



## Shedding light on causal recipes for development research uptake

Applying Qualitative Comparative Analysis to understand reasons for research uptake

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# Foreword

In the absence of definitive guidance on how to use and integrate Qualitative Comparative Analysis (QCA) into existing Monitoring and Evaluation (M&E) systems and practice, this paper is primarily intended as a practical contribution to the growing knowledge base on how QCA might (or might not) strengthen learning and accountability agendas within organisations and international development. It is the result of work done by an organisational M&E Unit without prior QCA experience or training, collaborating closely with project managers. The research drew on initial expert support on operating the fsQCA software used for data analysis, otherwise relying on existing M&E data and internal resources for coding, analysis and interpretation. An initial draft of the paper was reviewed by Dr. Carroll Patterson. As such it represents the efforts of an M&E team that is user- instead of expert-led as much as possible, but also wants to work with new approaches and test what its experience can add to current M&E practice. This is part of the authors' search for new ways to answer relevant questions asked by managers and researchers in international development, in this case, by their colleagues in the Climate and Development Knowledge Network.

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## List of abbreviations

AMC	Ahmedabad Municipal Corporation
CCD	Climate Compatible Development
CDKN	Climate and Development Knowledge Network
COP	Conference of Parties
CSA	Crisp Set Analysis
DfID	Department for International Development (UK government)
FSA	Fuzzy Set Analysis
fsQCA	Software designed for Qualitative Comparative Analysis
IIPH	Indian Institute of Public Health
INTRAC	International NGO Training and Research Centre
M&E	Monitoring and Evaluation
NRDC	Natural Resources Defence Council
ODI	Overseas Development Institute
QCA	Qualitative Comparative Analysis
RCTs	Randomised Control Trials
ToC	Theory of Change
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office for Disaster Risk Reduction

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## Key terms

**Cases** are the main unit of analysis, in this example constituting completed CDKN research projects. Each case displays manifestations of conditions that CDKN has identified as theoretically relevant to the outcome of research uptake.

**Causal recipe** or causal pathway refers to the configurations or combinations of conditions that represent ‘explanations’ for the outcome in question. Different combinations or ‘recipes’ of causal conditions may generate the same outcome.

**Conditions** are the factors (or variables) identified on the basis of a Theory of Change to be crucial for bringing about the desired outcome. Central to the understanding of Qualitative Comparative Analysis (QCA) are concepts of sufficiency and necessity of conditions, specifically INUS conditions, which are “*an insufficient (I) but necessary (N) part of a causal package, which is in itself unnecessary (U) but sufficient (S)*”<sup>1</sup>.

**‘Crisp Set’ Analysis (CSA)** is done through binary coding of key conditions and outcomes, indicating their presence (=1) or absence (=0) in every case.

**‘Fuzzy Set’ Analysis (FSA)** enables analysis of further gradations or ‘degrees’ of presence or absence of each condition and the outcome. These gradations represent qualitative ‘thresholds’ for how conditions interact with each other to produce an outcome.

**Research uptake** in this example is defined as the direct or indirect use of CDKN-commissioned research by the target audience, consisting of government officials, funding agencies, multilateral organisations, civil society and business representatives working in the wider area of climate compatible development.

**Solution** refers to the full set of causal recipes that have been found to explain the outcomes of the selected cases.

A **truth table** is a tabular representation of all logically possible configurations of conditions. In Crisp Set Analysis, each row represents a case, which is made up of the conditions (1 = presence, 0 = absence), the effect or outcome (likewise 1 = presence, 0 = absence) and their consistency with necessity and sufficiency.

For a more comprehensive glossary of QCA terms, refer to Raab & Stuppert 2014.

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<sup>1</sup> Befani, 2012.

# Executive Summary

For years, the international development sector has grappled with questions of how to rigorously assess and understand contribution to impact and how to navigate complex causalities that make up the road to success. Randomised Control Trials (RCTs) and other econometric approaches are frequently mentioned as an option, alongside more case-based and context-focussed methods such as Process Tracing. Qualitative Comparative Analysis (QCA) has arrived recently on this scene, from the social sciences. QCA is an analytical approach that combines deep contextual case knowledge with the ability to identify patterns across a number of cases – making it possible to examine different ‘combinations’ of causes leading to an outcome.

While at a first glance QCA holds enormous promise for unpacking contribution to achieving development outcomes in complex contexts, its practical application in monitoring, evaluation and impact assessment in international development has not been widely demonstrated to date.

This paper explores the use of QCA for learning-focussed monitoring and evaluation (M&E), using recent work with the Climate and Development Knowledge Network (CDKN) as a case study<sup>2</sup>. It is aimed at experienced monitoring and evaluation (M&E) practitioners interested in a more detailed understanding of the potential application of QCA. A secondary audience is researchers interested in the results of the QCA analysis of factors influencing the uptake of research in Climate Compatible Development (CCD) policy and practice.

## Research question and methodology

On the basis of Theory of Change (ToC) thinking around research uptake, both internally and as publicised by its affiliate, the Overseas Development Institute (ODI), CDKN has been articulating and recording its assumptions and experiences about the factors or conditions that lead to research uptake. The process of reflection about how change happens through research has been accompanied by an M&E process that builds on impact reviews of each sizeable research project six months to two years after it has ended, to establish its medium- to longer-term outcomes. In addition, CDKN Research Programme staff produce case studies every year to report and reflect on results and learning.

Against this backdrop of a robust theoretical framework and available case and outcome data, combined with CDKN’s desire to understand better how research can increase its chances of being influential, the central research question for QCA analysis was:

Which combinations of conditions lead to CDKN’s research being taken up by key stakeholders within two years of research completion?

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<sup>2</sup> CDKN is an alliance of organisations delivering demand-led research, technical assistance, and convening support on Climate Compatible Development (among other activities) in response to developing countries’ needs. CDKN’s policy research intends to bridge the gap between climate change science and the information needs faced by decision-makers, with the primary aim of influencing development discourse, practice, policy and plans.

QCA was identified as a methodology with potential to answer this question i.e. what conditions are necessary and/or sufficient for research uptake to happen? As CDKN's M&E team was not formally trained in QCA, this was also seen as a useful opportunity to pilot the use of the approach, and understand its strengths and weaknesses as a practical tool in user-led M&E.

The study focused primarily on analysis of the different factors that contribute to research uptake<sup>3</sup>. After prioritising a shortlist of 13 conditions deemed by CDKN to be most important for research uptake in decision-making, the QCA analysis was run with 20 cases (completed research projects) for which adequate information on all variables was available. The analysis showed three possible causal pathways leading to the outcome of research uptake; with *credibility and research quality* being the 'gatekeeper' condition for uptake as it was present in all cases with research uptake. These are discussed later in this paper along with case study illustrations.

### **Key messages on the use of QCA for M&E**

While CDKN is planning to build on this existing QCA analysis, various methodological and other challenges remain. The M&E team's initial conclusions, based on our experience so far are:

- **QCA's main value lies in its ability to challenge or re-affirm assumptions in a Theory of Change** through a systematic and transparent process of inquiry that can be implemented over a longer time frame, with new cases being added to the analysis. Instead of providing clear-cut answers, QCA has hinted at where CDKN should invest in greater scrutiny or reflection.
- **There is little guidance available that is easily digestible and accessible to those unfamiliar with QCA.** Thus, for people curious about the method, the threshold for actually piloting it is relatively high. The team found that while QCA principles and process are accessible to someone with basic training in data analysis and social sciences, operating the software requires a degree of technical expertise and quality assurance.
- **QCA provides a rigorous and transparent process to drawing out patterns and going beyond the importance of single causal factors,** but it also necessarily reduces causal complexity by limiting the number of variables one can realistically look at. Some might feel it does not capture nuances enough to provide much value beyond challenging or strengthening assumptions about how change happens. Therefore QCA is likely to constitute one piece of evidence that can be added to what is already available to weigh for or against an argument.
- Considering the effort required for a rigorous application of the methodology, the authors would only recommend **using QCA as part of ongoing M&E to organisations running flexible M&E systems,** which can build on data and theoretical thinking already available through regular M&E processes.

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<sup>3</sup> See key definitions.

# Introduction

The ongoing debate about the most appropriate impact evaluation approaches in international development has often centred around quantitative counterfactual approaches to establishing causality<sup>4</sup>. The debate has been accompanied by efforts at establishing rigorous theory-led impact evaluation approaches that produce more generalisable findings and lessons than Randomised Control Trials (RCTs) or statistical approaches. Most of these, such as Process Tracing, Realist Evaluation or Contribution Analysis, use generative logic – providing “*an account of why the regularity turns out as it does*”<sup>5</sup>– i.e. they explore the mechanisms linking specific causes and effects in different contexts, allowing for a more in-depth understanding of the association of variables.

One of the newcomers to the scene of evaluation methodologies is Qualitative Comparative Analysis (QCA). Unlike the other approaches mentioned, it combines deep knowledge of individual cases with the ability to identify patterns emerging across a medium number of cases (approximately 15 – 50<sup>6</sup>), explaining a shared outcome. Its genuinely mixed methods nature has the potential to yield lessons that are qualitatively different from those produced through generative and counterfactual approaches to causality. Therefore, it has been hailed as a promising new way to evaluate complex interventions, sometimes in combination with other more established methods such as Contribution Analysis<sup>7</sup>.

For a number of years, INTRAC has worked with the Climate and Development Knowledge Network (CDKN) on developing monitoring and evaluation (M&E) approaches that suit CDKN’s complex settings. CDKN supports decision-makers, particularly those in developing countries, in designing and implementing climate compatible development (CCD)<sup>8</sup> policies and practices, by combining technical advisory work with research and the facilitated access to knowledge. One of CDKN’s niches is the hands-on commissioning of research on specific policy issues within CCD, intended to influence policies, practices and discourse at different levels. Throughout the years the CDKN Research Team has made adjustments to the way it commissions and manages research projects based on evolving thinking about how to maximise their chances for research uptake.

Recently, CDKN piloted QCA as a tool to understand better and more systematically than in the past what combinations of external and internal factors in CDKN’s research are associated with tangible changes in developing country policies, programmes and plans – what we call ‘research uptake’. This paper explores the practical use of QCA by CDKN’s M&E function, led by INTRAC, to understand ‘causal recipes’ for the uptake of CDKN-supported development and policy research by its target audiences.

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<sup>4</sup> OECD and World Bank commonly limit impact evaluation to counterfactual approaches. E.g. <http://www.oecd.org/dac/evaluation/dcdndep/37671602.pdf> last accessed 23 Oct 2015

<sup>5</sup> (Pawson 2007 cited in Befani 2012, 18). The key word in the quote is ‘why’, whereas RCTs treat the process between cause and effect as a ‘black box.’

<sup>6</sup> Legewie, 2013

<sup>7</sup> Baptist & Befani, 2015

<sup>8</sup> CDKN’s definition of CCD refers to strategies deployed to achieve low emissions, high resilience and development. See <http://cdkn.org/resource/defining-climate-compatible-development-3/> last accessed 24 Mar 2016

The **primary research question** the team is interested in is:

***What combinations of conditions lead to CDKN's research being taken up by key stakeholders within two years of research completion?***

QCA is commonly used as a one-off evaluation methodology. However, for INTRAC and CDKN it is a method that can potentially draw on and feed back into different elements of CDKN's M&E and Learning system, including Theory of Change thinking, long-term monitoring and evaluation data, case studies produced annually for CDKN's reporting on results, and organisation-wide learning questions, on a continuous basis. Emergent findings from medium- to long-term impact reviews across CDKN's research projects have the potential to be added to the QCA inquiry as new data, to allow for regular testing and corresponding adjustments of assumptions about what makes for influential research.

The process of implementing QCA has illustrated some of its strengths and weaknesses. This paper will demonstrate the rationale, steps, findings and challenges associated with the QCA inquiry that was undertaken within CDKN and draw conclusions on QCA's promise as a new M&E methodology that contributes to an understanding of complex causal relationships. By sharing the experience of the QCA researchers, the authors of this paper are hoping to make decision-making on whether and how to use QCA more approachable for other M&E practitioners. The paper will also be of interest to researchers interested in the results of the QCA i.e. CDKN's analysis of factors influencing the uptake of research, in this case in CCD policy and practice.

The paper will start off with a brief introduction to QCA, followed by an explanation of the theoretical framework used to derive conditions and coding. It will then present findings about what makes for research uptake in CCD. The last section will conclude with methodological observations on QCA's strengths and weaknesses and reflections on the practical usability and value added of QCA as an M&E tool, with the intention of informing management and decision-making of others who are considering using QCA.

# Why QCA? A brief introduction and CDKN's rationale

## Understanding QCA

The most conventionally recognised way of establishing cause and effect – at times contentiously referred to as the ‘gold standard’ in rigorous impact evaluation – relies on the strength of association between one independent variable or condition (the ‘cause’) and a dependent variable (the ‘effect’). The direction of causality is part of a ‘black box’ that the researcher does not penetrate<sup>9</sup>.

QCA originates in the social sciences, where it has been used since the late 1980s. Instead of establishing the strength of association between a single condition and an effect (or outcome), QCA uses **configurational logic**. This means that it investigates the link between a *package of conditions* (also called factors or variables) – and an effect.

Central to the understanding of QCA are concepts of sufficiency and necessity of conditions, specifically INUS conditions, which are “*an insufficient (I) but necessary (N) part of a causal package, which is in itself unnecessary (U) but sufficient (S)*”<sup>10</sup>. Put into more simple language, this concept implies that:

- It is not the net effect of single conditions that is the focus, but rather the role of single conditions in a combination of conditions. Thus, for example, an ingredient could be a necessary element of a recipe in order for the recipe to work (have an effect), but would be insufficient on its own if not combined with other ingredients.
- An effect (or outcome) may be caused by different and potentially numerous such ‘recipes’ - combinations or ‘packages’ of conditions.

In applying this thinking in impact evaluation, one would hope to find that the intervention being evaluated “*can be shown to be a necessary component of a sufficient strategy, and thus be shown to ‘cause’ [an outcome], in combination with other factors*”<sup>11</sup>.

One of the reasons why QCA is provoking so much interest in the evaluation community is that the complex interventions and settings prevalent in international development are likely more concerned with INUS conditions than with absolute necessary or sufficient conditions – making for complex as opposed to simple answers to the famous question “What works for whom where under what circumstances?”

It is also worth noting that QCA relies on either binary coding of quantitative or qualitative data or coding along a scale. ‘**Crisp Set**’ **Analysis** (CSA) is done on binary coding of key conditions and outcomes, indicating their presence or absence in every case. ‘**Fuzzy Set**’ **Analysis** (FSA) employs further gradations for each condition and the outcome. These gradations represent qualitative thresholds which determine how the condition interacts with others in producing the outcome.

Thus, the application of QCA relies on a detailed Theory of Change (ToC) that articulates the links between the strength of the conditions required for social change.

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<sup>9</sup> Befani, 2012

<sup>10</sup> Befani, 2012

<sup>11</sup> Befani, 2012

In practical terms, QCA's main features are its focus on in-depth case knowledge, combined with its ability to draw out patterns across a medium number of cases<sup>12</sup>. This avoids some of the respective weaknesses of purely qualitative or quantitative approaches: the former often lack generalisability or replicability across different researchers, while the latter often do not take context into account adequately. These things, however, are given with QCA: "QCA seeks to combine the strengths of qualitative and quantitative research, by linking theory and evidence while also providing increased measurement precision"<sup>13</sup>. Crucially, for QCA to work, there needs to be sufficient diversity of cases and outcomes; including only cases with positive outcomes takes away the unsuccessful scenarios that QCA needs to be able to identify sufficient causal recipes for achieving change.

For the QCA analysis, several software tools free for download are at the researcher's disposal<sup>14</sup>. While fsQCA appears to be among those most widely used (including in this case), its user-friendliness is limited. Alternatives, some of which offer different functionalities, are available<sup>15</sup>.

## Evaluative practice in CDKN and using QCA

With the intention of driving organisational learning and the sharing of reflections internally and externally, various CDKN departments have been addressing learning questions, envisaged to inform CDKN operations and strategy. In 2015, CDKN's Research Team set itself a learning question on what determines impact and uptake in CDKN's portfolio of research projects. QCA appeared to lend itself to addressing this question while enabling CDKN to capitalise on information that to a large degree already existed and merely needed to be systematised and analysed in a different format. QCA also seemed ideal in serving explicit learning needs as opposed to more accountability-focussed questions aiming to 'prove' interventions' effectiveness as frequently employed in external reviews or evaluations commissioned directly by institutional funders. Instead, QCA encouraged everyone involved to scrutinise their assumptions on what conditions were considered necessary and/or sufficient for research uptake to happen.

In applying the QCA methodology, the researchers made frequent use of well-established M&E processes and tools within CDKN's research department. Existing ToC thinking captured in different places – the explicit CDKN Research ToC, relevant analysis and reflections by the CDKN research team captured throughout the years as well as formal commissioning guidelines and criteria applied to the selection of research proposals – provided the building blocks of the QCA's theoretical framework, which is explained below.

For the QCA, the CDKN M&E team also drew on medium-to long-term impact data generated and accumulated as part of CDKN's regular project M&E. Project Impact Reviews are commonly carried out for all of CDKN's research projects between six to 24 months after they have come to an end (depending on expected timing and ambition of impacts) to assess and capture the extent to which longer-term changes have materialised. Primary data sources for these reviews include information from the organisations that carried out the

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<sup>12</sup> Definitions of medium number differ, but a medium number can be said to be within the range of 15 to 50, though a higher case number is also possible for QCA.

<sup>13</sup> Befani, 2015

<sup>14</sup> For small numbers of cases/conditions using crisp-set QCA, it is also possible to perform some analyses manually.

<sup>15</sup> <http://www.compass.org/software.htm> Last accessed 16th February 2016

original research and policy stakeholders for whom the project was carried out, online research, project reporting and internal CDKN interviews. This data provides the basis for meaningful inquiry through QCA into how best to explain the observed degrees of research uptake.

The team envisaged that the results of the QCA would feed back into the M&E and management system in various ways, for instance by:

- Feeding into analytical stories of change – case studies written by CDKN staff reflecting on what worked well, what did not work well and why – as part of CDKN's annual report on results, shared internally and with funders;
- Informing future opportunities to adjust research commissioning guidelines where appropriate;
- Incorporating new and emerging M&E findings and reflections (both on projects' impact and around significant conditions) at strategic points to strengthen the QCA. Each year, about 15 – 20 new projects could be added to the QCA based on ongoing Project Impact Reviews.

The QCA was also intended to widen the toolbox of methodologies used by CDKN to go beyond assessing its impact and to draw out actionable learning – to establish what interaction of factors has been most significant for effecting change. In the past, stories of change and internal reflections as well as good practice suggested by other organisations<sup>16</sup> have frequently focussed on the importance of individual conditions or characteristics of research, such as how important direct policy-makers' demand for a specific piece of research is for it to influence actual policy. The QCA served to broaden this predominant framing and to acknowledge the complex interplay of factors required for change to happen – a framing that better suits CDKN's adaptive management practices.

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<sup>16</sup> E.g. Young, J & Court, J, 2004, *Bridging Research and Policy: Insights from 50 Case Studies*. ODI Working Paper 213; DfID, 2013, *Research uptake. A guide for DfID-funded research programmes*.

# Theoretical framework and methodology

## Theoretical framework

The CDKN research portfolio explicitly aims to maximise the **uptake of research** findings from the projects it funds. While enhancing academic understanding is important, CDKN is particularly interested in influencing policy, plans and practice. Research uptake is defined as the direct or indirect use of CDKN-commissioned research by subsets of the target audience, consisting of government officials, funding agencies, multilateral organisations, civil society or business representatives working in the broad area of climate change mitigation, adaptation and development. Uptake can take the shape of research being referenced by or implicitly influencing concrete policies and plans as well as influencing more informal practices, and collaborations amongst these key stakeholders. Evidence for use usually consists of direct testimonies and explicit examples from these stakeholders, unless use can be demonstrated in other more direct ways.

Considering that two to three years (the maximum extent of time between the end of a project and CDKN's impact reviews) is still a relatively short time span to observe contributions to policy change, the threshold for an outcome to be considered 'positive' in this case was set relatively low. For example, where research was still being actively discussed in key policy *fora* and where policy-makers intended to integrate research in tangible policy outputs and processes, this would have been coded as 'uptake'. At the same time, 'uptake' in some cases signified research feeding directly into policy, budget allocations and implementation on the ground.

The **Theory of Change** underlying CDKN's research is complex and evolving. CDKN's research is designed to be different from classic development research, by (1) explicitly articulating objectives relating to policy and practice changes, (2) responding to explicit and direct demand from decision-makers (often expressed in written correspondence) and (3) delivering high quality yet timely research in response to the questions they were asking.

As CDKN and its in-country presence matured, larger parts of the research portfolio have been focussed on CDKN's priority countries, where research interventions were envisaged to positively interact with CDKN's technical assistance, knowledge management and convening support for greater overall effectiveness and programmatic coherence. Based on evidence such as that from ODI's Research and Policy in Development (RAPID) programme, research uptake is understood to be more likely where demand is explicit and strong, stakeholders are engaged in the research process from the beginning, and research outputs are of high academic quality, written in accessible language and conducted by credible institutions.

However, given the relative youth of Climate Compatible Development (CCD) and the complex and evolving policy landscape within which it operates, CDKN also funds thought-leading research to fill knowledge gaps and advance understanding of important issues within CCD. This type of research lays the foundations for advancing policy and practice. Policy uptake is a longer-term and indirect prospect, with research impacts first seen in international fora before trickling down to domestic level, where tangible policy and practice changes may later be observed.

In aiming to achieve uptake, CDKN's process of research commissioning to date has followed a set of principles which, according to its ToC, are likely to lead to that desired uptake. In many cases these principles derive from relatively straightforward logic, but they have also been informed by existing literature and thinking on the subject and by the experiences of other research donors. During the research commissioning, some of these principles are translated into criteria against which research proposals are scored. For the purposes of this QCA study, these principles and our experience to date formed the basis of the variables against which the cases were scored and analysed.

**Conditions** to be included in the QCA were long- and then short-listed based on this ToC thinking in CDKN, which in itself had been influenced by staff's own experience as well as wider thinking in the research community. In several rounds of deliberation, the M&E and the CDKN Research Team – with the latter based at and drawing on thinking within ODI – arrived at a list of conditions including those deemed highly significant for the uptake and influence of research.

The following conditions were prioritised during the analysis (see Annex 1 for a comprehensive overview):

*Scale.* This variable refers to the scale at which the research was set, rather than the specific geographic location. Research without location-specific case studies is considered to be set at the 'global' level, and scores 0. Action-oriented research aiming for policy change in a specific locality, such as a city, is considered to be set at the 'local' level and scores 1. Between these extremes, research with case studies in multiple countries, or at national level, were given scores of 0.33 and 0.66 respectively. There is an assumption that the more strongly locally focussed the research is, the better its chances of uptake by policy channels.

*Policy-relevant knowledge gap.* This variable refers to the degree to which the knowledge gap articulated in the research proposal is described in terms of its relevance to policy, rather than purely its academic value. Projects which discuss the need for the research in the context of policy in the relevant country or locality, or define policy windows, target legislation and/or government stakeholders score highly. This is considered important as it serves to ground the research in the relevant policy environment; it demonstrates that the team is approaching the research in terms of its intended practical use, alongside its potential to further academic understanding. The emphasis CDKN has placed on policy-relevance in a proposal's discussion of a knowledge gap has evolved over time, and therefore some of the early projects funded were more academic in nature.

*Stakeholder demand.* Projects which, in their proposal, demonstrate demand for the research from the policy community are considered to have greater potential to achieve uptake of research results by that policy community. Ideally, specific government stakeholders or 'recipients' of the research are clearly identified, and have already expressed an interest in and need for the research. This demand does not necessarily need to be organic; in some cases, it is necessary for demand to be built by research partners through a process of awareness raising, for instance if a government is not taking a particular threat sufficiently seriously.

Whether organic or built, when reviewing proposals CDKN looks for evidence of that demand. This could take the form of a letter of support, an official document stating the need for research on the topic, or active involvement of a government stakeholder in the project. There is an assumption made that all these forms of evidence are equal, but the reality is more nuanced – some letters of support are inevitably more meaningful than others, for instance. In addition, CDKN's thinking around what 'good' demand looks like has evolved since the early commissioning.

*Previous relationship between researchers and target audience.* CDKN considers that an established relationship between research partners and the relevant policy stakeholders, prior to the start of the project, enhances the extent and likelihood of uptake of research findings by that policy community. This is based on an assumption that an existing relationship will produce positive working relationships during the project, create trust between research and policy parties, and strengthen the research partners' understanding of the policy context and needs. Moreover, there is an assumption that where these important relationships already exist, more efforts can be spent on content early on, favourably interacting with other conditions listed here.

*Engagement with stakeholders.* A higher degree of engagement between research partners and policy stakeholders is considered to have greater potential to lead to uptake of the research findings. This includes consultation with stakeholders in defining the research questions and approach, and their continued involvement throughout the project, for instance through regular meetings or their active participation as partners in delivering the project. CDKN's understanding is that regular contact helps to build and maintain buy-in of policy stakeholders and their interest in research results, as well as to ensure that the research itself is designed and delivered with intended policy users in mind.

*Communication.* This variable refers to the nature of the materials used to promote the research results. This is often linked to other variables such as the policy-relevance of the knowledge gap, demand and degree of engagement, and at its core is determined by the extent to which the research outputs were designed and delivered with policy change in mind. Communication materials which have a clear policy audience, a strong strategy for reaching that audience (including ongoing engagement), and which provide direct, clear and accessible messages score highly.

*Credibility and research quality.* Credibility refers to the quality of the research and research outputs produced, and as with all academic research is measured here by submission and acceptance to peer-reviewed academic journals. Publication in high quality and well respected policy-oriented fora was also accepted here as a sign of credibility. CDKN considers this to be important as, without such credibility, there is a risk that research may be flawed and lead users to take bad decisions.

*Influence on discourse.* This relates to the uptake of the research and its influence in global or local (non-policy) fora. The ability of a research project to influence international or national debates and discourses is closely linked to its credibility, as without credibility the results are unlikely to be taken seriously by other experts working in the field. Invitations to present findings at high profile events, or references in important literature, for example, are considered to be indicators of influence in international or national fora.

*Planning for sustainability.* Recognising that the path to policy change is often a long one, usually beyond the length of a CDKN research project, projects with a strategy for continuing their work are considered to be more likely to achieve policy impact. Further work might take the form of additional research, or further engagement with existing policy partners, or plans to scale-up or replicate their work. Ideally, follow up work would be budgeted and planned for before the CDKN project closed – this scenario would have resulted in a high scoring of the condition.

*Degree of alignment with other CDKN work (alignment with design and implementation as separate variables),* in terms of the design of the project and through implementation. These two variables relate to internal factors within CDKN. The ‘design’ variable is about the degree to which a project aligns with CDKN’s priority countries, themes, and ideally CDKN’s portfolio of projects within a particular country. CDKN’s focus countries and themes have evolved over time, and were not clearly defined by the time that some of the projects reviewed in this QCA study were funded. Alignment with other CDKN work during implementation refers to the degree of interaction the researchers had with various parties in CDKN throughout the project, beyond their CDKN project manager. A project with a high degree of ‘alignment in implementation’ would often have worked with CDKN to produce a CDKN publication, publish blogs on the website, participate in CDKN events and even shape the direction of the CDKN ‘Country Programme’ within which it sits. This tends to be related to a project’s ‘alignment in design’, as projects located in CDKN’s focus countries or which are close to core themes will clearly have greater cause and opportunity to work with CDKN in this way. It is also often shaped by a project’s influence on international debates, and by its success in influencing policy.

While these are assumed to be important conditions contributing to research uptake, making systematic sense of how they interact and their relative weights presents a challenge. QCA was identified as an appropriate methodology to unpack this further.

## **Case selection**

Cases represent completed research projects commissioned by CDKN and conducted by a host of non-governmental organisations, research consultancies and academic institutes or universities. The cases were selected out of a pool of about 50 completed projects in total, on the basis of data availability. While data on the conditions could have been collected at any time, availability of data on the outcome variable – ‘Uptake of research by policy and practice’ – depended on sufficient time having passed between the end of the research project and initial uptake. As this is a long-term process, CDKN’s M&E team at the time of analysis had at its disposal 20 cases with full and conclusive information on all variables.

Note that there may be selection bias at play. Most of the projects with available impact data were commissioned early on in the lifetime of CDKN (2010 to 2012). The commissioning process and management of research projects was adjusted in later years, for instance, by using different commissioning criteria or establishing stronger strategic links with CDKN’s country programmes. CDKN has plans to continue adding research projects to the QCA framework as further cases, based on incoming data on the outcome variable from Project Impact Reviews. This has the potential to reveal whether patterns and trends in CDKN’s research and causal recipes are shifting.

## Coding the cases

The extent to which conditions and the outcome had materialised was coded using a four-point scale, to create a dataset for Fuzzy Set Analysis (FSA) with QCA. The scale is used to represent values for different types of data – primarily nominal (scale-points representing different permutations of a variable) and ordinal data (scale-points representing an ordered sequence of values against a variable). While many of the variables are of a conceptual nature, the intervals were considered to represent meaningful qualitative differences with implications for the likelihood of research uptake.

While the data was initially prepared to be used for FSA, it was later used for Crisp Set Analysis (CSA) only, as a first attempt at obtaining results. However, starting off with FSA allowed for easy conversion of data into binary values. The researcher doing the coding developed a narrative case file for each research project included in the study, which documented the coding decisions taken, case-specific context, and data sources used. The coding was cross-checked by a second and at times a third researcher, and discrepancies in views on how to code specific cases were resolved through discussion or further data collection<sup>17</sup>.

### An example for difficult-to-code conditions

Some conditions, such as ‘Scale’, are unambiguous and can be easily coded. In this case, the difference between two scores - “Project was set in one locality in one country” (score of 1) and “Project set in one country but including different regions within the country or project set at national level” (score of 0.66) – is relatively clear-cut. Conditions of this nature generally revealed no differences between two coders’ decisions.

Other more qualitatively framed conditions, such as “Extent of Stakeholder Engagement” were more open to interpretation by the individual researcher. For instance, drawing the boundary between “Consultation/involvement of policy-makers was rudimentary or ad-hoc” (score of 0.33) and “Consultation/involvement of policy-makers throughout project development and implementation” (score of 0.66) required a nuanced decision based on deep case knowledge. Conditions such as this one tended to result in more disagreement between coders. Disagreements were resolved by drawing on the project manager’s experience of the project and a final consensual decision by the whole team.

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<sup>17</sup> See Annex 2 for more details on coding.

## Data sources

A range of sources was used to establish the extent to which conditions were met and the extent and nature of impact achieved, in order to proceed with the coding process (Table 1).

For data on conditions	For data on outcomes
<ul style="list-style-type: none"> <li>• The original research proposals or Terms of Reference;</li> <li>• Progress reports generated during the projects by the research teams;</li> <li>• The knowledge held within the CDKN research team;</li> <li>• Online search for citations;</li> <li>• Supplementary evidence from research providers in response to written questions.</li> </ul>	<ul style="list-style-type: none"> <li>• Project Impact Reviews using primarily qualitative data on research uptake and impact;</li> <li>• Supplementary evidence from research providers in response to written questions.</li> </ul>

Table 1: Data sources used for coding of conditions

## Previous trends in CDKN’s research portfolio

While the QCA investigates configurations of conditions leading to an outcome, it is worth looking at trends within CDKN’s research first, focussing on the behaviour of individual conditions. This can provide hints as to where to look further during QCA.

Research uptake was observed in 10 out of 20 cases included in the QCA. When comparing the overall prevalence of conditions with their prevalence among ‘successful’ research projects, *credibility and research quality* emerges as the ‘gatekeeper’ condition for uptake as it is present in all cases with research uptake. Other conditions that had a higher likelihood of being strongly represented in successful research than in CDKN research overall – notably *targeted communication*, *explicit stakeholder demand*, and *stakeholder engagement* as well as *policy-relevant knowledge gap*, *influence on discourse and debates*, *scale* and *previous relationships*. While most of the cases are not strongly aligned with CDKN strategy at design and implementation stages, successful cases have a slightly higher tendency to be associated with strong alignment. The condition that does not seem to have a bearing on the outcome variable is *sustainability planning* (see Table 2).

Condition: High levels of...	Overall prevalence	Prevalence in cases with research uptake
Credibility and research quality	85%	100%
Policy-relevant knowledge gap	65%	80%
Influence on discourse	65%	80%
Communication	60%	90%
Stakeholder engagement	50%	80%
Scale	50%	60%
Previous relationship between researchers and audience	50%	60%
Stakeholder demand	50%	80%
Planning for sustainability	50%	50%
Alignment with CDKN design	35%	50%
Alignment with CDKN implementation	40%	50%

Table 2: Factors represented in CDKN's research (in descending order of 'strength').

## Data analysis

Running cross-tabulation of the data before QCA - described in the previous section - revealed inconsistencies with two variables - *stability* and *receptiveness* - which behaved contrary to logic and which were therefore omitted from further analysis. The condition *credibility and research quality* was shown to appear in all cases that had seen research uptake but not in all of those cases without research uptake. This provided a strong hint at this condition being a necessary but in itself insufficient condition for research uptake. This is in line with CDKN's Theory of Change, which assumes that even where research targets different processes and different groups, particularly in the contested and high-cost realm of climate change, credibility of information is one of the main conditions for influence of research on decision-making.

The researchers used fsQCA software to produce truth tables and conduct the Crisp-Set Analysis (CSA). The CSA was first employed with all the conditions that had been identified as theoretically relevant in bringing about the outcome:

- scale of the research
- identified policy-relevant knowledge gap
- stakeholder demand
- previous relationship between researchers and audience
- stakeholder engagement
- targeted communication
- credibility and research quality
- influence on discourse and debates
- planning for sustainability

- alignment with CDKN design
- alignment with CDKN implementation

The initial round of analysis provided indications for variables that appeared to have no bearing on the outcome as a component of causal pathways. These variables were not prioritised in further iterations of analysis. The intermediate solution provided by QCA<sup>18</sup> – displayed *policy-relevant knowledge gap, alignment with CDKN implementation, alignment with CDKN design, planning for sustainability, targeted communication, influence on discourse and debates, stakeholder engagement* and *stakeholder demand* as factors that were part of causal pathways, offering explanations for all cases. The analysis was subsequently repeated with these conditions only to explore which conditions could be eliminated without changing the overall explanatory power of the model. An overview of findings is provided later in this paper.

Most of the individual factors that are significantly more prevalent (as much as or more than 15% more prevalent) in research that saw uptake than in the entire set of research cases reappeared as important variables in the causal pathways of the QCA. An exception to this is *alignment with CDKN design* – even though successful cases were more likely to display this feature than unsuccessful ones, it did not prove a necessary component of any causal pathway leading to the outcome. The case studies below also illustrate and confirm that this variable had little bearing on successful uptake of research by policy and practice in the majority of cases, even where research was situated in strategic focus countries for CDKN.

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<sup>18</sup> The intermediate solution in QCA is often chosen for more detailed analysis as it reduces the amount complexity provided by the comprehensive complex solution and the over simplicity of the parsimonious solution.

# QCA findings: which causal pathways lead to uptake of research by policy and practice?

## Overarching findings: what explains uptake of research by policy and practice?

The starting point of the analysis is the question:

**Which combinations of conditions lead to CDKN’s research being taken up by key stakeholders within two years?**

The following represents the intermediate solution provided by the analysis run with the fsQCA software<sup>19</sup>. The **solution consists of three pathways**, which taken together explain all the cases observed (overall coverage and consistency of 1.0).

It is notable that one of the identified pathways covers 80% of all relevant empirical cases. For these pathways, raw coverage (share of cases displaying the same configuration) and unique coverage (share of cases that can be explained fully with the pathway) are the same. Due to high unique coverage, there is no overlap of cases, meaning each case is covered by only one of these ‘recipes’.

	Raw and unique coverage	Number of cases covered	Causal pathway <sup>20</sup>	Outcome
1	80%	8	Credibility*Communication*Stakeholder Engagement*Demand*Influence on debates	Uptake of research by policy-makers and/or practitioners
2	10%	1	Credibility*Alignment with CDKN implementation*~Policy-relevant knowledge gap	
3	10%	1	Credibility*Communication*Policy-relevant knowledge gap*~ Influence on debates	

Table 3: Full intermediate solution provided by fsQCA.

The dominant pathway consists of *strong communication* of research findings, *strong engagement of stakeholders* throughout the research project, explicit *demand for the research* project by the target group and a high level of *influence on debates* as characterised by invitations to present in important fora or references in high profile literature or by influential figures.

In addition to this, *credibility* appeared to be acting as a necessary but insufficient condition for research projects to translate into research uptake – 100% of all cases that had seen initial research uptake also scored high on credibility, whereas of those 10 cases that had not seen uptake, three had scored low on credibility. This condition will be explored further below.

<sup>19</sup> See details on the parsimonious and the complex solutions in Annex 3.

<sup>20</sup> ‘\*’ signifies ‘and’ in QCA. ‘~’ signifies ‘absence of’.

Even though the remaining two pathways only cover a combined total of two out of the ten cases that had seen uptake, these indicate alternative configurations of conditions that can also lead to successful uptake, which is worth exploring more.

## Three causal pathways to research uptake

Since each case is covered by exactly one causal pathway as indicated by QCA, it is helpful to look at the real-life expressions of the pathways in order to acquire a better understanding of how they play out in producing the outcome. Examples of each pathway are described below. QCA provides us with the various combinations of conditions associated with an outcome without explaining how these interact and what lessons to draw from this. As such, it provides concrete guidance on what conditions matter more or less in what causal recipe while needing to be complemented by further collaborative sense-making and discussions in order to be truly useful.

### Causal pathway 1: Credibility\*Communication\*Engagement\*Demand\*Influence

#### Example 1: Tackling the health risks of extreme heat in India

**Why did we choose this case to illustrate this pathway?** This is a city level project which resulted in clear policy uptake, and which is now implementing a second phase. It is widely viewed across CDKN to be among its most impactful and successful projects, with a clear impact pathway at subnational level.

**What was the research about?** India has a long history of living with extreme heat, but the risks associated with heat waves have typically been underestimated by the authorities and residents alike. This situation is not unique to India; due to complexity in identifying heat-related illness and deaths, and as the impact of heat waves are less visually powerful compared to other extreme weather events, heat-related mortality is often underreported. Prompted by a severe heat wave which hit the city of Ahmedabad, Gujarat State in 2010, this project sought to better understand the heat threat in the city, identify the most vulnerable groups, and develop a prioritised plan of action which the city authorities could implement to enhance resilience to future extreme heat events.

**Which uptake of research by policy or practice was observed?** The project, a joint initiative led by the Natural Resources Defence Council (NRDC), the Indian Institute of Public Health (IIPH), and the Ahmedabad Municipal Corporation (AMC; the city government), directly led to policy change at the city level. This process began with a process of awareness raising by the NRDC and IIPH with the AMC, which motivated the AMC to work with the partners in tackling the heat-risk. By the end of the project, the partners had developed AMC's Heat Action Plan 2013, and the AMC had set aside a budget of \$100,000 US to implement the first phase of affordable, prioritised actions. The Heat Action Plan has been updated each subsequent year, and early indications suggest that these efforts are helping to reduce heat-related mortality in the hot pre-monsoon months.

### **How did the causal pathway produce the outcome?**

*Engagement with stakeholders:* In this case, engagement with the city authorities was the first step on the road to success, prior to the development of the research proposal which CDKN went on to fund. The AMC did not realise the extent of the impact that heat waves were having on the city's residents until estimated mortality figures for the 2010 heat wave were presented to them by the NRDC and IIPH. From this early engagement, the project partners built a relationship with the AMC which continued throughout the project. The AMC were directly involved in this research as a project partner, appointing a 'nodal officer' to lead on AMC's involvement and signing a Memorandum of Understanding with the other project partners. Workshops and meetings were held throughout the project with medical and government officials, who were also involved in supporting the development of the Heat Action Plan.

*Stakeholder demand:* The AMC's interest and motivation for tackling the impact of heat waves in the city of Ahmedabad was, and remains, central to this project's success. Because of demand from the AMC for this work, the research partners were able to work with them throughout the process, from establishing the aims and agreeing the approach of the research, and during the research process. The result was a locally-appropriate Heat Action Plan which is 'owned' by and meets the needs of the city authorities. However, it is important to note that this demand was 'built' rather than 'organic' demand, as outlined above.

*Communication:* The research communication strategy was oriented around informing municipal decision makers and mobilising action. A range of channels were used, including written briefing notes with recommendations for each of the identified vulnerable groups, and presentation and discussion of results with authorities to update on their findings and equally to integrate feedback into outputs. The Heat Action Plan itself was designed to provide a comprehensive, accessible, prioritised strategy with low cost actions which could be implemented in the short term, and longer-term options. This enabled rapid implementation of strategic activities the following year. By launching the Heat Action Plan at the start of a hot season, accompanied by a significant media push, the plan was launched with the momentum and support from both government and the public needed to realise action.

*Credibility and research quality:* Elements of this research were published in peer reviewed journals including the International Journal of Environmental Research and Public Health, though the academic world was a secondary audience here – the primary focus was on policy makers. Demand for further work expressed by the AMC and State-level authorities, and endorsement by the National authorities, also indicates a high degree of credibility.

*Influence on discourse:* The project had significant impact on the discourse on heat waves in India, and ripples beyond. As a result of this project Ahmedabad became the first city in South Asia to comprehensively address the health risks of extreme heat. The Plan received widespread media coverage, and Ahmedabad has been commonly highlighted as a 'shining star' in media articles discussing heat wave impacts in the country in the years since. Gujarat State officials, as well as authorities

in at least four other cities, expressed interest in similarly tackling heat risks. This 'scale out and scale up' process is already being supported in select localities as part of a second phase of the project. At the World Conference for Disaster Risk Reduction in Sendai, in March 2015, the project was selected as one of the top 20 for the Munich Re Risk Award 2015.

**Were there other factors that are not reflected in the QCA?** This project followed a reasonably straightforward path to impact, and one which was easily tracked through the QCA. However, the factors outlined above (Causal Pathway 1) were influenced by several other factors which are not reflected in this pathway. The fact that the project team approached this research specifically aiming to support policy change at city level as the core desired outcome (policy-relevance of the knowledge gap) was fundamental in this project. If the research had been conducted as a primarily academic exercise the result would likely have been very different. In addition, while a previous relationship between researchers and the target audience does not feature as part of this causal pathway, this is essentially embedded within the Stakeholder Demand element as the demand was 'built' through prior engagement which generated such a relationship.

## **Example 2: Designing games for forecast-based humanitarian decisions**

**Why did we choose this case to illustrate this pathway?** This project is very different from Example 1, which was set at city level and had a clear target policy audience. The research was not focussed on a specific location but was instead oriented at a regional level in Africa. Rather than aiming to directly achieve policy change in a particular locality or country, the project aimed to develop, test and pilot the viability of games as a tool to influence decision makers. Therefore, this project had two core audiences: organisations who might use these games as part of their own efforts to inform and influence decision makers, and the decision makers involved in piloting the approach.

**What was the research about?** From September 2011 to May 2013, CDKN funded the Red Cross/Red Crescent Climate Centre and its partners (START Secretariat and UNISDR Africa) to develop and pilot participatory games to help practitioners, decision-makers, farmers and institutions from different sectors to understand climate risks and associated trade-offs. The research sought to enhance the capacity of decision-makers to link climate knowledge with humanitarian and development action by employing experiential learning. In total the project designed 25 games exploring food security, the link between gender and vulnerability to weather events, supply chain logistics in the humanitarian sector, interpreting and acting on climate information, and disaster preparedness.

**Which uptake of research by policy or practice was observed?** In this case, numerous instances of uptake but little in the way of concrete policy changes were reported. After playing games with institutions such as the World Bank, universities, UNFCCC and the White House in Washington D.C., more than a hundred formal and informal partnerships – for instance with the World Bank, DfID and other donors – have been promoting this approach further. Some of these partners integrated games

into their work, others used them to make complex mechanisms more easily comprehensible to stakeholders, yet others have organised courses to promote games. A number of academic institutions, including Harvard, MIT, Yale, Oxford and the University of Cape Town, have begun to utilise the project's participatory games.

### **How did the causal pathway produce the outcome?**

*Demand from identified service recipient.* While the initial project proposal reveals implicit interest from the policy community, the Liaison to Policy Dialogue Processes from the United Nations International Strategy for Disaster (UNISDR) Regional Office for Africa played an active role in the project as a partner. UNISDR can be considered a primary service recipient in this case. Therefore, demand scored high on this factor.

*Stakeholder engagement.* External stakeholders articulated demand for project outputs after research completion, and stakeholders played an active role as partners – indicating a very high level of engagement. As previously mentioned, UNISDR played an active partner role throughout the project. What may have been more important in the constellation of factors is the aspect of ongoing demand, which is linked to the high level of influence the project has had in policy fora. Since the end of the project, in addition to engaging thousands of individual stakeholders in their trainings, the Climate Centre has worked with development organisations to help them utilise games-based approaches - for example, with the World Bank's Development Network's Chief Economist in designing workshops with high-level officials that featured a game on Deep Uncertainty.

*Communication.* Project outputs were targeting both a scientific and a practitioner audience effectively. In fact, the games had been specifically designed to engage the 'learner' more effectively than a presentation or written output. Also, the Climate Centre and partners pursued various avenues for publishing the project's progress and results in journals, working papers, policy briefs, research reports, a book chapter, videos and on its own website. The outputs had clear, accessible messages for policy makers, and while the strategy for uptake of those messages was not context-specific this was because the communication approach was designed for the significant breadth of intended audience (i.e. multiple contexts, levels of government etc.). This suggests strong iterative interactions with the conditions *stakeholder engagement* and *influence on discourse* over time.

*Credibility and research quality.* A high level of both credibility and research quality was established. Compared to other CDKN research projects, the project produced a relatively high number of scientifically oriented outputs. The flagship publication from this research was planned to be a journal article on the conceptual framework, but it grew in both supply of ideas and demand for information to the extent that the Climate Centre ended up writing a book which was published jointly by the Climate Centre and Boston University. Another two journal articles were published in the Journal of Urban Climate and the Journal of Climate and Development respectively.

*Influence on discourse and debates.* A very high level of influence was observed. The Climate Centre has received numerous invitations from global institutions to facilitate sessions. The project's visibility has established the Climate Centre and partners as

global leaders in participatory approaches for promoting climate risk management. This has prompted rapidly growing demand for training, partnerships, further game design to address partners' specialisms, and facilitation of games-based initiatives from a diverse set of stakeholders ranging from the World Bank to Yale University. The games also directly linked into the US White House – the Climate Centre played a game on disaster risk management with 130 participants there in September 2012. The project also received a large amount of media coverage, with over 63 media outlets covering the project in less than two years, both in print and broadcast and in a number of languages. This highlights the global interest in this new approach.

**Were there other factors that are not reflected in the QCA?** What seems to have been relevant in this case – though not as an isolated factor – is that the funding enabled the Climate Centre to invest in internal capacity on the games approach and publicise it widely. They have been carrying on a multitude of activities since this project ended, with additional donor funding. Thus, it was also the funding modality employed by CDKN – giving a large amount of core funding to testing an approach in a situation where the Climate Centre could not have proceeded without it – that made this case a success story. Another factor that appears to have been at play here was innovation and its emphasis on 'fun learning', increasing the research's appearance of novelty.

## **Causal Pathway 2: Credibility\*Alignment with CDKN implementation~policy-relevant knowledge gap**

### **Example: Achieving triple wins: identifying climate smart investment strategies for the coastal zone**

**Why did we choose this case to illustrate this pathway?** This was the only case which followed this causal pathway, so it merited separate consideration.

**What was the research about?** 'Triple Wins' in this project referred to activities that can reduce emissions, enable people to adapt to climate change and enhance local livelihoods. By determining the potential co-benefits (and possible damages) of adaptation and mitigation activities in coastal areas, the project aimed to enhance understanding of appropriate adaptation and mitigation priorities, and trade-offs between such policies, in the coastal zone. The project attempted to respond to a lack of readily accessible information to guide decision-makers and coastal planners in prioritising action that brings co-benefits of adaptation and mitigation in coastal zones. Its geographic focus was on Belize, Ghana, Kenya and Vietnam.

**Which uptake of research by policy or practice was observed?** There has been some uptake of this research in expert or academic communities. Project team members contributed to a UNEP publication on ecosystem-based approaches to adaptation, citing 'triple wins' research from Ghana, Kenya and Belize. While the concept of triple-wins is widely echoed in the climate change sector, this predates the end of the research and thus, there is no evidence to suggest this is due to the

influence of the project. In addition, it has been reported that the outputs informed the finalisation of Ghana's National Climate Change Policy, and the Kenyan National Performance and Benefits Measurement Framework as part of the National Climate Change Action Plan. This claim is strengthened by the language used in the plan.

### **How did the causal pathway produce the outcome?**

*Credibility:* The research was captured by a working paper and a journal article submitted to Environmental Science and Policy, and presented at COP18. This does not appear to have been published, though may have informed a paper on a similar 'triple wins' theme by the same research team focussing on Sub-Saharan Africa. The project's other outputs were a set of case studies and policy briefs for national coastal managers in the four target countries, as well as a more generic brief.

*Alignment with CDKN implementation:* Adaptation and mitigation co-benefits are core to the concept of climate compatible development, and by aiming to enhance understanding of the opportunities and limits of these co-benefits the topic of this research is very close to CDKN's core themes. Members of the research team joined a CDKN panel to explore these questions at a public event, though no joint written outputs were produced.

*No policy-relevant knowledge gap:* The project proposal identified a lack of readily accessible information to guide decision makers / coastal planners in prioritising action, and to identify co-benefits between adaptation and mitigation in the coastal zones. However, the research problem was outlined primarily with regard to a gap in academic or expert understanding. The research attempted to fill this gap, but there was no significant focus on influencing specific policy processes or stakeholders.

These conditions worked together in leading teams engaged with CDKN work beyond this particular project to take up the findings of this research in their own work, in the absence of an identified and narrow decision-making channel that this project could feed into directly.

### *Were there other factors that are not reflected in the QCA?*

This project was different from many other CDKN projects in that it did not heavily invest in tailored communication and responding to a narrowly defined policy-relevant knowledge gap.

Given that this project was active in four different countries it would be comparatively more difficult to target specific policy processes in each locality, and therefore this project could be an example of research which achieves uptake despite not closely targeting specific policy processes. However, this causal pathway suggests that this lack of policy focus played an active part in the uptake it achieved. It is possible to consider the lack of a knowledge gap as a contextual factor in this case – under this condition, alignment with CDKN's work was necessary to achieve some degree of uptake. This warrants further consideration.

### **Causal Pathway 3: Credibility\*Communication\*Policy-relevant knowledge gap~influence**

#### **Example: Advancing climate compatible development for food security through the implementation of national climate change strategies**

**Why did we choose this case to illustrate this pathway?** This was the only case that corresponded to the causal pathway. In some regards, this piece of research played out in unusual ways in securing uptake.

**What was the research about?** This research, supported by CDKN from January 2011 to August 2014, and implemented by a consortium of NGOs and research organisations set out to develop funding concepts for adaptation and mitigation in the agriculture sector, targeting the national climate change strategies of Bangladesh, Honduras and Kenya. The research aimed to provide policymakers, in particular those in the three case study countries, with the tools to harness climate finance for food security in national climate change strategies. The project outputs were envisaged to assist policy-makers in establishing national climate strategy 'gatekeepers', integrating climate funding in the agricultural sector while maximising mitigation, adaptation and food security benefits. Ultimately, the project sought to contribute to increased food security and decreased agricultural emissions in the case study and other developing countries.

**Which uptake of research by policy or practice was observed?** Uptake in two of the case study countries was observed for this research. For Honduras, there are some indications that this project contributed to the development of a National Node for Agriculture and Food Security. A Subcommittee on Agriculture and Food Security was reportedly constituted in response to the project's recommendations and serves as a joint platform for stakeholders within the inter-institutional Technical Committee on Climate Change of Honduras, coordinated by the Ministry of Resources and Environment (SERNA). Regional Development Councils (CDRs in its Spanish acronym) were identified and proposed as a feasible private/public local platform to become the gatekeeper institution responsible for the management of potential resources from climate funds. In Kenya, the Ministry of Environment, Water and Natural Resources was reported to have developed a training strategy for county stakeholders on integrating climate change into development plans. There is little evidence to suggest the research was meaningfully feeding into policy channels in Bangladesh.

#### **How did the causal pathway produce the outcome?**

*Identified policy channels and knowledge gap.* The project team early on identified a gap in available knowledge on how to develop fully integrated approaches to mitigation and adaptation in agriculture. At the same time, they realised that an increasing number of developing countries (including the case study countries) had been preparing national climate change strategies. The team aspired to address these strategies' main purpose of providing a repository of proposals that could be funded by climate finance from developed countries.

*Credibility and research quality.* The project aimed for publication in several peer-reviewed journals early on, as well as for integration of outcomes into the fifth IPCC Assessment Report. The paper has been accepted by Climate and Development for publication in 2015.

*Communication.* Research results were disseminated at the UNFCCC negotiations COP17, COP18 and the Subsidiary Body for Implementation (SBI) 38, several international conferences and at domestic meetings in Kenya, Bangladesh and Honduras, including bilateral talks with policy makers in the three countries. Findings were also shared at the 7th community-based adaptation conference in Dhaka and CDKN's Deputy CEO presented key outcomes at the Asia LEDS Forum in Manila. The team also placed a lot of emphasis on tailored dissemination via final workshops and personal meetings with high-level representatives.

*No/low influence on discourse and debates.* The project was represented at several UNFCCC-events and the team had plans to distribute the findings to influential contacts, but there is no evidence of influence on global or local discourses or wider uptake and interest by the scientific or practitioner community.

**Were there other factors that are not reflected in the QCA?** In this particular case the 'knowledge gap' was particularly strong, and was linked to policy windows for national climate change strategies. The analysis hints at the possibility that where research is targeting a strongly policy-relevant knowledge gap and combines this with strong tailored communication with the target audience, the other conditions emerging in the dominant causal pathway – *stakeholder demand, influence on debates and stakeholder engagement* – are not necessary to bring about some degree of research uptake.

## ***Credibility and quality of research as a necessary condition***

In CDKN's Theory of Change of how research findings are taken up by stakeholders, credibility plays a particularly important role. Anthropogenic climate change (resulting from human activity) is a particularly contested area, with continued emphasis on the uncertainty of the climate science itself by powerful lobbies and governments, as well as a disproportionate coverage of sceptical voices by the media. Therefore, it has been assumed that research needs to come from a particularly credible source in order to be taken up by decision-makers. This credibility can be generated through publication in established journals where rigorous peer review ensures objectivity and reliability of data and conclusions. The study findings have not disconfirmed this assumption as **credibility has been shown to be the one 'necessary condition'** to research being taken up, for the cases investigated.

## Conclusions and implications of the QCA for CDKN's research portfolio

The findings mostly confirm CDKN's existing thinking but also uncover a few surprises.

The factors highlighted in **Causal Pathway 1** reflect elements CDKN already looks for in new projects, and each are reflected in the evaluation criteria to some degree. However, some of the QCA findings are surprising. All the factors included in the QCA framework were assumed to increase the likelihood of success if present. Thus, some elements that had previously been assumed to be crucial or at least decisive for uptake were found to play no notable role in causal pathways in themselves – such as *previous relationships between researchers and policy-makers, close alignment with CDKN strategy at a planning and implementation stage, and explicit forward-looking sustainability planning* by the research team beyond the duration of the funded project. This does not mean that these factors by themselves do not contribute anything in specific project situations but that they were not found to be part of causal pathways that are sufficient for bringing about uptake of research. In addition, this sheds light on the interplay between some of these variables. For instance, while a previous relationship between the research partners and policy makers was a core building block of the demand and engagement seen in the Heat Health project, this factor alone does not necessarily lead to success.

The analysis also uncovered further questions, which can be tackled by adding data from more recent research projects to the QCA data set and by running a Fuzzy Set Analysis as opposed to a Crisp Set Analysis. For instance:

- Some of the QCA findings already mirror CDKN's updated Theory of Change of how research uptake happens. Due to the time lag expected between research completion and research uptake, the research projects included in this QCA tended to be among the early ones in CDKN, which had not benefited from iterative learning.  
→ *Would an inclusion of more recent projects shift the causal recipes identified through this inquiry? In other words, how has adaptive strategizing and management of CDKN's research portfolio looked in practice and what rates of research uptake is it associated with?*
- Research uptake in reality manifests itself in various ways, some more desirable than others. For instance, research actually resulting in a subnational plan with a corresponding budget allocation from the government is an outcome that is qualitatively different from subnational planners merely using a piece of research as part of a curriculum to train government officials. The present binary coding does not reflect these nuances in outcomes, nor in conditions.  
→ *What are the causal recipes for research that actually influence policies and planning versus those that trigger or shape more informal practices? Might the causal recipes for research targeting different levels of policy look different?*

The CDKN team will continue to explore the use of QCA as an empirically grounded guiding tool to start answering some of these difficult questions.

# Challenges of using QCA methodology and areas to be explored

## Challenges of using QCA

Some of the QCA-related challenges that were faced were general in nature. What started as an internal research project quickly required some degree of external expertise on QCA and more importantly on use of the software, fsQCA. What the team found was that there was **little guidance** available that is easily digestible and accessible to those unfamiliar with QCA. Thus, for people curious about the method, the threshold for actually piloting it is relatively high. While principles and QCA process are accessible to someone with basic training in data analysis and social sciences, operating the software might initially and at some point in the process require a degree of technical expertise and quality assurance. As with Randomised Control Trials, there is a tendency for external and specialised expertise to be necessary for a rigorous application of the methodology. As a barrier related to this, there were few examples available from which to learn. While QCA has been used more widely in the social sciences, little appears to have been done to document efforts at applying it under conditions typically encountered in a civil society or third sector environment.

Most challenges were more methodological in nature:

- When employing QCA for effectiveness-focussed inquiries such as the one we attempted, there is always the issue of **time lag**: there might be a tension between the need to obtain a sufficient number of cases on which effectiveness data is available and decision-making windows and opportunities within organisations. Beyond this, further challenges linked to the lag between implementation and (expected) effect relate to **staff turnover** and the relatively high probability that those most intimately familiar with the project and its unrecorded details will have moved on from their positions. This becomes particularly relevant when making sense and trying to draw conclusions from the findings – matching the causal recipe with the reality of a project by elaborating on case studies.
- The evaluation of **policy influencing** interventions (whether this relates to traditional advocacy or technical assistance) faces particular challenges where claims about conditions and outcomes **can be highly politicised**. The target group may not necessarily be open about what influenced their attitudes and behaviour or researchers might not always want to reveal all the strings they pulled to get people to listen. This becomes problematic with QCA as the methodology cannot deal with missing values for the conditions influencing an outcome for a case. Essentially this means that only cases where complete information is available on all the specified criteria can be included in a QCA study.
- Some development organisations and their staff are under internal and external pressure to demonstrate results and produce ‘stories of change’. While there has been a shift in discourse towards openness to failure and learning from what did not go well, in reality a lot of practice remains **biased towards demonstrating success**. Potential difficulties from this might arise for QCA, which relies on the occurrence of both positive and negative outcomes.

- While it accommodates complex causal pathways well, the formula produced by **QCA does not tell the whole story**. Where decision-making about what research to fund and how to manage ongoing research is concerned, a QCA hastily or incorrectly done will lead to low confidence in findings and low utility.

Other challenges were not necessarily QCA-specific, for instance, we encountered the risk of coding bias among researchers that were also involved in elaborating the theoretical framework. We guarded against this as much as possible by employing multi-researcher coding of the same variables and discussions where discrepancies had emerged. Also, CDKN only had outcome data on a relatively small number of cases<sup>21</sup>. This meant that further disaggregation of analysis was not possible – for instance to isolate causal paths for research projects aiming at changes at the global level or other variables that are often at the heart of designing commissioning strategies.

## Tentative lessons on QCA for the field of M&E and impact evaluation

Based on our experience, we can offer a few reflections on the usability of QCA for M&E:

- The approaches that M&E and research employ often heavily overlap but M&E tools need to be practically feasible and provide decision-making value to stakeholders, even with less than perfect levels of resourcing and rigour. The QCA does not produce an unambiguous list of explanations, and needs to be informed by programme logic and theory of change thinking. It in turn relies on an organisation's reflective culture, capacity and willingness to engage with findings thoroughly, to arrive at a set of usable recommendations. The great importance of a rigorous coding and data management process makes it a **highly resource-intensive exercise** that some organisations with small research or M&E budgets may find difficult to justify.
- Using fsQCA, in the absence of pragmatic and user-friendly manuals, relies on initial assistance and advice of a **technical** expert. However, the analysis and decisions on what to look at more closely are best taken by someone with good knowledge of the subject matter and context.
- QCA should only be attempted if there is full buy-in and understanding of the purpose of the methodology i.e. not to capture the effectiveness of a single condition (as is the case in many other approaches) but rather to **serve a learning focus**.
- Building QCA into the **workings of an M&E system** early on as an explicit vehicle for testing assumptions in a Theory of Change would ensure to some extent that the deep case-based knowledge that is required does not get lost over time due to staff turnover, as it is challenging to reconstruct cases years after they have been finalised (when impacts may be becoming visible). There are clear links with developmental evaluation, where the focus is on adaptive learning rather than accountability and the evaluator can be embedded as a member of the team<sup>22</sup>.

<sup>21</sup> Most guidance notes on QCA recommend using at least 5 to 8 cases, however, these would need to have been rigorously chosen in order to minimise bias and increase confidence in the findings. This QCA included 20 cases.

<sup>22</sup> Gamble, 2008.

- QCA is **likely to constitute one piece of evidence** that can be added to what is already available to weigh for or against an argument. While it provides a rigorous and transparent process to drawing out patterns and going beyond the importance of single factors, it also necessarily reduces causal complexity by limiting the number of variables one can realistically look at. Some might feel it does not capture nuances enough to provide much value beyond challenging or strengthening assumptions about how change happens.

Having embarked on the QCA journey for the first time, we would recommend that **QCA may be most useful as part of an M&E system** where a significant amount of data collection has already been done.

INTRAC and CDKN remain interested in exploring further how QCA could be used for rigorous learning about assumptions and Theory of Change thinking as opposed to one-off (meta) evaluation. QCA has great potential as a learning approach that capitalises on the qualitative data CDKN gathers on impact and individual research projects and draws out patterns with the potential to inform strategic and operational decisions within the organisation. While some of the findings confirmed internal assumptions, some conditions commonly considered of utmost importance to research success were not a necessary component of causal pathways leading to the desired outcome. Increasing the number of cases in the QCA, based on recent project impact reviews, will allow for greater confidence in findings, and will allow for monitoring of old and new assumptions over time.

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# Annexes

## **Annex 1: Theoretical and coding framework**

The following are some initial suggested criteria for the CDKN research study.

It is important to note that QCA relies on developing a series of ratings which can be consistently applied across all cases. This means that we cannot use abstract concepts or criteria that could be assessed in some cases but not others. In general, considered opinions of staff and stakeholders will be given more weighting than written descriptions of what 'should' happen. We are concerned with observable criteria, not abstract concepts.

By and large the evidence needs to come through:

- The initial proposal
- The project impact reviews (or evaluation investigations)
- Discussions with the PMs or suppliers concerned

Note that it is not the intention to produce scales which are always incremental in terms of positivity. The scales are based around 'inclusion'. This means data can be looked at with all cases that meet criteria ('1') or all that meet at least criteria ('0.66') or all that meet at least criteria ('0.33') separately.

Thus, for examples, the 'global or local' criteria are really there so we can separate out data for different kinds of projects.

Table 4: Theoretical conditions and qualitative thresholds

<b>Criteria</b>	<b>'0' (not in set)</b>	<b>'0.33' (slightly in set)</b>	<b>'0.66' (mostly in set)</b>	<b>'1' (fully in set)</b>
<b>Scale:</b> whether the research was designed to influence concrete plan, policy or practice or to influence global debates	Project set at global level.	Project covered more than one country.	Project set in one country but may have included different regions within the country, or project set at national level.	Project was set in one locality in one country.
<b>Previous relationship between supplier and policy-makers:</b> whether the supplier of the research already had engagement with the policy-makers concerned	No previous relationship between supplier and policy-makers.	Some informal relationships between supplier and policy-maker.	Supplier had pre-existing relationship with policy-makers through work on other projects.	Supplier had pre-existing relationship with policy-makers through research work relevant to the topic.
<b>Receptiveness of policy environment:</b> whether the policy environment was receptive or not	BTI status index $\leq 5.5$	BTI status $>5.5$ and $\leq 6$	BTI status $> 6$ and $\leq 7$	BTI status $>7$
<b>Stability:</b> the stability of the environment (for local projects in particular)	State Fragility Index of 16-24	State Fragility Index of 8-15	State Fragility Index of 4-7	State Fragility Index of below 4
<b>Alignment with other CDKN work (design):</b> degree of alignment with CDKN Country Programmes and Outcomes in design	Not in a CDKN focus country; topic not directly relevant to CDKN Outcomes and themes.	In a CDKN focus country but topic not relevant to country programme strategy or CDKN Outcomes/ themes.	In a CDKN focus country and broad alignment of topic with country programme strategy or CDKN Outcomes/ themes.	Fills a known gap in a CDKN country programme OR clearly builds on existing country programme work, AND fills important knowledge gap relating to CDKN Outcomes/ themes.
<b>Alignment with other CDKN work (implementation):</b> extent to which the research contributed to CDKN work	Project closed with no engagement with CDKN KN, learning or Country Programme activities.	Some engagement with CDKN KN, learning or Country Programme activities but piecemeal with no sustained	Involvement in CDKN KN, learning or country programme activities resulting in CDKN Inside Story or similar on the project	Project came to be seen as core part of CDKN programme – has shaped future Country Programme

across Country Programmes and Outcomes through delivery		engagement or tangible outputs.	findings/ drawing on project learning.	portfolio and/ or interest in a second phase.
<b>Addresses policy-relevant gap in knowledge:</b> degree to which the pre-articulated knowledge gap was policy-relevant	Discussion of knowledge gap is entirely academic – no explicit mention of policy-relevance.	Discussion of knowledge gap mentions relevance to policy on the topic but nothing specific to the focus country.	Discussion of knowledge gap includes relevance to policy in the context of the country.	Clear articulation of policy relevance of research in that country/ locality, with policy windows, target legislation and/ or stakeholders in government defined.
<b>Demonstrated policy demand:</b> to what extent the research was carried out in response to demonstrated demand from specific policy-makers	No interest or demand from policy community.	Some interest from the policy community but no observed demand and no clear service recipient.	Service recipient defined and interest from the policy community, but no explicit evidence of demand.	Explicit demand from policy community outlined in official documents, letter of support, evidenced by policy stakeholders' active role in project or similar.
<b>Sustainability planning:</b> to what extent the research planned beyond the period of the research (by the end of the project – on the basis of end of project reports)	No planning was made beyond the project period.	Some tentative activities were planned for beyond the project period.	The project clearly demonstrated potential for scale-up and positive socio-economic impacts.	Plans and budgets were forecasted beyond the project period, and the ongoing involvement of the project team and/or policy-makers was planned.
<b>Stakeholder engagement:</b> to what extent the proposed users of the research were involved throughout the project	No effective consultation or involvement of external stakeholders (policy-makers).	Consultation / involvement of external stakeholders (policy-makers) was rudimentary or ad-hoc.	Consultation / involvement of external stakeholders (policy-makers) throughout project development and implementation.	External stakeholders articulated demand for project outputs after completion of project and active participation by stakeholders. This can include where stakeholders have an active role as partners in the consortium.
<b>Research quality and credibility:</b> whether the	Research was never submitted to peer-reviewed	Project results submitted to peer-reviewed publications	Project results are submitted to international peer	Project results are published in international peer reviewed

research was carried out to appropriate standards	publications or failed to meet basic standards.	but CDKN had to provide considerable input to support research outputs.	reviewed publications or quality policy-oriented for a, without significant support from CDKN.	publications or quality policy-oriented for a.
<b><i>Influenced global / local discourse and debates:</i></b> how far the research influenced international debates and discourses	No significant input of project team in debates at global or local level.	Some limited inputs into global or local discourse and events but no evidence of influence.	Evidence of influence on global/ local discourse and debates e.g. through participation in events, findings referenced within relevant niche literature.	Evidence of significant influence on discourse and debates – eg. project team invited to present research in important fora, findings referenced in high profile literature or by influential figures internationally.
<b><i>Communication:</i></b> how well the results were communicated	Policy-relevant messages not identified and outputs not communicated to decision-makers.	Outputs had some messages for decision-makers but weaknesses in messaging (e.g. language not appropriate for target audience) or communications observed.	Outputs had clear, accessible messages for policy makers but no clear context-specific strategy for uptake of those messages.	Outputs had direct and clear messages for policy uptake, and were communicated through a clearly planned and context-specific strategy.
<b><i>Policy impact:</i></b> to what extent the research impacted on policies, plans and practices	No policy impact observed, in that it cannot be traced.	Clear pathways to policy change still exist for project, and work is being carried out informed by research.	Changes to policies, programmes or plans observed with a plausible contribution from the research.	Specific changes to policies, programmes or plans which are largely (more than 50%) attributable to the research (e.g. without the research the change would not have happened).

## Annex 2: Further details on coding and analysis

The following provides more detail on the coding and analysis process. While the initial data set was coded as a Fuzzy Set (with several qualitative thresholds instead of simple binary coding), it was subsequently turned into a Crisp Set with binary values for reasons explained in the main text.

It was generally felt that counting a rating of 0.66 and 1 for the conditions as fully in set for Crisp Set Analysis was appropriate and justified by the theory: 0.66 and 1 represented a condition's state theoretically much more conducive to the outcome than 0 and 0.33. Solely for the outcome variable – 'Research uptake by policy and practice' – fuzzy coding indicating at least slight membership in a set was turned into full membership in the process of binary coding. In other words, for the Outcome variable, all projects with '0.33' or above were counted as 'in set' for the crisp analysis and only those with '0' (half the cases) as not in set.

Points on scale	'0'	'0.33'	'0.66'	'1'
<b>Fuzzy Set</b>	Not in set	Slightly in set	Mostly in set	Fully in set
<b>Crisp Set</b>	Not in set	Not in set <sup>23</sup>	In set <sup>24</sup>	

Table 5: Turning a four-point scale (Fuzzy Set Analysis) into binary values for Crisp Set Analysis.

For the intermediate solution, an assumption was made that the presence of each of the factors would contribute to the outcome, as the coding is unidirectional (that is, the highest score always implies membership in the set, the lowest score always implies no membership). The interpretation of data focussed on the causal pathways identified by the intermediate solution<sup>25</sup>.

The intermediate solution displayed *gap, implementation, design, sustainability, communication, influence, engagement* and *demand* as factors that were part of causal pathways, offering full coverage of cases. The analysis was subsequently repeated with these conditions only.

<sup>23</sup> Policy and practice uptake – the Outcome – is an exception.

<sup>24</sup> An exception to this rule were the conditions Stakeholder Engagement and Sustainability. Following coding and initial analysis, the calibration chosen was seen to be inaccurate and therefore adjusted. Only original coding of 1 was counted as in-set for the binary analysis as the threshold overall had been set too low to be meaningful.

<sup>25</sup> Most guidance in literature on QCA highlights the intermediate solution as most useful as it allows for some degree of simplification based on theory unlike the complex solution, and avoids oversimplification often reflected in the parsimonious solution. See Legewie 2013, p. 13f.

## Annex 3: Comprehensive overview of QCA results

### *Intermediate solution*

	communication*influence *engagement*demand	implementation*~gap	gap*communicatio n*~influence
<b>Consistency</b>	1.00	1.00	1.00
<b>Raw coverage (# of cases)</b>	0.80	0.10	0.10
<b>Unique coverage (# of cases)</b>	0.80	0.10	0.10
<b># of cases explained</b>	8	1	1
<b># of cases explained uniquely</b>	8	1	1
<b>Overall solution</b>			
<b>Consistency</b>	1.00		
<b>Coverage</b>	1.00		
<b>Simplifying assumptions</b>	All conditions must be present.		

### *Parsimonious solution*

	~influence*com munication	~gap*implement ation	demand*commu nication	demand*engag ement*influen ce
<b>Consistency</b>	1.00	1.00	1.00	1.00
<b>Raw coverage (# of cases)</b>	0.10	0.10	0.80	0.80
<b>Unique coverage (# of cases)</b>	0.10	0.10	0.00	0.00
<b># of cases explained</b>	1	1	8	8
<b># of cases explained uniquely</b>	1	1	0	0
<b>Overall solution</b>				
<b>Consistency</b>	1.00			
<b>Coverage</b>	1.00			

Complex solution

	demand*engage ment*influence* communication* ~implementation	demand*engage ment*influence* communication* gap	~demand*~enga gement*~influen ce*~communicat ion*~gap*imple mentation	~demand*~eng agement*~influ ence*communi cation*gap*~im plementation
<b>Consistency</b>	1.00	1.00	1.00	1.00
<b>Raw coverage (# of cases)</b>	0.40	0.70	0.10	0.10
<b>Unique coverage (# of cases)</b>	0.10	0.40	0.10	0.10
<b># of cases explained</b>	4	7	1	1
<b># of cases explained uniquely</b>	1	4	1	1
<b>Overall solution</b>				
<b>Consistency</b>	1.00			
<b>Coverage</b>	1.00			

**Analysis of Necessary Conditions**

Outcome variable: impact

Conditions tested	Consistency	Coverage
location	0.600000	0.600000
previous	0.600000	0.600000
receptiveness	0.300000	0.333333
stability	0.300000	0.300000
design	0.500000	0.714286
implementation	0.500000	0.625000
gap	0.800000	0.615385
demand	0.800000	0.800000
sustainability	0.500000	0.500000
communication	0.900000	0.750000
influence	0.800000	0.615385
credibility	1.000000	0.588235
engagement	0.800000	0.800000

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