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Interfaces with Other Disciplines

# Neural networks and organizational systems: Modeling non-linear relationships

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**Abstract**

For decades, organizational researchers have employed standard statistical methods to uncover relationships among variables and constructs. However, in complex organization systems, the prevalence of non-linearity and outliers is to be expected. Under such circumstances, the use of standard statistical methods becomes unreliable and, correspondingly, results in degraded predictions of the relationships within the organizational systems. We describe the use of neural network analyses to model team effectiveness so as to provide more accurate predictions for managers.


*Keywords:* Organization theory; Neural networks; Group; Outliers

## 1. Introduction

Researchers in organizational behavior have commonly employed standard regression methods to map out relationships between a set of independent variables and one or more dependent variables. Using such methods researchers are able to state, given a significance threshold level, if the relationship is strong, its direction, and the role of the intervening moderator variables. Examples of most commonly used statistical methods include linear regression, path analysis and, more recently, structural equations modeling. Time series methods have also been used when the data set has a time element within it.

Results from these methods are often reported in terms of significance levels ($p$ or $t$-values), weights ($\beta$) and correlations ($R^2$s). From such results, we can arrive at certain conclusions about the types of relationships between sets of dependent and independent variables. Also, given the estimated weights, one can then predict (forecast) the expected values for a set of given independent variables.

Some researchers in organizational behavior, however, are frustrated with the results (or lack of significant results) that they obtain via standard statistical methods while testing for relationships among organizational constructs. Often the

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problem lies not in the data collection methods or the definitions of constructs, but rather in the way these complex relationships are defined and the statistical techniques used to test them. Researchers may be unaware of the assumptions that many of the common statistical procedures such as time series methods, linear regression, path analysis, and structural equations may carry. For example, are the observations truly independent of each other? Are the relationships actually linear in form? What about extreme observations (outliers)? It has been well documented that such patterns in the data may play havoc with standard statistical procedures.

In this research, we identify a new way to model the complexity of organizational variables through robust neural network analysis. This technique, when used in modeling organizational systems, may help overcome some of the limitations of standard statistical procedures and may be particularly suited to understanding and learning about organization behavior. Organizational behavior literature and theory is, often, built upon methods that assume linear relationships. However, the complexity of organizations begs a reexamination of the relationships via a non-linear approach such as neural networks. In addition, the ability to account for outliers would greatly add to the accuracy in predicting organizational outcomes.

We demonstrate the value of neural network by applying them in the context of teams, a popular and complex intervention in organizations today. Partisans of teamwork claim that all organizations need teams to compete in the marketplace, and the proliferation of work groups and teams in US organizations (Tata and Prasad, 2004) suggests that managers appear to agree with those partisans. In addition, research on teams suggests that teams do appear to be critical to organizational effectiveness (Langfred, 2000). A number of studies have identified direct relationships between team effectiveness and work team characteristics such as the organizational context of teams, intra-team processes, inter-team processes, and team size (Campion et al., 1993, 1996).

It would be naive to assume that the problems associated by traditional statistical techniques, such as auto-correlation, non-linearity, and outliers do not exist in the analyses of teams. In fact, studies suggest that teams, especially self-managed teams, are not always effective in practice (Wall et al., 1986), a finding that may be attributed to the statistical techniques used to measure team processes and team effectiveness. For example, it is quite possible that within a particular team an individual's decision is partly influenced by peers within the same group. Also, team members may vary in terms of their tenure in the team and in the amount of team-related training that they receive. This could result in a large variation in team processes, such that newer or untrained team members could perform extremely poorly (outliers), distorting findings of team effectiveness. In addition, non-linear patterns have also been noticed in the literature. For example, it has been reported that the optimal size of teams ranges between four and seven individuals (Brightman, 1988; Ray and Bronstein, 1995), suggesting a non-linear relationship between team size and effectiveness, yet studies (e.g., Alexander et al., 1996; Stoel, 2002) still examine linear patterns between these two variables. Thus, employing standard statistical methods risks the possibility of obtaining $p$-values indicating relationships that may not exist or, perhaps, missing out on some important complex relationships. Such misidentification and misinterpretation of the relationships between work team characteristics and team effectiveness could result in problems with team implementation in organizational settings.

Although the literature on neural network applications has been connected to the production/operations, finance, marketing/distribution, and information systems areas (Hu et al., 1999; Wong et al., 2000), studies that apply neural networks to behavioral patterns in organizational systems are largely non-existent (Wong et al., 2000). Hence, in this study we use a data set collected from actual teams in real business settings to examined the relationships between team effectiveness and a number of independent variables such as inter and intra team processes, organizational context, and team size. We run our analyses using: (1) standard regression models, (2) robust regression techniques, and (3) robust neural network analyses.

We believe that this study should be of use to both academicians and practitioners. Researchers can gain by having a more accurate tool to map relationships and possibly uncover important relationships that had previously been undetected. Because research, theory, and practice are never completely detached from each other, the findings of organizational researchers are also relevant to practitioners interested in improving the performance of teams at work. Hence, the ability to