2013

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Qualitative Comparative Analysis in Information Systems and Wirtschaftsinformatik

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Abstract. The application of scientific methods is an essential element when conducting research. They ensure reproducible results and improve the overall quality of the research projects. The aim of this paper is to introduce a method called Qualitative Comparative Analysis, which is currently nearly unrecognized within our discipline. Being neither a pure quantitative nor qualitative method, it yields potential benefits arising from both research streams. It accommodates answering research questions that simultaneously demand a deep understanding of complex relationships and also require the analysis of more than just a few single cases. The paper gives an introduction to this method and demonstrates its usefulness on the basis of two recently carried out research projects. In the end, the Qualitative Comparative Analysis proves to be a valuable addition to the canon of research methods and enriches the applied character of our discipline by contributing to the improvement of both rigor and relevance.

Keywords: Qualitative Comparative Analysis (QCA), research methods, case study research, design-oriented research, empirical research

1 Introduction

This article introduces a research method called Qualitative Comparative Analysis (QCA) [1], a method which is nearly unrecognized within our discipline to date and possesses many potential benefits for design-oriented as well as empirical research projects. Furthermore, the method fills in current gaps within and between different existent research paradigms.

Within the last years it became clear that there exist two main research paradigms in Information Systems (IS): the behavioral or positivist paradigm, which focuses on the creation and testing of theories, and the design-oriented paradigm, which emphasizes the development of IT-related artifacts and the design of the organizational environment [2–4]. Today, the behavioral approach clearly dominates Anglo-American research (respectively IS), whereas the design-oriented approaches are prevalent in European research, especially in the German-speaking “Wirtschaftsinformatik” (WI). Despite the ongoing development of these research streams, the last years showed some dis-

11th International Conference on Wirtschaftsinformatik,
27th February – 01st March 2013, Leipzig, Germany

satisfaction with both [4-5]. On the one hand, the behavioral approach faces increasing discussion about its identity, the application of qualitative vs. quantitative methods, and the relevance and limitations of the prevailing research methods [4], [6-7]. On the other hand, the design-oriented approach struggles with the availability of a rigorous set of research methods and a lack of international recognition [4], [8].

Consequently, a call for approaches arises which may overcome the current limitations in the research fields of both IS and WI and bridge the gaps between existing paradigms. Frank claims that "due to the diversity of research topics and objectives in ISR [Information Systems Research], mono-paradigmatic research is not sufficient" [4]. Indeed, there seems to be huge potential within the convergence of the behavioral and the design-oriented approach. Lyytinen & King stated, with regard to the legitimacy of IS research: "Theory has value *only* in reference to praxis" [7]. However, limiting attention to the IT artifact alone would be misleading, too, because "artifacts never deliver value in their own right. They are complementary assets in production, and their value cannot be understood without the context of their application" [7].

One essential element to ensure (scientific) rigor as well as (practical) relevance is the selection of suitable research methods that take into account the characteristics of the research questions in IS/WI [9]. Different research questions ask for different research methods, and the chosen method should always be determined by the questions asked. However, if the dichotomy of the two named paradigms remains, there is the danger that scientists in IS/WI ask their questions in a way that fits predefined methods instead. This would be a clear threat to the improvement of both rigor and relevance.

Such progress could already be observed in Management Science and Sociology. Researchers were stuck within a dispute between qualitative case-oriented (more practical) approaches and quantitative variable-oriented (more theoretical) approaches. It has been discovered that the prevalent methods have limitations in answering specific research questions, despite focusing on measurement, sampling, analysis, and so on [10]. In the end, the quality of research suffered, because "often, the desire to use these [multivariate statistical] techniques shapes the way social scientists ask their questions" [1].

Hence, to support the call for a pluralistic pool of scientific methods which are equally acknowledged among the research community of IS/WI [4], [7-8], [11], we are introducing QCA as a potential method. To support our argumentation, the paper is structured as follows: Section 2 gives a short introduction to QCA and explains basic concepts on the basis of a simple example. Section 3 discusses the potential benefits of QCA in IS/WI and highlights possible usage in design-oriented as well as behavioral research approaches. The argumentation is underlined by two recently conducted research projects. Finally, section 4 points out possible limitations and summarizes the article.

2 A Short Introduction to Qualitative Comparative Analysis

2.1 Origin and Classification

Qualitative Comparative Analysis is a research method whose roots date back to the mid of the 19th century. In this period John Stuart Mill established the fundamentals in his essay “Of the Four Methods of Experimental Inquiry”, especially the “Method of Agreement” and the “Method of Difference”, which deal with a systematic comparison of cases to search for common causal relationships [12-13].

QCA in its current form emerged from the work of Charles C. Ragin in the 1980s [1]. QCA has been known in Comparative Politics for a time, but soon it was recognized as a potential method for Sociology, too [14-15]. Today, QCA has been applied also in Management Science, Business and Economics, Health Research, Legal Studies, and International Relations, among others. An overview of current application areas, software tools, and further references can be found at the website compasss.org (COMPArative Methods for Systematic cross-caSe analySis) [16].

In fact, the term “qualitative” may be misleading. The method can be classified as neither a qualitative nor a quantitative approach, but shares key elements of both. Strictly speaking, QCA can generally be seen as a more quantitative method which operates on qualitatively coded data and allows a systematic comparison of cases [17]. Therefore, in recent years one can observe a tendency to subsume QCA and related methods, like multi-value QCA (*mvQCA)* and fuzzy set QCA (*fsQCA*), into a family of so called “Configurational Comparative Methods” [18].

This ambiguity reflects itself also from an epistemological point of view. As a method, QCA cannot be categorized to one distinct paradigm. Although the logical foundation of QCA (see section 2.2) conveys a rather positivist character of the method, it can be rarely established that way [12-13]. Furthermore, the results obtained by utilizing QCA heavily rely on the interpretation and the decisions of the researcher. These are characteristics of an interpretative paradigm [18]. However, supporting Mingers’ view that methods may be used “critically and knowledgeably” within different paradigmatic assumptions [11], QCA does not exclude itself from one or the other paradigm. It is flexibly applicable depending on the researcher’s goals and individual positioning.

2.2 Basic Concepts

This section aims at introducing some basic concepts necessary for conducting a QCA in a very brief manner. Due to restrictions in space, we cannot give a comprehensive description. Therefore, interested readers may be referred to the publications of Ragin [1], Schneider & Wagemann [14], and Rihoux & De Meur [19] which serve as basis and orientation for the following explanations within this section, too.

Furthermore, the given explanations, mainly taken and modified from [1], are accompanied by an example which we kept simple for illustration purposes. Let a research project deal with the success (S) of reorganization projects. The researcher analyzes the effect of the three variables: Top Management Support (T); Early Employee Involvement (E); and Investments Spent (I), over eight independent cases. In QCA terms, the variables are called *Conditions,* whereas the success is called *Outcome*.

First of all, QCA builds upon the use of Boolean Algebra. That means variables have to be coded dichotomously into 0 (false, absent) or 1 (true, present), and cases are represented as sets according to set theory. For our example, the outcome would be 0 for an unsuccessful project (written lower case: s) and 1 for a successful project (written upper case: S). Analogously, the conditions are coded into Top Management Support was absent (t) or present (T), and Early Employee Involvement was absent (e) or present (E). The third condition, Investments Spent, is an interval-scaled variable. Therefore the researcher needs to identify what constitutes a high (I) or low (i) investment.

The collected data is then presented in a *Truth Table*. A hypothetical truth table for our example is given in Table 1. Every row represents a possible *Configuration*. That means every theoretically possible combination of conditions (excluding outcome). For our example, there exist $2^3 = 8$ rows at maximum. Our example is chosen in such a way that every case represents a possibly configuration. Of course, this is unlikely to happen. So there may be less than 8, if some configurations were not observed, and simultaneously, one row may represent more than one case. Both situations would not affect the application of the standard QCA procedure.

Table 1. Hypothetical truth table

Configuration ID	**Conditions**			**Outcome**
	Top Management Support (T)	Early Employee Involvement (E)	Investments spent (I)	Project Success (S)
1	0	0	0	0
2	0	0	1	0
3	0	1	0	1
4	1	0	0	0
5	0	1	1	0
6	1	0	1	1
7	1	1	0	1
8	1	1	1	1

For instance, row (configuration) 5 is characterized as follows: The project had no top management support (0), but an early employee involvement took place (1). A high amount of investments was spent (1), but the project was not successful in the end (0).

The next step is to find out which combination of conditions leads to successful or unsuccessful projects. For that, QCA utilizes combinatorial logic and Boolean minimization. Therefore, it is important to understand Boolean addition and multiplication. A Boolean sum represents the logical OR, meaning at least one of the parts of the sum has to be true. A Boolean product, however, is a combination of conditions and is equivalent to the logical AND. Every configuration now can be written in a Boolean product, whereby uppercase letters indicate presence (1), and lowercase letters indicate absence (0). For instance, configuration 5 can be written as “tEI”, whereas configuration 7 would read “TEi”. Now, we are already able to write down a primitive Boolean term for both outcomes success (S) and no success (s) in the form of Boolean sums combining the corresponding configurations that are given in Table 2.

Table 2. Primitive Boolean sums-of-products

Sum-of-products	**Corresponding configurations**
s = tei + teI + tEI + Tei	unsuccessful projects 1, 2, 4, and 5
S = tEi + TeI + TEi + TEI	successful projects 3, 6, 7, and 8

However, such a representation is not satisfying. So, QCA continues with a pairwise comparison of every configuration with the aim of minimizing complexity and simultaneously maintaining causality. The fundamental rule of minimization states: “If two Boolean expressions differ in only one causal condition yet produce the same outcome, then the causal condition that distinguishes the two expressions can be considered irrelevant and can be removed to create a simpler, combined expression.” [1]. Looking, for instance, at configurations 7 and 8 in Table 1, both differ only in the investments spent. Nevertheless, both are successful. Therefore, the investments spent are irrelevant for this (and only this!) pair of configurations. They can be reduced to:

$$S = TEi + TEI = TE \quad (1)$$

This procedure is carried on for every pairwise comparison and is repeated with the reduced configurations (like TE in the example above) until no further minimization is achievable. However, only those configurations are compared to each other, which had the same outcome. The analysis of successful and unsuccessful projects results in two independent runs of QCA. The pairwise comparison of all primitive expressions for project success (S) in our example results in the following minimized Boolean expression that cannot be reduced any further:

$$S = Ei + TI + TE \quad (2)$$

The last step in QCA is the deduction of *Prime Implicants*. The Boolean concept of implication states that one expression implies another, if the second is a subset of the first. The goal of this step is to produce a final expression with a logically minimal number of prime implicants. For this task, the *Prime Implicant Chart*, illustrated in Table 3, is a helpful tool. It maps the minimized against the original primitive expressions, whereby an X states that the minimized expression implies the primitive one.

Table 3. Prime implicant chart

	tEi	TeI	TEi	TEI
Ei	X		X	
TI		X		X
TE			X	X

The requirement for a logical minimal expression is that every column of the chart has at least one X. This means that every primitive expression is covered by a minimized one. As easily becomes clear, the third row (TE) is redundant and can be omitted without changing the result. Another advantage of this chart is that primitive expressions not covered by any of the minimized expressions become visible. They have to be included as prime implicants, too (this is not the case in our example). The final solution, then, for the project’s success is:

$$S = Ei + TI \quad (3)$$

This is read as follows: Projects are either successful when employees are involved early (E) AND the spent investments are low (i) OR when top management support was given (T) AND the spent investments are high (I). It becomes clear that QCA keeps causality and analyzes the effect of conditions, always in observance of the presence or absence of other causally relevant conditions. The researcher may now interpret this result further.

Additionally, Boolean minimization allows distinguishing between *Necessary* and *Sufficient Conditions* for specific outcomes, which in turn allows a deeper interpretation. Further important concepts are *Logical Remainders*, configurations that are logically conceivable but missing in the data set, and *Contradictions*, cases with identical configurations but different outcomes. The interested reader may refer to basic literature (for instance [1], [14], [20]) for further explanation of these issues.

3 QCA in IS and WI: Potential and Examples

As a scientific discipline, IS/WI is rooted between Business Administration and Economics, as a part of Social Sciences on the one side, and Computer Science with Engineering foundations on the other side [21-22]; hence, it continually seeks to unite two different research traditions. Furthermore, it inherits an applied character from both disciplines, and thus the need to make its findings available to practice [8]. This constellation poses a considerable challenge to establishing generally accepted research approaches. This conflict has been made visible by the discussion about the role of behavioral and design-oriented research methods in IS/WI (see section 1) [3], [8]. Within WI, researchers are now leaning towards finding a consensual middle way between relevant, application oriented research and rigorous, systematic research procedures, strongly soliciting the design-oriented approach [8]. It is our aim in this article to support this development by presenting QCA as a suitable method for increasing the rigor, without an unnecessary detachment from the practice or reduction of complex practical cases.

The nature of QCA as a systematic and configurational comparative method yields a number of benefits for researchers of IS/WI. First of all, the QCA stands outside the two main fields of qualitative and quantitative methods but combines some of the key strengths of both [1], [23-24]. Therefore, QCA is suitable for application in our discipline for two reasons: it supports the systematic comparison of multiple cases with limited information loss and it helps to establish causal relationships based on factor configuration while maintaining case-inherent complexity [24]. Due to the applied character of the IS/WI discipline, combined with the frequently used design-oriented approach, researchers often deal with complex case studies. While this approach allows an in-depth understanding of the empirical context, systematic and reproducible comparison and generalization of findings are often difficult [25].

By using the QCA instead, context and findings of the case studies can be simplified into sets of different outcomes and hence made comparable. The calibration of the data – unlike simple quantification – allows the retention of the context through set description and the definition of set membership. Furthermore, the configuration, as means of expressing causal relationships, results in meaningful descriptions of possible case variations.

While quantitative methods have been used to describe causal relationships in IS, their interpretation and application in practice appears difficult. Furthermore, these methods imply the isolation of factors (variables), and therefore suffer limitations regarding the complexity of underlying theoretical models [1], [6], [15], [24]. QCA does not view causes in isolation but always within the context of other relevant conditions. Every case is analyzed as a whole regarding absence or presence of dependent and related conditions [1]. Moreover, combinations of factors are easier to interpret and provide suitable models as a foundation for analysis and configuration of cases in practice.

In addition, the QCA offers some new possibilities in the way that the variables are determined. Variables are not seen as pure quantitative data rather than interpreted as qualitative construct. Although the dichotomization yields some limitations in itself, this treatment allows a direct coding of a qualitative construct instead of technically driven operationalization via dummy variables [17].

When compared to qualitative methods, QCA can also offer a valid alternative. While it cannot provide the same deep data emergence as for example Grounded Theory [26], its structured process helps the researchers explicate their decisions and reasoning. The reliance on set-theory rather than statistical methods emulates the causal relations from the real world and thus helps to maintain the applicability of the results. Qualitative research in IS/WI is often based on single or multiple case studies [25], where the QCA can be suitable for abstracting and comparing the findings.

In summary, both behavioral as well as design-oriented research in IS and WI can benefit from the application of QCA. The method can be applied in behavioral studies where the research is based on a moderate number of case studies and is concerned with the description of causal relationships and the identification of patterns. In design-oriented research, QCA can be helpful to support different research steps to deduce artifacts and useful IT solutions: during the analysis and exploration of the problem as well as during evaluation of the designed artifact.

QCA expands the set of useable methods apart from surveys, single case studies, interviews, pilots, simulations, etc. Therefore, it offers a possibility that does not force the researcher to decide between understanding complexity and gaining generalized insights rather than allows asking research questions combining both aspects [1], [27].

In the following section, we present and briefly discuss two examples of the application of QCA in IS/WI research. The first example is concerned with the identification of success factors in agile project management and the second with the search-behavior on online profiles belonging to scientists. Both examples are meant to show possible uses of the method in two different settings – not to serve as references of proper implementation of the method. On the contrary, we use the experience from the two research projects to point out and discuss difficulties and risks in the use of QCA in IS/WI research.

3.1 Identification of Success Factors in Agile Project Management

The analysis shown in this subsection was accomplished within a research project in cooperation with an international communication and web 2.0 company. The company's main focus lies in developing and providing software solutions. Since 2008, project managers in the company have used agile methods like Scrum to accomplish software and organizational projects. Originally, the purpose was to save time and costs due to increased transparency and shorter development cycles. However, it emerged that most

Scrum projects were not more but less successful than projects conducted with traditional methods. Interviews indicated that missing basic Scrum conditions could be the reason for the lack of success. Therefore, a total of 19 Scrum projects were analyzed using QCA. The aim of the study was to determine on which basic Scrum conditions, or combinations of these, the success of Scrum projects depended.

The most agile project management methods are based on the "Manifesto for agile Software Development" from 2001. Agile methods contain four principles: they are based on individuals and interactions; the relationship with the customer; an efficient solution; and a fast reaction to changed requirements [28]. Therefore, the purpose of agile project management is to develop pieces of the solution in short time, under permanent contact to the customer and changing requirements. Within this environment, Scrum was developed in 2001. To ensure short development times, Scrum uses the term "Sprint". A Sprint is usually two to four weeks long and begins with a discussion between the Scrum Team and the requirements manager (Product Owner). This role is responsible for the customer communication during a Sprint, in case of changed requirements. Simultaneously, the Scrum Team develops customer requirements in self-controlled environments and presents the solution to the Product Owner for approval at the end of a Sprint. The Scrum Master is responsible for the motivation of the Scrum Team only by using specialized motivation methods. Hence, no disciplinary methods are necessary. Additionally, Scrum requires several basic conditions to unroll its advantages [29–31]. During a theoretical analysis, seven basic Scrum conditions were discovered: Training and Coaching, Internal Communication, Allocation of Tasks, Role Understanding, Problem Solving, Requirements Management, and Meetings.

Due to the fact that, in summary, 19 projects could be analyzed, the csQCA proved suitable regarding sample size and the research aim. A questionnaire was created to collect data. It was based on the identified Scrum basic conditions and the success of the project, which were operationalized by several questions. Afterwards, the Scrum Master, one project employee, and the customer of every project were given the questionnaire. Every answer in the questionnaire received a score which depended on how good the answer matched with the Scrum theory. Thereafter, the sum of the achieved score points were divided through the possible maximum score. The outcome was a "degree of fulfillment" of the basic conditions and the success per project.

Table 4 shows an example for this procedure. The basic condition of Problem Solving contained three questions. Every project could gain 0, 0.5, or 1 point per question. The maximum score was 3 points. Therefore, project 1 for instance, achieved a degree of fulfillment of 83.33%.

Table 4. Example for data collection and calculation of degree of fulfillment

Project	Q. 1	Q. 2	Q. 3	Achieved score	Maximum score	Degree of fulfillment
1	1	0.5	1	2.5	3	83.33%
2	0	0.5	0	0.5	3	16.67%
3	0	1	0	1	3	33.33%

Afterwards, it was necessary to dichotomize the data regarding the calculated degrees of fulfillment. This was done with the help of thresholds for every basic condition as well as the success. The exact threshold was determined according to two restrictions. On the one hand, it was important not to separate degrees of fulfillment which were close together. On the other hand, both produced sub-groups should be of similar size. In some cases, it was not possible to accommodate these restrictions. Hence, a single case analysis was accomplished to create clearness of doubtful project classifications. The result of this step was a truth table which was analyzed by the computer program TOSMANA (see [16] for further information).

The analysis delivered the following basic conditions which were responsible for positive project success: the presence of Internal Communication, Training and Coaching, and the Task Allocation. The results for negative project success were: the absence of Internal Communication, Problem Solving, Task Allocation, Requirements Management, and Role Understanding. The results again underline the qualitative nature of the QCA approach, because they show that the conditions for unsuccessful projects are not simply the opposite of the ones affecting successful projects. Both analysis were conducted independently, and thus together they deliver a more detailed picture. For some projects it was necessary to analyze them separately. For example, one project had the basic condition "Internal Communication" unfulfilled (absence), despite being successful, and thus was investigated and evaluated separately in the form of a single case analysis. Afterwards, the identified factors were interpreted further, because the company needed deep information for every positive or negative success factor. Based on these results, recommendations to improve future projects based on Scrum were deduced and given to the company.

The QCA proved itself to be a very suitable method to investigate the success of Scrum projects because of the following reasons: First, due to time and resource constraints, it was not possible to investigate and compare every one of the 19 projects using single case analysis. The QCA, however, offered a standardized procedure to cope with this amount of cases. In addition, it was still possible to investigate conditions in more detail for selected projects. This was necessary with regard to content. One result of the analysis was that a successful project had to show presence of Internal Communication OR a number of other AND-connected conditions. But as mentioned above, one single project did not fulfill this rule, despite being successful. The QCA allowed identifying this project by treating every case as one whole unit and conducting an additional single case analysis. If regression analysis or a similar multivariate method had been used, this additional insight would not have been gained.

At the same time, this example illustrates another important issue: in every step of QCA, the researcher has a relatively wide range of intervening actions (selection of cases and variables, dichotomization or categorization of data, interpretation of results). It is crucial that the method is not applied in a mechanical way because this may lead to misinterpretation of findings [1], [23]. This underlines the qualitative side of the method, but inherits the same pros and cons of other qualitative methods like transparency of decisions and reproducibility of findings. Furthermore, the applicability within design-oriented research can be illustrated through this example. The developed guideline, with recommendations for further Scrum-based projects, can be seen as artifact [32], and the accompanying research process went through the proposed phases of analysis, design, evaluation, and diffusion [8]. The QCA was utilized especially in the analysis phase to create a substantial basis for deducing the recommendation guidelines for the company. The use of QCA within the evaluation phase is conceivable, too, but was not carried out through this project.

3.2 Analysis of Search-Behavior Patterns on Scientists' Online Profiles

The study was carried out in context of a larger research project on the self-presentation of scientists on the Internet [33]. Scientists from different disciplines increasingly use the Internet to present themselves. Besides the traditional institution or private HTML webpages, scientists can now also use Web 2.0 tools, such as social networking services, blogs, or microblogs [34-35]. The growing number of self-presentation options on the Web has led to discussions of the influence of online self-presentation on the reputation of scientists [36]. However, while the self-presentation of scientists in online profiles has been studied, there is little research on the impact and use of the profiles by others. Thus, the purpose of the study was to analyze the search behavior of European scientists on the Internet profiles of their peers, providing a foundation for the potential of online self-presentation for scientists. It was not an aim of the study to provide representative statements about the general behavior of all European scientists, but rather to detect behavioral patterns. The search behavior was thus analyzed using QCA. Furthermore, quantitative association measures were used to provide a direct comparison.

The study was based on the theory of social networks, assuming that individuals are connected by social ties of different strengths [37-38]. These ties can be strong, with close relationships and intensive exchange; weak, with lesser exchange intensity and little shared resources; latent, founded on organizational structures rather than social contact; or fully absent [38-39]. According to Haythornthwaite [38], the acceptance and adoption of technology for the purpose of communication depends on the strength of the existing tie between two communicators. Hence the study viewed search patterns in connection to existing social ties. To collect data, an online questionnaire based on the critical incident technique [40] was sent to a stratified clustered sample of 1008 European scientists, delivering 123 usable answers. The study looked for search patterns in several different areas, but as it is not our aim to describe the entire study [41] here, we will demonstrate the proceeding on one of them: the access way to the online profiles.

The analysis of the data was carried out using a csQCA [1], [42], in combination with quantitative association measures. The collected data were first coded for quantitative analysis, coding tie strength as an ordinal variable and labeling the different access ways as a nominal variable. These data were then used to generate measures of association. The existence of a relationship of the tie strength and the access ways in general, as well as each access way separately, were then determined using quantitative association measures (Decady-Thomas corrected chi-squared test [43-44], Perason's chi-squared test, Gamma, and Cramer's V). However, this procedure only tested the general existence of a relationship between tie strength and access ways and described associations between single access ways and tie strength. To derive more complex access-way patterns, a csQCA was used. fsQCA and mvQCA were not applied, because tie strength was interpreted as the existence of four distinct outcomes rather than of increments, where a distinct combination of access ways (condition) was sought for each tie-strength set. The data was recoded for the csQCA: tie strength was interpreted as four separate sets (StrongTie, WeakTie, LatentTie, and AbsentTie), and a separate set was created for each access way. The data were then calibrated according to their membership in each set. To depict the relationship between the tie strength and the access ways, the combinations of access-way set-memberships were viewed as potential predictors of the tie-strength sets:

$$\text{TieSet} = f(\text{AccessWay}_1, ..., \text{AccessWay}_n) \tag{4}$$

Table 5. Resulting access-way patterns

		Direct	Looked up page	Looked up person	Search for person	Search for topic	Used link	Other	Raw coverage	Unique coverage	Consistency	**Solution coverage**	**Solution consistency**
Latent	**b1**	**X**	X	**O**	**X**	X	**X**	O	0,01	0,01	1,00	**0,62**	**0,84**
		X	O	**O**	**X**		**X**	X	0,19	0,00	0,89		

The QCA was carried out with the fs/QCA software (see [16] for further information). The derived combinations for each tie set were grouped according to common features, identifying core and periphery elements of the patterns [45]. Table 5 shows as an example two (out of seven) patterns describing the access-way combination for scientists with latent ties. The conditions, i.e., the used access ways, that are present in the combination are marked with an X, and the conditions that are absent, i.e., the unused access ways, are marked with an O. One condition is unmarked, as its presence or absence has no influence on the outcome. The two patterns in Table 5 were grouped as being similar, where the conditions describing their similarities were considered core conditions (marked bold), while the others were considered peripheral. The derived combinations, although not describing clear, general patterns, showed visible trends in the way scientists access the online profiles of their peers [41].

Unlike in the previous example, this study can be seen as a part of a theory-building research design. It shows that the QCA can prove beneficial in areas that cannot be easily satisfied with traditional quantitative methods. The identification of patterns and configurations plays an important role in IS research and practice, but the factors of interest often defy meaningful quantification. Hence the available quantitative analyses offer but a simplified picture, such as in this study. The QCA offered more complex and holistic results. At the same time, the results of the study also show pitfalls of the QCA application: this high number of conditions allowed only recognition of trends. In order to obtain better details, the number of responses for each tie set would have had to be higher. At the same time, the increase in the number of cases in itself does not necessarily guarantee better results, as the data may not cover the possible combinations. Selective sampling is helpful in order to cover different combination possibilities.

4 Conclusion

Our aim in this article was to present the QCA method and discuss its potential for IS and WI research. To this end, we have briefly introduced the method and its application, discussed its usability in IS/WI, and presented two studies that have actively applied QCA: one related to design research process and one related to theory building research process. From these, we have concluded that the use of QCA in IS/WI appears suitable and offers a number of advantages. These include a structured method for the comparison of several case studies, simplification and variable calibration without full context loss, focus on causal relationships, and the derivation of understandable and applicable configurations. The QCA also offers new, creative ways of doing research, as it is based on different principles than traditional quantitative methods. However, there are limitations and potential pitfalls that have to be taken into account when using QCA. These will be discussed in the following.

Firstly, the move from quantitative coding towards an interpretative calibration is helpful when dealing with qualitative data, but it relies strongly on the researchers' interpretation. While some variables can be easily calibrated, as they are already binary or nominal, in other cases (e.g., the project section 3.1), the researcher must decide upon suitable threshold values. In IS/WI, this can be of advantage: as an applied discipline IS/WI research often studies in-depth cases and the researchers thus possess good case knowledge necessary for calibration. At the same time, the focus on data calibration and use of a standardized data manipulation method can lead to the loss of the "big picture". While well structured, QCA relies on qualitative means and requires researchers' attention to the actual meaning of the data. Losing the overview of the context for the benefit of high granularity and standardization of the sets can lead to overcomplicated results with essentially trivial outcomes.

Secondly, although QCA uses calculation to assess the causal relationships, it is not well suited for exploratory analysis based on quantitative measures (i.e., hunting for strong correlations), as it is sensitive to both coding and measurement errors [46]. This aspect makes the method dependent on a sound theoretical foundation and good case-level knowledge, as these determine the adequate specification of the causal conditions for inclusion in the truth table. Unlike conventional quantitative approaches, the QCA does not offer a simple mechanism for excluding 'nonsignificant' variables. Typically, most if not all of the causal conditions that are considered while constructing the truth table appear in the statement of causal combinations that conclude as a result [27], [47]. While a disregard of this explicit reliance on researchers' knowledge and interpretation can lead to mistakes, in IS/WI it may actually help bridging the mentioned gap between behavioral and design approach. QCA explicitly demands the combination of existing theories (coming from behavioral research) with in-depth case studies (in design research). The method can thus help to generate results both grounded in empirical data as well as with a sound theoretical foundation.

Thirdly, the results do not always paint a clear picture. The derived configurations can exhibit traits such as of equifinality (different configurations leading to the same solutions) and natural permutations (interaction stable core conditions and changing peripheral conditions) [48]. As QCA is not a quantitative method, it does not offer definite analytical measures, and sometimes even disregards traditional measures (e.g., frequency). Similarly, QCA is not a tool designed for assessing net effects, as the underlying logic is that causes combine, not that they are in competition with each other. QCA is still in development, and further measures may appear, but provided the character of the method, the effort connected to evaluation and generalization of the results must lie largely with the researchers. Hence, the real test of the value of an application of QCA is not a summary statistic but researchers' assessments of how well the results help them understand their cases. Again, this explicit reliance on the applicability of the results appears particularly relevant for IS/WI research.

In summary, QCA is a well-structured but highly interpretative method, suitable for dealing with a limited number of complex cases. It focuses on the description of causal relationships using a configurational approach and Boolean algebra. We believe that QCA can be used in IS and WI in areas where it is necessary to generate descriptions and factor configurations from a limited number of cases. As such, it offers potential of increasing the rigor of empirical research without sacrificing contextual richness, and the practical applicability of the findings.

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