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# Integrating social network analysis with analytic network process for international development project selection

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## ABSTRACT

The social relationships between development agencies, non-governmental organizations, private companies, and other groups working on development projects play an important role in the overall success of projects. However, traditional project selection and prioritization processes ignore the organizational relationships. This paper proposes to integrate social network analysis into multi-criteria decision-making processes to enhance the effectiveness of project selection. A set of topological metrics of social network are used to quantitatively measure the organizational relationships and integrated into the analytic network process (ANP) to form a multi-criteria ANP project selection model. Utilizing empirical social network data of a water and food security research for development network in the Mekong River Basin, we investigate the effectiveness of the proposed model. The results show that it will offer companies, government agencies, and other donor organizations the opportunity to prioritize strategic network goals simultaneously with research and development priorities, and help companies and research organizations to increase their impact and reach within networks.

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## 1. Introduction

Across the globe, there are roughly 850 million people who remain chronically hungry, 780 million people without access to clean drinking water, and 2.5 billion people without access to sanitation facilities (FAO, 2013; UNICEF and WHO, 2013). For decades, international development agencies have loaned, invested, and donated billions of dollars worldwide to combat poverty and work to provide everyone with these basic human rights such as food, water, shelter, and healthcare. The Official Development Assistance of \$127 billion dollars in 2012 includes disbursements from the Organization for Economic Co-operation and Development's Development Assistance Committee (DAC) (World Bank, 2014). In addition to government distributions there are billions of dollars more in expenditures from both private philanthropic and non-governmental organizations each year. The Bill and Melinda Gates Foundation alone spent \$2.6 million dollars on global grants and programs during the 2012 fiscal year (Gates Foundation, 2013). These massive resources are allocated

through international aid, loans, investments, or a combination of these and other efforts. In the current economic climate, both public and private organizations are pushing for strong accountability of expenditures and proper utilization of funding. Often the associated projects fail to meet intended objectives, for any number of reasons including but not limited to a lack of local perspective from project implementers, trying to accomplish too much in a short timeframe, or not having social capital or support for continued project success after implementation. For example, a comprehensive external review of 133 completed World Bank projects showed that 50% of projects failed to meet the original objectives of the project (Marwanga, Nyangara, & Deleveaux, 2006). As a sector example, the percentage of water and wastewater treatment projects that fail to be sustained for long term use ranges from 10% to 75%, with commonly found estimates that state half of all water projects fail within 5 years (Elmendorf & Isely, 1981; Harvey & Reed, 2007; Whittington et al., 2009; World Bank, 2004).

Due to the ineffective development interventions, there is an increasing need to select and prioritize a project for funding that has the highest potential for long-term success. These multifaceted factors lead to choosing projects to allocate funds using a variety of complex multi-criteria decision-making techniques. There are many multi-criteria decision techniques for modeling decisions including optimizing and prioritizing project selection in various

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settings. Some popular techniques include information system approaches such as the TOPSIS method (Boran, Genç, Kurt, & Akay, 2009; Ozturkoglu & Turker, 2013), the PROMETHEE method (Brans, Vincke, & Mareschal, 1986), the goal programming model (Santhanam & Kyparisis, 1995), non-linear integer programming (Yu, Wang, Wen, & Lai, 2012), and a number of others as described in several review papers (Figueria, Greco, & Ehrgott, 2005; Zavadskas & Turskis, 2011; and Stewart (1992)). One decision-making technique that has previously been utilized for project selection of research and development programs is the analytic hierarchy process/analytic network process (AHP/ANP) (e.g. Amiri, 2010; Aragonés-Beltrán, Chaparro-González, Pastor-Ferrando, & Rodríguez-Pozo, 2010; Archer & Ghasemzadeh, 1999; Habib, Khan, & Piracha, 2009). While other techniques have notable benefits, the AHP has been highly regarded because it can relate any element of a complex problem to a quantitative measurement even if the problem has difficulty to quantify components.

Classical project selection models focus more on the individual attributes of the candidate projects and therefore the decision-making criteria do not account for the interdependencies among alternative projects. Some project selection studies (e.g., Santhanam & Kyparisis, 1996) realized that interdependencies exist among alternative projects and proposed nonlinear programming formulations to address the resource, benefit and technical interdependencies among candidate projects. However, one type of project interdependencies, i.e., the inter-organizational communications and social relationships, has never been considered in existing multi-criteria project selection models. It should be noted that some studies (e.g., Abedini, Uhadi, & Modiri, 2013) have considered inter-organization factors in multi-criteria decision making models, although these models do not focus on project selection and inter-organizational social relationships.

Trust and communication between project coordinator and task manager are critical factors in successful development projects (Diallo & Thuillier, 2005). Another study of successful development project criteria in Southeast Asia suggests that using participatory planning and stakeholder participation will lead to more successful projects (Khang & Moe, 2008). The relationships between an organization and the broader network of entities working in the international development community have strong implications for the overall functioning of that organization. Global civil society, which refers to the large array of non-governmental organizations worldwide, has often been referred to as a highly networked and relational group (Anheier & Katz, 2004; Castells, 2000). Ozturkoglu and Turker (2013) sought to analyze stakeholder relations given relative power and interests, and found significant differences between public organizations, banks and financial institutions, universities, and non-governmental organizations in Turkey. The social relationships between development agencies, non-governmental organizations, private companies, and other groups working on development projects play an important role in the overall success of projects and the working community as a whole.

The inter-organizational communications and the social relationships between organizations can be considered as a new set of evaluation criteria in the project selection model. These communications and the social relationships criteria can be measured by applying metrics developed in social network analysis (SNA). SNA investigates the connections and relationships among social entities and draws patterns and implications from these relationships (Wasserman, 1994). Like all network analysis, it is based on the assumption that there is importance in the relationship among the interacting units. Investigating the network structure and properties is the most common method of analysis used in organizational network research (Provan, Fish, & Sydow, 2007). The metrics based on the network structural data can investigate the causes of structures or the consequences (Borgatti & Foster,

2003). Network analysis is well-suited for investigating the relationships of organization communities such as research for development groups that rely on research outputs being utilized by other groups as a sign of effective programs (Aberman, Johnson, & Droppelmann, 2012; Shrum & Beggs, 1997).

Inter-organizational communications and the social relationships could be integrated into a variety of multi-criteria project selection methods. However, the ANP model was chosen because it allows for practical integration of social network data within its easy-to-comprehend formulation. This indicates ANP is an excellent choice for organizations in the development community interested in leveraging interdependencies with project selection procedures. Due to these factors, integrating social network analysis with the ANP could yield more successful outcomes and development interventions throughout the world.

This paper is motivated by real-world practical needs arising from the perspective of a donor organization in the water and food security research for development network in the Mekong River Basin. In the broader research for development community context, these needs can be characterized as follows. First, there is the need to select and fund project proposals that will succeed in meeting research or development goals. Second, a donor organization also seeks to increase its social capital by strengthening its standing in the network of organizations within the given field by connecting with the key players in the social network. While bridging these two important gaps in the current literature, this paper illustrates the application of a multi-criteria ANP model for international development project selection that integrates social network relationships into project selection, which can be applied to numerous disciplines. In addition to project selection outcomes, leveraging traditional applications of ANP in conjunction with traditional social network analyses can also serve to further and strengthen social network analyses. Empirical data from a social network of “research for development” organizations in the Mekong River Basin is used to analyze the proposed model. This model can be a systematic tool resource for development donors and grant recipients in the Mekong Basin and the larger research for development community worldwide. Building social network criteria into an AHP/ANP model allows for the development of this model that can be applied in many project selection problems in multiple disciplines. However, to the best of our knowledge, none of the existing decision-making model approaches factor the inter-organization relationships in the project selection process.

## 2. Analytical formulation

Assume there are  $M$  (development) projects that are under consideration by a donor. The donor has a set of criteria, denoted by  $\{e_j | j = 1, \dots, N\}$ , for project evaluation. Let each project be associated with a final numerical score  $\tau_i$ ,  $i = 1, \dots, M$ . The project selection process is to determine the scores  $\tau_i$  based on the given criteria  $\{e_j\}$  through a multi-criteria decision-making model, such that the set of projects can be prioritized according to their scores  $\tau_i$  and the optimal alternative can be identified.

In this study, ANP is employed as the multi-criteria decision-making model to determine the scores  $\tau_i$  of candidate projects. In the rest of this section, a brief review of the ANP will be presented first, followed by the social network analysis and the proposed integrated model.

### 2.1. Analytic network process

ANP is a comprehensive model that is appropriate for making multi-objective, multi-criterion and multi-actor decision with and without certainty for any number of alternatives. As the ANP

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