Leadership: Do Networks Matter?

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Abstract—Leadership has traditionally been viewed as a relationship between the leaders and their subordinates. Recent research has shown the significance of the social aspects of leadership. This view forms the basis for the research reported on in this paper. Social network analysis provides socio-metric measures of leadership, which can be associated with traditional leadership measurement scales. The research evaluates U.S. Military cadets’ social networks of friendship, trust, and perceived leadership in concert with leadership attributes, organizational identity, and attitude. The significance of perceived leaders’ social position is ascertained. Additionally, the channels and extent of influence of perceived leaders over other cadets are assessed. A significant result was that leaders are not spreading their influence over the friendship network but over the leadership perception network. Leaders have a particular influence on those who perceive them as leaders when it comes to leadership style and performance. This result contributes to our knowledge of “social leadership”, in particular, the ability to manage the social dynamics inherent in leadership.

Keywords—social network analysis; trust networks; leadership.

I. INTRODUCTION

Traditionally leadership was perceived as a relationship between the leaders and their subordinates. However research has showed the significance of the social aspects of leadership [1], including the importance of a leader’s ability in perceiving, interpreting, and solving complex social problems [1][2]. Social network research has provided socio-metric network measures, which can be associated with traditional leadership measurement scales. The research presented in this paper takes a socio – structural perspective by constructing and assessing U.S. Military cadets’ social networks. The results of these analyses are then statistically related to measures of leadership attributes, organizational identity, and attitudes. The results include ascertaining the significance of perceived leaders’ social position and the channels and extent of influence of perceived leaders over other cadets.

The paper is organized as follows: first, the research questions are formalized; then recent research literature on the topic is explored; the data is described; the methodology used to answer the research questions is presented; finally, the results, contributions, and future directions are given.

II. RESEARCH QUESTIONS

The focus of this paper is on questions of what constitutes a leader in the eyes of the military academy cadets and how the perceived leaders influence the cadets. These questions can be formalized as follows:

1) How do leadership attributes, organizational identity, and attitude contribute to the perception of leadership?
2) How does social position, evaluated in the context of friendship and trust relationships, contribute to the perception of leadership?
3) How do perceived leaders influence other cadets in terms of leadership attributes, organization identity, and attitudes?

Answers to these questions will aid in determining the attributes of the perceived leaders, the reach of their influence, and potential effects of the social networks on perceived leadership.

III. RELATED WORK

A. Overview

The research in this paper seeks to identify the relationships between the U.S. Military cadets’ social networks of friendship, trust, and perceived leadership and the leadership attributes, such as values, motivation to lead, leadership style, self-monitoring, personality type, perception of shared leadership and cohesion within the unit. Additionally, the effects of organizational identity and attitudes on perceived leadership are evaluated. The link between the above described attributes and the cadets’ performance will be explored. In this section, related research on the relevance of those attributes to the effective leadership is discussed. This discussion will also examine previous research on the relationship between the social networks and perceived leadership.

B. Leadership Attributes

A clear set of individual and organizational values, such as those demonstrated by the cadets towards Army and U.S. Military Academy, plays an important role in one’s behavioral choices [3]. People use their values as instruments to judge
and justify actions. Those values are transmitted through social interactions and personal experiences. A clear set of organizational values foster efficient interactions among the members of the organization, which are necessary for the organizational success [4]. Past research in military education also showed a relationship between organizational values, organization and leaders performance [5]. Additionally, personality characteristics were shown to mediate the linkage of value-leadership [6]. U.S. Army clearly outlines a set of values [7]:

1. Loyalty - true faith and allegiance to the U.S. constitution, the Army, and other Soldiers;
2. Duty – fulfillment of obligations;
3. Respect – treat people the way they should be treated;
4. Selfless service – prioritize the welfare of the nation, the Army, and subordinates first;
5. Honor – live up to Army values;
6. Integrity – do the right thing, legally and morally;
7. Personal courage – face physical and moral fear, danger, and adversity.

Several studies have linked motivation-to-lead and leadership style to one’s success as a leader. One’s motivation to lead has been associated with potential for achievement and promotion [8][9]. The link was also shown to be relevant in military officers’ career achievement [1]. Self-monitoring refers to one’s ability to monitor social cues and control self-expressive behavior. Leadership style has been linked to the performance of subordinates [10], group potency, group decision-making [11], and organizational culture [12]. In the military context, the research has focused on the differences in leadership styles between males and females [13][14].

Personal characteristics such as self-monitoring skills, self-awareness, and one’s ability to be a team player (i.e. group cohesion) have also been linked to one’s success as a leader. Specifically, a strong relationship has been found between self-monitoring skills and emergent leadership ranking [3][15]. Research has also been conducted in military settings to show a relationship between self-monitoring and effectiveness of leadership [16]. There has been research in the types of personalities that are closely associated with effective leaders [17]. Research on personality types was also conducted in military settings and provided insights into certain personality characteristics associated with leadership [18][19]. Group cohesion has been demonstrated to have a significant impact on subordinate satisfaction in both non-military and military settings [20], and on efficiency, motivation, discipline, flexibility [21], and performance [22][23]. The study at U.S. Naval Academy showed a relationship between self-awareness and performance. The students were evaluated on their self-perception as leaders and the agreement between the self-perception and perception of others was evaluated. The results proved that one should consider the self-awareness when attempting to predict leader behavior and performance [19].

C. Networks and Leadership

Many organizations organize themselves in a hierarchical manner with multiple reporting levels. Such organization is also typical of the cadets in United States Military Academies. First, cadets are broken up into the companies where each company has a company leader selected by the senior officer. Within each company of an average size of about 120, there are four levels of command – the bottom layer with no subordinates (about 40 cadets), the lower middle layer with a one or two subordinates reporting directly to them (about 50 cadets), upper middle layer with three to six subordinates (about 16 cadets), and top layer with many subordinates (about 5 cadets). An example of such structure can be observed in Figure 1. In the Figure 1 black nodes represent top layer, dark gray represent upper middle layer, light gray represent lower middle layer, and, finally, white nodes are the bottom layer. Additionally, the nodes are sized based on its hierarchical structure with the largest nodes belonging to the top layer. The circle nodes represent male cadets and square circles represent female cadets.

![Fig. 1. Cadets' Hierarchical Structure](image)

Such non-organic structures rarely provide a view of the true perception of leadership. Social network approach has been demonstrated to show promise in evaluating the organization leadership. Researchers have shown the importance of social ties in leadership. Specifically, the research showed the significance of maintaining the informal leadership networks within such hierarchical structures [30].
The social network approach has provided a macro view of leadership and has the potential of enhancing our understanding of organizational behavior [30].

In this research, three networks are evaluated – friendship, trust, and leadership networks. There is a lack of current research on the relationship between friendship and military leadership. It has been argued that personal or affective relationships are critical in one’s ability to lead and influence others [24]. Military research shows that effective leaders develop trust, focus effort, clarify objectives, inspire confidence, build teams, and set the example for their subordinates [5]. The research has shown that trust is one of the key components in a leader’s ability to be effective [25][26]. Additionally, a number of antecedents to trust have been found, such as participative decision-making, providing organizational support, expectations management and fulfillment, and leadership style [26]. These findings on trust have also been validated in military research through evaluation the relationships between the leaders characteristics and subordinates behaviors [27].

Research has evaluated military leadership in the context of cadets’ perceptions when selecting other cadets as best performers and leaders. Such evaluations considered personal attributes [18][19], self-monitoring [28], and performance [19][29]. In this research, a cadet’s leadership perceptions are evaluated in relation to leadership attributes.

IV. SURVEY

In order to evaluate leadership attributes a survey was developed and administered to cadets. The survey included three attributes, which were developed at U.S. Military Academy (USMA) – organizational identity, organizational cynicism (i.e. attitudes toward USMA), and Army values. The remaining six attributes – motivation-to-lead, shared leadership, authentic leadership, self-monitoring, and five factor model were developed in the previous leadership research.

To develop a scale for organizational cynicism a pilot study was conducted. A focus group consisting of four cadets was utilized. Once the preliminary scale was developed, the pilot study was conducted targeting 423 cadets from three organizational units (i.e. cadet companies). Participants received and completed paper surveys during lunch formation (cadets line up in preparation to march into the lunch hall). The response rate was 98%. The initial scale included 14 items. Factor analysis was used to narrow down the scale. Only the items that scored higher than .35 were kept. The final scale included seven questions with six questions falling into a single factor and one question was added per request of the USMA Brigade Tactical Officer. A second pilot study was used to develop Army values scale and test two modified organizational identity scales. The pilot population consisted of 132 cadets from a single cadet company. The response rate was 100%. Factor analysis was used to develop two distinct scales – organizational identity with Army and organizational identity with USMA. The scales used the items proposed by previous scales – Mael and Ashworth’s [31] and Edwards and Pecccei’s scales [32]. Next, an Army values scale was developed using existing Army doctrine. The scale included two questions per Army value: loyalty, duty, respect, selfless service, honor, integrity, and personal courage. Factor analysis was used to refine the scale. From 14-item scale only 10 items had significant (greater than .4) factor loadings.

The other six leadership attributes were constructed as follows:

1. Motivation to Lead: five item scale of person’s perception of their own leadership instincts; scale was modified from original 9 item Chan and Drasgow’s scale [8];
2. Shared Leadership: ten item scale of group leadership; items included “The members of my team discuss our team’s tasks and objectives to ensure that we have a fair understanding” and “The members of my team talk enthusiastically and enthusiastically about our team’s progress.” [33];
3. Authentic Leadership: a 16 item scale used to assess leadership skills [34];
4. Self-monitoring: an 18 item scale used to assess how a person adjusts his/her behavior based on the social situation [35];
5. Five Factor Model: a 10 item scale that measured five personality traits: openness, conscientiousness, extraversion, agreeableness, and neuroticism [36][37];
6. Group Cohesion: four-question scale which asked about a group level cooperation (Goodwin per correspondence with Andy Slaughter).

Finally, a set of questions was constructed to inquire about some demographics such as age, gender, and ethnicity. Three questions were also implemented to obtain network data:

1. Name up to 5 people you consider to be a friend (someone you choose to spend your time with and go on pass with).
2. Think of the qualities of an effective leader. Name up to 5 cadets you think have the most potential to become the best leaders (consider of all four classes).
3. Name up to 5 cadets you trust (not necessarily a friend, but someone you deem trustworthy).

Moreover, the measurement of academic performance consists of two separate grade point averages - one for academic performance and another for military performance.

Per Internal Review Board approval, informed consent was obtained from the cadets. Informed consents were delivered to seven cadet companies (avg=123 students each; n= 859), of
which 580 (64%) consented to participate. Two waves of data were collected with the first survey administered in January, 2013 (the first week of Spring semester) and the second survey, in April, 2013 (two weeks before the semester end). Of those targeted, 64% (n=551) completed the survey at time 1 and 54% (n=465) completed the second survey three months later. Across company networks, completion rate of both surveys in time 1 and time 2 ranged from 45% (n=51) to 8% (n=79). Every semester, cadets receive a new formal position (described earlier as the command network). Data collection was designed at the beginning and end of the semester to capture the dynamics generated by these imposed social positions.

Cadets were 17% female aged 18 to 25 (mean = 20.1) years. Ethnic distribution was 73% Caucasian, 9% African American, 8% Hispanic and 7% Asian. Cadet companies were reflective of the entire student body with respect to gender and ethnicity. This population had a slightly older population compared to the Academy student body with approximately equal numbers of students from the four class years: 23%, 25%, 26% and 26% of freshman, sophomores, juniors, and seniors, respectively (typically cadet companies have decreasing numbers of the upper classmen due to attrition.)

V. METHODOLOGY

A. Network Analysis

The results of the survey provided socio-metric data consisting of each cadet naming five cadets they consider to be a friend, five cadets they consider to have the most potential to become best leaders, and five cadets they trust. Using these results three networks were constructed: (1) friendship, (2) trust, and (3) leadership. In these networks each node represents an individual cadet and each edge is directed and represents cadet’s choice of friends, leaders, and trusted peers within their company. R software was used to evaluate network properties. The socio-metric data collected in the survey was converted into an edge list and igraph package was used to construct the network. The survey results were used to compile a list of cadets’ attributes – Army Values, Leadership, Leadership Style, Self-Monitoring, , Cohesion, Army Organization Identity, Cynicism, and Shared Leadership. Demographic information and academic grade point averages were retrieved from the Academy’s records.

The leadership network was used to establish the ranking of perceived leaders. InDegree centrality measure represents the number of the node’s incident edges [38]. In terms of the leadership network the InDegree measure represents the number of times a cadet was chosen to be potentially best leader by other cadets in the network. The InDegree measure was used in linear regression modeling, described later, to evaluate the relationship between the cadet’s leadership ranking and his/her attributes.

B. Regression Modeling

In this paper the following modeling techniques were employed: (1) linear regression modeling, including ordinary least squares method, and (2) linear network autocorrelation modeling. Linear regression was used to estimate statistically significant relationships between the attributes collected in the survey and the network properties. Specifically, in order to answer the first research question, linear regression was used to evaluate the relationship between cadets’ leadership rankings, InDegree centrality, and cadets’ attributes. This analysis was used to show which characteristics were most important to the cadets when choosing a potential leader. Ordinary least squares linear (OLS) network regression was utilized to answer the second research question and predict the leadership network using trust and friendship networks. Network OLS regression is similar to standard OLS regression element-wise using adjacency matrices of the networks (i.e., trust and friendship networks). Following is the representation of the OLS network regression model:

\[ A_y = b_0 A_1 + b_1 A_{x1} + b_2 A_{x2} + \cdots + Z \] (1)

where \( A_y \) is a dependent adjacency matrix, \( A_{x1} \) is the ith independent adjacency matrix, \( A_1 \) is an n x n matrix of I’s, and Z is an n x n matrix of independent normal random variables with mean zero and variance \( \sigma^2 \) (Carter, 2014). In this research, \( A_y \) is the leadership network adjacency matrix, \( A_{x1} \) is a friendship network adjacency matrix, and \( A_{x2} \) is a trust network adjacency matrix.

Finally, the linear network autocorrelation model (LNAM) was used to model network effects on individual attributes and answer the final research question. The model can be represented as follows:

\[ y = W_1 y + X \beta + e \] (2)

\[ e = W_2 e + v \]

\[ W_1 = \sum_{i=1}^{n} \rho_1 W_{1i}, W_2 = \sum_{i=1}^{n} \rho_2 W_{2i} \]

where y is a response vector, X is a covariance matrix and v ~ N(0, \( \sigma^2 \)). \( W_{1i} \) and \( W_{2i} \) are adjacency matrices. \( \rho_1 \) is a vector of parameters parameterizing the auto regression of each y value on its neighbors in \( W_1 \), whereas, \( \rho_2 \) parameters parameterize the autocorrelation of disturbances in y on its neighbors in \( W_2 \). The two models are distinct, and in this research, the later model was chosen because the goal of the research is to study the effects of one node on the attributes of the other nodes in its neighborhood. The parameters of the model are estimated using maximum likelihood [39][40]. Leenders [40] posits questions that need to be answered prior to evaluating the model – (1) how social influence occurs; (2) which mechanisms govern the social influence (communication or comparison); (3) sources of influence; and (4) how much influence is exerted. In this research the social influence occurs through autocorrelation of disturbances and is
governed by comparison. Moreover, the sources of influence are the perceived leaders evaluated using their InDegree measure from perceived leadership network.

Therefore, in this research, the focus is the spread of influence by the perceived leaders onto the other cadets. In order to accomplish this task the following procedure was followed:

1. Select cadet i;
2. Find all cadets who chose cadet i as the best potential leader in time 1 and time 2, these populations represents neighborhood1(i) and neighborhood2(i);
3. Select first attribute in the attribute matrix for time 1 and time 2 – attribute11 and attribute12 respectively;
4. Calculate the mean values of first attribute for neighborhood1(i) and neighborhood2(i) – mean11 and mean12;
5. Find the difference: mean11 - mean12 and assign the value as a new attribute;
6. Repeat 3-5 for each attribute;
7. For cadet i find the difference of the values of each attribute between time 1 and time 2 and assign as a new attribute;
8. Repeat 6-7 for all cadets;
9. Repeat 1-9 for the friendship network – select cadet i from the friendship network in step 1 and select all cadets who consider cadet i a friend.

The neighborhoods found in task 2 represent the potential neighborhoods for each cadet. In this paper, these neighborhoods are referred to as influence neighborhoods. In order to evaluate the influence of the perceived leaders the LNAM was used to model value found in task 5, which represent the average shift for each attribute in the influence neighborhood for each cadet, as a dependent variable; leadership ranking, i.e., InDegree and values found in task 7 for each attribute, as independent variables. In another words, the LNAM is used to model the effects of the cadet’s leadership ranking and change in his/her attribute value on the change in mean value for each attribute for the cadet’s influence neighborhood.

VI. RESULTS

First, three types of networks were constructed and their similarities and differences were evaluated. The densities (i.e., the proportion of all present edges to all possible edges) of all three types of networks were very small (around 0.003). Network reciprocity (i.e., vertex tendency to form mutual connections) in the friendship network was the highest and lowest was found in the leadership network. Finally, the degree distributions of the graphs suggest that the leadership network has a high core periphery structure, where there is a clear separation between a few cadets who were chosen as perceived leaders (i.e., the core) and a large number of cadets who received only one or two nominations as leaders (i.e., the periphery). This property was not typical of friendship or trust networks.

<table>
<thead>
<tr>
<th>Network</th>
<th>Density</th>
<th>Reciprocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friendship</td>
<td>0.003351</td>
<td>0.362</td>
</tr>
<tr>
<td>Trust</td>
<td>0.003229</td>
<td>0.145</td>
</tr>
<tr>
<td>Leadership</td>
<td>0.003909</td>
<td>0.0651</td>
</tr>
</tbody>
</table>

Fig. 2. Leadership Network Degree Distribution

Next, linear regression conducted on the attributes and leadership ranking (i.e. InDegree) showed that the following attributes were statistically significant in predicting leadership ranking in time 1 (p-value < 0.05): motivation-to-lead, authentic leadership, group cohesion, organizational identity, shared leadership, and academic performance (See Table I). For time 2, the only attributes that were statistically significant were motivation-to-lead, authentic leadership, and academic performance.

The Ordinary Least Squares procedure used trust and friendship networks as independent variables to predict perceived leadership network. The results showed trust and friendship networks are statistically significant in predicting the perceived leadership network, however, the performance of the model (R-Squared) was lower than 10% suggesting that there are other factors such as the ones described in linear regression analysis that affect the perceived leadership network structure.

When LNAM was applied to the friendship network, results suggested that leaders did not possess any influence over the
attributes of their friends. This finding suggests that the perceived leaders don’t spread their influence over their friendship ties. However, when LNAM was applied to the perceived leadership network, findings suggest that the leaders were able to spread their influence and cause change over their respective neighborhoods in terms of attitudes about authentic and shared leadership. Authentic leadership is a frequently used scale that assesses traditional leadership skills, with items such as “I make difficult decisions based on high standards of ethical conduct.” The shared leadership scale, represents a coordinated effort among the company members in sharing responsibility of leadership, and academic performance, include items such as “The members of my team discuss our team’s main tasks and objectives to ensure that we have a fair understanding” and “The members of my team talk enthusiastically about our team’s progress.”

### TABLE II. LEADERSHIP RANKING PREDICTION SUMMARY

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Time 1</th>
<th>Time 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Army Values</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motivation to Lead</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Authentic Leadership</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Self-Monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personality Scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group Cohesion</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Org. Identity (Army)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Cynicism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shared Leadership</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Academic Performance</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

In summary, a statistically significant positive relationship was found between the leadership ranking (i.e., InDegree in the leadership network, which is the number of people who picked the person as a leader), and the change of authentic leadership styles from time 1 to time 2. The change in leadership ranking of a person was also related to the change in the authentic leadership style of the people who perceive him/her as a leader. Additionally, there was a positive relationship found between the leadership ranking of a person and the change in shared leadership style by those who perceive that person as a leader. More importantly, a relationship was discovered between the performance of the leader and performance of the people who perceive him/her as a leader. Specifically, the change in a person’s leadership ranking and his/her performance cascaded into a change in the performance of those who perceive him/her as a leader. These findings suggest that as perceived leaders share common leadership skills with their respective influence neighborhoods and as they grew stronger in their leadership ranking, they were able to make a positive impact on the leadership skills of their respective influence neighborhoods. Moreover, the perceived leaders were able to foster a positive change in collaborative leadership and academic performance of the members of their influence neighborhoods.

Overall, to answer the research questions, analysis showed that motivation-to-lead, authentic leadership, group cohesion, organizational identity, shared leadership, and academic performance attributes contribute to perceptions of leadership. The research has also discovered that social position in the context of trust and friendship networks plays a significant role in predicting perceived leadership. Moreover, the perceived leaders spread their influence over the leadership attributes, organization identity, and attitudes to other cadets through their perceived leadership ties and not through their friendship or trust ties.

### VII. CONTRIBUTIONS AND FUTURE WORK

This paper demonstrates how social networks can be used to improve our understanding of leadership. The results demonstrate that it is important to differentiate between different types of social networks, as in this case, trust, friendship, and perceived leadership networks. The use of statistical techniques, which incorporate the structure of the network, provide insights into our understanding of how the influence of the perceived leaders diffuse. The research presented in this paper has shown that trust and friendship networks can help predict the structure of perceived leadership. Additionally, it was demonstrated that leaders spread their influence positively through their follower ties as opposed to their friendship ties. This influence includes the cadets’ perceptions of leadership skills, leadership style, and academic performance. Leadership attitudes have been shown to correspond to effective leadership, further suggesting that informal leaders have the ability to influence their followers’ ability to lead.

In future work the findings will be incorporated into a comprehensive model of network peer effects on leadership. Specifically, the researchers will seek to develop a model, which aids in developing future military leaders, while incorporating traditional leadership research and social network analyses. Current results and future work will open an opportunity for developing creative ways of enhancing leadership skills in educational settings aiding in improving the skills of the future leaders.

### ACKNOWLEDGMENT

This material is based upon work sponsored by the Department of Homeland Security, Science and Technology Directorate, Office of University Programs through Command, Control, and Interoperability Center for Advanced Data Analysis Center of Excellence.

This material is also based upon work sponsored by the Army Research Laboratory under Cooperative Agreement
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