Achieving Equitable Aid Delivery During Rehabilitation: A Case Of Primary Education

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ABSTRACT

Purpose: To understand the current state of network of NGOs working in the field of primary education and analyse the factors affecting them.

Design/methodology/approach: Social network analysis (SNA) using exponential random graph model (ERGM)

Findings: Geographical location, political stability, economic status, and absence of violence are the major factors for the aid organizations to select aid delivery country.

Research limitations/implications : ERGM method cannot handle missing value we limited our analysis by including only the complete variables.

Practical implications: The results highlight key areas where the network is not connected and HOs work in isolation compared to few countries where flocking of different HOs is present. Managers can take the insight from the analysis to identify lack of connected networks to better manage the operations.

Originality/value: Our study employs SNA to understand the complex web of countries receiving aid through a novel approach in humanitarian logistics and supply chain management. This can be further extended to identify important locations for establishing hubs for relief aid distributions in the area.

Keywords— Social Network Analysis, Education, Humanitarian; SDG; UN

I. INTRODUCTION

Humanitarian organizations (HO) have been effective and efficient in managing (logistics and supply chain) processes in place to deliver assistance to those in need, both within and between organizations, while adhering to humanitarian principles of humanity, impartiality, neutrality, and independence. HOs have helped several countries sustain long-term education programs for all levels, namely primary, secondary and higher education. Developing and underdeveloped nations across the world receive the support of these different HOs in running different education programs. There is a high variance in the operations of HO across the world. There are cases where many HO are running education programs in one country; also, there are a few HOs that are running education programs across multiple countries. It is interesting to know how the network of these HO and the host countries are formed in the current state. Further, it is observed that many of these network countries are working in isolation and are not part of an extended network. These may be due to several restrictions for international HO in the host country. Additionally, it is observed that the density of the network differs in countries with different geographical regions. We assume that this might be due to several factors, which include media attention and proximity to UN headquarters, among others. Countries that are in conflict receive greater international media attention and hence might attract more HO, but these countries also have been prone to unstable political and geographical environments, which might hinder the HO from approaching the same.

It is believed that coordination between the countries receiving aid and the HO can help improve the system's performance as a whole. It is observed that there are highly dense regions receiving a majority of aid and also sparse regions in the network structure. This highlights the areas which might need more attention and probably need to be connected with the larger network in order to provide "impartial" assistance, which is one of the major pillars for a HO. The network structure also highlights the organizations which are working in isolation; these organizations must be encouraged to join the larger relief network. This might increase the effectiveness of the total assistance at the global level. Further, the country-level variables like GDP, school dropout rate, and geographical region might affect the presence of these HO and their operation. Following these, we aim to explore the following three research objectives of this study.

- To understand the current state of NGOs working in developing and underdeveloped countries in the field of primary education and visualize the network.
- To understand the effect of different country-level parameters in the network of countries that are receiving humanitarian assistance.
- To understand external/exogenous factors affecting the network characteristics.

II. LITERATURE REVIEW

Social network analysis (SNA)

SNA is a subfield of graph theory, a discipline of mathematics developed in the eighteenth century by a Swiss scientist named Leonhard Euler. This mathematical underpinning was combined with a significant sociological component that has its roots in the work of Georg Simmel [1], who was the first to conceptualize interpersonal social dynamics. The approach was quickly expanded to include research on bigger groups, organizational systems, and whole societies[2]–[4]. As social connections were officially characterized as network embeddedness, the "original interest in patterns of affiliation" gave rise to what may be dubbed the "second wave of SNA" [5]. Sociologist Granovetter then put forth the influential theory of weak ties, which holds that while strong bonds of frequent contact and/or degree of closeness tend to bring together people who are similar, weaker ties

frequently serve as a bridge between communities that would otherwise be at odds with one another[6]. Social capital, or the benefit of membership in a dense social network, is another significant idea from this time period[7]. Burt, a sociologist and strategist, continued by arguing that, as opposed to those who are immersed in tight, highly linked networks, those who transcend structural gaps—that is, those who connect otherwise isolated social entities—benefit most [8].

One may argue that the third phase of contemporary SNA research, development into the more general field of network science, has occurred. At this point, the emphasis switches to whole networks, with interest growing in topics like network development, complexity, synchrony, and spread. Although these concepts have long-standing theoretical roots, the novelty comes from the statistical rigor that has recently been made available by technological advancements.

Barabási and Albert [9] explain the scale-free network, which can be seen in biological networks and the World Wide Web and is identified by a small number nodes with connections that are far higher than the network's average, as an illustration of how SNA's applicability to real-world contexts is expanding. One of the main issues in SNA nowadays is the identification of key influencers or a smaller group of individuals responsible for spreading beneficial or bad effects over a much broader network. This new perspective on network structure has given birth to this issue [10]. According to recent study, poorly linked entities, who have historically been considered inconsequential, may really become influential players of considerable significance, surpassing the best-connected actors by acting as more effective conduits [11]. Several SNA software platforms have assisted progress in related research with the emergence of network science [12]. UCINET[13] which integrates a broad range of network ideas with empirical testing, is one of the most extensively used in social research. Alternatives include Gephi for network visualisation and dynamics [14], Igraph for complex networks [15], Cytoscape for biomolecular interactions [16], and SNAP for extremely large networks [17]. increasing the third phase of SNA's development. The rise of social media sites like "Twitter," "Facebook," and "Instagram," which both embody many of the original SNA ideas and provide enormous data sets for empirical investigation, is considered SNA in the field of humanitarian logistics research[18].

'Social network analysis has been used to analyze the unimodal and bimodal networks of countries and the HO operating in them. The academic interest in social network analysis has exploded in the recent two decades. Several factors have aided in this expansion. First, the rise of social media has increased people's awareness of networks and provided them with tools to help them network intentionally. Second, data from social networks has become more readily available on a variety of socially relevant topics, including the spread of incorrect information, cooperative business ventures, cyber-attacks, migration, lobbying, disease transmission, and friendship. Third, computer technology has advanced to make it easier to collect and analyze the massive and complicated data sets that social networks yield. Finally, network analysis approaches are now more accessible to a broader community of scholars, and they are more comparable to traditional statistical methods due to the development of computational capabilities and sophisticated statistical tools and software [19].

SNA has been quite useful for studying the dynamics between individuals and organizations, which are often too complex to study due to the limitations of traditional statistical methods like regression [3], [4]. Humanitarian logistics' promise in terms of SNA (and vice versa) is based on its powerful combination of community well-being with commercial SCM structures, which connects two network-based worlds. In both situations, SNA can give useful information [20]. Several authors have used SNA to understand the phenomenon in Humanitarian supply chain management. Bisri & Beniya[21] used SNA network modeling to identify the important gap between the network of humanitarian organizations, which would help them to formulate policy-level decisions to enable NDRF as a central coordinating body. Closer to this study, Curtis [22] used SNA to show that better communication between the NGOs could have made the Hurricane relief activities more efficient. He showed that the organizations which could have been vital in communication had been left out of the network.

III. DATA AND METHODOLOGY

Data was collated from published survey results from partners with Accelerated Education Programs worldwide. This includes two modes of data of 94 humanitarian organizations focusing on primary education in 54 developing or underdeveloped countries. Country level attributes used in the study are global region (as per UN), GDP, percentage of children out of school (primary age), Probability of survival to age 5, Expected years of school, and Human capital index (HCI). The data has been collated from the official website of the World Bank. The variables have been chosen based on the factors which might affect the primary education of the children

The data collected was checked for missing values and arranged in standard form to provide input as required by the "statnet package" in R. We used R studio software version 1.3.1093 on 64-bit windows pc with processor Intel(R) Core(TM) i5-9400 CPU @ 2.90GHz and 16 GB RAM for this analysis.

First, a bi-partite network was formed using country and organization data. The network features are calculated as below

Network density

The network density is measured by the ratio of a number of actual ties and potential number of ties. The number of potential ties is calculated by finding out all the potential ties, i.e., maximum number of connections possible.

Ego network density = Nactual ties/Npontential ties

Potential ties= n(n−1)/2, where n is the number of alters

Exponential Random Graph Model

The exponential Random Graph Model (ERGM) is used to analyze the network of countries receiving assistance. The goal of an ERGM is to predict the presence or absence of a network tie between every dyad in a network[23]. By understanding the formation of dyads while explicitly accounting for network dependence, we understand the formation of network structures. We have used both exogenous and endogenous explanatory variables, which

allows us to test competing explanations for network formation [24].

Fig 1. Two-mode network.

Fig 2. Organization Network.

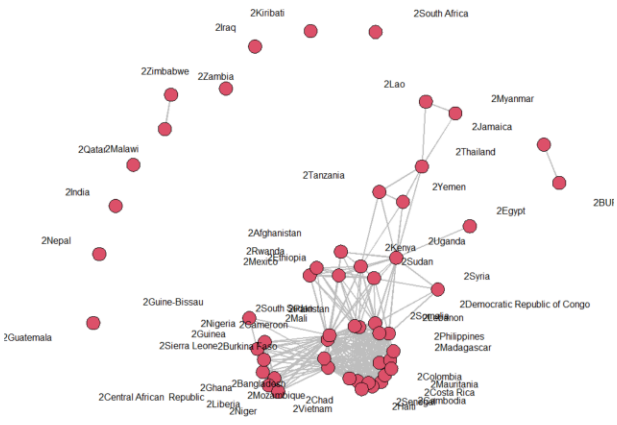

Fig 3. Country Network.

IV. Results

The results are represented with the help of Figures 1, 2, and 3 and Tables 1 and 2, and 3.

Two-Mode Network attributes

Two mode network is formed using the organization and country attributes, as shown in figure 1. A cursory glimpse of the network provides insights into its properties. Most of the organizations (represented by a red circle) are clustered, serving a single country (Blue square); simultaneously, many organizations are serving in more than one country, which may indicate a lack of efficient coordination at the system level. There are a significant number of organizations in 'isolates' (not connected with any other organization) which again might indicate the lack of effective coordination resulting in inefficient operations.

The descriptive stats of the network is provided in table 1, which shows a density of 0.0085. This indicates a very low relational attribute in the network and provides scope for more connectedness in the network.

TABLE I: NETWORK ATTRIBUTES

Attributes	***Vertices***	***Bipartite***	***Total edges***	***Missing edges***	***Density***
Values	148	94	186	0	0.0085

TABLE II: COUNTRY NETWORK STATISTICS

Attributes	***Transitivity***	***Reciprocity***	***Indegree***	***Dyad Census***	***Betweenness***	***Density***
Values	0.7838	1	186	304	0	0.0085

Further, we convert the two modal country and organization networks to a single mode network of organizations and countries they are present. We present the network structure of the same in Figures 1,2 and 3. Since we aim to study only country networks, hereafter, we only discuss the country network receiving aid.

V. Discussion

The country network is formed by the data collected over presence of humanitarian organization providing primary education. The descriptive analysis of network shows several important insights about the coverage of different countries and how these countries are connected. This might have important implication on determining scope for future projects by HO. Presence of several isolates may be avoided in future as better communication and coordination can help these HO improve their effectiveness. ERGM shows how these factors affect the network. Few important conclusions can be made as below.

- More the school dropout rate, more are the humanitarian organizations present.
- The Middle East and North African countries have a lesser presence of humanitarian organizations
- GDP has a very minimal effect, as the countries receiving a majority of assistance are smaller in size.

TABLE III: ERGM MODEL RESULTS

Variables	Estimate	Std. Error	Pr(>|z|)
edges	8.32E+00	2.36E+00	0.000426
nodeicov.Prob_sur	-1.44E+01	2.87E+00	< 1e-04
nodeicov.HCI	8.97E+00	1.47E+00	< 1e-04
nodeicov.School_years	-1.47E-01	4.12E-02	0.000346
nodeicov.GDP	-6.41E-07	1.80E-07	0.000361
nodematch.region	7.03E-01	1.16E-01	< 1e-04
nodefactor.region.Eastern and Southern Africa	8.15E-01	1.40E-01	< 1e-04
nodefactor.region.Latin America and Caribbean	7.96E-01	1.44E-01	< 1e-04
nodefactor.region.Middle East and North Africa	-1.14E-01	1.77E-01	0.518441
nodefactor.region.South Asia	9.28E-01	1.64E-01	< 1e-04
nodefactor.region.West and Central Africa	8.84E-01	1.39E-01	< 1e-04

TABLE IV: GOODNESS-OF-FIT FOR MODEL STATISTICS

Variables	obs	mean	MC p-value
edges	6.08E+02	6.08E+02	0.92
nodeicov.Prob_sur	5.72E+02	5.71E+02	0.92
nodeicov.HCI	2.61E+02	2.60E+02	0.94
nodeicov.School_years	5.42E+03	5.41E+03	0.98
nodeicov.GDP	6.81E+07	6.86E+07	0.9
nodematch.region	1.88E+02	1.89E+02	1
nodefactor.region.Eastern and Southern Africa	3.52E+02	3.53E+02	0.92
nodefactor.region.Latin America and Caribbean	1.68E+02	1.67E+02	0.98
nodefactor.region.Middle East and North Africa	6.20E+01	6.13E+01	0.98
nodefactor.region.South Asia	1.10E+02	1.11E+02	1
nodefactor.region.West and Central Africa	4.30E+02	4.30E+02	1

A few important managerial implications can be made for the managers of humanitarian organizations. First, the existing web of HO operating in the region should be considered for efficient and impartial assistance. Second, it may be important to include local NGOs, which might prove beneficial for them as well as the recipients of the aid. Third, not all the countries that ask for help might really need it. There might be few avenues that are not able to garner high media attention leaving them isolated and deprived of any aid. Lastly, the coordinated effort might be much more efficient for the system containing HOs and countries which receive the aid.

VI. CONCLUSION AND FUTURE DIRECTIONS

We have analyzed the network structure of countries receiving aid through this study. We make an attempt to understand the underlying factors for a humanitarian organization to select an aid delivery location. Descriptive analysis shows many isolated countries in the network, which could be connected to increase delivery efficiency. The network analysis shows that potential factors like region and geography impact the delivery location in addition to economic factors like GDP, child survival rate, and the number of years of schooling.

Based on the results, future studies can aim to further expand the model by including relevant variables which would make the model robust and more accurate.

There might be certain limitations in this study as we have many isolates which might have affected the network diagnostics. Another limitation was the unavailability of education status for all countries for a single year. The latest available data was used for this study. Finally, conversion to a single mode might have led to a loss of information. More variables affecting the country and its education program, like overall education status, education budget by the host government, fertility rate, child mortality rate, and human health index, among others, can increase the explanatory power of the model.

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