Speaker Notes: Qualitative Comparative Analysis (QCA) in Implementation Studies

PART 3: A FUZZY SET EXAMPLE

Slide 1: A Fuzzy Set Example

Welcome to Qualitative Comparative Analysis (or QCA) in Implementation Research. This narrated Powerpoint is the third in a series of presentations and describes how we used fuzzy-set QCA to study the implementation of a federally funded national provider based research network. The presentation is offered to you by the Translational and Clinical Sciences Institute of the University of North Carolina at Chapel Hill.

Slide 2: What was the specific aim?

With funding from the NCI, my research team examined the organizational design features that were consistently associated in 2010 with high levels of patient enrollment in NCI cancer treatment trials among the oncology practices and hospitals participating in the NCI's Community Clinical Oncology Program, or CCOP.

The CCOP is a federally funded provider-based research network with a 29 year history of conducting cancer clinical trials in community settings and translating trial results into better care.

Slide 3: What is the CCOP?

A few words about the CCOP will set the context for what we did.

Established in 1983, the CCOP is a three-way partnership involving the NCI's Division of Cancer Prevention, selected cancer centers and clinical cooperative groups (CCOP research bases), and community-based networks of hospitals and physician practices (CCOP). NCI provides overall direction and funding for community hospitals and physician practices to participate in clinical trials; CCOP research bases design clinical trials; and CCOP assist with patient accruals, data collection, and dissemination of study findings. As of July 2012, 46 CCOPs operated in 28 states and included over 450 hospitals and physician practices, with the average CCOP comprised of about 10 hospitals or practice sites. CCOPs also include over 2,000 physicians, with the average CCOP composed of 48 physicians.

Slide 4: How did we design the study?

To conduct this study, we used a single-group, cross-sectional study design with the CCOP as the unit of analysis. The sample included all 47 CCOPs in operation in 2010.

We focused on 2010 because it was a difficult year. Many CCOPs struggled to meet the NCI's expectations for treatment trial enrollment. Some CCOPs, however, exceeded the NCI's expectations.

We wanted to know what strategies these CCOPs used to achieve high levels of patient enrollment in NCI treatment trials. Specifically, we wanted to know how they combined organizational design features

to achieve high performance, which in this study, meant high patient enrollment. The strategies we examined focused on the organizational design choices that CCOPs make.

To keep our results practical, we focused on organizational design features that met three conditions:

1. They had to reflect key resource inputs or productive capabilities for CCOPs

2. They could not depend directly on the level of funding the CCOP receives from the NCI

3. They could be modified by CCOP leadership.

We chose fsQCA as our analytic strategy for three reasons: (1) we had a medium-size sample of 47 organizations, (2) we suspected that strategies that CCOPs used to achieve high patient enrollment were not simple (that is, we suspected that their recipes for success involved more than one ingredient; and (3) we suspected that there might be more than more than one strategy for achieving high enrollment (that is, we suspected that more than one recipe for success existed).

Slide 5: What were our data sources?

We obtained data from two sources.

The NCI CCOP, Minority-Based CCOP and Research Base Management System provided data on CCOPs' 2010 patient enrollment in NCI treatment trials and 2010 NCI treatment trial menu

CCOP grant progress reports provided data on CCOP patient volume, CCOP-affiliated physicians, and CCOP organizational structure.

Slide 6: What were our study measures?

The dependent variable in our study was 12-month patient enrollment in NCI treatment trials.

Using substantive knowledge and prior research, we selected four organizational design features likely to drive CCOP treatment trial enrollment.

Slide 7: How did we calibrate the measures?

Analysis proceeded in five steps. First, we calibrated the study measures by transforming them into fuzzy-set membership scores.

To do so, we asked NCI officials to use their expert knowledge to specify three values for each of the five study measures:

Those values indicated:

1. Full membership in the set of interest (e.g., definitely high-enrollment)

2. Full non-membership in the set of interest (e.g., definitely not high-enrollment)

3. A cross-over point reflecting maximum ambiguity in membership in the set of interest (neither high enrollment nor not-high-enrollment).

We used these values to transform study measures into scores ranging from 1.0, indicating full membership in the set, to 0.0, indicating full non-membership in the set.

For example, NCI officials told us that CCOPs were definitely in the high-enrollment set if they enrolled 100 or more patients in cancer treatment trials. CCOPs were definitely not in the high-enrollment set if they enrolled 50 or fewer patients. CCOPs that enrolled 70 patients were kind of in the middle. CCOPs that enrolled between 71 and 100 patients were more than out of the high-enrollment set, while those that enrolled between 49 and 70 patients were more out of than in the high-enrollment set.

The values we used to calibrate the other study measures are shown here. Based on these values, every CCOP received a set membership score that ranged from 1 to 0. That's what distinguishes fuzzy-set QCA from crisp-set QCA.

Slide 8: How did we analyze the data?

After calibrating the measures, we constructed a data matrix (known as a truth table). Each row in the truth table represents a strategy, that is a specific combination of organizational design features. Since we had four organizational design features, our truth table had 16 rows representing 16 logically possible strategies. We then sorted CCOPs into the rows of the truth table based on their fuzzy-set membership scores.

Next, we reduced the truth table based on two criteria. First, strategies (or rows) had to exhibit at least one empirical case. Second, strategies had to exceed the minimum consistency threshold of 0.80 by an amount greater than could occur by chance. Consistency refers to the degree to which cases displaying a given strategy also display the outcome of interest, which in this study is high patient enrollment. Strategies that met both criteria were considered in further analysis.

Finally, we used Boolean algebra to eliminate logically redundant strategies. To illustrate, suppose some high-performing CCOPs have many open trials, see many cancer patients, and have many enrollment sites. Suppose other high-performing CCOPs have many open trials, see many cancer patients, and do **not** have many enrollment sites. These two strategies can be logically reduced to a simpler strategy— namely, have many open trials and see many cancer patients. Why? Because the outcome is the same whether CCOPs have many enrollment sites or not.

Slide 9: Descriptive Analysis

Here's a quick look at the CCOPs in our study.

In 2010, CCOPs enrolled an average of 90 patients to NCI treatment trials. CCOP enrollment ranged from a low of 17 patients to a high of 341 patients.

CCOPs also varied widely in terms of the number of treatment trials they had open, the number of newly diagnosed patients with cancer they saw, the number of physicians affiliated with the CCOP, and the number of sites where patients could enroll onto NCI treatment trials.

Slide 10: Truth Table

This is our Truth Table, which lists the 16 logically possible combinations of organizational design features examined in this study. These logically possible combinations represent different strategies. The upper-case letters represent the presence of an organizational design feature, while the lower-case letters indicate the absence of an organizational design feature. So, for example, the last row in the truth table represents the strategy of seeing many cancer patients, having many open trials, having many enrollment sites, and having many CCOP physicians.

The second column indicate the number of CCOPs that exhibit each strategy. CCOPs are assigned to strategies based on their fuzzy-set membership scores. As expected, some strategies are more commonly observed than others.

The five strategies in yellow font met both the minimum frequency threshold of one case and the minimum consistency threshold of 0.80 by an amount greater than could occur by chance, as shown by the F-test and p-values.

These five strategies consistently led to high patient enrollment in cancer treatment trials in 2010.

Not surprisingly, one winning strategies was to have many open treatment trials, see many cancer patients, have many affiliated physicians, and have many sites where patients can enroll. However, this strategy was not the only one that consistently led to high patient enrollment.

Slide 11: Boolean Minimization

These five strategies can be logically reduced to two simpler strategies using Boolean algebra.

The first simple strategy is to have many open treatment trials and see many new cancer patients.

For CCOPs that do not have many affiliated physicians, another simple strategy is to have many open treatment trials and many component sites where patients can enroll onto clinical trials.

The fact that having many open treatment trials is a condition shared by both strategies suggests this condition may be necessary for achieving high performance. By itself, however, having many open treatment trials is not a winning strategy for achieving high patient enrollment.

As you can see, consistency scores are high for each strategy individually and for the two strategies together. High consistency scores mean that almost all of the CCOPs that followed these strategies exhibited high performance. Coverage scores indicate the percentage of cases that achieved high performance by using a given strategy, allowing one to evaluate the empirical relevance of a recipe. In terms of overall coverage, the set of recipes accounts for 63% of fuzzy membership in the outcome. The first strategy (i.e., many trials, many patients) was the more empirically relevant recipe, both in absolute

terms (see raw coverage) and in relative terms (see unique coverage). The smaller unique coverage values indicate that the two strategies overlap. Not only do the two strategies share a condition (i.e., many treatment trials), some CCOPs may be employing more than one strategy.

Slide 12: How did we publish the results?

You can learn more about how we applied fuzzy-set Qualitative Comparative Analysis, including how we did counterfactual analysis and sensitivity testing, by consulting the article we published in the Journal of Oncology Practice. The article presents a non-technical description of our methods and results, making it a very useful introduction to fsQCA. The article includes a technical appendix that describes set theory and the mathematical operations of fuzzy-set QCA in more detail.

Slide 13: Thank You!

- This concludes our 3-part series, Qualitative Comparative Analysis in Implementation Studies.

- Staff from the TraCs Institute are available for consultations. In order to become a member and request a consultation, please call us at 919-966-6022, email us at nctracs@unc.edu, or visit our website at tracs.unc.edu.