Quantifying qualitative case study research with QCA: implications and process of the method from the example of a study on inter-organizational collaboration

Amélie Artis, Anne Bartel-Radic, Hezam Haidar

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ABSTRACT

This chapter discusses the quantification of qualitative case study research with the QCA method on the example of a study of inter-organizational collaboration. The study explores collaborations between companies and not-for-profit organizations implementing projects in the renewable energy sector, using secondary data. Qualitative comparative analysis permits to identify the success factors of these collaborations. The chapter details the opportunities and limits of this method of analysis, and its implications for researchers using qualitative case studies.

KEYWORDS: Inter-organizational collaboration, Not-for-profit organizations, QCA (Qualitative Comparable Analysis), Renewable energy sector

INTRODUCTION

For more than thirty years, there has been an opposition between quantitative and qualitative research methodologies in the field of management science. Beyond the fact that the two categories of methods answer different and complementary objectives (Bergadaà and Nyeck, 1992), the quantification of qualitative data can contribute in closing the "gap" that continues to separate them. One of the methods used to quantify qualitative data is QCA, Qualitative Comparative Analysis, also called comparative qualitative analysis (Ragin, 1987, Rihoux, Marx and Alamos-Concha, 2014). Although the increase in using QCA in management was predicted more than ten years ago (Chanson et al., 2005), and despite a significant growth since 2005 (Rihoux, Alamos-Concha, Bol, Marx and Rezsöhazy, 2013; Kan, Adegbite, El Omari and Abdellatif, 2016), researchers still largely ignore this method. Its interest lies in the analysis of the causal complexity that involves different combinations of conditions, capable of generating the same result on samples of intermediate size.

The objective of this chapter is not to re-describe the QCA method and its past or potential uses for the study of organizations, but to discuss the interest of this method among the different methods of quantifying qualitative data for a didactic purpose. This method, initiated in comparative political science, is increasingly used in sociology and management science, particularly in strategy (Wagemann et al., 2016, Rihoux et al., 2013) and in management (Seny

Kan et al., 2016). The challenge for its founder, C. C. Ragin (1987), was to develop a social science method that articulates "case-centered" and "variable-centered" approaches (Rihoux et al., 2014: 77). Even though other uses are possible, and sophisticated and computerized variants have been developed, we argue that the "basic version" of the QCA deserves to be better known by researchers collecting qualitative data in case studies.

We rely on a study that we conducted on inter-organizational collaborations, in which we used the QCA method for the analysis of collected data. Based on this study, we will discuss the opportunities and limitations of this method for social scientists. Through our example, the challenge is to present research protocol of a study to discuss the methodological choices faced by social scientists and the contributions of the QCA method compared to other methods. The originality is to explain the "unthinking" methodological and their "naive" techniques (Sims, 2010). In our example, we are interested in the success factors of collaborations between companies and non-profit organizations (associations, NGOs, research organizations and public) to implement a project in the renewable energy sector - for the vast majority. In some cases, it involves the construction of power plants using renewable energies (solar, hydro, wind and geothermal).

We will proceed as follow: in the first part, we will present the theoretical framework and the problematic of the study on the collaborations between organizations of different natures. In addition, we will question the opportunity to approach them with the QCA method compared to other methodologies. In the second part, we will present the empirical data collected on thirty cases of collaborations in detail, and their analysis with the QCA method. Finally, taking inspiration from this research example, we will discuss the contributions and limits of the QCA method for management science and propose recommendations for its further use.

1. CONTEXT OF THE RESEARCH: THEMATIC AND CHOICE OF ANALYSIS' METHOD

We will first briefly present the literature on the subject studied, the inter-organizational collaborations in the renewable energy sector, before addressing the interest of retaining the QCA among the various methodologies that can be considered in order to carry out a study on the topic.

1.1. Review of the literature on inter-organizational collaborations in renewable energy projects

Renewable energies are a sector of technological innovation implemented by large multinational companies. Often created by governments, large companies in the energy sector today have more and more injunctions to meet the challenges of the energy transition (Reverdy, 2014). Yet these companies are not significantly engaged in the transition. Few take financial risks in order to take care of environmental and social issues. This type of behavior is not spontaneous because it is expensive, difficult to guarantee and often not rewarded in the market - despite the incentives emanating from public players and changes in consumer behavior (Chanteau, 2011).

The commitment of companies to corporate social responsibility (CSR) can be explained on the one hand by the search for a better image among consumers, public actors and civil society, and on the other hand by the improvement of the competitiveness of a company. In fact, this commitment involves collaborating with different stakeholders, especially civil society organizations. Indeed, companies that demonstrate a stronger commitment to CSR will have a greater propensity to collaborate with NGOs than those with lower engagement (Den Hond et al., 2012). Interactions with external stakeholders can provide a firm with several types of resources (Pfeffer and Salancik, 1978, Barney, 1991): expertise and know-how, legitimacy and reputation, new forms of communication, and preferential access to supports from key players outside the company. The choice to engage in CSR is linked to the specific vulnerabilities and opportunities of the company (Smith, 2003). External pressures are also an important incentive for collaboration: the worsening of environmental crises (Gray, 1989) or the political and economic situation (Dütting and Sogge, 2010). The context of CSR thus highlights the fact that resources and skills are not necessarily owned by a firm, but also reside in its collaborative relationships with other organizations (Dyer and Singh, 1998).

Work on corporate social responsibility highlights the role of large international institutions (World Bank, European Union, ILO, etc.), local NGOs, governments in developing countries (Elyachar, 2003, 2005), as well as business communities (Maurer, 2012), in development projects. The study of sectoral systems of production and innovation shows the relevance of taking into account market and non-market interactions to understand the changes in the industrial system (Bianchi and Labory S, 2013, Laurent and Du Tertre, 2008).

In many cases, inter-organizational collaboration occurs between businesses and non-profit organizations, such as associations. The associative organizations are collective private enterprises, not-for-profit (because of the absence or the limitation of the individual remuneration of the social capital) but which nevertheless participate in commercial exchanges and are fully anchored in our productive system. In several fields, they participate in the emergence and structuring of new sectors (textiles, energy, waste, eco-construction) with the specificity of integrating technological innovations as social innovations (Klein et al., 2014). Therefore, they participate in taking into account the economic, environmental and social dimensions to which the energy transition must respond.

The industrial economy and management sciences have for several years highlighted cooperations between firms, such as those in clusters, industrial districts or innovation centers (Forest and Hamdouch, 2009, Davis, 2016). While inter-firm relations are most often analyzed from the perspective of contract theory and its recent developments, this research seeks to question the success factors of inter-organizational collaboration. The special case of international joint subsidiaries has given rise to a relatively abundant literature. The success of these subsidiaries has been studied through different dimensions such as the survival of subsidiaries, financial performance, partner satisfaction, achievement of objectives and learning (Ren et al., 2009). The analyzed performance factors cover broad themes such as engagement, control and power, trust, justice, conflict and resolution, cooperation, cultural distance, and shared goals (Ren et al., 2009). The degree of diversity between the partner organizations influences the sustainability of these collaborations; a "medium" variety and a balance between the partners have a positive impact on the survival of joint multi-partner subsidiaries (Mohr, Wang and Goerzen, 2016).

1.2. The choice of analysis' method and the opportunities of QCA

Supporters of the quantitative model have always proposed a scientific criterion for their approach (Bergadaà and Nyeck, 1992). Admittedly, through the enumeration of things and the frequency of phenomena (Grawitz, 2001), only quantitative methods allow us to conclude on the possibility of statistical dissemination of results. However, the collection of quantitative data on a large number of observations can be difficult to achieve in management sciences, especially when the observed unit of analysis is at the organizational or inter-organizational level. Beyond that, qualitative methods have rich intrinsic qualities that have contributed to their development over the decades. They describe the essential qualities of the objects studied rather than counting frequencies. Often used in case studies, they make it possible to describe phenomena in a rich and contextualized way (Yin, 1989). Accused by "quantitative" researchers of not being scientific (Bergadaà and Nyeck, 1992), qualitative methods have been structured and analytical approaches have been specified (Eisenhardt, 1989, Gioia, Corley and Hamilton, 2012). But these approaches concern the rigor of the analysis of the data and the internal validity of the results, the statistical generalization of the results remains impossible. On the other hand, this method constitutes a new approach to study the causality between variables (Wagemann et al., 2016). The quantification of qualitative data appears as an interesting perspective to face these different difficulties, and to try to combine the virtues of these two categories of methods. We argue that the choice (or not) of a method for quantifying qualitative data must be made taking three parameters into account (see Table 1).

Methodology (software example)	Sample size	Data	Coding	Data Quantization Modes
(Crisp-set) QCA (fs/QCA)	Small to big, but mainly intermediate	Binary variables	Encoding qualitative data in binary variables	Upstream of data processing to enable analysis with Boolean algebra
Discourse Analysis (Sphinx, Alceste)	From a single case to many cases	Words / lexemes	No pre-coding by the researcher	The analysis aims at counting the occurrences of the lexemes, groups them together, places them on axes
Content Analysis (NVivo, Atlas.ti)	From a single case	Meaning / content	Qualitative coding	Downstream of the treatment, we can count the frequencies of occurrence of categories, the number of cases concerned by theme …

Table 1: Quantification Methods for Qualitative Data in Case Analysis

Ragin's approach was to consolidate the rigor of the comparative analysis of qualitative data by integrating statistical laws (Boolean minimization, treatment of logical cases) (Chanson et al, 2005). The QCA method then makes it possible to process intermediate samples[1] while

[1] According to Rihoux et al. (2014) the intermediate sample contains between ten and fifty cases.

maintaining the scientific rigor and always interrogating the chosen variables, their combination and the deviations from the expected results (Chanson et al, 2005). It makes it possible to understand the diversity of phenomena thanks to the causal heterogeneity, unlike the monolithic and causal linearity often induced by quantitative methods (Chanson et al., 2005). It thus makes it possible to conclude on the necessary or sufficient conditions for this or that result.

The QCA method was founded by Ragin (1987) in order to rigorously compare "cases" in comparative political science. First kept confidential, the number of research cases using this method strongly increased from the period 2003-2005, when the method was gradually adopted in other disciplinary fields such as sociology and management sciences (Rihoux et al., 2013). At the same time, like the other methods of quantification of qualitative data, the QCA method benefited from the development of computer software; the oldest and most well-known is fs / QCA, co-developed by Ragin himself. Today completed by and in competition with several other software, it corresponds to one of the variants of the method. The QCA went through profound changes over the years. The initial approach, called "QCA crisp-set" and based on binary variables has since been supplemented by the "fuzzy-set QCA" and "multi-value QCA" variants in which variables can take more than two values (Rihoux et al., 2014, Haesebrouck, 2016). These are difficult to envisage without the use of analysis software, which is not essential for the initial approach.

Several factors justify the choice to use the QCA method over other alternative methods. These elements are essential to validate the consistency of this method with the available material. First, the QCA method is particularly appropriate in work that questions complex causal relationships and multiple interactions (Fiss, 2011). The added value of this method is to understand how causes combine to create an outcome and then propose to model organizational configurations (Fiss, 2011). Beyond its ability to systematize the comparison of "intermediate" sample of case studies, the QCA method provides an alternative to conventional quantitative methods by comparing cases in multiple configurations. It studies the diversity and heterogeneity of cases according to different conditions and causally relevant contexts. Second, the choice can be guided by the unit of analysis. In management science, the case analysis approach is historic. But what is meant by a "case"? In sociology, for example, when conducting research as a unit of analysis, the individual collects data on very large samples that can be studied in "classical" quantitative methods. Much more "macro" approaches take a country as a unit of analysis, for example in political science or economics. In Business Sciences, the units of analysis range from the individual (notably in marketing and human resources management) to the country (for example in comparative cross-cultural management), through teams, projects and, in particular, organizations. It is in this context that the QCA method has begun to be transposed and used in management science (Curchod 2003, Chanson et al., 2005).

Third, the possibilities of access to data, the collection methods used and the number and variety of sources (interviews, observations, documents ...) studied represents the richness of the data collected within a case, and that varies greatly. The quantification of qualitative data leads to a great simplification, and reduces the richness and variety of representations collected - especially in the initial variant of the QCA ("crisp-set QCA") using binary variables and can be performed "manually". As a result, the richer the data, the simpler the quantification; on the other hand, for more basic data, quantification has more advantages than limits.

Researchers often encounter difficulties in accessing data to study organizations, which is the preferred level of analysis in fields such as strategy (Chanson et al., 2005). Qualitative data in quantification methods can also help to cope with the difficulty researchers encounter in restoring qualitative data and their analysis processes in constrained spaces defined by academic journals. Thus, it allows a dialogue between users of quantitative and qualitative methods.

Fourth, the size of the sample and the total population influence the choice of the method. The QCA method was initially developed for small to intermediate sample sizes, ideally exhaustive of the total population (Chanson et al., 2005). From about thirty observations, several methods of quantitative analysis are offered to researchers, such as regressions or models of structural equations with PLS. Conversely, for a small number of cases, the quantification of qualitative data may have more disadvantages than advantages, since the simplification of the data is not offset by the possibility of listing frequencies of occurrence. phenomenons. It is precisely between these two orders of magnitude that the QCA method is particularly appropriate, for an intermediate number of cases (Rihoux et al., 2014), being approximately between ten and thirty or even fifty. The QCA method therefore makes it possible to analyze a number of intermediate "cases", beyond the single case or a small number of cases, but below a number of cases that can be analyzed using "conventional" methods, which raises particular difficulties. Today, the QCA method is also used for large samples (Rihoux et al., 2013), but then its relevance to competing methods is more open to debate.

Fifth, the nature and coding possibilities of the variables guide the methodological choice. The way to quantify the qualitative data depends on the chosen coding scheme. The unit of analysis used for the coding of qualitative data can range from the word (discourse analysis) to the interpretation of meaning expressed in a set of sentences (content analysis) (Allard-Poesi, 2003). Qualitative data analysis software is generally specialized in one or more of these logics, with software such as Sphinx or ALCESTE for discourse analysis or representations, and NVivo or Atlas.ti for content analysis. The QCA method compares "cases" and is therefore more relevant to searches in content analysis logic.

The QCA method relies on an iterative process between cases and variables. Data analysis involves feedback on qualitative data and case studies (Legewie, 2013). During this process, it is common to add or delete cases based on combinations of conditions or consequences obtained (Wagemann, 2007).

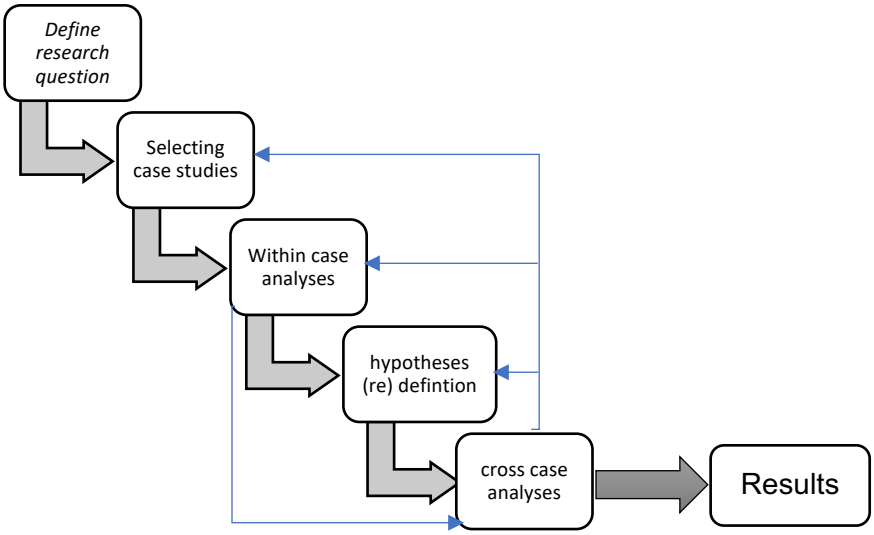

Figure 1: The data analysis process according to the QCA method (Adapted from Legewie, 2013)

Like other methods of quantification of qualitative data (e.g. statistical textual analysis with the ALCESTE method, Artis and Cornée, 2016), this approach requires a very good knowledge of the cases. In fact, unlike quantitative methods, these methods require regular round-trips between the analysis and the data. In the case of ALCESTE, the software does not take into account the meaning, literally or figuratively, of the textual forms used. Thus, ALCESTE proposes lines of reflection and interpretation for the researcher to distinguish and interpret classes, and leaves the possibility of not dealing with abnormal phenomena that are difficult to interpret or do not correspond to the hypotheses (Delavigne, 2004). In the QCA method, the treatment of contradictory cases and the study of so-called logical combinations are all stages of interpellation of the researcher and verification of the coherence of the analytical framework. Unlike methods that are not controlled by the researcher in the process, like the black box, the QCA method requires the researcher to master the entire analysis process. The binary coding of the variables requires the researcher to do a detailed job of deconstructing the cases in order to justify them theoretically.

Qualitative case studies are often associated with exploratory research designs (Bergadaà and Nyeck, 1992; Yin, 1989) and quantitative studies on large samples are often aimed at testing a pre-existing theoretical model. The QCA method can be used in both inductive and deductive reasoning. In a deductive reasoning, different conditions assumed to lead to a result are defined, and their impact is observed in the results. In an inductive and exploratory aim, if it is necessary to define the analyzed result, the researcher can propose as many conditions as the data permit, in order to highlight the necessary or sufficient conditions for the results between these variables. The QCA method involves grouping cases into homogeneous categories, defined by specific characteristics. The number of possible categories is 2^k: one criterion defines two categories, two criteria four categories, three criteria eight categories, and so on. As for the number of conditions to be retained, there are mainly two possibilities: either, to limit oneself to a number of categories which is much smaller than the number of cases observed, in order to arrive at a few subsets of the cases, or to include more variables but accept that the observed cases which will be divided into many categories without forming subsets. A deductive research design seems more coherent with a small number of conditions, whereas in an exploratory view, it is relevant to include a large number of conditions. But it is

also possible to explore the data by comparing several "models" with a small number of conditions.

2. APPLYING QCA METHOD TO INTER-ORGANIZATIONAL COLLABORATION

Our research analyzes collaborations between organizations of various natures. Based on a saturation system saturation[2], we found thirty collaborations, for which the QCA analysis is very relevant. Our research fits well within the logic of content analysis and appropriate for QCA. Using the QCA method, we were able to explore thirty cases of qualitative data and identify success factors for inter-organizational collaboration between big companies and non-profit organizations.

2.1. Case selection and qualitative data collection

We built the case database by identifying renewable energy projects around the world. The data which we have collected is secondary data on the internet. We have included various energy technologies: wind, solar, hydro and geothermal. The data was collected from reports written by international bodies involved in the field (e.g. public investment banks, international renewable energy agencies, and government agencies). We found 30 cases of inter-organizational collaborations within our criteria. Systematically, we identified:

- Stakeholders involved in the project: companies, associations and NGOs, research centers, government agencies, and funders;
- The economic characteristics of the project: location, start date of the project, duration of the project implementation, number of workers, and cost of the project;
- The technological characteristics of the project: technology and quantity of energy produced;
- The characteristics of the country's energy situation: quantity of energy consumed, tension in the energy market, and dependence on a specific source of fossil energy (oil, gas, coal, etc.);
- Acceptance of the project: local people's views on the project (according to the media).

2.2. QCA analysis of the data

We have therefore followed the different steps of QCA methodology (Rihoux and Ragin, 2009): i) selection and coding of the information of the selected cases, ii) construction of the truth table using data dichotomization, iii) verification of the robustness of data (resolution of contradictory cases, Boolean minimization process and taking into account so-called "logical" combinations) and iv) interpretation of the results. We have decided to limit ourselves to three conditions which will create theoretical configurations to eight categories 2^k. Adding an additional condition would have created 16 theoretical configurations, with an average of less than two cases per category. We therefore made a difficult choice because it is simplistic to retain the three conditions that seem to us the most important given the available data:

[2] We completed our database by adding all the new projects we found that met our criteria (organizational diversity, and renewable energy).

1. Presence of incentives for renewable energies and innovation: public incentives (tax reductions, dedicated financing, etc.) and incentives from civil society. For example, Singapore has invested more than $570 million in incentives since 2011, particularly in solar energy solutions (ASEAN Briefing, 2015). Incentives from public policies such as regulations, subsidies, tradable permits, or tax reductions have a positive (direct or indirect) effect on environmental innovation (Depret and Hamdouch, 2009)
2. The presence of a conflict over natural resources: the exploitation of renewable energies can generate conflicts in the management and use of natural resources. Indeed, Ostrom (1990) highlights that renewable resources are more prone to scarcity than abundance, and their exploitation can lead to conflicts between users. Several studies on water management crystallize these conflicts in the possible choices of uses of the resource. These conflicts are also present in land management between alternative uses (agricultural use, energy production or real estate).
3. The international dimension of inter-organizational collaboration. Beyond these elements, the international dimension of collaboration is a major factor contributing to differences between actors (Mohr et al., 2016). Whether at the cultural, linguistic, institutional or political level, the international nature of the collaboration adds to the differences that already exist between the partners in the cases that we have chosen because on one side are the companies and on the other the non-profit organizations.

We have determined whether the projects are successful based on three criteria related to the contribution of the project to the energy transition:

- The amount of energy produced compared to the country's production capacity
- The duration of the project completion, compared to the average time per megawatt required in equivalent technologies.
- The contribution of the project to a sustainable energy supply in the country. This indicator is composed of three variables: the contribution of the project to the diversification of sources of energy production, the impact in terms of environment and reduction of CO^2 emissions, and the productive capacity of the technology in response to local needs.

We determined the success of the project based on the combination of these indicators (success = 1, failure = 0); only projects rated "1" for at least two of the three criteria were considered successful. This multi-criteria determination of success has the consequence of classifying projects in a situation of failure despite their production of renewable energy. Projects are considered "failures" only if more time is required to complet the project (more than the estimated time initially), energy production is low or environmental impact is less clear. We filled in these factors from the data previously collected, and we coded them in a dichotomous way (table 2) to then build the truth table (table 3).

	Case	Techno-logy	Localiza-tion	Incen-tives	Con-flict	Inter-national	Suc-cess
1	Solar farm in ASYV	Solar	Rwanda	1	0	1	1
2	Hydropower in Intibucá	Hydro	Honduras	0	1	1	0
3	Hydropower Nepal	Hydro	Nepal	1	0	0	1
4	Solar Lantern Rental System Laos	Solar	Laos	0	0	0	1
5	Salkhit wind farm	Eolien	Mongolia	1	0	1	1
6	Sapphire wind farm	Eolien	Pakistan	0	0	1	1
7	Lesedi & Letsatsi projects	PV	South Africa	1	0	1	1
8	Hami project	CPV	China	1	0	1	0
9	Wind farm in Singida	Wind	Tanzania	0	0	1	1
10	Karadzhalovo solar park	Solar	Bulgaria	1	0	1	1
11	Wind farm in Madhya Pradesh, Andhra Pradesh	Wind	India	1	0	0	1
12	Energy efficiency	Energy efficiency	China	1	0	0	0
13	IVANPAH	Solaire Thermal	USA	1	0	0	1
14	Ouarzazate Solar Power Station "Phase one"	Solaire PV	Morocco	1	0	1	1
15	Bugoye Hydro Power	Hydro	Uganda	0	0	1	1
16	The Lake Turkana Wind Power Project (LTWP)	Wind	Kenya	1	1	1	1
17	Palo Viejo Hydro Plant	Hydro	Guatemala	1	1	1	0
18	San Jacinto-Tizate Geothermal Project	Geo-thermal	Nicaragua	1	0	1	1
19	Jasper Solar Photovoltaic Power Plant	Solaire PV	South Africa	1	0	1	1
20	Amanecer Solar CAP Power Plant	Solaire PV	Chile	1	0	1	1
21	Chaglla Hydroelectric Power Plant	Hydro	Peru	0	0	1	1
22	Ulubelu II Geothermal Power Plant	Geo-thermal	Indonesia	1	1	1	0
23	Dai Ninh Hydro Plant	Hydro	Vietnam	0	1	1	0
24	Burgos Wind Project	Wind	Philippines	1	0	1	1
25	Rampur Hydro Project	Hydro	India	1	1	0	0
26	Agua Prieta II	ISCC	Mexico	1	0	1	0
27	Augustin Fresnel 1, Targassonne	Solar	France	1	0	0	0
28	Hassi R'mel	ISCC	Algeria	1	0	1	1
29	Khi Solar One	CSP	South Africa	1	0	1	0
30	Manchasol 1	Th. Solaire	Spain	1	1	1	0

Table 2: Description and coding of the projects

Configu-ration	Incen-tives	Conflict	Inter-national	Cases	Number of cases	Result (successful or not)
1	0	0	0	4	1	positive
2	1	0	0	3,11,12,13,27	5	Positive with 2 contradictory cases
3	0	1	0	-	0	-
4	1	1	0	25	1	Negative
5	0	0	1	6,8,9,21,15	5	Positive with 1 contradictory case
6	1	0	1	1,5,7,10,14,18,19 ,20,24,26,28,29	12	Positive with 2 contradictory cases
7	0	1	1	2,23	2	Negative
8	1	1	1	16,17,22,30	4	Negative with 1 contradictory case

Table 3: Truth table of the success factors of the 30 case studies

2.3. CQA Analysis Results

Table 3 presents the eight possible configurations from our three variables; seven configurations can be observed in the data. Configuration number 6 is the most common. It is characterized by international projects that have not had conflict and are located in countries where there are incentives for renewable energies (12 projects). However, we have two contradictory cases in this configuration (cases 26 and 29). Configurations 2 and 5 have five cases each, configuration 5 has one contradictory case, and configuration 2 has two. Configuration 5 groups together cases that are international, have not had conflicts and had no incentive; and configuration 2 brings together local cases, without conflict and with incentives. Configuration 8 is interesting because it groups failed projects, except for one contradictory case. Paradoxically, the simultaneous presence of three factors leads to failed projects. Contradictory cases were re-evaluated from the available data, allowing these contradictions to be resolved. For example, case 8 has been classified as unsuccessful because the duration of implementation of the project is above average (1.7 MW per month against an average time for solar projects of 4 MW / month) and the production is considered low (production of 20.5MW compared to a total electricity production in China of 1223GW). These two criteria led to classification of this case as unsuccessful. However, this project is based on solar technology, while production in China is mainly fossil and hydroelectric. It therefore participates in the diversification of energy sources in a context of increased needs and international pressure (signature of COP21 agreements). In view of these complements, we finally considered this case a success. The same procedure for resolving contradictions was carried out in all configurations.

Four configurations are possible to achieve success. In all these configurations, there is no conflict over natural resources. This criterion is therefore a sufficient condition for a positive result.

The most observed configuration shows that two causal relationships are possible:

- If there is no conflict over the resources, then the project will be a success;
- If the project is international and there are incentives, then it will be a success;

By adopting the norms of Boolean algebra notation (Chanson et al., 2005, Ragin, 1987), the equation is as follows:

SUCCES = INCITATIONS.INTERNATIONAL.conflit

This configuration represents 12 cases of our total population, and 12 of the 20 success cases (60%).

However, the homogeneous distribution of cases between configurations 2 and 5 results in imprecision between the "incentive" and "international" factors. Of the 23 cases where incentives were available, nine cases were unsuccessful. Of the 23 projects with actors from different countries, eight failed. Therefore, it seems that incentives are a sufficient condition. However, the differentiation between these two conditions (international and incentive) needs to be further developed. The QCA method makes it possible to highlight the diversity of the possible causal relationships between the conditions and the result. There are then several modalities to arrive at a situation of success.

The consideration of logical cases makes it possible to validate the robustness of the method and the conceptual framework chosen for this study (Carsten and Schneider, 2012). Of the eight possible configurations, a configuration (3) was not observed, it corresponds to the following logical case: a configuration of failure in the presence of conflict over resources, without international dimension or incentive to renewable energies. We conclude that the "absence of conflict" condition leads to a positive result.

Another perspective for future work would be to compare multi-stakeholder collaboration with business-to-business collaboration to challenge the differences between these different types of collaboration.

3. METHODOLOGICAL DISCUSSION

Based on the example of our research, we now return to key aspects of the QCA method and their challenge for researchers using this method: the number of conditions selected, the binary nature of the variables, the causality analysis rather than probabilities, and the generalization of the results obtained.

3.1. The number of integrated variables ("conditions")

One of the limitations of the QCA method is the exponential increase in the number of possible configurations depending on the number of criteria retained. Adding a variable will double the number of configurations, three criteria produce eight possible configurations, four criteria, 16, and so on. Principally, there are two logics to decide the number of conditions: either, the objective is to arrive at categories including several cases and, thus, with a sketch of typology (but it is then necessary to limit the number of conditions); Or, the researcher wishes to explore the relevance of a maximum of variables even if each category is illustrated only by one or a

few cases, or none. If for a small number of variables, a manual analysis is quite simple to perform, the multiplication of variables may justify the use of software. 61% of 313 studies were published between 1984 and 2011 using the QCA method with more than four variables (Rihoux et al., 2013) - but these studies date mostly from 2004, when QCA computer analysis software became widespread.

We chose the first option: with 30 collected cases, we limited ourselves to eight configurations, i.e. three variables or conditions. We could enrich our results by adding an additional variable. This development would allow us to consolidate the importance of the "absence of conflict" factor, to refine the understanding of "international" factors and "incentives" and to explore an additional dimension, for example, the "innovation" dimension of technologies.

3.2. The binary nature of the variables

The binary coding of variables is one of the rules of the method in its original version ("QCA-set QCA"), which can be achieved without reference to a particular software. In our research, we explored a very particular type of inter-organizational collaboration, that is, between at least one company and at least one non-profit organization, dealing with the implementation of a project in the renewable energy sector. Since this exploration was global, we had no choice but to limit ourselves to secondary data collected on the internet. Although we cross-referenced sources and documents, the data at our disposal remain much poorer than those that can be collected *in situ*, through semi-structured interviews and direct observations. This is on the one hand unfortunate - but on the other side, particularly compatible with the QCA method because the coding of data in binary variables depletes the richness of the collected data less than other methods.

The binary encoding of the data represents a limit of the method, because many studied dimensions correspond to continuous variables. In our study, measuring project success and quantifying it was a challenge. The challenge was to not rely only on a quantitative measure related to energy production, and to question inter-organizational collaboration. For example, the use of the "duration of project implementation" criterion was also intended to measure the quality of inter-organizational collaboration. In fact, the forms of hybrid organizations are modes of coordination between agents that are alternatives to the market and to the competition, which raise criticisms and questions about their effectiveness, particularly in terms of time (Ménard, 2003). This aspect of inter-organizational collaboration is therefore an essential dimension but this variable is by definition a continuous variable. It is in response to this limit that the QCA "fuzzy-set" and "multi-value set" variants have been developed, integrating non-binary variables. But this debate goes beyond the opposition of binary variables and continuous variables. Adopting the QCA method is equivalent to entering into a logic of typologies (Fiss, 2011), to question whether or not a case is part of a type, and not to measure intensities. Typologies form a central pillar of strategic management and organizational theory (Fiss, 2011), and some are extremely popular within the discipline. The binarity of well-chosen variables can potentially lead to new ones.

3.3. A causal diversity rather than the probability of a single model

Even before starting an analysis based on Boolean algebra, the intermediate stage of the truth table has, in our opinion, virtues for case study research. It requires researchers to clearly identify the main elements of their theoretical model (emerging or pre-existing), to differentiate possible causes of the consequences in the formulation of their problem, and to systematically question all the cases as to the presence or absence of each of these variables. The presentation as a table (like the truth table of the QCA method) has the advantage of simplicity and clarity. Certainly, such a summary table of results may also be used for presentation purposes only, without necessarily seeking causalities and without giving rise to a subsequent quantitative analysis (for example, Bartel-Radic, 2013). The QCA method thus favors the distance of the researcher from the field to reinforce the objectivity of the analysis. Moreover, in certain situations, this distance from the analysis unit may be an alternative solution to physical or linguistic difficulties of access to the data. Initially presented as an opportunity to analyze small to intermediate samples (Ragin, 1987), QCA is now often used for larger samples. 17% of the 313 studies analyzed by Rihoux et al. (2013) have samples of more than 100 observations, and other methods of statistical analysis (regressions, structural equations, ...) could have been used as well. A majority of the studies involve samples of more than 30 observations that could have been analyzed with the PLS method, for example. More than a default method, QCA is a different way of addressing causality. When statistical models test a single causal model, QCA admits a causal diversity, i.e. the coexistence of several parallel paths to arrive at a result (Chanson et al., 2005). In our study, if the absence of conflicts over natural resources appears to be a sufficient condition, several combinations of configurations lead to successful collaborations. The contradictory cases (we had to treat several in our study), rather than "atypical observations" to put away, represent an opportunity to systematically interrogate the theoretical frameworks and observed cases, allowing the researcher to objectify one's research, questioning all the time one's postulates and hypotheses.

3.4. The generalization of the obtained results

The previous point directly impacts the possibility of generalizing the obtained results. One of the challenges of the QCA method lies in the generalization conditions of the results. The initial goal of the method is to be "case-centered" (Ragin, 1987), which is an advantage but also a disadvantage. "Case dependence" has been repeatedly cited as a limitation of QCA (Rihoux et al., 2014). In the case where the research relates to a whole population of cases exhaustively (one of the initial criteria of the QCA, cf. Chanson et al., 2005), the question of generalization arises only outside this population.

We cannot verify the completeness of our sample, but it is very likely that we have not identified all of the existing renewable energy projects on the planet involving businesses and non-profit organizations - in other words, that the sample is not exhaustive. This lack of data questions the generalization of our results.

As with case study research in general, if statistical generalization is impossible, analytical generalization is feasible and useful (Yin, 1989). It is based on a detailed description of the

case context, which must therefore accompany the QCA analysis. In other words, if the "table of truth" was built following the quantification of qualitative data, the researcher has rich data that allow us to contextualize and specify the results obtained through QCA analysis. On the other hand, if the variables analyzed in the QCA had been collected differently (in pre-existing quantitative databases, for example), this point could be more problematic. The combination of the QCA method with other methods of analysis, qualitative or quantitative, is pointed out as highly desirable by some researchers (Schneider & Wagemann, 2012). However, it is absent from 61.3% of the research referenced by Rihoux and colleagues (2013), in which the QCA analysis does not coexist with any other method of data analysis.

CONCLUSION: RECOMMENDATIONS FOR THE USE OF THE QCA METHOD IN MANAGEMENT SCIENCE

The purpose of this contribution was to present and discuss the contributions and limitations of the QCA method for researchers working with qualitative case studies. We chose to explain the steps of the QCA process by systematically questioning its specificities compared to other research methods. We discussed the choices that are necessary for any researcher who wishes to use this method. We conducted our research on inter-organizational collaboration in the field of renewable energies.

Given the limitations of qualitative and quantitative data collection and processing methods, the QCA method offers promising prospects. It establishes causalities between qualitative variables for mid-size case samples. It enriches qualitative and quantitative approaches while ensuring statistical rigor; it retains the richness of qualitative approaches while allowing a generalization approach. This method is also a challenge for the researchers because it forces them to systematically question their theoretical frameworks and their assumptions. The control of the data (of their nature, collection and processing) and the explanation of the different stages of the research design are essential to the good use of this method. However, and despite its recent strong development, this method remains confined to a few circles of researchers initiated to debates on the epistemology of methods in the social sciences.

The use of QCA has given us an important result: inter-organizational collaboration in renewable energies is a success in contexts where there is no conflict over the management and use of natural resources. The new approaches to natural resource management developed by Elinor Ostrom and his collaborators show that conflict is ubiquitous in the collective management of common resources. In this context, the factory of institutions is in itself "a difficult, time-consuming process, a source of conflict" (Ostrom, 1990: 14). It theorizes conflict as a cognitive problem due to differences in interpretation, and thus presents the establishment of institutions within the community as a process allowing interaction and interdependence between actors, which can increase mutual trust. and decrease conflicts. One of the perspectives for our research would then be to study the Ostrom institutions set up during these successful collaborations. In other words, how has collaboration with non-profit organizations helped to avoid major conflicts over resources and thus facilitate the faster implementation of more significant projects involving renewable energies?

As we have discussed in this chapter, the generalization of this result is not as obvious from our data as from the method used. The choice of a limited number of variables and the binary coding greatly simplify the results. But the QCA method also allowed us to discuss the different configurations and their combination to achieve a successful collaboration on a vast field of exploration. Even though we were not able to carry out *in situ* observations directly, the QCA method enriched the debate on this topic.

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AUTHORS

Amélie Artis
Associate Professor in Economics
Univ. Grenoble Alpes, Sciences Po Grenoble, CNRS, PACTE, F-38000 Grenoble, France

Anne Bartel-Radic
Full Professor in International Management
Univ. Grenoble Alpes, Grenoble INP, CERAG, F-38000 Grenoble, France

Hezam Haidar
PhD Candidate in Industrial Engineering
Univ. Grenoble Alpes, Grenoble INP, CNRS, G-SCOP, F-38000 Grenoble, France