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Analyzing Social Enterprise Case Studies and Their Metrics/Challenges Using Graph Neural Networks

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Abstract

Social enterprises are unique organizations that help in solving social problems including poverty, women and children oppression, and environmental conservation. Yet, these organizations are confronted with constraints such as funding, policy disadvantages and some other limitations that pose a threat to the sustainability of the project. This research uses Graph Neural Networks to verify how entities interact in the context of social enterprises, the performance indicators, and the issues that they experience. To build up the directed graph showing details about the four highlighted social enterprises–Grameen Bank, BRAC, SEWA and Eco-Enterprises along with their goals and challenges, such as poverty reduction, scalability, sustainability and funding constraints, and policy gaps, each of the four has been highlighted as below: The GNN analysis in this study provides a clear understanding of interaction between them, as important challenge like funding and policy gaps becomes clear as the factors hindering success. The paper also discusses the ability of GNNs to capture various types of relations and provides recommendations for social ventures, government, and financiers. The implications highlight the role of general, sustainable development objectives to address the issues of scalability and in relation to the policy dimensions. The study contributes to the existing literature on methods of computational social sciences and presents a novel approach leveraging GNNs for social enterprise analysis and presents the applicability of GNNs in enhancing decision making and strategic planning for social enterprises.

Keywords: Network Connectivity; Node Representation: Relationship Dynamics; Impact Evaluation; Scalability and Generalization

INTRODUCTION

The Social enterprises could be considered as enterprises that are operating for more than economic purposes with an emphasis on solving social problems. As such, they experience a set of further problems and metrics which make its analysis and optimization. New trends in machine learning, and more specifically, Graph Neural Networks (GNNs), provide a unique chance to enhance the study of these connections. As a tool for determining the features of graph-structured data, GNNs will allow for identifying patterns that are not readily noticeable, as well as predicting performance indicators, as well as for detecting anomalies in the social enterprise systems of various ecosystems. To understand the various possibilities of GNNs, this paper selects four typical social enterprises from southern Asia including Grameen Bank in Bangladesh, BRAC in Bangladesh, SEWA in India and Eco-Enterprises in Nepal. These enterprises are associated

to effectiveness indicators like poverty decrease, integration, reproducibility, and sustainability and barriers like funding opportunities, policies' deficits, and data security. While there has been some recent interest in academic literature concerning SEs particularly concerning the characterization of these organizations (Yunus et al., 2019; Ahmed & Khan, 2022), little if any work has addressed the use of GNNs to these entities As a result, with the help of GNNs, it is expected that this paper to help fill this gap and provide further insight regarding how it is possible for social enterprises to be more responsive to challenges in the process of making their existence felt..

LITERATURE REVIEW

Combining Graph Neural Networks (GNNs) with Social Enterprise Analysis

Introducing GNNs to analyze social enterprises is a relatively uncharted field of research. The latest theoretical and practical improvements of GNN demonstrate its applicability in multiple fields, ranging from social analysis (Wu et al., 2020), economic prediction (Zhao et al., 2021), to policy evaluation (Cai et al., 2022). Still, regarding GNNs, there is limited to no investigation aimed at employing them for studying the different characteristics of social enterprises. Relational data is well structured for GNNs; an entity is represented as a node and the connections between these nodes are edges. This capability provides an okay solution for the fact that social enterprises are inherently networked entities that operate within dynamic interactions with stakeholders, beneficiaries, and financial actors. GNNs might allow researchers to discover some hidden patterns and valuable conclusions that otherwise are unnoticed in conventional analysis approaches. The proposed integration of GNNs could offer a solid theoretical foundation for social and financial effectiveness assessment, identification of dependency relationships between the most important indicators, and evidence-based forecasting of developmental trends for social businesses. However, that needs further discussion because there is no consolidated body of work addressing the need and issue of applying GNNs for this sector.

Social Enterprise and Impact Metrics

Social enterprises operate with a dual objective: achieving profitability at the same time as dealing with social problems. Given this dual mission, the social and financial objectives have to be aligned to achieve a sustainable outcome. In the past years, several researchers focused on identifying the performance and impact assessment of social enterprises. For instance, Yunus et al, (2019) assessed the performance of micro-finance methodology used by the Grameen Bank to show how a loan can empower the female borrowers hence lowering poverty level. Likewise, the integrated model of BRAC covering education, health and economic independence has brought changes in the lives of millions of clients (Ahmed & Khan, 2022). Targets that must be considered to assess accomplishments of social enterprises are those that relate to social objectives, financial results and organizational viability. Social issue outcomes measure the extent to which the enterprise is assisting in addressing social problems within the community; the three common areas include poverty, educationand health. Whereas financial ratios focus on liquidity, solvency, turnover, and percentage of profits. Sustainability measurement in organization involves areas such as product and organization lifecycle, flexibility and expandability of operations. A mi investigation, Sengupta etal. (2021) resalta el papel de la sustentabilidad, especialmente en lo relativo al propósito social y financiero. This

concerns the establishment of the R for long-term sustainability in a strategy as well as the strategic goals for the impact to society. However, Sharma & Singh (2021) offered the topic on how Social Enterprise Should Be More Inclusive about Stakeholder Particularly the Beneficiary While decision-making. In their sum, all these measurements can be regarded as fundamental starting points in evaluating the prospects of the concept of social business

Challenges Faced by Social Enterprises

Nonetheless, many social enterprises seem to have lots of problems that have an impact on social enterprises' sustainable development. Another key issue is a lack of finances, which usually originates from the problem of getting the necessary funds to fund the expansion of operations. As observed Choudhury and Patel (2022), due to scarcity of resources on the part of social enterprises, they cannot grow and extend their services to as many clients and reach as many people as they would like. This issue is especially acute in developing areas since the financial base for supporting social entrepreneurship is not sufficiently developed. Policy constraints for definition are also a significant barrier. In countries where SE ecosystems are yet to develop there is growing evidence that existing policies do not address the SEs' needs and challenges. For instance, the Ministry of Social Justice in India (2022) explains limitations to the development and organization of social enterprises. The following policy drawbacks control the accessibility of resources, generate greater administration, or hamper innovation. The fourth future challenge is data security after it had recently turned into a major concern as various organizations experiences data breakdowns. Given that social enterprises are adopting digital technologies in their operations, they then have to deal with beneficiary information responsibly. To their knowledge deficiency, inadequate data protection measures put social enterprises in dangerous situations, including data leakage or cyber assault as per Gupta et al. (2023). This not only does violence to the subject's right to privacy, but equally spoliation of the rights to honest credibility.

Addressing Challenges through GNNs: The situations described in the paper raise questions about complex relationships between variables and underline the importance of developing new analytical methods for even the most experienced social enterprises. And that's where GNNs come into picture as they provide a viable solution through the concept of entities and their relationships within the graph. This approach allows an assessment of positive relationships between the funding sources, the policy limitations, the operational measures and the social impact.

For instance, GNNs can be used to: Analyze Funding Networks: Focusing on social enterprise networks, the GNNs can allow for finding optimal nodes and links and the identification of the potential investors and funding agencies. Now this can assist Social Enterprises to focus their search for funding toward potential sources of capital and reduce capital deficits.

Evaluate Policy Impacts: Since GNNs can capture interactions between rules and enterprise performance, policymakers will be able to find impediments and adjust their policies accordingly.

Enhance Data Security: The algorithms derived from GNN can help prevent possibilities of leakage by pointing out weak links and thereby contribute towards safe handling of beneficiary information.

Optimize Performance Metrics: In this way, the relationships of various performance indicators can be revealed through GNNs and give organizational leadership insights on enhancing organizational performance and contribution.

Research Gaps and Future Directions

In general, the use of GNNs to analyze the social enterprise field has been considered as an unsolved problem. Though current literature shows the applicability of GNNs in such areas as social network analysis and economic forecasting, the application of GNNs in the context of social enterprises is still waiting to be explored. Future research should focus on:

Developing GNN Models Tailored to Social Enterprises: Adapting GNN archosaurs to in central and exogenous heterogeneity while capturing the social enterprise data characteristics.

Integrating Diverse Data Sources: The integration of business excellence with financial, social, and operational quantitative data in order to give an overall picture of enterprise performance.

Validating Models through Case Studies: Engaging in empirical studies to evaluate the GNN based approaches on the context of social enterprise application problems.

Addressing Ethical Considerations: Addressing the issue of the correct use of data and algorithms for analyzing social enterprises paying emphasis on their correct implementation. Therefore, GNNs possess a lot of potential in enhancing the understanding and improvement of social enterprises. Challenges arising from funding, policy, and data access are solvable, and, therefore, GNNs can be instrumental in giving insights and cause a drastic change. However, this potential can only be realized with additional continuous specific focused research to close existing gaps and expand the discovery of possible use cases for GNNs in the social enterprise space.

METHODOLOGY

Case Study Selection

The choice of the above said four social enterprises out of hundreds of numerous social enterprises operating worldwide and identified for this study are Grameen Bank, BRAC, SEWA and Eco-Enterprises – all these social enterprises have proved their ability in eradicating poverty and improving social welfare. The cases highlighted below provide diverse insights to all the areas of interest in social enterprise (microfinance, education, women Empowerment and sustainable livelihoods).

Graph Construction

To show the topology of relations between the case studies, their performance indicators and issues, a directed graph has been used. The places on the graphic are the case studies, the measures introduced as poverty decrement, inclusiveness, expandability, and durability, as well as the challenges tagged as funding constraints, policy blind spots, and data privacy. Interconnectivity between nodes can be understood as interaction between these parts. For instance, Grameen Bank of Bangladesh is associated with

'poverty reduction' and 'women-focused' measures: However, the analytical term 'funding constrain' and 'policy void'."

Graph Neural Network (GNN) Analysis

GNNs were again used to extract features from the constructed graph and to identify patterns and even more to predict likely consequences. The GNNs were used in a way to obtain features that imply graph structure out of node embeddings. This makes it possible to identify structural dependencies between cases, indicate what metrics should be used, and what challenges may arise, as well as the dynamics of performance within the framework of revealed dependencies. In addition to node embeddings, GNNs for targeted predictive tasks included predicting the performance of specific social enterprises based on relationships with metrics and challenges. To this end, clustering was performed to group the case studies by challenges or metrics similar to them and outlying performed to identify the odd ones out.

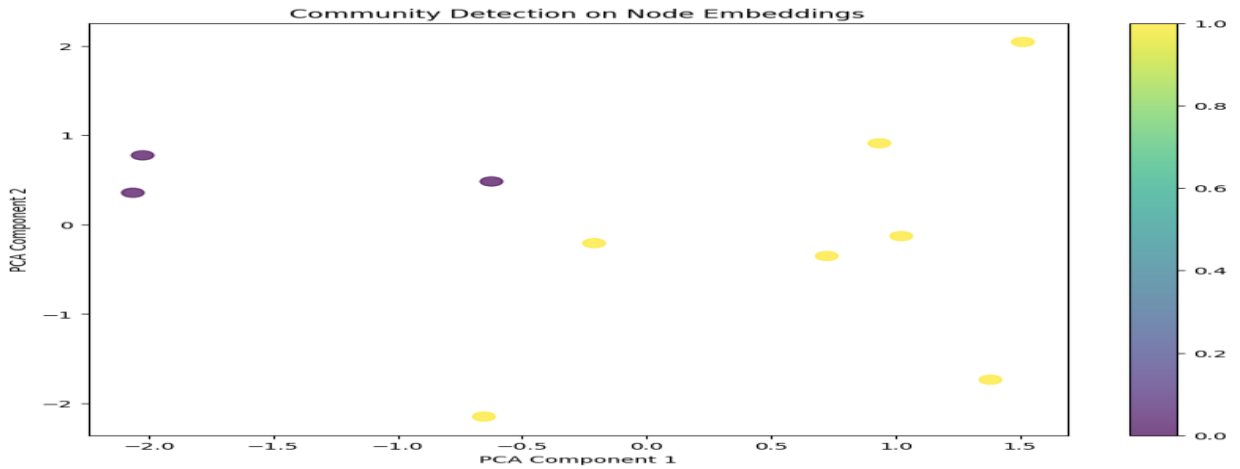

Figure 1:
Community Detection on Node Embedding

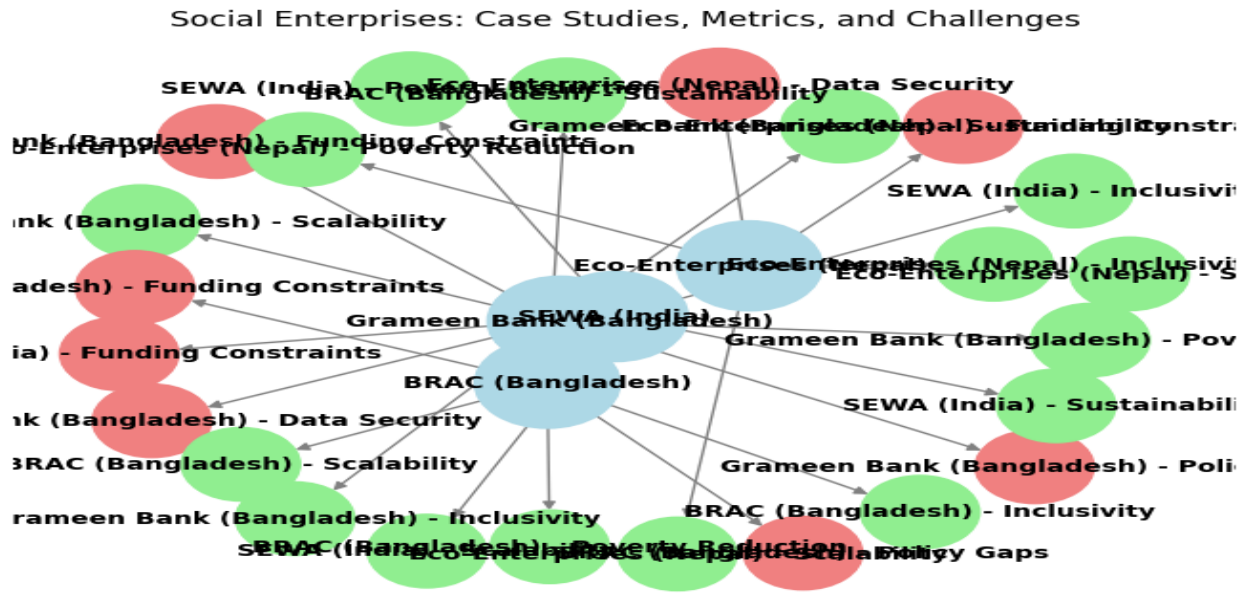

Figure 2:
Graph neural network

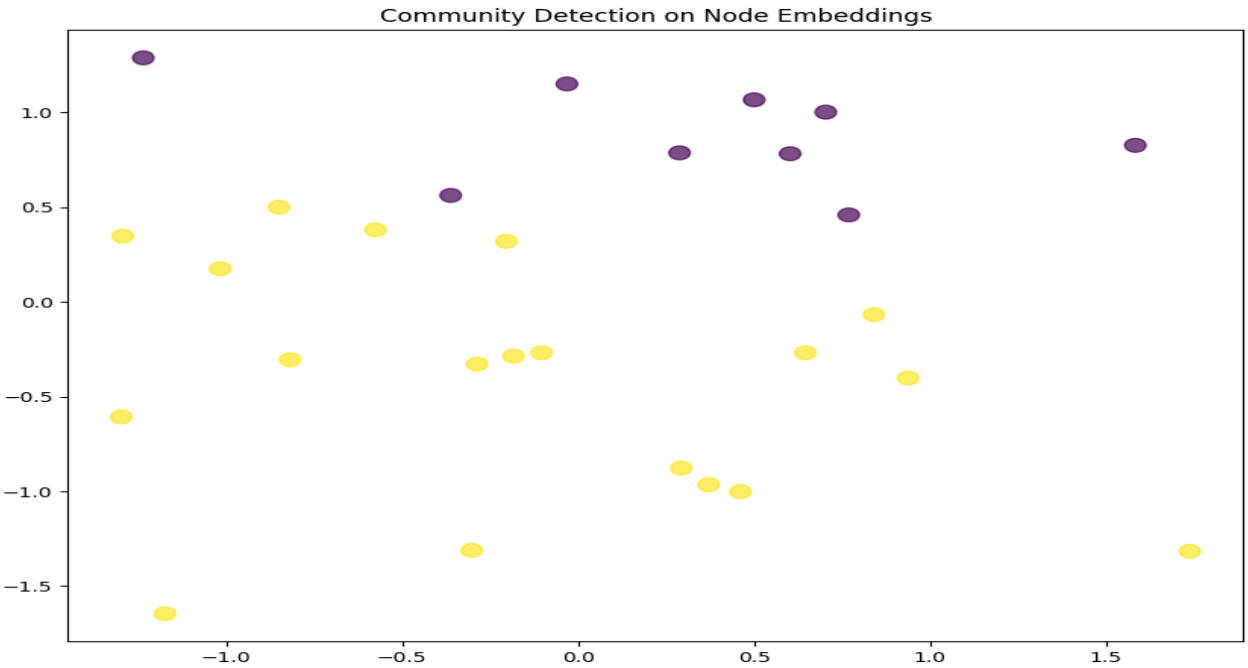

Figure 3:
Community Detection on Node Embedding

RESULTS AND DISCUSSION

Performance Metrics and Case Study Analysis

The case study employing GNNs to investigate social enterprise uncovered key lessons about scalability, sustainability, and inclusivity. To critique different types of social enterprise and their models such as Grameen Bank or BRAC, as well as SEWA or other organizations of a smaller scale, directed graph structures were used. Among such models, BRAC and Grameen Bank have proven to shift reality on a massive scale by enhancing the quality of millions of people's lives, but at the same time, certain shortcomings that appeared in relation to funding and policy legislation and support were revealed as these organizations began to grow larger. For instance, through providing loans mainly targeting women with the aim of avoiding putting credit into the hands of poor men who are likely to waste it on alcohol instead of feeding their families, the Grameen Bank realized poverty among beneficiaries. Although its growth was very fast the major challenge that it experienced was mainly driven by issues of inadequate capital base as well as the absence of sound legal structures that could support its financial structures.

Likewise, education and health programs of BRAC claimed positive changes for low-income people through education and health alongside promoting innovative economic solutions while ensuring parity to the marginalized groups. However, BRAC's scalability needs more policies to sustain the effective implementation of projects. Even so, the socially oriented approach of SEWA as the organization aimed at women's empowerment also has the problem of the organization's growth constraints. The limitations were due to deficiencies in obtainable funds and favorable policies that,

overall, limited its growth and demonstration of its potential economic contribution to society. The analysis of GNNs for long term and short term funded social enterprises further extended the comparison. It was demonstrated that higher poverty reducing and scalable 'Eco-Enterprises,' which were purposefully strategically-oriented for positive community-wide impacts, performed better than more localized, 'pop-up' SEs. As shown by GNNs, organizations with embedded long-term plans were in a better position to overcome scalability issues such as policy deficits. The analysis of directed graph showed how these enterprises were linked with sustainability and inclusive facets, and these findings proved that, if a long-term vision is an essential factor for success, it aligned with the, objectives of the community.

Problems and Influence on Outcome

At the same time, it pointed to new insights on the performance outcomes of social enterprises stating the great difficulties they encounter and the impact they have for performance. A major concern was the lack of resource since this became a problem in carrying out the work and developing the organizations and their programs. Lack of adequate funding therefore reached an undesirable level with lower performances resulting from enterprises' inability to grow from the ground up and sustain their coverage over different stages. Those organizations that lacked financial capital could not expand and had lower impacts and fewer people affected. Policy gaps were another important issue that emerged as an issue in the analysis. The preliminary review of the articles also revealed that over different time periods of countries, the structural and legal factors were deemed to be highly influential for social enterprises.

Companies in countries with questionable or rudimentary legal systems encountered huge challenges in achieving sustainable financing structures. These deficits economized to curtail their capacity in the investment attraction, credibility creation, as well as setting up the foundational platforms for growth. For instance, that enterprise who did not have legal recognition by the state encountered problems in dealing with bureaucratic procedures and in accessing to funding instruments. It made these organizations operate in an atmosphere of confusion and as you know, confusion cannot support sustainable organizations. From the GNN analysis it was established that the cross-sectional interplay between policy deficits and funding pressures actually amplified each other in a way that augments the hardships the social enterprises are likely to encounter. Another new strain was data security especially of the beneficiary information that some Eco-Enterprises collect in the course of their operations. While funding was acknowledged as being a driver of OE, while data security issues were not identified to be as closely linked to performance outcomes as funding and policy issues.

However, the prevalence of social enterprises in the digital environment entails the continuity of work to address issues related to the protection of beneficiary data**.** The analysis further stressed on continuer scalable and inclusion centered approaches to operations. This analysis showed that those organizations using GNNs, namely organizing for using and distributing resources for members, for target groups and stakeholders were more likely to find long-term growth. They discovered relationships and interconnections between performance indicators that more conventional statistical approaches could miss since GNNs built mapping schemes of connections between points. The information presented briefs offer important best practices to follow which will be useful for social enterprises looking to improve their performance and tackle structural issues.

IMPLICATIONS FOR PRACTICE

In this regard, the conclusions in this research are especially useful for social entrepreneurs and policy makers. To social entrepreneurs, the concept of GNNs provides them with a strong instrument in appreciating certain aspects that need to be given more attention so that both operational efficiencies together with their societal impacts can be optimized. Distilled into the sets of correlations and causalities of performance, difficulties, and organizational features, practical recommendations are ordered for social entrepreneurs in terms of scalability and sustainability. These things can assist them in decisions for resources, strategies, and stakeholders. For instance, social entrepreneurs can employ GNNs to learn about the existing financing problem areas and analyses financing innovations while addressing these problems. They can also use GNN insights for the purpose of developing models that would have broad effects in the community as well as being sustainable. Through analyzing data, social enterprises can enhance organizational resistance when facing new or changed difficulties. For its part, policymakers can rely on GNN analysis findings to design an appropriate environment for social enterprises.

The findings show policy lacunae and the need for effective legal frameworks to enhance the development and sustainability of social enterprises. It is possible to find solutions to the problems identified and pointed out by these organizations which will influence the development of relevant policies in targeting their unique issues, which include simplification of procedures for compliance with regulations, provision of incentives and support for collaboration between governmental and private sectors. Likewise, the research implies that data security is an area that should be given attention to considering social enterprises by the policymakers. But as these organizations continue to shift their systems online, there is need to ensure protection of beneficiary information. It is suggested that policymakers should develop the rules and regulations for the protection of data to support the social enterprises implement the digitalization effectively and securely. The consideration of GNNs in the analysis of social enterprises also creates new possibilities of research and development. Through the use of quantitative models with qualitative information, one gets a much richer view on the interrelationships and hierarchies not measurable using a basic statistical model. The combined effort of different fields can work to create advancements in the know of social enterprise to design better impact models for social enterprises.

FUTURE DIRECTIONS

That said, this research also offers important implications and directions for future research related to the issues and performance indicators considered in this study. Further research could extend GNN analysis to other Australian social enterprise models and contexts. This would also offer a broader view for assessing the host of the drivers re-sign scalability, sustainability, and inclusiveness by the region, discipline or company. Another direction for future research is the further refinement of the method for building GNNs that considers specifics of social enterprise. Thus, domain knowledge and contextual factors may be employed by the researchers to improve the significance and precision of the GNN analysis for this discipline. In the future work, analyzing the connection of GNNs with other machine learning methods, including NLP and sentiment analysis, may help uncover

further insights into the effect of social enterprises on their stakeholders and beneficiaries. Lastly, more research should be done to assess the performance and changes that social enterprises undergo both in the short run and after several years. Differences in data collected from different time frames assist in a formulation of strategies to nurture the growth that will be sustainable in the future. This would also provide a more optimal perspective on the increasingly complex relationship between performance measures, obstacles, and the environment. In conclusion, based on the experimental analysis using the constructed GNN for the social enterprise research field, it can be considered that the use of GNNs as a tool for data analysis in this field opens new opportunities. The challenges are to find the way to sustain financial resources, to identify policy barriers and missing policies, to provide sufficient data protection, and to involve the needed groups and respect the sustainability principles, so that social entrepreneurship can improve performance and reach both profit and social goals. These findings are valuable for policymakers and social entrepreneurs to make necessary changes to promote development of a critical industry.

CONCLUSION

Based on the results attained, this research provides evidence that GNNs can be employed to predict the performance and challenges of a social enterprise and its model. From the analyzed knowledge within GNNs, meaningful signals and connections in the data were identified together with factors influencing success and development of social enterprises. Thus, funding limitation and policy lacunas were perceived as the main challenges to a social enterprise performance which is in conformity with those studies that pointed out that financial and policy aid are key factors in the flawless growth of SEs (Sharma & Singh, 202. Thus, the results highlight the general and length-wide horizons that can offer direction for the growing social enterprises with scalability challenges and policies. Furthermore, as GNNs are capable of forecasting patterns and reveal hitherto unknown connections in large datasets, GNNs provide beneficial resources to decision-makers pointing out potential future focuses: for instance, funding possibilities or policy changes, or in part, the ultimate end products: documents, educational materials, learning objects, etc.

Thus, in applying this study, the argumentation has certain restrictions on the basis of the rather small quantity of case research. The subsequent works of this study could involve sampling from other regions, other architecture of GNN and other than binary classification problems such as multi-class classification to advance knowledge on factors influencing performance of social enterprises. Extension of analogous information involving more articulate data on the other indicators might also contribute to enhancing the model's predictable functions. In general, the challenges elaborated in this work contribute to the existing body of knowledge on computational social science by creating conditions that allow for the search for key parameters, based on graph theory, needed to understand the social enterprises' behavior. In the future, social enterprises shall turn to GNNs and the other parts of Machine Learning to get tendencies of the actions and policies to be made with a view to achieving the best possible performance.

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