A PROPOSITION FOR A CONSTRUCTION RESEARCH TAXONOMY

John Kelly

School of the Built and Natural Environment, Glasgow Caledonian University, Glasgow, G4 OBA, UK.

Texts aimed at construction research students at all levels describe the organisation and undertaking of research work. These generally include a descriptive discussion of the works of such philosophers as Aristotle, Kant and Popper and relate this to theory building, theoretical frameworks, paradigms, etc. Reference is made to hypothetico-deductive methods, action research and grounded theory together with debates on the relative merits of positivist or constructivist approaches to construction related research. The aim of this paper is to review the construction research methods literature and present a taxonomy aimed at the classification of all construction research. In this description the paper will present a methodology for the derivation of research questions from literature through structured synthesis involving interrelationship between issues. The paper will also propose a four level classification structure comprising conceptual framework, theoretical framework, technical framework and technical analysis. This classification is illustrated with a construction research focused practical example.

Keywords: Research methods.

INTRODUCTION

This paper introduces two approaches to research development. The first postpones the development of the hypothesis or formalising research questions until after the completion of all inductive research, commonly represented at undergraduate and masters level in a literature review. The second approach proposes a research taxonomy founded on four levels of theory as illustrated in the Jaykay research methods strategy diagram. This diagram highlights the importance of both inductive and deductive research and the development of new theory.

Jack, a fictional student, is introduced as a medium for a critical review of the traditional approach to research dissertations at undergraduate and masters level.

JACK’S DISSERTATION

Jack is a student of construction management who observed, during his time in industry, inefficiency in the working of the construction design team. Jack has informed his dissertation supervisor that he wishes to pursue a research dissertation on the topic of improving the performance of construction design teams. Following discussion and some reading of the technical press Jack develops an initial working hypothesis of “design team performance can be improved through the adoption of project intranets”.

Jack’s approach to the stage of formulating the hypothesis is appropriate; he is interested in the topic, has identified the research question, has checked the feasibility of doing the topic with his supervisor, has a clear aim and has formulated a
hypothesis. The approach is largely consistent with the advice contained in texts focused on the preparation of a research dissertation. (Fellows and Liu, 1997; Naoum, 1998; Swetnam, 2000; White, 2000). For the purposes of reference these four texts will be referred to as the “dissertation texts”.

Jack is advised by his supervisor to carry out initial research by focusing his attention on literature. The objective of undertaking a literature review (Fellows and Lui, 1997) is to ensure that the intended research has not previously been carried out and to validate the hypothesis. Jack reads a significant amount of literature on project intranets in computer science journals and one key recent textbook in which he finds a high degree of correlation. He is confident of the major issues and considers that the time is right to investigate whether construction design teams find intranets an acceptable method of improving efficiency. Jack’s approach to the literature review is consistent with the advice given in the dissertation texts.

Consistent with the dissertation texts Jack must decide whether to follow a quantitative or a qualitative research route. Reviewing the major issues from literature Jack’s supervisor suggests a qualitative route, turning the characteristics into statements for a Likert study. The risky part of the research is complete and from this point onwards can be regarded as a technical exercise in data collection and processing. The results and conclusions will of course require reflection.

ANALYSIS OF THE RESEARCH PROBLEM

The nature of the research problem and its solution has been debated since the time of Aristotle, particularly whether the researcher chooses a research method based on the approach to the problem or whether the identification of the problem demands a consequent research approach. The terms; phenomenology, inductive, deductive, positivist, constructivist, structuralism, metaphysics and ontology, are described as a prelude to a discussion of the approach to the research problem.

- Phenomenology is the observation or description of any event that can be explained in precise terms. Complex phenomenon will require breaking down into its component parts until it can be precisely defined. Audi (1995 p664) describes phenomenology as “….a clearly delineated body of doctrines whose essential characteristics can be expressed as a set of well chosen statements.”

- Inductive research is the formulation of a generalisation from a number of observations or instances.

- Deduction is defined as a series of logical statements where the last is the conclusion of the sequence. Each statement in the sequence must be an axiom (in this context an established principle or fact) and the final sentence is a theorem or logical deduction. The inductive-deductive cycle is illustrated in Figure 1.

- Positivism is the situation in which the researcher stands apart from the research problem facilitating its solution through the use of established objective measures uninfluenced by the researcher. Nothing is inferred. Easterby-Smith, Thorpe and Lowe (2002, p28) state that the researcher must be truly independent of what is being observed, and the choice of what to study and how to study is determined by criteria rather than by human beliefs and interests. The French philosopher August Comte is quoted, "all good
intellects have repeated, since Bacon's time, that there can be no real knowledge but that which is based on observed facts".

![Induction/Deduction cycle](image)

**Figure 1 – Induction/Deduction cycle**

- Structuralism proposes a "scientific" model of language comprised of a closed system of words, sounds, drawings, etc and rules which attempt to precisely represent fact by negating ambiguity (Audi, 1995). The concept of structuralism is not widely debated in research methods texts and for the purposes of this paper can be seen to be analogous to positivism.

- Social constructivism also called social constructionism assumes (Audi, 1995 p855) the world and our knowledge of it is interpreted through social practices and institutions. Therefore research results will necessarily be filtered by their relevance within a particular social context i.e. it is not just a matter of measuring but also understanding the constructs that people place on their experience of the subject under interrogation. Easterby-Smith, Thorpe and Lowe (2002) see social constructivism as being at the opposite end of a continuum to positivism.

- Metaphysics is the philosophical investigation of the nature, constitution and structure of reality and is broader in scope than factual science. The term dates from an early editor of Aristotle who collected works following the scientific work under the heading of “after physics” or metaphysics. Positivists generally reject the concept on the basis that logical statements are not factually verifiable.

- Ontology is a subset of metaphysics that recognises that any concept is comprised of attributes that are related or characteristic. An entity in this context is self contained, definable and possesses particular properties. An entity has identifiable relationships with other entities. In this context a value system for example is a concept within which aesthetics and comfort are related entities.

The question posed for debate at the head of this section is whether the researcher makes the choice of research method based on their approach to the problem or whether the problem itself demands a particular research approach. There are two
basic approaches to the research problem being either phenomenological/inductive i.e. working in the area of the discovery of generalisations from observation of phenomena; or deductive i.e. developing existing research through combination, integration and logical deduction to form new theory. Easterby-Smith, Thorpe and Lowe (2002, p57) see the approach to the research problem as being dependent on the researcher’s attitude to positivism and social constructivism and the desire to be involved or detached from the investigation. These issues are seen as fundamental in the choice of a research design illustrated in Figure 2. Gill and Johnson (2002, p29) agree stating that observation is "theory laden" raising the problem that there is no independent or neutral point for the researcher to observe the world and thus all knowledge is from a particular viewpoint or paradigm. Logically therefore the research approach is always the choice of the researcher.

![Figure 2 – research methods are driven by approach (adapted from Easterby-Smith, Thorpe and Lowe (2002, p57))](image)

An issue ignored until now is the issue of theory building. The structuring of the hypothesis should be with the intention of adding to theoretical knowledge therefore any hypothesis should be a part of a theory or a part of theoretical development. The next section addresses the issues of theory and theory building.

**THEORY BUILDING**

**A theory is a generalised statement that seeks to explain.**

Gill and Johnson (2002, p31) state that the terms theory and hypothesis are often used interchangeably but should be viewed as working together to conceptualise and explain a particular social or natural phenomenon. In deductive research a number of related hypotheses sharing one or more common properties, may combine to form a theory for testing whereas in inductive research the investigation of phenomena will, through empirical observation, generate theory. (Gill and Johnson, 2002, p34).

Fellows and Lui (1997, p56) state it is the body of theory that determines the theoretical base for the research describing theory as providing the frame for the research “like a structural steel or reinforced concrete frame is used in a building".
Naoum (1998, p39&42) states that in quantitative study, hypotheses, research questions and objectives can be better understood when they are grounded in a theoretical framework which is stated explicitly at the commencement of the research project. In contrast in qualitative research the situation is less clear as the theory may emerge at any point during the data collection and analysis phase. Theories derived in qualitative research should be compared with other theories to determine whether they reinforce or supersede. Creswell (1998, p84) broadly supports this view indicating that the theory used depends upon the approach to the study. If the study is ethnographic or phenomenological then theories need to be established early in the development stage. If the study is biographical or case study based then theories can be developed at a later stage during the research and finally if a grounded theory approach is adopted then theory will be developed from the data.

Easterby-Smith, Thorpe and Lowe (2002, p46) debate whether the theory or the data comes first describing the Glaser and Strauss work in grounded theory in 1967 and their subsequent difference of opinion. Yin (1994, p28) provides the conclusion stating that the goal of initial theory building is to have a sufficient blueprint for the study and that theory development prior to the collection of any case study data is an essential step.

Wacker (1998) states that in the context of research, theory provides; the framework for analysis, an efficient method for field development and clear explanations for the pragmatic world. Quoting Van de Ven (1989) Wacker states "good theory is practical precisely because it advances knowledge in a scientific discipline, guides research towards crucial questions, and enlightens the profession of management."

Wacker (1998) addresses the definition and nature of theory stating that theory should have four basic criteria:

- Conceptual definitions - The role of the literature search is a fundamental stage of theory building as it provides accepted theory. This gives the context and the current state of research in a given area. In research endeavours to build new theory it must be recognised that new theory cannot just confirm existing theory, it must either supersede or negate it (known as the conservation rule).

- Domain limitations – The aim is to generalise the theory such that it will apply to the widest possible domain. Domain limitations are considered unhelpful. Applying existing theories to new broader areas, testing the theories in new environments or at different time periods broadens the domain and is useful.

- Relationships – There are four types of theory building relationships; with fundamental laws, theorems derived from fundamental laws, theories that span between the theoretical and empirical world, and current research hypotheses. The importance of new research is proportional to the care taken to relate new research to existing laws and theories.

- Predictions – Whilst it is only necessary for a theory to be logically intact and predicted to be so, for it to be sound, many researchers seek to prove that the theory has empirical application in a pragmatic world.

Theory builders should observe the following supplementary criteria. (Wacker, 1998)

Uniqueness: means that one theory must be differentiated from another.
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- Conservatism: a current theory can only be replaced by a new theory if it is superior in important aspects.
- Generalisability: the more areas that a theory can be applied to makes the theory more important.
- Productive: a good theory is one that is fertile in generating new models and hypotheses.
- Parsimony: the fewer assumptions the better.
- Internal consistency: the theory gives adequate explanation for all relationships.
- Empirical risk: the theory should hold itself up for refutation and not hide behind limiting caveats.
- Abstraction: the theory should be independent of time and location.

**Synthesis - the four levels of theory**

Wacker’s relationships (1998) give a useful indicator of four levels of theory.

**Level 1 – Conceptual framework**: operates at the level of concept or idea and includes issues of philosophy, logic, or natural occurrence. However, interpretation can be influenced by culture, perspectives and existing paradigms. Concepts are related to fundamental laws and fall into two distinct categories:

- those which can be judged by physical laws and are measured usually with a physical tool for which only one sense is required to interpret. Examples of conceptual frameworks at this level are speed, force, stress, pressure, torque, etc. The measurement is on an interval scale in respect of their weight/mass; dimension/volume/capacity; time, temperature; light emitting/conductance, sound emitting/conductance, magnetism and electricity.

- those which are measured on a notional scale possibly requiring more than one sense for their interpretation. Examples of conceptual frameworks at this level are value, quality, aesthetic, ethics, etc. The scale will be ordinal and relates to safety, security, goodness, compassion, excitement, comfort, etc.

**Level 2 – Theoretical framework**: operates at the level of derived theory either deductive being a theorem derived from existing theory or inductive when derived from grounded theory. A theoretical framework is a specific combination of concepts to form a theoretical construct. The theoretical construct recognises and makes explicit context, behaviour, perspectives and paradigms. Examples at this level include team dynamics, motivation, procurement, incentivisation, facilitation, etc. A theoretical framework, logically validated, does not have to be proved to exist but new theory at the framework level should comply with Wacker’s criteria (1998).

**Level 3 – Technical framework**: is the explicit empirical application of one or more theoretical frameworks. A technical framework has a well understood service outcome and is generally defined in terms of its processes or tools. Technical frameworks in the context of theory include virtually all aspects of engineering and researched aspects of management for example risk management, value management, project management, cost control, etc.

**Level 4 – Practical framework**: can arise either by the practical development of a technical framework such that it becomes operational or as a pragmatic development
based upon practical usage, which is found to work. In the later case practical frameworks are not developed from previous theories nor are they developed in an academically robust way using validated research strategies e.g. a construction performance indicator developed pragmatically, introduced and found to work. For a practical framework to become a technical framework it must first be validated in terms of its component theoretical frameworks. Therefore, practical frameworks provide a fertile environment for theoretical development.

The Jaykay research methods strategy diagram summarises possible research paths through the four levels. Possible routes are:

- Purely deductive taking existing theoretical concepts from the conceptual framework level literature and developing a new potential or embryonic theoretical framework of either existing theory or new potential or embryonic theory. Although Wacker (1998) indicates that the new theoretical framework and/or new theory could lie unproven it is logical for the new framework be validated by developing hypotheses and/or research questions, undertaking deductive research to validate or falsify the theory, rebounding at levels 2, 3 or 4 into a validated new theoretical framework of new or existing theoretical concepts.

- Deductive taking an existing theoretical framework, for example, from another scientific, social, commercial or industrial context and developing a new theoretical framework of existing theory then following the test criteria as previously.

- Inductive research makes an observation from the pragmatic world either at levels 3 or 4. Grounded theory and/or structured literature review builds a new theoretical framework of theory. Any new theory proposed at this point must take cognisance of existing theories and obey Wacker’s criteria principally that of conservatism.

The Jaykay research methods strategy diagram also indicates the concept of theory bounce where new theories and/or theoretical frameworks are formed as a result of the research. It is suggested that the height of the bounce in terms of level is directly proportional to the effort put into the research.

SYNTHESIS – THE APPROACH
The development of a workable hypothesis is seen by research methods literature as the commencing point for research activity. Yin (1994, p6) and Fellows and Liu, (1997, p22) both propose that the validity of the hypotheses and the research method is determined by answering the key questions what, why, where, when, how, who, and how much.

The contention of this paper is that the continual probing of the hypothesis in this manner at the commencement of the research is inefficient and can be soul destroying. An alternative approach is not to labour over the formulation of a provable hypothesis but to begin with a project mission. The project mission is determined in a single exercise at the commencement of the project preceding any inductive research in the form of structured literature review, grounded theory, etc.
For an undergraduate or masters dissertation the following procedure is proposed:

1. Consider and record in outline terms the aim of the project.
2. Ask the questions “what?”, “how?” and particularly “why?” repeatedly until the aim becomes refined into a clear mission statement. Typically objectives will be generated as a by-product of this process.
3. Ensure that the project mission contains \textit{a priori} elements of two or more related areas at the levels 2 or 3 i.e. theoretical framework or technical framework.
4. Undertake a structured literature review of the two or more related areas in which the facts, theories and issues are recorded. This will be the major literature review of the dissertation or thesis.
5. Prepare for a synthesis by preparing a list of issues and recognising interrelationships.
6. Synthesise the issues formulating research questions.
7. Group and combine the research questions and if appropriate prepare a hypothesis. Argue the case for a particular research method.
8. Undertake the research, record the results and draw conclusions.
9. From the conclusions produce new theory and/or a new theoretical framework (theory bounce).
11. A recommendation for further work indicates refining or testing the theory.
An alternative approach to Jack’s dissertation

Referring to Jack’s dissertation and the above this section proposes an alternative approach. First, Jack needs to decide whether his approach is to be positivist or constructivist. Unless there are known to be a finite number of cases all of which can be observed or there is a valid way of sampling a huge population in observance of the fundamental laws then it is difficult to be positivist in construction management research. Jack’s approach to date would certainly be classed as constructivist, it is suggested that it may be helpful to Jack to know this.

In the text above Jack’s initial working hypothesis is described as being “design team performance can be improved through the adoption of project intranets”. In this alternative approach the identification and subsequent validation of a hypothesis is postponed until the completion of all inductive research. A project mission answering the question “what is the primary aim of the research?” replaces the initial identification of a hypothesis. The “what?”, “why?”, “how?” questions are used to make explicit the exact mission.

In Jack’s case example “what?” questions are:

• what is a design team? – a team of people brought together for the purpose of designing a solution to the project problem
• what is performance? – the quality or manner of undertaking an action
• what is a project intranet? – a means of communication using computers

The “how?” question addresses the question of methodology and research method. Fellows and Liu, (1997, p23) state “the choice will be influenced by the purposes of the research, the subject paradigm, the expertise and experience of the researcher the supervisor ….resource and data availability”. The alternative “how?” question leads to an initial identification of theory.

• how do we assess the bringing together of a team of people for the purpose of designing a solution to the project problem? – by understanding the theories of procurement, teams and team dynamics, design, etc.
• how do we measure the quality or manner of undertaking an action? – by understanding the theories of work study, incentivisation, performance indicators, benchmarking, etc.
• how do we measure communication using computers? – by understanding the theories of communication, applied computer science, etc.

The “why?” question is a useful logic check to make sure that we are answering the right question. For example individuals use the intranet so why are we looking at teams? Were we considering the efficiency of site meetings then an examination of teams would be valid. Why are we looking at design teams only and not at all users of the intranet, which might be wider than just the design team? Why are we proceeding down the path of intranets when the original aim was to look at design team efficiency? The penetrating “why?” questions are helpful in mapping the research area. In this case Jack develops a project mission and primary aim of “investigating techniques for measuring the performance of design teams” with two primary objectives “a study of teams and team dynamics with specific reference to construction design teams” and “a study of performance measurement techniques”.

Jack’s literature search field and effectively the first two chapters of the dissertation, are now exposed. Jack begins an inductive research exercise in the two identified fields noting facts, established theory and issues relating specifically to construction. At the completion of this part of the research Jack undertakes a synthesis, diagrammatically linking all issues exposed under the two areas of search. Jack has inductively worked towards his theoretical framework and has effectively written chapter 3. The conclusion to chapter 3 is either a hypothesis and/or one or more research questions. Jack is now ready to commence the deductive stage of the research using appropriate research methods and design of the research strategy, which are described in chapter 4 of the dissertation. The final chapters record results and conclusions.

**CONCLUSION**

This paper sets out to introduce two approaches to research development. The first considers from an operational viewpoint postponing the development of the hypothesis or formalising research questions until after the completion of all inductive research commonly represented at undergraduate and masters level in a literature review. Secondly the paper proposes a research taxonomy through the four levels of theory as illustrated in the Jaykay research diagram. This diagram highlights the importance of both inductive and deductive research and the development of new theory by what is diagrammatically referred to as the theory bounce.

This paper is a theoretical proposition inspired by the paper by Wacker revisited recently when undertaking further research in the area of value. There is at yet no proof that the Jaykay diagram is valid or that the four levels of conceptual framework, theoretical framework, technical framework and practical framework really exist. However, it is concluded that they are logically intact as theory and do obey Wacker’s criteria. The theory is presented knowing that it attracts considerable “empirical risk”.

**REFERENCES**


