Technical Brief

APPLYING SOCAL NETWORK ANALYSIS IN EVALUATION

June 2021

data INNOVATORS

SUMMARY

The Technical Brief on applying social network analysis in evaluation focuses on the use of Social Network Analysis (SNA) as a method of data analysis in understanding complex social networks and the positive role it can play in Monitoring and Evaluation practices. Explained, Social network analysis (SNA) is an innovative method that investigates social structures by combining graph theory, statistical analysis, and the use of computer programmes to visualise networks. SNA graph theory has previously been used in various fields such as computer science, linguistics, biology, social science, and many others. Furthermore, this paper explores various examples of how SNA can be applied in multiple sector studies, including COVID-19 research and the role of SNA in supporting Monitoring and Evaluation work.

Monitoring and evaluation (M&E) tools play a vital role in improving the way organisations achieve results. To keep up with a world that is ever evolving, there is a need for new M&E approaches that can be adaptative. This paper illustrates the importance of understanding the intervention networks through SNA mapping. Understanding SNA allows M&E practitioners to supplement existing methods with analysis and visualisation useful for depicting the nature and change of networks.

APPLYING SOCAL NETWORK ANALYSIS IN EVALUATION

Social network analysis principles and concepts

Social network analysis (SNA) is an innovative method that investigates social structures by combining graph theory, statistical analysis, and the use of computer programs to visualise networks (1). Graph theory is referred to as the study of graphs; where graphs are made up of nodes (vertices) and connected by edges (lines). Graph theory can be applied across various fields of study including computer science, linguistics, biology, and the social sciences. Graph theory, as it relates to SNA, suggests that relationships among people, entities or records can be depicted according to variables that influence the nature, or depth of such relationships. In social science, graph theory has been used to describe relationships among people, whether people know each other, how certain people can influence the behaviours of others, and whether two people work together. The SNA method uses these graphs, alongside quantitative patterns, and trends (statistical analyses) and visualisations to increase the awareness of the power of networks, to catalyse relationships and connections, as well as strengthening the capacity of the network to act collectively (2).

The use of SNA in the development sector allows leaders and key stakeholders to understand diverse and often complex relationships that may affect strategic development. Researchers explain that SNA results can be applied at various network levels, e.g., individual, department, organisational) to identify bottlenecks or isolated individuals, as well as detect opportunities to improve knowledge flow.

In a more recent study on climate change adaptation, SNA was applied in agricultural communication to identify opinion leaders and to map out patterns of information flow (1). This study highlighted the importance of informal social networks in the diffusion of information. SNA has also been widely used in public health to promote interventions. For example, infectious disease researchers used SNA to identify high-risk populations for targeted vaccination to curb the spread of infectious diseases (3). Similarly, researchers in Saudi Arabia have used network analysis to investigate the spread of MERs coronavirus. These researchers argued that real-time network analysis was essential in identifying important players for isolation and selective treatment (4). Recently, Data Innovators[1] used SNA to visualise the geographic network of the first 150 COVID-19 cases in South Africa.

Key concepts in SNA

- Nodes: entities, e.g., individuals, groups, or organisations within a network
- Edges: the connections between nodes in the network. Edges can either be directional (focusing on who is providing the connection) or non-directional (focusing on the overall connection).
- Isolate: a node without any connections
- Density: measures the overall connectedness of the network, i.e., how individuals/entities in the network are connected. Density values

[1] *In 2021, Data Innovator Pty LTD joined the Advisory Services Unit of New Leaders Foundation to form the new entity trading as Data Innovators.*

range from 0 (no one is connected to anyone) to 1 (everyone is connected to everyone else).

- Average degree: the average number of connections per node in the network
- Modularity: measures how much entities within the network are broken up into sub-groups, i.e., clusters or communities. Networks with high modularity have dense connections between the nodes within subgroups, but sparse connections between nodes in different subgroups.
- Betweenness centrality: the shortest paths between nodes. It incorporates the importance of key nodes within the network, i.e., bridgers. Bridgers are relay points between nodes in the network.

Related trends in M&E

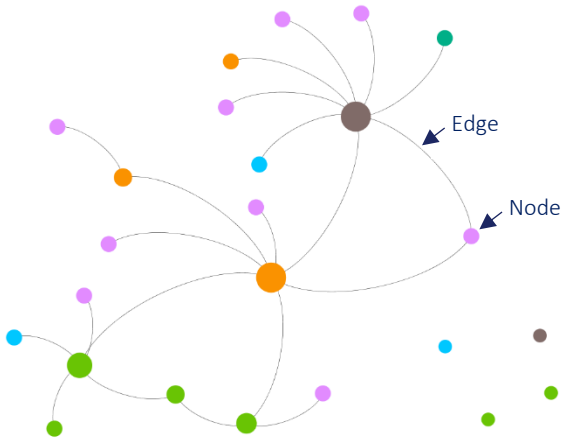
Use of technology and data visualisation

SNA use of technology is evident in its application of computer software to run analyses and to generate graphs. SNA software is often free and open source making it easier for new evaluators to learn and get accustomed with data. Moreover, SNA data are collected through surveys which may be done using online platforms therefore reaching a wide range of responders across the globe.

The ability to collect data via web and mobile platforms affords efficient ways to generate SNA network graph illustrations. In visualising network formations, these graphs make it easier for evaluators and stakeholders to understand key behaviours and strengths of a network. The labelling of nodes makes it possible for programmers to identify a network as formed by individuals/organisations instead of just numbers and statistics. The use of edges in the graphics also make it clearer for evaluators to identify existing networks and draw attention to key role players in the network without having to go back to the data.

Towards achieving sustainable development goals

Leveraging technology and the application SNA can be of great value for assessing and evaluating progress in the development sector. For example, the UNs Sustainable Development Goals (SDGs) serve as a call for action for member countries to work together in tackling some of the world's most challenging issues including ending poverty, improving education, and reducing inequality by 2030. Using SNA to evaluate certain goals, such as Goal 17: Partnerships for SDGs, could identify collaboration throughout the network of organisations and member states. Furthermore, SNA and data visualisations could assess the various goals and recognise the interlink between organisations, common issues, and strategy alignment.



Source: Nature of the networks formed between entrepreneurs in a co-working space, Data Innovators, 2017

Evaluation case studies

Evaluation of an online problem-based learning program

In the age of problem-based learning (PBL), where critical thinking and problem-solving methods are encouraged, it is often difficult for educators and school administrators to find suitable approaches to measure differentiated learning and progress. In addition to monitoring learners' progress,

assessing collaborative interactions among learners is equally as important as collective problem-solving is a critical component of PBL.

To identify important actors in classroom interactions, isolated learners, as well as groups that showed dense or sparse interactions requiring support, researchers used SNA to monitor interactions in an online PBL environment (7). Easy to use SNA indicators also allowed researchers to conduct high-level, rapid analysis to identify active groups and individuals, as well as to flag potential inactivity among groups.

Researchers' use of the *closeness centrality measure* was deemed beneficial in reflecting the role of learners in moderating information and connecting other unconnected learners. This measure, therefore, was of great importance as it highlighted qualities that could not be recognisable in simple interaction parameters. Like other studies (8) (9), the study identified SNA as, "a practical method that can reliably monitor the interactions in an online PBL environment." SNA has also been used in higher education, deeming it as a valuable tool that can be added to educators' and researchers' current toolset for monitoring and supporting teaching and learning (10).

Supporting the evaluation of a fellowship program

In 2017 and 2019, Data Innovators and Barbara Klugman Consulting conducted a SNA for an evaluation of the "*Advocacy for Health Equity* (AHE)"[2]. The SNA formed one component of the broader evaluation.

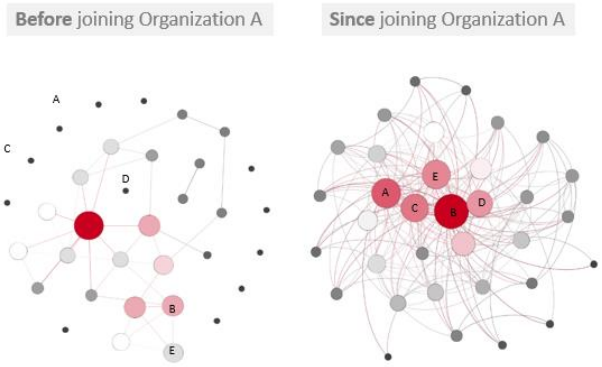
Advocacy for Health Equity (AHE) evaluation used SNA to enable the organisation to assess the program's hypotheses (e.g., that the fellowship program helps to establish and sustain networks that strengthen a fellow's ability to influence social change) and to draw on insights from the SNA to adjust its programming.

The first step in conducting the SNA was to clarify the questions that would generate the information required, (i.e., have you received information from this person to support your advocacy project?). This process was conducted with the client and facilitated by an SNA specialist.

Following the engagement session with the organisation, we drafted an online survey and ran test analysis. The survey was administered to two cohorts of fellows to determine baseline and immediate (within 3 months) network formation within each cohort. Cohort 1 completed a follow-up assessment approximately 12 months since joining the fellowship program. The same SNA questions were posed at each point of the evaluation, in addition to qualitative questions related to challenges in collaborating and validating examples where collaboration and information sharing was reported. A second cohort also received the survey in the following year.

The data were analysed and visualised using Gephi Software. The change in networks for each cohort was compared between time points. The analysis of cohort 1 informed specific changes and support to the intervention to improve how the network supported each other (e.g., creating platforms to share what individuals do and have to offer each other). Cohort 1 and cohort 2 networks were compared to assess whether changes made by the AHE program team have influenced the degree of connectedness among fellows in the different cohorts and what differed or remained similar.

[2] *Name has been changed to maintain client confidentiality.*



Source: Evaluation conducted by Barbara Klugman Concepts & Data Innovator, 2018-2019

The figure on above illustrates the SNA maps for cohort 1 and demonstrates the density of fellows' networks since joining the program.

Density was analysed to verify the volume of the networks created during the fellowship, as well as the strength of these relationships. The colour coding of the SNA map depicts individuals (nodes) in red who are more frequently reported a source of information relevant for advocacy projects (have many information connections to other individuals), and those in grey to black are less frequently a source of information (few connections). The scaled size of the nodes also represents the number of connections, in addition to the placement in the network representing their significance as a source of information (i.e., those in the centre are key sources of information vs those on the outskirts). The image labels specific individuals who have made **significant shifts in the network**. For example, "A" was an isolate before joining the program, having not a single individual report them as a source of information. Within 3 months since joining the organisation "A" is a key source of information (red, larger in size and at the centre of the network).

After additional analysis, we were able to identify the formation of **cliques** (where the network is denser among specific sub-groups of individuals). As a program aiming to ensure that all individuals within the cohort work together to support each other in their work, the formation of such cliques could have resulted in major problems, such as low homogeneity in information sharing within the group. Such **insights** could be used to create intentional meeting points or platforms for the individuals to share information, not only in their sub-group but across others as well.

The use of SNA supported part of the program's hypothesis, e.g., that the fellowship assists the fellows in **establishing new networks**. The current findings supported the comparative analyses of the latter portion of AHE's assumption, e.g., network sustainability and leveraging the network to influence social change.

The evaluation findings were used to inform AHE's continuous improvement of the fellowship program and decisions around the continued funding of the initiative based on its effectiveness.

To build AHE's internal capabilities, the evaluation team conducted three analysis workshops with AHE's in-house evaluation specialist.

SNA EXAMPLE: See the African Evidence Network – Annual Member Survey 2018 report which includes application of SNA.

Steps to using SNA in evaluation

Step 1 - Define your SNA questions. Questions must be very specific including what type of connection you are measuring (e.g. information sharing, collaboration), who the connection refers to (individuals, groups, organisation), where (within a project, country), when (before a date, during a period, or after), why/how (more than 5 times, via a funder or referral, etc.). You may have more than 1 question and the question may compliment other evaluation (non-SNA) questions.

Step 2 - Define you survey questions. Design survey questions that are specific, sensitive, and

unambiguous. Minimize the number of questions posed (particularly with large samples). The questions should test whether a specific connection existed between 1 node and another. You may include questions to test weak and strong connections (e.g., information sharing vs partnership).

Step 3 - Design the survey. The SNA specific questions of your survey are commonly designed in a grid format. The rows of the grid represent each node (e.g., individual or organisation names). The columns represent each type of connection (SNA survey question). The survey participant who represents one of the nodes listed, uses the grid to select where each connection type is relevant (e.g., I have received information from person A, B and D only). Additionally, the survey may include fields related to attributes – binary or categorical data such as demographics or characteristics which may influence how we interpret the network. It is recommended that some qualitative questions are included which provide context, validation, or complementary data.

Step 4 - Configure your dataset to suit your software. The survey platform and SNA analysis software may have different data requirements. Ensure that you have determined what the structure and format requirements are and configure your data accordingly. Software: Gephi, Kumu, Node, Pajek, EgoNet.QF.

Step 5 - Import the data and run the analysis. You will need to have a good understanding of the software you have selected and the metrics that are important for your evaluation, i.e., density, modularity, betweenness centrality. Run only the necessary analysis.

Step 6 - Adjust visualization and compare analysis by attributes. Using the software, you may adapt your network visualisations. Each network visualisation represents one connection type, so the visualisation process must be repeated (e.g., one visual for information sharing at baseline and another for follow-up). Adjust the node and edge size and colour to emphasise the density or use colour to depict specific attributes. The web may be depicted to visualise the whole group or 'untangled' to emphasise where there are cliques formed.

These steps apply to participatory evaluations where the SNA is part of the other evaluation and participant engagement activities. It is possible to use secondary data sources such as social media data or other sources and proceed from step 1 to step 4. However, in such instances the relevance to the SNA question, data quality, data format and ethical considerations in using the secondary source must be considered before opting for secondary network data sources.

Conclusion

Social Network Analysis is an innovative method of analysis and visualisation which may complement other evaluation methods. There are limitations in the method as a sole source of insight when understanding networks and should be used with other qualitative methods. SNA provides data insights for evaluation which helps visualise networks as a whole and pinpoint the roles of specific individuals or entities. The process of collecting and interpreting SNA data is itself valuable in strategic planning and influencing network shifts where the data providers are directly involved in interrogating network maps and the emerging insights or contextual factors.

Contributors: Teboho Letuka, Dineo Maboke, Mary-Grace Villanueva and Jerusha Govender

References

(1) Joseph O, Fred M, Philip N, William O, Gerald M. Applying social network analysis, centrality measures in identification of climate change adaptation opinion leaders. International Journal of Agricultural Research, Innovation and Technology. 2016; 6(1):1-7. Available from: https://doi.org/10.3329/ijarit.v6i1.29188.

(2) Hoppe B, Reinelt C. Social network analysis and the evaluation of leadership networks. The Leadership Quarterly. 2010; 21(600-619).

(3) Sun X, Lu Z, Zhang X, Salathe M, Cao G. Infectious Disease Containment Based on a Wireless Sensor System. Access. 2016; 4(1558–1569). Available from: https://doi.org/10.1109/ACCESS.2016.2551199.

(4) Adegboye OA, Elfaki F. Network Analysis of MERS Coronavirus within Households, Communities, and Hospitals to Identify Most Centralized and Super-Spreading in the Arabian Peninsula, 2012 to 2016. Canadian Journal of Infectious Diseases and Medical Microbiology. 2018; 2(9). Available from: https://doi.org/10.1155/2018/6725284.

(5) Rosenberg E, Kotschy K. Monitoring and evaluation in a changing world: A Southern African perspective on the skills needed for a new approach. African Evaluation Journal. 2020; 8(1), a472. Available from: https://doi.org/10.4102/aej.v8i1.472.

(6) Carman JG, Fredericks KA. Applications Social Network Analysis in Evaluation: Challenges, Suggestions, and Opportunities for the Future. The Canadian Evaluation Society. 2018; 33(2) Available from: https://doi.org/10.3138/cjpe.31156.

(7) Saqr M, Alamro A. The role of social network analysis as a learning analytics tool in online problem-based learning. BMC Med Educ. 2019 19 (160). Available from: https://doi.org/10.1186/s12909-019-1599-6.

(8) Zhang J, Zhang J. A case study on web-based knowledge construction in Moodle platform. In: Computer science and education (ICCSE), 2010 5th international conference on, vol. 2010. Hefei: IEEE; 2010. p. 1110–4.

(9) Bakharia A, Dawson S: SNAPP: a Bird's-eye view of temporal participant interaction. Proceedings of the 1st international conference on learning analytics and knowledge - LAK '11 2011:168–168.

(10) Saqr M, Fors U, Tedre M, Nouri J. How social network analysis can be used to monitor online collaborative learning and guide an informed intervention. PLoS One. 2018;13(3): e0194777.

ABOUT US

Helping organisations push data boundaries to create positive futures.

Data Innovators is a social enterprise led by a team of young Africans who are passionate about making systemic change in development through data. Data Innovators Group was founded in 2021, borne from the partnership between Advisory Services at New Leaders Foundation NPC and Data Innovator PTY Ltd. Our core services include Data Driven Solutions, Monitoring, Evaluation, Research and Learning Services, Capability Building and Project Implementation.

Three ways the Data Innovators aims to help organisations overcome data boundaries for a positive future are by:

1. Innovating and strengthening impact measurement in across sectors globally
2. Collaborating in efforts to drive strategic business intelligence in the development sector broadly.
3. Providing thought leadership and reach new frontiers in setting up data and MERL systems.

Contact:

The Education Hub, 6 Blackwood Ave, Parktown, Johannesburg, 2193, South Africa | www.datainnovators.co | info@datainnovators.co | @data_innovators