credit to the role of triangulated approaches to modelling, testing, theory construction, and paradigm 'drift' (a progressive, iterative movement between paradigms).

Whilst it is common for techniques themselves to be regarded as being 'value free', the selection of techniques to be used is 'value laden', due to indexicality (e.g. Clegg 1992) and associated factors. However, techniques are devised and developed by researchers and so, encapsulate the values of those involved in formulating the techniques – leading to debate over the merits of alternative techniques and their applications. Such potential for biases continues throughout the modelling process and, indeed, may be made explicit – as in adopting a particular theoretical position to build an economic model.

Orton (1997: 421) expresses the philosophical question underpinning the positivism – interpretivism debate as '… whether theories are discovered, implying the existence of an objective world, or generated, implying the existence of a socially constructed world'. Thus, Pettigrew (1997: 339) observes that 'Scholars are not just scientists, they remain obstinately human beings and as such are carriers of assumptions, values and frames of reference which guide what they are capable of seeing and not seeing'.

Thus, '…the interpretive paradigm would reject determinism and universal rules….Its anti-positivist epistemology would not be concerned with whether samples are representative of wider populations, but with validity in the sense of findings' being representative interpretations of the world of the research subjects…' (Williamson 2002: 1381).

1.3.6 Pragmatism

Pragmatism is concerned with what works or what is useful; as such, it purports to deal with facts and it is the results of the research that determine its importance. Hence, pragmatists focus on the real world's problems and questions and seek results that can be applied (Kelemen and Rumens 2008). Therefore, truth is constituted by theory and knowledge that facilitate successful action (i.e. provide positive outcomes in solving problems).

Pragmatism adopts a pluralistic perspective for both conducting research and understanding the world. Pragmatists may adopt aspects of both positivism and interpretivism as well as a wide variety of methods for carrying out investigations. The underpinning driver is what works to address the problem and, thereby, provide a practical solution.

1.3.7 Models and hypotheses

A primary use of theory is to facilitate prediction. Instances where theories fail to predict correctly are anomalies. However, if a number of serious anomalies occur, the theory is likely to be rejected in favour of an alternative which is more appropriate: one which explains all the occurrences more accurately. That leads to theories which may be modified by auxiliary statements. Eventually, the theory may be rejected in favour of another theory of wider, accurate predictive ability. During the period of modifications and potential substitutions of theories, the 'competing' theories may be the subject of much debate in which advantages and disadvantages of each are considered to yield hierarchies of the theories continuously.

Another great value of theories is to enable researchers to produce models which show how the variables of a theory are hypothesised to interact in a particular situation. Such modelling is very useful in clarifying research ideas, contents, context(s), and limitations and so, to give insights into what should be investigated and tested. For such purposes, it is helpful for a researcher to be both inquisitive and open-minded, but critical and sceptical – and so, not to accept things at face value but require valid and reliable evidence from authoritative sources (not social media!). Thus, a fundamental task of research is to interrogate all the evidence discovered (both for and against existing beliefs and knowledge as well as in respect of any propositions and hypotheses) and, only then, to arrive at an informed judgement/conclusion – as illustrated in Fig. 1.5, which models the interrogative cycle.

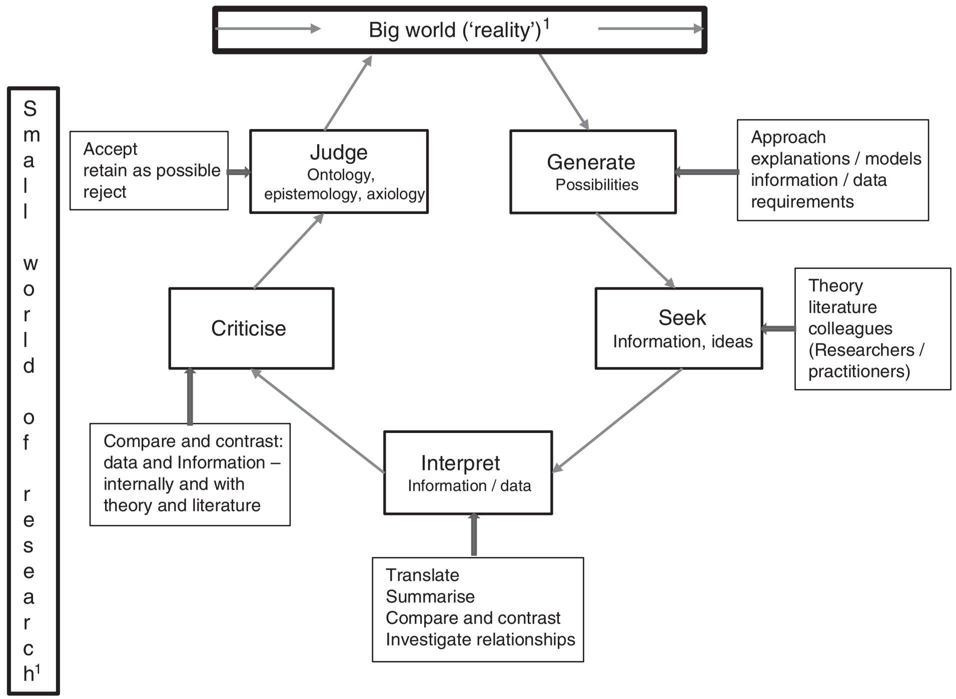

Figure 1.5 The interrogative cycle. *Note*: The cycle applies to the overall research process and to the constituent stages of research.[1] (Kay and King 2020) The 'reality' of the big world includes many problems of the mystery ('wicked') type; the subset, small world of research transposes and, then, usually, addresses such problems but as simplified, 'puzzle' ('tame') type problems (*Source*: Modified from Wild and Pfannkuch (1999)).

1.4 Research styles

In determining what is the most appropriate approach (methodology and method(s)) to adopt – the research design – the critical consideration is the logic that links the data collection and analysis to yield results, and, thence, conclusions, to the main research topic or question being investigated. The purpose is to ensure that the research maximises the chance of realising its objectives. Therefore, the research design must take into account the research topic/questions, determine what data are required, and how the data are to be collected and analysed.

Bell (1993) suggests styles of research to be Action, Ethnographic, Surveys, Case Study, and Experimental. Yin (1994) considers that there are five common research strategies in the social sciences: *surveys, experiments* (including quasi-experiments), *archival analysis*, *histories*, and *case studies*. Unfortunately, definitions of such styles vary and so, at best, the boundaries between the styles are not well defined. Clearly, the styles are, essentially, taxonomies of the array of methods used to execute research.

Each style may be used for explanatory or descriptive research. Yin (1994) suggests that determination of the most appropriate style to adopt depends on the type of research operation (what, how, why, etc.), the degree of control that the researcher can exercise over the variables involved, and whether the focus of the research is on past or current events (future events concern predictions/forecasts – which are not research but may be derived from research). Requirements of the major research styles are set out in Table 1.1.

1.4.1 Action research

Generally, action research involves active participation by the researcher in the process under study, in order to identify, promote, and evaluate problems and potential solutions. Inasmuch as action research is designed to suggest and test solutions to particular problems, it falls within the applied research category, whilst the process of detecting the problems and alternative courses of action may lie within the category of basic research. The consideration of quantitative vs. qualitative categories may be equally useful.

Table 1.1 Requirements of different research styles/strategies.

Style/strategy	Research Questions	Control over Independent Variables	Focus on Events
Survey	Who, what, where, how many, how much?	Not required	Contemporary
Experiment/Quasi-experiment	How, why?	Required	Contemporary
Archival analysis	Who, what, where, how many, how much?	Not required	Contemporary/past
History	How, why?	Not required	Past
Case Study	How, why?	Not required	Contemporary

Source: Yin (1994).

Action research (Lewin 1946) is where the research(er) actively and intentionally endeavours to effect a change in a (social) system. Knowledge is used to effect the change which, then, creates knowledge about the process of change and of the consequences of change (as well as of the change itself).

In programmes of action research, the usual cycle of scientific research (problem definition – design – hypothesis – experiment – data collection – analysis – interpretation) is modified slightly, by the purpose of the action rather than by theoretical bases, to become 'research question – diagnosis – plan – intervention – evaluation', the 'regulative cycle' proposed by van Strien (1975) (in Drenth *et al*. 1998).

Liu (1997) notes that action research is a shared process different from a hypothetical–deductive type of research. Thus, it is necessarily highly context dependent and so, is neither standardised nor permanent as it is reliant on the project/process and the knowledge and subjectivity/perceptions of the persons involved; indeed, action research, often, is regarded as co-produced by the participants and the researcher (Sexton and Lu 2009). Action research is operationalised to address a problem or issue which has been subject to structuring from the use of theory and literature.

The process of action research includes problem formation, action hypotheses, implementation, interpretation, and diagnostic cycles (Guffond and Leconte 1995).

Action research is complex; the observer (who should provide a systematic perspective, relatively objectively) is involved and has the main role of creating a field for discussion and interpretation of the process and products. As change/innovation is the subject matter of the research (and the subject matter and the research processes continue in parallel), coordination and evaluation mechanisms are necessary which involve both the researcher and the participants.

In consequence of the nature and objectives of action research, Henry (2000: 669) asserts that three primary requirements exist:

(1) 'A trust-based relationship … built up beforehand … accepted by all parties …
(2) The researchers will have fully accepted the firm's or institution's objectives for innovation or change by having negotiated the extent to which they will be involved and their freedom as regards access to information and interpretation.
(3) A research and innovation project will be jointly drawn up, which must be open ended with regard to the problems to be explored, but very precise in terms of methodology … '

1.4.2 Ethnographic research

The ethnographic ([scientific] study of races and cultures) approach demands less active 'intrusion' by the researcher and has its roots in anthropology. The researcher becomes part of the group under study and observes subjects' behaviours (participant observation), statements, etc. to gain insights into what, how, and why their patterns of behaviour occur. That dual role of researcher–participant necessitates very extensive and detailed recording of events and activities from as many perspectives as possible – including the contrasting roles of researcher and participant, and observations of potential bases of theory. Determination of cultural factors, such as value structures and beliefs, may result, but the degree of influence caused by the presence of the researcher, and the existence of the research project, will be extremely difficult (if not impossible) to determine.

The empirical element of ethnography requires an initial period of questioning and discussion between the researcher and the respondents to facilitate the researchers' gaining understanding of the perspectives of the respondents. Such interaction involves the 'hermeneutic circle' of initial questioning and transformation as a result of that interaction, all of which is embedded in the subject tradition (paradigm) of the researcher. Thus, 'Any interpretive act is influenced, consciously or not, by the tradition to which the researcher belongs' (Baszanger and Dodier 1997: 12).

A further consideration is how the researcher integrates the empirical data, etc. into a holistic perspective. The researcher's expertise and experience of field investigations represents a crucial moment in his/her education, prior to which he may have accumulated dissociated knowledge that might never integrate into a holistic experience; only after this moment will this knowledge 'take definitive form and suddenly acquire a meaning that it previously lacked' (Levi-Strauss 1974, quoted in Baszanger and Dodier 1997: 12).

Complementarily, a sociological or political perspective recognises that the investigator is part of the group being studied and so, is a viable member of the group and a participant in the group behaviour as well as being the observer – more akin to the action research approach.

Thus, the approach focuses attention on determining meanings and the mechanisms through which the members of the group make the world meaningful to themselves and to others. Such integration prompts the perspective that ethnographic research is co-produced by the ethnographer (researcher) and the other participants, as well as emphasising the impact of context; hence, the way in which ethnography should be considered is, somewhat, different from other research (see, e.g. Rooke and Rooke 2012).

1.4.3 Surveys

Surveys operate on the basis of statistical sampling; only extremely rarely are full population surveys possible, practical, or desirable. The principles of statistical sampling – to secure a representative sample – are employed for economy and speed. On occasions, it may not be possible, or practical, to adopt statistical sampling methods; in such instances, the non-statistical sampling method adopted (e.g. convenience sampling) should be explained and justified in the context of the research.

Commonly, samples are surveyed through questionnaires or interviews. Surveys vary from highly structured questionnaires to unstructured interviews. Irrespective of the form adopted, the subject matter of the study must be introduced to the respondents. For a given sample size of responses required, particular consideration must be given to the response rate (i.e. the percentage of subjects who respond), the number of responses obtained, and the number of responses obtained which are not usable for the analysis. Following determination of the (usable) sample size required, appropriate procedures must be followed to assist in securing the matching of responses to the sample selected. This is a special consideration for 'stratified' samples; samples classified into categories, usually by proportion of the total population under investigation or measured degrees of another important, continuous attribute.

Thus, for any survey, the starting place is scrutiny of the population – notably, its size and structure. If the population is structured significantly (relating to the purpose of the research), the size of each category of the population should be determined. For theory-oriented research, Steers and Sanchez-Runde (2002) advocate strategic sampling (driven by the requirements of testing the theory, acknowledging its content and derivation, in the empirical context – i.e. theory-based sampling) rather than convenience sampling. A rather extreme instance of the latter approach is to choose a theory that 'matches' the sample (conveniently) available (i.e. sampling-based theory – which is likely to have very low external validity/generalisability).

Following determination of any such sampling frame, features of the total population and its categories, if any, must be examined to facilitate determination of the method of sampling (how the sample will be determined) and the size of the sample and of each subsample of the frame.

As the purpose is to secure a set of data for analysis such that the results of the analysis are reliable and valid indicators regarding (any categories and) the total population, that quantification should begin with determination of the requisite data set (the usable sample). Then, the quantification proceeds (backwards) from the usable sample required, via the likely sample to be obtained, to arrive at the size of each sample to be sought.

A further, fundamental consideration for surveys, which should be addressed from the outset, is the scale(s) of measurement to be used in collecting data – to ensure that the data can be collected readily from the providers, that it will be suitable for the analytic techniques that will be used, and that the results will be appropriate to the purpose of the research.

1.4.4 Case studies

Case studies encourage in-depth investigation of particular instances within the research subject. The nature of the in-depth data collection may limit the number of studies when research is subject to resource constraints. Cases may be selected on the basis of their being representative – with similar requirements/conditions to those used in statistical sampling to achieve a representative sample, to demonstrate particular facets of the topic, or to show the spectrum of alternatives. (See also the detailed classification in Yin (1994).) Case study research may combine a variety of data collection methods, with the vehicle or medium of study being the particular case, manifestation or instance of the subject matter – such as a claim, a project, a batch of concrete.

Commonly, case studies employ interviews of key 'actors' (key informants) in the subject of study; such interview data may be coupled with documentary (archival) data (such as in a study of a production process). Alternatively, a case study may be 'situational', such as a wage negotiation or determining safety policy, and for such research, several 'cases' may be studied by individual or combined methods of ethnography, action research, interviews, scrutiny of documentation, etc. Hence, case studies constitute a distinct 'style' of research.

Case studies operate through theoretical generalisation, as for experiments, rather than empirical/statistical generalisation (as is the approach via surveys, which employ samples designed to be representative of the population such that results, and findings, from researching the sample can be inferred back to the population with a calculated level of confidence).

Flyvbjerg (2006: 242) reiterates the assertion of Kuhn (1996) regarding the importance of case studies in that ' … a discipline without a large number of thoroughly executed case studies is a discipline without systematic production of exemplars, and that a discipline without exemplars is an ineffective one'.

1.4.5 Experiments

The experimental style of research is, perhaps, suited best to 'bounded' problems or issues in which the variables involved are known, or, at least, hypothesised with some confidence. The main stages in experimental design are shown in Fig. 1.6. Usually, experiments are carried out in laboratories to test relationships between identified variables; ideally, by holding all except one of the independent variables constant and examining the effect on the dependent variable of changing that one independent variable. Examples include testing the validity of Boyle's Law, Hooke's Law, and causes of rust experiments. However, in many cases, notably in social sciences and related subject fields, experiments are not conducted in specially built laboratories but in a dynamic social, industrial, economic, political arena. An example is Elton Mayo's 'Hawthorne Experiments' which took place in a 'live' electrical manufacturing company (Mayo 1949). Such instances are 'quasi-experiments' as the ability to control variables (independent and environmental) is limited and, often, coupled with measurement problems which impact accuracy.

Thus, to regard a particular (geographical) area, even if tightly bounded (e.g. Isle of Man; Hong Kong), as a 'laboratory' in which studies of construction activities, real estate, or town planning can be undertaken is quite false and likely to lead to erroneous results and conclusions. The best that can be achieved in such a context is a quasi-experiment, not a laboratory experiment, as it is impossible to hold independent (environmental) variables constant, even for a very short time. That is a very important concern for all research relating to construction projects and processes, facility management, property development, etc. and so, should be noted as an important 'limitation' of the research.

Example

Consider investigating client satisfaction with the provision of a construction project. What quantitative and what qualitative data are likely to be available readily on a case study of a construction project?

Quantitative data would comprise time and cost performance derived from project records – predicted vs. actual; quality might be considered from records of reworked items, corrections required due to defects recorded during the maintenance period – measured by number, value, etc.

(continued)

Experimental design	
Aim	To test a theory, hypothesis or claim.
Objectives	Determine what is to be tested and what limits the scope of the experiment.
Identify variables	Determine the variables likely to be involved and their probable relationship – from theory and literature.
Hypothesis	State the hypothesis which is to be tested by the experiment (see Chapter 5).
Design the experiment	Decide what is to be measured and how those measurements will be made and consider confidence intervals for the results and practical aspects – time and costs of the tests.
Conduct the experiments	Maintain constant and known conditions for validity and consistency of results. Collect data accurately.
Data analysis	Use appropriate techniques to analyse the results of the experiment to test the hypothesis (etc.).
Discuss	Consider the results in the context of the likely impact of experimental conditions and procedures as well as theory and literature-derived knowledge.
Conclude	Use the results of the analyses and the known experimental technique(s) and conditions, via statistical inference etc. and in the light of other knowledge to draw conclusions about the sample and population.
Note limitations	Note the limitations (restrictions/constraints) which apply to the conclusions' applicability due to objectives, theoretical base, methodology, methods, etc.
Further research	Note further work which is advisable to test the hypothesis (etc.) more thoroughly.

Figure 1.6 Experimental design.

(continued)

Qualitative data could present participants' perceptions of client satisfaction with respect to the performance criteria of cost, time, and quality. Such data would be obtained through questioning of those participants, identification of the variables and hypothesising of their interrelations. Research could proceed by endeavouring to hold all but one of the independent variables constant and examining the effects of controlled changes in the remaining independent variable on the dependent variable.

In certain contexts, such as medical research, the sample under study may be divided into an experimental group and a control group. After the experimental period, the results from the groups may be compared to determine any differences between the groups' results which can be attributed to the experiment. In such cases, the members of the groups must not know to which group they belong; it is helpful also (to avoid possible bias in analysis), if those who carry out the analysis of results are not informed of which person is in each group either.

Hence, experimentation is aimed at facilitating conclusions between cause and effect – the presence, extent etc. Experimentation is at the base of scientific, quantitative method.

1.5 Quantitative and qualitative approaches

It is quite common for small research projects to be carried out with insufficient regard to the array of approaches which may be adopted. This may be because the appropriate approach is obvious, or that resource constraints preclude evaluation of all viable alternatives, or it may be due to a lack of awareness of the alternatives. Such lack of awareness does not mean that the research cannot be executed well, but, often, it does mean that the work could have been done more easily and/or could have achieved more.

Usually, research methods and styles are not mutually exclusive, although only one, or a small number of them will, normally, be adopted due to resource constraints on the work. The different approaches focus on collection and analysis of data rather than examination of theory and literature. The methods of collecting data impact upon the analyses which may be executed and, hence, the results, conclusions, usefulness, validity, and reliability of the study.

'A measure is valid when the differences in observed scores reflect the true differences in the characteristic one is attempting to measure and nothing else … ' (Churchill 1979: 65); in practice, it is inevitable that there will be some error in that the observed measure is the aggregate of the true measure, systematic error (bias) and non-systematic (random) error; aggregation of those errors may be additive or multiplicative, depending on the model adopted. 'A measure is reliable to the extent that independent but comparable measures of the same trait or construct of a given object agree' (*ibid*).

However, Flyvbjerg (2006) notes that the (often hot) debate over sharp separation of quantitative and qualitative research methods is spurious. Thus, ' … good social science is opposed to an either/or and stands for a both/and on the question of qualitative versus quantitative methods. Good social science is problem driven and not methodology driven in the sense that it employs those methods that for a given problematic, best help answer the research questions at hand' (*ibid*: 242).

1.5.1 Quantitative approaches

Quantitative approaches tend to relate to positivism and seek to gather factual data, to study relationships between facts and how such facts and relationships accord with theories and the findings of any research executed previously (literature). Scientific techniques are used to obtain measurements – quantified data. Analyses of the data yield quantified results and conclusions derived from evaluation of the results in the light of the theory and literature.

It is essential to ensure that the subject matter of investigation is both comprehended well by the researcher and is defined precisely as, otherwise, the variables cannot be measured (reasonably) accurately and so, compromise the analyses and findings. Edmondson and McManus (2007: 1171) note that ' … it is difficult to create measures of acceptable external validity or reliability when phenomena are poorly understood'. Further, they caution that quantitative approaches may restrict the scope and potential of investigations, 'Quantitative measures indicate a priori theoretical commitments that partially close down options, inhibiting the process of exploring new territory (Van Maanen 1988)' (*ibid*).

1.5.2 Qualitative approaches

Qualitative approaches seek to gain insights and to understand people's perceptions of 'the world' – whether as individuals or groups. In qualitative research, the beliefs, understandings, opinions, views, etc. of people are investigated – the data gathered may be unstructured, at least in their 'raw' form, but will tend to be detailed, and hence 'rich' in content and scope. Consequently, the objectivity of qualitative data often is questioned, especially by people with a background in the scientific, quantitative, positivist tradition. Analyses of such data tend to be considerably more difficult than with quantitative data, often requiring a lot of filtering, sorting and other 'manipulations' to make them suitable for analytic techniques.

Analytic techniques for qualitative data may be highly laborious, involving transcribing interviews, etc. and analysing the content of conversations. Clearly, a variety of external, environmental variables are likely to impact the data and results and the researchers are likely to be intimately involved in all stages of the work in a more active way than, usually, is acceptable in quantitative studies.

1.5.3 Triangulated studies

Both qualitative and quantitative approaches may adopt common research styles – it is the nature and objectives of the work, together with the nature of the data collected and analytic techniques employed, which determine whether the study may be classified as qualitative or quantitative. Given the opportunity, of course, triangulated studies may be undertaken. Triangulated studies are either multi-method or mixed-method research. As triangulated studies employ two or more research techniques, either or a combination of qualitative and quantitative approaches may be employed to reduce or eliminate disadvantages of each individual approach while gaining the advantages of each, and of the combination – a multidimensional view of the subject, gained through synergy. Thus, triangulation may be used for entire studies (such as by investigating a topic from several, alternative paradigms or/and research methodologies) or for individual part(s) of a study (such as collecting quality performance data from archival records of defects, questionnaires administered to project participants, and results of participant observation). Jick (1979) notes that between-methodology triangulation seeks to enhance a study's external validity whilst within-methodology triangulation seeks to enhance internal validity and reliability.

Triangulation may occur in four main ways – data (sources, types), investigator (more than one researcher – student and supervisor, primary investigator, and co-investigator(s)), theoretical, and methodological/methods (for data collection and data analysis). Thus, triangulation principles are applied quite widely and are also termed 'mixed method' studies or 'multimethodology'.

Whatever approach, style or category of research is adopted, it is important that the validity and applicability of results and conclusions are appreciated and understood. In particular, it is useful to be demonstrably aware of the limitations of the research and of the results and conclusions drawn from it. Such limitations are occasioned by various facets of the work – sampling, methods of collecting data, techniques of analysis – as well as the, perhaps more obvious, restrictions of time, money, and other constraints imposed by the resources available. Hence, it is very helpful to consider the constraints and methods at an early stage in the work to ensure that the best use is made of what is available. Indeed, it may well be preferable to carry out a reduced scope study thoroughly than a larger study superficially – both of those approaches have validity but achieve different things.

Thus, whilst triangulation employs plural methods, 'bridging' involves linking two or more analytic formats (research methods) to make them more mutually informative, while maintaining the distinct contributions and integrity of each independent approach/discipline. Therefore, 'bridging' uses plural methods to link aspects of different perspectives.

1.5.4 Data sources

As with any project, the planning phase is crucial and it is wise to evaluate what is being sought and the alternative approaches available as early as possible. Of course, re-evaluations may be necessary during the course of the work, in instances such as where the data required prove to be unavailable. As data are essential to research, it is useful to consider what data are required, and alternative sources and mechanisms for collection, during the planning phase. Use of surrogate data (indirect measures of what is sought) may have to be used, especially where the topic of study is a sensitive one (e.g. cost, safety, pricing, corruption, labour relations).

Where researchers have good contacts with potential providers of data, use of those sources is likely to ease the data collection process. If trust and confidence have been established, it is likely to be easier to obtain data and it may be possible to obtain data which might not be available otherwise. Trust and confidence are important considerations in data collection – the more sensitive the data, the more trust in the researcher which is required by the provider. Such trust and confidence relate to the use, disclosure, storage security, and disposal of the data, including issues of confidentiality and anonymity. These are important applications of research ethics – see Chapter 8.

Especially for obscure and complex processes, and sensitive/historical subjects, finding sources of data/respondents may be difficult. However, once an initial source has been found it may be possible to find others (progressively) by information from that initial source (from a paper or book as well as a person). The 'snowball' approach concerns the progressive discovery and investigation of different sources for a particular event (the initial sources providing further sources) whilst the tracer approach moves between sources relating to the development/operation of a process.

In undertaking research in construction management, Cherns and Bryant (1984: 180) note that, 'A basis must exist between the researchers and the [respondent] system for negotiating a relationship which has something to offer to the [respondent] as well as to the researchers'.

'Access must provide for deep and continued penetration into the [respondent] system at the earliest possible stage of the [building] project, preferably before the decision to [proceed]' ([..] added; *ibid*).

Often, it is essential to ensure that the providers of data cannot be traced from the output of the research. Statements ensuring anonymity are helpful as are methods which demonstrate anonymity in the data collection, such as not requiring names and addresses of respondents. However, anonymity must work. It is hardly providing anonymity if one identifies respondents as A,B … N rigorously in the research report but thanks respondents by name in the acknowledgements section.

Confidentiality is a similar, ethical issue to anonymity: anonymity refers to persons and organisations whilst confidentiality relates to the data also. The two issues are closely related such that confidentiality concerns neither revealing persons' or organisations' identities or data to anyone nor using the data for purposes other than those for which the respondents have given permission. Both confidentiality and anonymity are very important components of research ethics, the moral underpinnings of which dictate that the *express, informed consent of the respondents must be obtained and adhered to rigorously*.

Occasionally, respondents wish to scrutinise a report prior to its 'publication'. Whilst such provision is useful in building confidence over data provision and confidentiality and may assist in ensuring accuracy of data, etc., it may be regarded as an opportunity for the respondents to comment on the research, and, possibly, to demand changes – perhaps, to remove portions with which they disagree or which they dislike. Such changes should be resisted, provided the research has been conducted properly (accuracy of data and results, compliance with anonymity and confidentiality, etc.), as they would distort the research report and, thereby, devalue the work.

For applied research, it is increasingly popular to form a *steering group* of the principal investigators, industrialists, and practitioners. The steering group helps to form the strategy for the execution of the work and to monitor and guide the research during its execution. The objective is to ensure the combination of rigorous research with practical relevance. Of course, there are spin-off benefits of the researcher's enjoying easier access to data via the practitioners, and the practitioners' gaining knowledge and insight of issues/problems which are important to them.

1.6 Where to begin

Research methodology refers to the principles and procedures of logical thought processes which are applied to a scientific investigation; a system of methods coherent with and supported by appropriate, and, preferably, express philosophical aspects – ontology, epistemology, and axiology. *Methods* concern the techniques which are available (for data collection, analysis, etc.) and those which are actually employed in a research project. Any management of a research project must address certain questions in making decisions over its execution. The questions involved are:

- What?
- Why?
- Where?
- When?
- How?
- Whom?
- How much?

It is these questions which the study of this book will assist in answering or, rather, provide some information to help to reach an answer. By addressing the issues explicitly and logically, noting requirements, constraints, and *assumptions*, the progress through research projects will smooth and ease progressively as expertise and experience develop.

Often, a researcher is able to select a supervisor or supervisors. In selecting a supervisor, three considerations apply – that person's experience and expertise in the subject matter/topic, research experience and expertise and, perhaps the most important factor differentiating potential supervisors, the ability to relate to and communicate well with the researcher. The best research tends to be executed by people who get on well together as well as possessing complementary skills and expertise.

It is important to determine the scope of the work at the outset; the most common problem is for a researcher to greatly overestimate what is required of the work, what can be achieved and the amount of work that can be done. It is a good idea to consult an experienced supervisor or 'third party' to ensure that the programme and scope of the research intended is *realistic*.

What? Concerns selection of the topic to be researched with consideration of the level of detail. It is useful to note the resources available and constraints so that an appropriate scope of study can be determined.

Why? May command a variety of answers, each of which applies individually but some of which may apply in combination. So, 'required for a degree', 'required by employer', 'interest', 'career development', and, possibly, many other reasons, may be advanced to say why research is being undertaken. However, why a particular research project is being carried out or proposed, apart from the reasons given already, may be due to its being topical or because the researcher has expertise in that subject and wishes to use that expertise to acquire and advance knowledge in that field.

Where? Obviously, all research occurs somewhere – the host institution may be a university, as well as the various places at which individual research activities occur – libraries, data collection points, visits to experts, etc. It may be useful to consider the amount of travel, both cost and time, as an input to the strategy for executing the research.

When? The timing of the research and time available to carry it out, usually, will be specified. It will be necessary to produce a timetable for the work by dividing the time available between the component activities. Often, there will be restrictions on the time for data collection – allow for holiday periods, very busy periods, etc.; what sequences of activities are necessary and what are the alternatives? To what extent can the activities overlap? A common problem is to devote insufficient time to planning the work and to the scholarship stage (searching theory and literature) and to forget, or, at least, to underestimate, the time necessary for data analyses, production of results and conclusions, and for preparation of the report. All too often, the only real focus is on fieldwork (data collection) – such enthusiasm is healthy but must be kept under control.

How? It is the issue of methodology and of methods. In some instances, the methodology is obvious – virtually 'given' – as in computational fluid dynamics. Commonly, a topic may be investigated in a variety of ways, individually or in combinations, so a choice must be made. The choice will be influenced by the purpose of the research, the subject paradigm, the expertise and experience of the researcher and supervisor (if any), as well as practical considerations of resource and data availabilities.

Whom? Four main groups of people are involved in the execution of research – the researcher, the supervisor, the respondent personnel – who provide the data or access to it, and others who can help – such as laboratory technical staff. Naturally, a research project is 'commissioned' by someone – for instance, a university, as a requirement of a course of study, an academic agency such as a research council or a commercial agency, perhaps a government body, company consultant practice, etc.

How much? This issue concerns the resources which can be used. Many resources, such as money, are fixed but people's time tends to be rather flexible – especially the time input by researchers themselves. No research project is really completed from the researcher's point of view as there is always a bit more which could or ought to be done. Hence, each report contains a list of recommendations for further research.

1.7 Summary

This chapter introduced the main concepts of research – a rigorous search, learning, and contributing to knowledge – to provide a firm basis for producing a good research proposal and for undertaking research successfully. A definition of research was provided and the variety of contexts of undertaking research were discussed so that appropriate and informed selections of subject, methodology, and method(s) may be made, acknowledging the potential effects of contextual variables. Different approaches (classifications) to research were examined – notably, pure and applied; and qualitative and quantitative – together with their combination through 'triangulation', and the different types of problem (research question) to be addressed. The concepts of theories and paradigms were introduced as fundamental bases for executing a research project with discussion of how they develop and evolve through progressive testing according to scientific methods in which refutation is an important concern. Paradigms constitute perspectives on research – 'lenses' through which research is viewed – and so, indicate theoretical frameworks, issues for investigation, and appropriate methodologies and methods. Main forms of reasoning – deductive, inductive, and abductive – were introduced. Positivism and interpretivism were explained and contrasted. Styles of study were considered – including action research, ethnographic research, surveys, case studies, and experiments – and questions which research projects address were discussed. Issues relating to data collection were introduced. The ethical issues of confidentiality and anonymity were considered and the essential need for objectivity was emphasised. The chapter ended with discussion of practical issues of how to progress a research project by addressing a progressive series of questions to guide development of a project/proposal.

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2

Topic for Study

The objectives of this chapter are to examine the processes of the following:

- *selecting a topic*
- *writing a research proposal*.

2.1 Selection of a topic

Very often, the most difficult task for any researcher is to select a topic for study and, then, to refine that topic to produce a proposal which is viable. Generally, people set targets which are far too high in terms of both the extent of the research which is possible and the discoveries which are sought. It is surprising for most new researchers how little (in scope) can be achieved by a research project and, hence, the necessity to restrict the study so that adequate depth and rigour of investigation of the topic can be undertaken.

2.1.1 Resources

An important aspect to evaluate is the quantities of resources which can be devoted to the study. Often, it is helpful to calculate the number of person-hours, days, weeks, months, or years, which are available for the research. Given a fixed amount of time and the period within which the research must be completed, and taking account of any flexibilities, the amount of work which can be undertaken begins to be apparent. Usually, a report of the work is required, and that report must be produced within the time frame, so the period required to produce the report reduces the time available for executing the study itself.

Many people consider that undertaking a research project is 2% inspiration and 98% perspiration – clearly, research is *not an easy option*. Research is hard work, but it

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is often the most rewarding form of study. The satisfaction and sense of achievement derived from a project completed well can be enormous; the efforts are well worthwhile and provide the researchers with expertise, experience, and insights for future work. Especially in the early days of a project, enthusiasm is a great asset – it is a major contributor to overcoming difficulties which will, almost inevitably, arise. Determination is valuable for a researcher as it will help to ensure that the project is seen through to completion.

Even in cases where a topic is given – such as where a researcher applies for a post to carry out a particular project advertised – there is some selection of the topic details by the prospective researcher. Generally, where a research project is part of a course of study, the choice of topic to research is made by the individual *but* that choice should not be made in isolation. Potential tutors, supervisors, and mentors should be consulted, together with colleagues and, if possible, practitioners, to assist in selecting a topic which is interesting, viable, and appropriate to the context and the people concerned – most especially the *researcher*. The amount of time and effort spent in selecting and refining a topic and then planning to yield a proposal may appear very long, if not excessive. Invariably, it will be time well spent. Such formative stages are of paramount importance and, often, will be the main factor determining whether the research is a success.

For research projects, as for construction projects, planning project execution at the early stages ('front end') is vital to ensure that resource constraints are accommodated. In the management of projects, Morris is notable for recognising the importance of work at the front end (e.g. Morris and Hough 1987; Morris 1989, 1998, 2011, 2013; Morris and Jamieson 2004). During those stages, ambiguities are greatest and are interpreted so that decisions and actions are taken regarding both *product* and *process*. '… in the early stages of a project things are typically complex, intangible and uncertain … Front-end management entails work on a truly wide range of subjects … all of which need to be planned, … and organised appropriately' (Morris 2011: 6). The importance of the initial stages of projects is supported in complexity theory which recognises that the initial conditions of a complex process (a process comprising many interdependent components – such as a research project or a construction project), largely, determine that project's developmental trajectory (see e.g. Fellows and Liu 2010, 2013).

Some academics believe that the Pareto distribution applies to research study. A Pareto distribution is the '80–20 rule' (Fig. 2.1); a small proportion of components have the major effect on the outcome. Applied to a construction project, about 20% of the components account for about 80% of the project cost. The Pareto distribution is believed to apply far and wide; it applies to programmes of study in that 80% of the work is completed (or becomes visible) in the last 20% of the time available – this is partly due to preparatory work being carried out in the early part of the study and so, not being accessible, but also because certain people do not do the work until the deadline looms, due to other pressures or lack of programming. Requesting an extension of time may not be viewed favourably; indeed, if such a Pareto distribution does apply, it may be preferable not to grant an extension.