Mini Project - Centrality Measures Application

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I. Paper Citation

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II. Problem Description

In United States Tobacco is often viewed as a problem that has been solved. However, tobacco kills more than 0.48 million Americans per year1. About 1 in 5 deaths in the United States is due to tobacco. [1] The Department of Health and Human Services is responsible for protecting the health of all Americans (DHHS), including planning, guiding, and funding tobacco control activities in the United States.

However, it does not appear that these agencies communicate and collaborate effectively to reduce tobacco use in the United States. This fact is important because each agency brings unique expertise that can benefit the efforts of other agencies.

In the investigation Mapping U.S. government tobacco control leadership: Networked for success?, the authors constructed a data network to help agencies communicate more effectively in order to more rapidly reduce tobacco use and, ultimately, tobacco-caused morbidity and mortality. [2]

III. Network Science Methods

A social network analysis (SNA) is an essential strategic quantitative tool to research into the complexity of relations and patterns of entities belonging to the network. This is relevant for organizational communication and collaboration research, up to the point that it may explain information flow, point out central actors, and denote connectivity or its absence. **Centrality Measures**: Betweenness centrality emerges as a particularly powerful measure within network analysis due to its focus on the extent to which a node lies on the shortest path between others. This is invaluable for gauging the influence of individual actors in the control and distribution of resources, such as information. It highlights nodes that serve as critical conduits or 'bridges' within the network's architecture. Other centrality measures, like degree centrality, which simply counts the number of direct connections a node has, might not capture the nuanced role of nodes in a communication network. Degree centrality can often overemphasize the importance of nodes with many local connections that do not necessarily contribute to the broader network flow. Similarly, closeness centrality, which measures how close a node is to all other nodes in the network, can be less relevant in communication contexts. It assumes that information flows efficiently across all direct connections, which might not be the case in more complex or hierarchical networks. In contrast, betweenness centrality identifies those nodes that, even if not highly connected themselves, play a crucial role in facilitating communication between others who are not directly connected. By doing so, it accounts for the indirect influence a node has over the spread of information across the entire network.

Density Calculations: In the recent analysis of undirected networks within the Department of Health and Human Services, data reconstruction was employed as a remedy for the 7.3% of missing data, equivalent to 210 values. This method was based on available responses from one participant of each dyad. When both participants in a dyad provided no responses or were uncertain—indicated by a "don't know"—the relationship was designated as non-existent with a zero value. Such cases were minimal, affecting only 10 out of 1,431 pairs, indicating the data's reliability.

Prior to the symmetrization process, the network density was recorded at 0.26. Following symmetrization, there was a slight increase in network density to 0.32. This increment, although expected in the process of data reconstruction, was marginal, suggesting that the original data effectively reflected the network's structure with a high degree of accuracy. the measure of network density in the study further looked at that point to show an indication of an overall connectedness network and at the same time representing a ratio of the effective links to all possible links within the network. In essence, this was a macro-picture of how tightly the DHHS network was knitted, indicative of the level to which agencies and the persons therein inter-linked. A higher density of the network signals a more cohesive network, where information could flow with more ease among entities that have to do with tobacco control. It is helpful to identify using the software of Pajek for network visualization. Key Players-Patterns of Communication-Structural Gaps.

IV. Network Data Set

The network data set used in this study focuses on understanding the coordination of tobacco control efforts across agencies within the Department of Health and Human Services (DHHS) in the United States. The data set includes information on communication patterns among tobacco control leaders across 11 DHHS agencies, excluding the Administration on Aging (AoA) and the Agency for Toxic Substances and Disease Registry (ATSDR) due to their minimal or nonexistent role in tobacco control.

Data collection occurred in March 2005, with 49 of the 54 network members participating in the survey, resulting in a response rate of 91%. The survey collected information on participants' contact with others in the network, their experience in tobacco control, length of time at their current organization, and barriers encountered in working with other DHHS agencies on tobacco control.

The survey measured the frequency of personal contact between network members regarding tobacco control activities. The network was symmetrized to represent each relationship between two individuals as a single undirected link, with contact frequency dichotomized into "at least quarterly contact" and "less than quarterly contact." The final network used for analysis had a density of 0.16, indicating regular or ongoing

communication patterns among tobacco control leadership in DHHS.

V. Results

Based on the degree of contact between individuals from each agency, it was possible to construct a social network that allow it to evaluate communication patterns and gaps between agencies within the DHH. Through the analysis of centrality measures, it is possible to identify that the members belonging to the OS and CDC agencies act as bridges between the other members of the network. However, some agencies such as FDA and CMS have a very limited or no connection, despite playing a fundamental role in tobacco control. Given the impact of tobacco use on public health, the result of the analysis proves the need for greater communication and collaboration on tobacco control across DHHS.

VI. Team Members' Contributions

Team Member	Role	Contributions
Santiago Angarita	The Monitor Evaluator	Evaluate the application of centrality measures for the case studies.
Laura Chacón	Implementer	Provide examples from case studios and resources to develop the activity.
Sergio Vargas	Resource Investigator	Visualization and analyse data

Description of contributions of team members.

References

[1] C. for Disease Control, P. Smoking, and Tobacco, "Fast facts," Available at https://www.cdc.gov/tobacco/data_statistics/fact_sheets/fast_facts/index.htm. (2019/11/15).

[2] L. Scott, D. Luke, J. Harris, P. Ponder, S. Marcus, and P. Clark, "Mapping u.s. government tobacco control leadership: Networked for success?" *Nicotine tobacco research : official journal of the Society for Research on Nicotine and Tobacco*, vol. 12, pp. 888–94, 09 2010.