DESIGN STRATEGIES FOR A FUTURE CLIMATE: A QUALITATIVE COMPARATIVE ANALYSIS

Rachael Grinnell[1], Simon Austin and Andrew Dainty

School of Civil and Building Engineering, Loughborough University, Loughborough, Leicestershire, LE11 3TU, UK

Following on from international efforts to reduce carbon emissions and mitigate climate change, there is growing recognition that some change is inevitable and a degree of adaptation will be required. Beginning in 2009 the Technology Strategy Board provided funding for 50 live projects to undertake climate adaptation studies of their designs; 24 of the studies are now complete and provide insightful case studies of current practice in adaptive design. This study problematizes the applicability of existing construction management analysis tools to such a problem, proposing qualitative comparative analysis (QCA) as a rigorous and replicable alternative. Through describing the actual practice of the method by application to the problem of adaptive design in non-domestic buildings the paper explores both the benefits of a systematic, repeatable method when working with large data sets and ill-defined concepts, and reveals the 'hidden' data reduction that such an analysis requires.

Keywords: adaptation, climate change, design, non-domestic building, qualitative comparative analysis.

INTRODUCTION

It is now recognised that regardless of the success of current and future mitigation efforts, some level of climate change is inevitable (Jenkins et al. 2009). In the UK this is likely to mean warmer, drier summers, milder winters and general increases in the unpredictability of weather events that will result in an increased summer overheating risk, lower demands for winter heating, more frequent flooding and the possibilities of drought and clay heave related subsidence (DEFRA 2012). While change is predicted to be gradual over the next century, this presents an immediate challenge for our built environment because of its long lifetime – buildings constructed today typically have design lives of 60 years; many will be expected to remain in service beyond this.

Construction researchers have begun to address this challenge through the provision of climate data in a format familiar to designers (Eames, Kershaw and Coley 2010) and commentary on how it might be best applied to generate an accurate picture of risk (Kershaw, Eames and Coley 2011). Similarly climate impact studies (see de Wilde and Coley 2012 for a good list of examples) are describing how we might best design for resilience. However there are few, if any, efforts to describe reactions to emerging policy measures or the emergent climate change design guidance. While we are developing a picture of what designers could do, we know very little about what they are doing. How are designers reacting to climate change risk? Is this concurrent with academic findings? Are building designs changing as a result?

[1] r.c.grinnell@lboro.ac.uk

Grinnell R, Austin S and Dainty A (2013) Design strategies for a future climate: a qualitative comparative analysis *In:* Smith, S.D and Ahiaga-Dagbui, D.D (Eds) *Procs 29th Annual ARCOM Conference*, 2-4 September 2013, Reading, UK, Association of Researchers in Construction Management, 1103-1112.

Beginning in 2009 the Technology Strategy Board (TSB) initiated a funding competition entitled 'Design for Future Climate Change'. The competition provided funding of up to £100,000 for live building projects to undertake climate adaptation studies and deliver recommendation reports (TSB 2011). Eligible projects included both new build and refurbishments with a contract value exceeding £5M which were able to demonstrate “low impact goals” (e.g. BREEAM Very Good, or higher, aspirations). The funded projects created large volumes of readily accessible information: TSB adaptation reports, planning applications (available from the relevant local authority planning portal), construction media articles and online publicity material. While the provision of funding and the nature of the competition introduce an element of artificiality, the projects nonetheless represent a unique opportunity to study design for adaptation ‘in action’.

We find ourselves in possession of a socio-technical problem, a type increasingly important to construction researchers (Oreszczyn and Lowe 2010), and a ‘ready-made’ rich data set with which to address it. What we are also presented with are obvious problems with using traditional construction management methods developed for large random samples or comparative case studies. A quantitative treatment of the data is problematic for both methodological and practical reasons: methodologically, while we could reduce the data using quantitative methods, applying content analysis or extracting structured variables, this would undoubtedly overlook the social, qualitative complexity of any design process. Practically, the data set both lacks the random sampling requirements and is too small for meaningful statistical analysis.

Considering we have a rich, mixed data set and a desire to reflect real practice, rather than practice under ideal conditions, a case study approach seems more appropriate. Compatible with the use of multiple data types the case study provides a means to examine the complexity and depth of the data. A multiple case study approach (Yin 2003) allows for contrasts and differences between the cases to be brought to the fore and potentially demonstrates a “more compelling” (Yin 2003) evidence base on which to base conclusions, yet case research is intensive and resource demanding (Yin, 2003; Eisenhardt 1989) and there is a risk that theorists loose "their sense of proportion as they confront vivid, voluminous data” (Eisenhardt 1989). Thus, what is required is a method for the middle ground, which allows us to deal with complexity in a manageable way without entirely decomposing it. This paper proposes qualitative comparative analysis (QCA) as a potentially useful bridge.

QUALITATIVE COMPARATIVE ANALYSIS

Qualitative comparative analysis (QCA) is an alternative, set theoretic approach to case study research that maintains the view of cases as holistic entities (Rihoux and Lobe 2009), but allows for a larger number of cases to be considered and compared. In the context of a field where it has been observed there is unlikely to be a “one size fits all solution…but rather a range of multiple pathways” (Williams et al. 2012) to climate proof buildings, QCA is appealing because of its acceptance of multiple pathways to the same outcome (Rihoux and Lobe 2009; Ragin 2008) and deliberate emphasis on exploring diversity (Ragin and Amarosso 2011). Developed by Charles Ragin during the 1980’s (Ragin 1987) and subsequently refined (Ragin 2002; Ragin 2008) the method is now well established, if not widely used, in the fields of comparative politics and some social science disciplines and has attracted recent interest from built environment researchers in the US (Gross and Garvin, 2011a, 2011b, McAdam et al. 2010; Jordan et al. 2011; Chan, Levitt and Garvin 2010).

QCA has been described as a method that “starts by assuming causal complexity and then mounts an assault on that complexity” (Ragin 1987), highlighting two important aspects of QCA as an approach: firstly that is provides a means to selectively reduce the complexity of case data enabling comparative analysis across a greater number of cases than might otherwise be possible, but secondly that it does so in a way which is explicit and replicable. Thus, QCA is a systematic process and comprises a number of ordered steps through which to proceed. Yet it is also iterative (Berg-Schlosser and de Meur, 2009); researchers are encouraged to revisit both what constitutes a case and those conditions which are considered relevant to the outcome in light of the case evidence. Figure 1 visualises the key stages and highlights the main iterative loops.

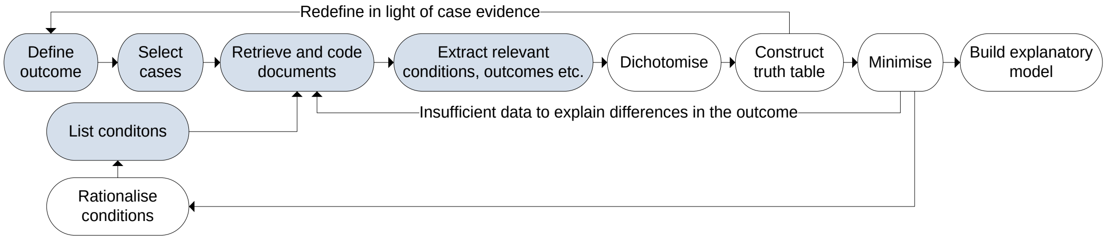

Figure 1 Graphical representation of the intended research process. Blue boxes indicate external theory.

This paper presents the preliminary stages of a method 'experiment', designed to test the applicability of QCA to construction management and design problems such as outlined above. Descriptions of the initial stages (shaded in figure 1) are provided below; readers interested in the latter steps will find comprehensive but accessible introductions in Ragin (2008), Rihoux and Ragin (2009) and Jordan et al. (2011).

DEVELOPING A QCA RESEARCH DESIGN

In the absence of a working familiarity with QCA analysis, a number of avenues were pursued to enable construction of an appropriate approach: formal methods training, a literature review of QCA studies and a study trip to meet with other researchers in comparable disciplines currently undertaking, or supervising, QCA analyses. The review focussed on exemplar studies identified from QCA textbooks, studies from the construction sector and other studies that aligned well with the proposed approach (see appendix 1 for a full, referenced listing) and forms a reference point for common practice. Due to advantageous timing the study trip was able to garner feedback from Charles Ragin on the outline research design at an early stage. All of these activities helped to formulate the approach outlined below, which details how the typical QCA steps were operationalized in the context of this climate adaptation design study, paying particular attention to aspects of the method that require a thoughtful approach in order to transfer the method successfully into a construction design setting.

Defining the outcome

The initial step of any QCA analysis is to define the outcome of interest, a process broadly comparable with defining a unit of analysis in replication type case studies (see Yin 2003) in that it defines what the cases are to be cases of and sets the boundaries for the study. This study is concerned with the nature and success of climate adaptation activities in buildings. Given that buildings typically have design lives of 60-100 years, we define success as the continued usefulness - through resilience and/or adaptive capacity - of a building to the end of the century.

Having decided on what we consider adaptation to be, it is also important to understand how we will observe, or measure, it. Since simply waiting to assess each building's performance in a future climate is infeasible, metrics are required that assess the as-designed building. At a national scale the Adaptation Sub-Committee (ASC, 2011) has developed a range of indicators to assess progress on adaptation in the built environment. While these measures are no doubt helpful in assessing movement towards national preparedness, being designed to observe trends rather than absolutes they are less appropriate for the judgement of individual buildings at a single point in time.

At the building scale, assessment of adaptation to climate change has largely centred on thermal comfort; de Wilde and Tian (2011) provide a good overview of the range of metrics employed by these types of study and demonstrate the current lack of consensus. There are limited examples of attempts to define more holistic methods for assessing the adaptation potential of the built environment. Pyke et al. (2012) attempt to utilise existing sustainability metrics in the form of LEED credits, but while this metric represents a useful step towards holistic measurement of climate adaptation and its addition into mainstream sustainability assessment, its reliance on LEED criteria used by only a minority of UK projects annually negates its adoption for this study.

In the absence of a single, coherent metric, a composite success measure using the available indicators and qualitative interpretation is proposed (Table 1). The assessment constitutes four aspects, in an attempt to both compensate for deficiencies in any single approach and provide a limited form of internal consistency.

Table 1: Climate adaptation success metrics

Definition	Evidence Source
Is the report consistent with current climate adaptation guidance?	Comparison of recommendations made to metrics currently found in the literature, and compliance with leading guidance.
Do the Technology Strategy Board, initiators of the competition, believe the project was successful?	Interview with TSB representative, to include a discussion of how they define success.
Does the report suggest that the project's undertakers believed the measures suggested successfully managed future climate risk?	Excerpts from the reports themselves, validated by project actors through interview where practical.
Is there evidence the required measures would be installed and/or form part of the detailed design?	Project reports (TSB requirement to state adopted measures).

The final outcome specification step is to determine how the metric will be applied to allocate cases to one set or another: calibration. Metrics are calibrated such that they are meaningful; they should relate to external standards that make them interpretable in a qualitative sense (Ragin, 2008). This allows for us to go beyond comparison (X is more than Y, X is less than average): a calibrated measure defines what is 'successful adaptation design', and what is not.

QCA has come under sustained attack for this process which is seen as artificially truncating the diversity of a sample (Vaisey 2009) and rendering an overly simplistic view of rich, qualitative ideas. In response the original crisp set QCA (csQCA) was revisited, resulting in the three variants on the original method now in existence: csQCA, multi-variate QCA (mvQCA) and fuzzy set QCA (fsQCA). fsQCA draws on fuzzy logic to allow cases to be allocated membership of a set on a partial scale (see Ragin, 2008). Despite these improvements the criticism remains and it is considered that an alternative response to the complexity of fsQCA is more appealing: any method of qualitative analysis necessitates some form of reduction, and QCA both does this in a way that is compatible with people's general methods of making sense of the social world they inhabit (categorisation) and does so in a manner that is transparent rather than developed through an opaque analytical process. This idea of transparency is particularly appealing to a built environment application where many concepts still lack consensus in definition and metric (e.g. value, design quality). QCA ensures a contribution to the debate on appropriate metrics through an explicit presentation and justification of the approach adopted.

For the purposes of this methodological ‘experiment’, csQCA was selected on the basis that it is considered the most easily interpreted and that it can be accomplished with the smallest case set (Gross and Garvin, 2010). Preliminary attempts were made to specify the means by which cases are to be allocated to the success set, paying particular attention to good practice in calibration: be transparent when justifying thresholds, ideally justify thresholds on substantive or theoretical grounds using mechanical cut offs as a last resort (Rihoux & De Meur, 2009). However, because calibrations should ‘make sense’ in relation to the data (Rihoux & De Meur, 2009) data collection included the amassing of information on how the cases themselves were ‘measuring’ success – comparisons made, benchmarks mentioned etc.

Sampling

QCA is described as applicable to “medium N” studies meaning that it is applicable in the range between theoretical replication type case studies and the probability samples of generalising quantitative methods. Samples in QCA are constructed rather than given (Yamasaki and Rihoux 2009) – they are purposeful. The intention is to create a sample which is sufficiently homogeneous to allow sensible comparison, while demonstrating sufficient diversity (in outcome and the conditions of interest) to allow for a thorough understanding of the conditions in which a given outcome does and does not occur. Case selection is also an iterative and incomplete process – cases may be added to and removed from the analysis at any point on the basis of the case evidence of what is relevant to an understanding of the problem. While this is helpful in suggesting that any initial decision on case selection need not be the final one, it provides little guidance on a suitable starting point – should we assume 5, 10 or 20 cases? To infer standard practice, the sample sizes of existing studies were reviewed. This revealed (Fig. 2) that in practice, samples of between 10 and 20 were most common, although one outlier study (not shown) consisted of over 2000 cases.

On the basis of the review it was decided that circa 25 cases would be appropriate. This allows for some cases to be excluded during the case definition refinement process (by the inclusion of a considerable ‘buffer’ in data collection activities – given sufficient diversity 10 cases would be permissible) while allowing for limiting the study to those projects for which the TSB competition was ‘complete’ at the time of data collection activities (Oct 2012 – Apr 2013).

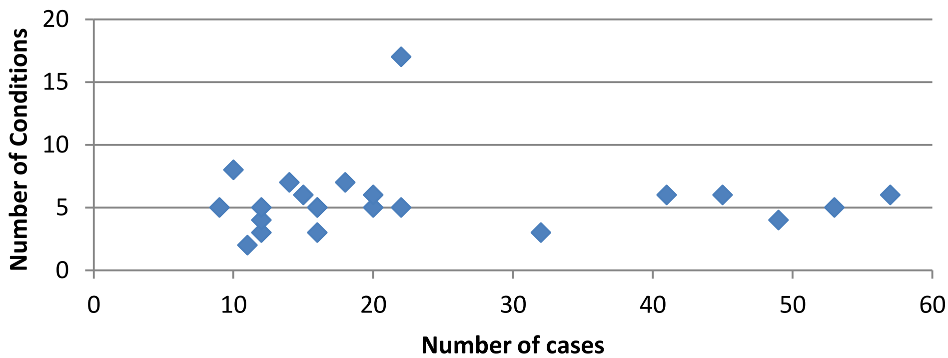

Figure 2 QCA studies review: case populations and causal conditions

As a partial aim of this study was to test QCA’s applicability to the selected data set, features of the data set were compared to sampling best practice: the importance of sufficient diversity to ensure explanatory strength in the QCA minimisation (Jordan et al. 2011) and retaining a sufficiently bounded case set to enable comparison. On considering the TSB cases it was realised that several of the projects were masterplans rather than isolated projects and as such adopted a spatial scale approach that made them distinct from the wider case set. Similarly projects that made use of multiple, single family dwellings were excluded on the basis of having a significantly different approach due to the scale of the buildings they considered. On the question of diversity, assessing the TSB cases was more problematic; given the comprehensive-inductive approach to condition selection this study adopts (see below) a complete a-priori framework against which to assess diversity was not available. The TSB data set does however demonstrate a range of project sizes and types, a mixture of new build and refurbishments, client types and procurement approach and the projects were undertaken by different combinations of designers. As such, it was considered the TSB cases were as likely as any other constructed sample to demonstrate diversity and the use of a subset of the available cases would allow the inclusion of additions if deemed necessary later in the analysis.

Selecting Conditions

For the purpose of complexity reduction QCA relies on the identification of factors that influence the outcome: conditions the outcome is contingent upon. Yamasaki and Rihoux (2009) list several ways that this may be accomplished: comprehensive, perspective, significance (statistical), second look, conjunctural and inductive. Perspective, second look and conjunctural approaches rely on the existence of theory in the area to be studied and were dismissed on the basis of an absence of a coherent theory of adaptation in the construction literature. Instead a comprehensive-inductive approach (Yamasaki and Rihoux 2009) to condition selection has been adopted. This draws on adaptation literature, while allowing for the latter addition of conditions drawn from the cases themselves. This latter feature was considered important given recent comments by those such as Nicol and Stevenson (2013) on the necessity for research to be informed by the practice of adaptive design.

For the comprehensive element a detailed literature review of both academic and practice adaptation literatures and also more general studies of design process was undertaken to identify all factors influencing the successfulness of an adaptation design process. This produced a long list that was condensed to remove duplication. In accordance with good QCA practice (Berg-Schlosser and De Meur, 2009) a note was made as to the likely effect of the condition on the outcome. This condensed list formed the base code listing for the preliminary data analysis and is in line with Miles and Huberman’s (1994) suggestion to begin data analysis with a preliminary list of codes. The inductive element followed a similar logic but applied to the case data: new conditions were added in accordance with the qualitative data handling procedures detailed in a comprehensive case protocol.

This process produced an extensive number of codes on the first pass. Returning to figure 2 we see how almost all the studies limited themselves to between four and six conditions. This highlights a key limitation of QCA: while it is necessary to sample for as much of the diversity existing in a population as possible, this diversity expands exponentially as the number of conditions included in the analysis increases: four conditions can be combined in 16 (24) ways, six conditions in 64 (26) ways. Beyond circa 10 conditions the ‘logic space’ becomes so large as to render any increase in the number of cases meaningless. This means we are limited to problems explainable with a limited number of conditions, perhaps undermining QCA’s assertion of retained complexity (Ragin, 2008) somewhat, or we must choose to examine only those variables of significant interest. Assuming the latter, there is a realisation that QCA is not a panacea for data reduction and as Coverdill and Finlay (1995) note, “one cannot use QCA until quite a bit of thought and analysis has been completed”.

How do we decide which conditions are important and which are not?

The problem of too many conditions is by no means novel for QCA theorists, and various methods for reducing the number of conditions have been suggested including Schnieder and Wagemann’s (2006) formalised MSMD (most-similar, most-different) method. We opted to first apply qualitative techniques to group and condense our data, before confronting the results with the extant literature to further direct our search. We then propose to follow Yamasaki and Rihoux’s (2009) example, subjecting the condensed listing to an iterative process of “many preliminary tests".

Due to the volume of documentary material (around 800 documents) we followed Dainty et al.’s (2000) example and employed NVivo for data management and retrieval. We then, as Coverdill and Finlay (1995), resort to “old fashioned techniques” of qualitative analysis. The use of NVivo as an interim recording mechanism, rather than the direct transposition of data to condition tables etc. enabled a return to information easily: node content could be extracted to Microsoft Word allowing for a further round of manual coding and database queries could be used to retrieve data with which to construct timelines, organisational trees and case vignettes in an attempt to elicit key themes. Future work will operationalize and calibrate the identified conditions to enable selection of those most relevant to the problem domain.

CONCLUSION: REFLECTIONS ON THE METHOD EXPERIMENT AND ITS APPLICATION

This paper has outlined the initial stages of a ‘method experiment’ to test the applicability of QCA to a complex socio-technical problem. QCA was initially seen as a way of systematically and efficiently managing the inevitable data reduction process. However, QCA requires considerable ‘up front’ data processing and, in the case of an inductive approach (not well represented in existing QCA studies), analysis too. Yet if structured rules are adhered to, QCA appears to provide a methodical and transparent way in which to perform data reduction. While this systemisation could be problematic in the context of a research problem with vague, ill-defined concepts, it was beneficial in forcing the development of a thorough understanding of what was meant by adaptation and project success, and how they might be best operationalized. While the QCA literature tends towards social concepts that come with pre-defined indicators, this experiment has demonstrated the plausibility of an involved metric creation stage where measures are less well defined. This finding should resonate with the wider QCA community, as should the analysis of sample size practice in QCA studies. In relation to the specific socio-technical problem at hand - to better understand the effectiveness of design strategies for mitigating future climate change effects - we conclude that QCA has potential for application to problems in low carbon and energy reduction fields, and especially those that require hard, technical data on consumption and building characteristics to be studied in their social context (see Oreszcxyn and Lowe 2010). However, further work will be required to fully understand the effects of the data minimisation process on the efficacy of the design principles which emerge from such an analysis.

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APPENDIX 1:

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