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# Rapid assessment framework for modeling stakeholder involvement in infrastructure development

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ABSTRACT

There is increasing global interest in the adoption of sustainable wastewater systems due to the significant human and environmental health benefits of properly treating wastewater effluents prior to being discharged into surface waters and local communities. Research demonstrates that wastewater infrastructure is sustainable only when multiple stakeholder groups are involved. Here we draw on the principles of integrated environmental resources management and sociocultural analyses to develop a framework for rapidly assessing stakeholder involvement in a proposed centralized wastewater project in Placencia, Belize. We demonstrate this framework by analyzing survey responses to measure stakeholder involvement and discuss the model's utility to inform groupings based on similarity in engagement. We employ Brainerd-Robinson similarity coefficients to rapidly assess stakeholders' involvement and produce a consensus score. We then evaluate the goodness of fit between these scores and correspondence analysis scatterplots. We conclude that Brainerd-Robinson scores provide a rapid means for determining relevant groupings of stakeholders, particularly in resource-scarce settings. Nuanced stakeholder groupings can inform researchers, policy makers, development workers, and community organizations about ways in which individuals are engaging with a project, providing a way to target suitable initiatives to promote sustained involvement.



## 1. Introduction

Stakeholder involvement has been an important factor in the sustainable development literature for decades, especially concerning infrastructure projects (Gleick, 1998; Holmes, 2000; Holmes, 2002; Torres, 2003; Fam & Mitchell, 2013; Tjandraatmadja, Sharma, Grant, & Pamminger, 2013). Most recently, the United Nations (U.N.) has reflected the growing emphasis on stakeholder involvement by articulating it as a necessary feature within the Sustainable Development Goals (SDG). While each SDG asserts a broad expectation for the next decade of development (i.e., SDG 6 encourages the global community to make efforts to, "ensure access to water and sanitation for all"), the sub-tasks (targets) provide instructions on improving specific aspects of stakeholder involvement, particularly building the capacity of community members and strengthening partnerships across various sectors (UN, 2015). However, some researchers (Rahman, 1993; Pretty, 1994; Daniels & Walker, 1996, 2001; Dent, Dubois, & Dalal-Clayton, 2013) have critiqued the means by which stakeholders are engaged, suggesting that some efforts are superficial attempts at involving the community without sufficiently addressing the complexities of implementing projects within a local context (e.g., diverse opinions, attitudes, beliefs, politics).

Particularly for capital-intensive infrastructure projects such as a centralized wastewater treatment system, the individuals on the ground (i.e. engineers, contractors) have little to no formal social science training to assess the varying degrees of stakeholder involvement, consensus, or awareness of project goals. Some authors provide practitioners with strategies and processes to engage community members in local projects to promote sustainability (Pretty, 1994; Bass, Dalal-Clayton, & Pretty, 1995; FAO, 1997 Rietbergen-McCracken & Narayan-Parker, 1998; Schmeer, 1999; Hjortsø, Christensen, & Tarp, 2005; Salentine & Johnston, 2011), while others extend the participatory approach by also assessing and grouping stakeholders according to their level of involvement (Arnstein, 1969; Romney, Weller, & Batchelder, 1986; Pretty, 1995;

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Garro, 2000; Beierle, 2002; Lienert, Thiemann, Kaufmann-Hayoz, & Larsen, 2006; Lynam, de Jong, Shiel, Kusumanto, & Evans, 2007; Paolisso, 2007; Prell, Hubacek, and Reed, 2009; Reed et al., 2009; Gatewood, 2012; Olson, 2013; Starkl, Brunner, Lopez, & Martinez-Ruiz, 2013). Each of these approaches requires a significant amount of time and resources to be spent conducting fieldwork (i.e. executing surveys or facilitating focus groups). However, there are no studies that provide a rapid assessment framework that guides non-social scientists through a robust, context-adaptive means to gauge stakeholder involvement. Instead, ambiguity and subjectivity remain regarding an approach to identify stakeholders and the ways they are grouped based on their involvement with a project.

Accordingly, a review and synthesis of stakeholder analysis literature is used as the foundation for developing and demonstrating this rapid assessment framework. The framework consists of two parts—a suite of factors to use for questionnaire development and a methodology for rapidly assessing the results of the questionnaire. The suite of factors is synthesized from the literature review to elicit fundamental themes of stakeholder involvement that span various contexts. After the questionnaire is executed in the field, the resulting data is assessed to consider a community's knowledge and access to information about a proposed centralized wastewater project in Placencia, Belize. Brainerd-Robinson (BR) coefficients are calculated to quickly determine consensus among stakeholders as they are grouped in various ways. In support of the BR scores, results from correspondence analyses are plotted to visually represent conformity among the same groupings. Finally, the study highlights the advantages of using the BR approach as a method to quickly assess a complex variable in resource-scarce settings.

### 1.1. Assessing stakeholder involvement

Stakeholder involvement is a concept that is addressed in wastewater literature, particularly by outlining its benefits in relation to successful system management (Holmes, 2002). This section underscores three assessments of stakeholder engagement that have emerged from the literature review: stakeholder analysis, social network analysis, and cultural consensus analysis.

#### 1.1.1. Stakeholder analysis

Stakeholder analysis is an approach used for understanding stakeholder involvement by specifying the different types of stakeholders and their roles in a project (Prell et al., 2009; Reed et al., 2009). In their review of stakeholder analysis methods in natural resource management, business, and development fields, Reed et al. (2009) note three primary aims of stakeholder analysis, which include the following: 1) define social and natural phenomenon affected by a decision or project outcome; 2) identify individuals and groups who are affected by or can affect the phenomenon; and 3) prioritize individuals and groups for involvement in decision-making processes.

From these aims, one can use various methods to investigate the roles, strategies, and initiatives stakeholders use to productively navigate policies, promote consensus, and share information between groups (Wedel, Shore, Feldman, & Lanthrop, 2005; Reed et al., 2009). Some ethnographic and social science methods are focus groups, semi-structured interviews, and surveys. The goal of these methods is to identify general stakeholder categories, contacts, and their attributes by employing top-down (analytical) and bottom-up (reconstructive) procedures (Reed et al., 2009).

#### 1.1.2. Social network analysis

As the importance of interactions and associations among stakeholders became clear to researchers, three major methods were developed to investigate these relationships, actor-linkage matrices, knowledge mapping, and social network analysis (Reed et al., 2009). Actor-linkage matrices characterize the type of relationships between stakeholders in a two-dimensional table using key words, often describing the stakeholder relationships as cooperating; complementary; or conflicting (Reed et al., 2009). Knowledge mapping is used to analyse the flows and content of knowledge exchange across a stakeholder network to inform models of power distribution. Finally; social network analysis assigns coded numbers to ethnographic data from interviews; observations; and surveys to represent the presence and strength of relational ties to quantify and assess the structure of stakeholder networks for a particular domain (Prell et al., 2009; Reed et al., 2009). Thus; the analysis facilitates anemic (insider)quantitative perspective rather than a top-down (external) assessment of relationships, relative levels of power, influence, and participation within a network of stakeholders (Prell et al., 2009).

#### 1.1.3. Cultural consensus analysis

As with other participatory methods used for analyzing stakeholder involvement, cultural consensus analysis mathematically models the relative levels of agreement within and between groups of informants with respect to their knowledge about a particular cultural domain or topic (Romney et al., 1986; Garro, 2000; Paolisso, 2007; Gatewood, 2012). The primary modeling tool is called Q-mode factor analysis and reflects the similarity among factors by calculating a normalized score based on the variance between groups. Originally, the "cultural consensus theory" was developed to estimate a groups' degree of consensus and "accuracy" in their responses to questions that sample a particular cultural domain. Each question type (e.g. true/false, multiple-choice) assumes a finite amount of responses and only one statically probable "correct" answer (Romney et al., 1986). The informants' responses then generate an "answer key" matrix based on the probability and level of confidence in the consensus to the questions (Romney et al., 1986). This matrix is used to compare each individual sampled to "objectively" characterize cultural knowledge among a group in comparison to the "answer key" (Romney et al., 1986). This approach accounts for response bias (the probability that an informant guesses an answer to a question based on the number of possible responses) to estimate individual "cultural competence" (the probability that the respondent knows the "consensus" answer to questions rather than guesses them) (Romney et al., 1986). An individual's "cultural competence" is calculated as a percentage using a weighted computation of aggregate responses representing a pattern of shared knowledge (Romney et al., 1986).

The cultural consensus analysis enables researchers to estimate the relative amount of cultural knowledge for a particular domain that is shared within a population and assesses how the knowledge is socially distributed (e.g., whether understandings follow a uniform, subcultural, specialist, random, or personal pattern) (Gatewood, 2012). Thus, the primary utility of the cultural consensus framework is its ability to compare the strength, congruence, and distribution of cultural beliefs and knowledge both within and between groups, and even in cross-cultural contexts, by drawing on analysis of coded responses to standardized questionnaires (Romney et al., 1986). This analysis has been applied across a wide variety of research contexts to understand intra-cultural variation in how individuals learn and distribute information for particular sociocultural domains including fisheries management (Paolisso, 2007), traditional ecological knowledge (Olson, 2013), and conceptions of health and illness (Romney et al., 1986; Garro, 2000), to name a few. However, the framework generally has not been applied in the context of development projects such as the case of this centralized wastewater system, likely because cultural consensus research requires ethnographic data collection and subsequent analysis.