Enhancing Digital Social Innovation Ecosystems: A Pythagorean Neutrosophic Bonferroni Mean (PNBM) -DEMATEL Analysis of Barriers Factors for Young Entrepreneurs

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Abstract

This study employs a Pythagorean Neutrosophic Bonferroni Mean (PNBM) - Decision Making Trial and Evaluation Laboratory (DEMATEL) approach to analyze barriers faced by young entrepreneurs in Digital Social Innovation (DSI). Pythagorean Neutrosophic Set (PNS) enriches the analysis, accommodating uncertainties in the complex socio-economic context. Limited Access to Funding emerges as the most influential barrier, showcasing its pivotal role in impacting other DSI challenges. Regulatory and Compliance Challenges are identified as interdependent, emphasizing their interconnected nature with broader barriers. Neutrosophic elements elucidate the uncertainties surrounding financial constraints, regulatory frameworks, and mentorship dynamics. The study contributes to a nuanced understanding of DSI challenges and pioneers the application of neutrosophic logic in socio-economic research. It advocates for a more inclusive decision-making methodology, fostering adaptability in addressing the indeterminate nature of barriers faced by young entrepreneurs navigating the digital social innovation landscape. The findings aim to enhance support systems, fostering a conducive environment for DSI initiatives and encouraging future research in neutrosophic decision-making methodologies.

Keywords: Digital Social Innovation (DSI); Young Entrepreneurs; Barrier Analysis; Pythagorean Neutrosophic Bonferroni Mean (PNBM); DEMATEL

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1. Introduction

Barriers to digital social innovation among young entrepreneurs are multifaceted and require a comprehensive understanding to address effectively. The intersection of digital technologies and entrepreneurship has raised critical questions regarding digital entrepreneurship. The way social positionality and intersectionality shape digital enterprise activities is crucial to understanding the challenges faced by young entrepreneurs. In the context of digital health ecosystems, systemic conditions play a significant role in navigating barriers to innovation [22]. Improving the entrepreneurial competence of young entrepreneurs involves factors such as digital government building, entrepreneurship education, and entrepreneurial cognition [28]. Human capital, knowledge sharing, and social media networking directly impact innovation, highlighting the importance of these elements in overcoming barriers to digital social innovation [16].

The impact of digital communications on shaping the career paths of youth, particularly in sectors like farming, underscores the influence of digital technologies on career choices [27]. Empowering young entrepreneurs involves addressing barriers such as access to interest-free start-up credit, skill development, and the use of ICTs [18]. Peripheral regions face challenges in developing effective innovation strategies, lacking institutional capital and support from local authorities to remove barriers to innovation [29]. Understanding the role of entrepreneurial influencers and influential entrepreneurs' sheds light on motivational factors and paths to entrepreneurial success [13].

Digitalization plays a crucial role in shaping entrepreneurial attitudes, particularly in rural areas, highlighting the importance of digital advancements in fostering entrepreneurship [10-13]. Women entrepreneurs' knowledge and use of social media are essential for keeping up with the pace of digitalization, emphasizing the role of social media in entrepreneurial success. Legitimacy building of digital platforms in the informal economy is vital for fostering trust and credibility among entrepreneurs [23].

Despite the increasing literature on social media for entrepreneurship, there is still a need for further research to understand its impact fully [22]. Women entrepreneurs' digital social innovation is a growing area of interest, particularly in exploring how gender, entrepreneurship, social innovation, and information systems intersect. Sociometrical assemblages play a significant role in shaping entrepreneurship in coworking spaces, emphasizing the importance of social and material elements in entrepreneurial environments [3].

Addressing barriers to digital social innovation among young entrepreneurs requires a holistic approach that considers factors such as intersectionality, systemic conditions, entrepreneurial competence, human capital, and social media networking. By understanding and mitigating these barriers, young entrepreneurs can navigate challenges more effectively and drive innovation in the digital landscape.

Table 1: The barrier of digital social innovation among young entrepreneurs.

	Barrier	**Definition**	**Source**
A1	Limited Access to Funding	Difficulty in securing financial resources such as venture capital, grants, or loans for digital social innovation projects.	Aksoy et al. (2019)
A2	Regulatory and Compliance Challenges	Complex government regulations and compliance requirements that can impede business operations and innovation.	Shkolnyi (2021)
A3	Technological Infrastructure Gaps	Inadequate access to necessary technology, including high-speed internet, advanced software, and hardware.	Grimaldi et al. (2021)
A4	Skill Gaps and Educational Deficiencies	Insufficient training and education in relevant digital and entrepreneurial skills.	Lombardi (2019)
A5	Intellectual Property Issues	Difficulties in protecting intellectual property, crucial for safeguarding ideas and products in the digital domain.	Deltsova (2020)

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A6	Lack of Mentorship and Expert Guidance	Shortage of experienced mentors or advisors who understand the unique challenges of digital social innovation.	Trequattrini et al. (2022)
A7	Market Understanding and Access	Challenges in understanding market needs and gaining access to target markets for socially-driven digital products.	Chen (2020)
A8	Cultural and Societal Resistance	Societal and cultural barriers that may not fully support or understand the value of digital social innovation.	Brieger & Clercq (2019)
A9	Networking and Collaboration Challenges	Difficulty in finding and establishing meaningful collaborations with other entrepreneurs, organizations, or institutions.	Nasiri et al. (2020)
A10	Sustainability and Scalability Concerns	Struggles with making digital social innovation projects financially sustainable and scalable in the long term.	Shan & Pan (2022)

The Neutrosophic Decision-Making Trial and Evaluation Laboratory (DEMATEL) method has gained attention in various research domains due to its ability to analyze complex cause-effect relationships. Neutrosophic MCDM methods, including Neutrosophic AHP, Neutrosophic DEMATEL, and Neutrosophic ANP, have been extensively studied in the literature [27,9]. The application of DEMATEL has been explored in diverse fields, such as sustainable online consumption, supply chain risk mitigation, and public health measures during the COVID-19 pandemic [7]. The method has been instrumental in identifying barriers, causal relationships, and critical success factors in different contexts [1].

Researchers have combined DEMATEL with various methodologies to enhance decision-making processes. For instance, the integration of DEMATEL with the hesitant Pythagorean fuzzy set and multi-valued neutrosophic approaches has provided valuable insights into decision-making under uncertainty [7]. Additionally, the use of DEMATEL in conjunction with other techniques like VIKOR and TODIM has facilitated evaluations in different domains, such as E-learning website selection and quality improvement strategies in energy investments [14]. The literature review indicates a growing interest in applying DEMATEL to analyze complex systems and interrelationships. Studies have utilized DEMATEL to evaluate critical leadership competences, performance indicators in Lean Manufacturing, and supply chain performance factors in the pharmaceutical industry [5]. Moreover, the method has been employed to study barriers to autonomous vehicle adoption, circular economy transitions, and humanitarian supply chain operationalization.

The integration of Pythagorean Neutrosophic Sets with Bonferroni mean aggregation in decision-making scenarios, offers a unique approach that combines the Pythagorean and Neutrosophic sets, incorporating dependent components like membership and non-membership. This combination provides a more comprehensive representation of uncertainty and vagueness in decision-making processes. By utilizing the Bonferroni mean aggregation operators specifically designed for decision-making problems with normal neutrosophic information, a more robust and accurate decision-making framework can be established. This approach enhances the analysis by considering the interrelationships among factors, which is crucial in complex decision-making scenarios. Furthermore, the integration of Pythagorean Neutrosophic Sets with Bonferroni mean aggregation can lead to more effective evaluations of factors influencing various projects, such as construction safety in high-speed railway stations, bid evaluation in government projects, and risk assessment in oil and gas construction projects. The utilization of this approach can provide a deeper understanding of the causal relationships between different factors, enabling a more holistic assessment of risks and influential elements in decision-making processes. Thus, the primary goal of this study is to utilize PNBM-DEMATEL analysis to identify the interconnections among different barrier factors that hinder young entrepreneurs in digital social innovation ecosystems.

The article unfolds with an exploration of Pythagorean Neutrosophic Sets (PNS) and their operational properties in Section 2, setting the mathematical foundation for subsequent discussions. Section 3 focuses on elucidating the methodology employed in applying Pythagorean Neutrosophic Bonferroni Mean (PNBM) to DEMATEL analysis. It outlines the procedural framework encompassing the selection of criteria, the involvement of a group of experts, and the steps undertaken throughout the PNBM-DEMATEL analysis. Moving into Section 4, the article delves into the results and discussion arising from the PNBM-DEMATEL analysis of barriers affecting young entrepreneurs in digital social innovation projects. This section comprehensively analyses each barrier's significance, ranking, and cause-and-effect relationships, providing insightful discussions on the implications of the results for enhancing the digital social innovation ecosystem. Finally, Section 5 consolidates the findings,

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emphasizing the notable contributions of employing Pythagorean Neutrosophic Bonferroni Mean (PNBM) in DEMATEL for a nuanced understanding of barriers in digital social innovation projects. The conclusion underscores the broader significance of the research in supporting young entrepreneurs to navigate challenges within the dynamic landscape of digital social innovation.

2. Preliminaries

This section explains the fundamental ideas allied to Pythagorean Neutrosophic sets.

Definition 1 [32] Let *X* be a universe or non-empty set. A Pythagorean neutrosophic set with ψ and κ as dependent membership is defined as

$$A = \{\langle x, \psi_A(x), \varsigma_A(x), \kappa_A(x)\rangle \mid x \in X\} \quad (1)$$

Where ψ_A, ς_A and κ_A are the truth, indeterminacy and false membership respectively such that $\psi, \varsigma, \kappa \in [0,1]$ and satisfying

$$0 \le \psi^2 + \kappa^2 \le 1 \quad (2)$$

$$0 \le \psi^2 + \varsigma^2 + \kappa^2 \le 2 \quad (3)$$

Definition 2 [5] Let $x_1 = (\psi_{x_1}, \varsigma_{x_1}, \kappa_{x_1})$, $x_2 = (\psi_{x_2}, \varsigma_{x_2}, \kappa_{x_2})$ and $x = (\psi_x, \varsigma_x, \kappa_x)$ are any two PNSs, then the operational rules for PNSs are defined as follows:

i) $$x_1 \oplus x_2 = \left(\sqrt{\psi_{x_1}^2 + \psi_{x_2}^2 - \psi_{x_1}^2 \psi_{x_2}^2}, \varsigma_{x_1}\varsigma_{x_2}, \kappa_{x_1}\kappa_{x_2}\right) \quad (4)$$

ii) $$x_1 \otimes x_2 = \left(\psi_{x_1}\psi_{x_2}, \varsigma_{x_1} + \varsigma_{x_2} - \varsigma_{x_1}\varsigma_{x_2} \sqrt{\kappa_{x_1}^2 + \kappa_{x_2}^2 - \kappa_{x_1}^2 \kappa_{x_2}^2}\right) \quad (5)$$

iii) $$\mu x = \left(\sqrt{1-(1-\psi_x^2)^\mu}, \varsigma_x^\mu, \kappa_x^\mu\right) \text{ where } \mu \in \Re \text{ and } \mu \ge 0 \quad (6)$$

iv) $$x^\mu = \left(\psi_x^\mu, 1-(1-\varsigma_x)^\mu, \sqrt{1-(1-\kappa_x^2)^\mu}\right) \text{ where } \mu \in \Re \text{ and } \mu \ge 0. \quad (7)$$

Definition 8 [5] Given $p, q \ge 0$ with $x_i = (\psi_i(x), \varsigma_i(x), \kappa_i(x))$ where $(i = 1, 2, 3....., n)$ be a set of PNS, then PNBM is defined as

$$PNBM(x_1, x_2, ..., x_n)^{p,q} = \left(\frac{1}{n(n-1)} \underset{\substack{i,j=1 \\ i \ne j}}{\overset{n}{\oplus}} \left(x_i^p \otimes x_j^q\right)\right)^{\frac{1}{p+q}} \quad (8)$$

3. METHODOLOGY

3.1 SELECTION OF CRITERIA

The methodology for the selection of criteria, guided by a panel of experts, followed a systematic and collaborative process to ensure the relevance and comprehensiveness of the chosen criteria for decision-making. An initial expert panel, comprising individuals with diverse and pertinent expertise, was assembled. The process commenced with a preliminary meeting to establish the project's objectives and scope. A comprehensive literature review was then provided to the experts, offering insights from existing frameworks and research relevant to the criteria selection process. Subsequently, a structured brainstorming session was facilitated, encouraging open dialogue among the experts to generate a wide array of potential criteria. These criteria were then defined and refined collaboratively, focusing on clarity and specificity. To quantitatively assess the criteria, a vetting process was implemented,

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wherein each expert individually evaluated and ranked the proposed criteria. Consensus-building sessions were conducted to address varying perspectives and arrive at a collective agreement on the final set of criteria.

To validate the selected criteria, feedback was sought from the expert panel, incorporating their insights and experiences into the decision-making framework. The finalized criteria, along with the rationale behind each selection, were documented comprehensively. The entire process underwent a final review and iteration, ensuring that the chosen criteria accurately represented the collective decisions of the expert panel as shown in Table 2.

Table 2: Panel of Experts and Their Areas of Expertise

Expert	Expertise Area	Years of Experience
Expert 1	Industry Specific Knowledge	10
Expert 2	Academic Research	13
Expert 3	Policy and Regulation	12
Expert 4	Technology Implementation	10
Expert 5	Entrepreneurial Experience	6

This structured methodology, complemented by the input of a diverse group of experts, guarantees that the selected criteria align with established practices and encompass a holistic understanding of the decision-making context.

3.2 PNBM DEMATEL

Step 1: Construct the Initial Direct-Relation Matrix, X^k

A matrix was created using Pythagorean neutrosophic numbers to represent the direct relationship depending on decision makers' preferences. Each decision maker assesses their preferences as a nonnegative matrix, $X^k = \left[x_{ij}{}^k\right]_{n\times n}$, where $1 \le k \le m$. The notation of $x_{ij} = (\psi_{ij}, \varsigma_{ij}, \kappa_{ij})$ indicates the extent to which decision makers feel that criteria *i* influences criteria *j*, with all diagonal components being set to zero. The score is calculated using seven linguistic scales ranging from 'no influence' to 'extremely high influence' based on the PNS linguistic variable, as shown in Table 3. Thus, there exist m distinct matrices $X = \left\{X^1, X^2, ..., X^m\right\}$ that correspond to each DM.

Table 3: The Linguistic Variable of Pythagorean Neutrosophic Set

Score	Linguistic Variable	Pythagorean Neutrosophic Number
1	No Impact	(0.10, 0.80, 0.90)
2	Low Impact	(0.20, 0.70, 0.80)
3	Medium Low Impact	(0.35, 0.60, 0.60)
4	Medium Impact	(0.50, 0.40, 0.45)
5	Medium High Impact	(0.65, 0.30, 0.25)
6	High Impact	(0.80, 0.20, 0.15)
7	Very High Impact	(0.90, 0.10, 0.10)

Step 2: Acquire the Aggregate Direct-Relation Matrix *A*.

In accordance with Eq. (8), PN-NWBM is used to combine all of the individual direct relation-matrices $X^k = \left\{X^1, X^2, ..., X^m\right\}$ into a single collective decision matrix $A = \left[a_{ij}\right]_{n\times n}$, where $a_{ij} = \left(\psi_{ij}, \varsigma_{ij}, \kappa_{ij}\right)$.

Step 3: Deneutrosophication to a crisp matrix *B*.

Equation (9) is used to deneutrosophicate the aggregated matrix $A = \left[a_{ij}\right]_{m\times n}$ to a crisp matrix *B*.

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$$B = \frac{\psi_A(x) + \varsigma_A(x) + \kappa_A(x)}{3} \tag{9}$$

Step 4 : Normalizing the matrix to normalized matrix *Z*

The following is the procedure for normalizing the matrix using Equation (10).

$$Z = \frac{B}{s} \tag{10}$$

where $s = \max_{1 \le i \le n} \sum_{j=1}^{n} b_{ij}$ and all elements in the matrix *Z* are complying with $0 \le z_{ij} < 1$.

Step 5: Create the Total-Influence Matrix *T*

Create the entire influence matrix by applying equation (11).

$$T = Z(I - Z)^{-1} \tag{11}$$

where *I* is the identity matrix.

Step 6: Computing the Sums of the Rows and Columns

Equation (12) defines vector *R* as the sum of the rows in the total-influence matrix T, while Equation (13) defines vector *C* as the sum of the columns.

$$R = \left[\tilde{r}_i\right]_{n\times1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times1} \tag{12}$$

$$C = \left[\tilde{c}_i\right]_{1\times n} = \left[\sum_{i=1}^{n} t_{ij}\right]_{1\times n}^{T} \tag{13}$$

Where t_{ij} is the element of matrix T.

The *R*+*C* and *R*-*C* values are determined to represent importance and relation values, respectively.

Step 7: Network Relationship Map (NRM), the Threshold Value

The data set used to plot the graph is ($R+C$, $R-C$). There is $R+C$ a label for on the vertical axis and a $R-C$ label for on the horizontal axis. Understanding the interdependencies among the components of the decision-making process is made easier by NRM's visual depiction of the intricate relationships among its many parts.

4. Result and Discussion

The results obtained through the PNBM-DEMATEL methodology are succinctly presented in this section. Table 4, Direct Matrix A, encapsulates the perceived influence of each criterion on one another as assessed by decision-makers. Table 5, the Normalized Decision Matrix, offers a standardized view of the relative importance of each criterion, facilitating consistent analysis. Lastly, Table 6 provides the Ranking and Cause/Effect Analysis, detailing the overall ranking and the nature of influence (cause or effect) for each criterion based on vectors R and C. Subsequent discussion delves into the implications of these findings, unraveling the intricacies of decision-making dynamics and emphasizing the significant role played by individual criteria in the overall process.

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Table 4: The direct matrix A

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
A1	1.7762	0.9181	0.9293	0.8186	0.9003	0.8791	0.8200	0.8877	0.8813	0.8733
A2	0.7843	1.7101	0.8088	0.6824	0.7745	0.7808	0.7234	0.7661	0.7974	0.7528
A3	0.7600	0.8275	1.7312	0.7253	0.8236	0.7554	0.7381	0.7733	0.7683	0.7916
A4	0.7493	0.7818	0.8157	1.6223	0.7752	0.7423	0.6976	0.7550	0.7579	0.7768
A5	0.8010	0.8040	0.8483	0.7338	1.7282	0.7947	0.7327	0.7765	0.7921	0.7843
A6	0.8003	0.8179	0.8271	0.7274	0.8303	1.6930	0.6995	0.7890	0.8134	0.7898
A7	0.7798	0.8018	0.8443	0.7451	0.8361	0.7628	1.6434	0.8109	0.8173	0.8089
A8	0.7121	0.7776	0.7730	0.6852	0.7743	0.7265	0.6391	1.6474	0.7421	0.7275
A9	0.8348	0.8691	0.8820	0.7795	0.8423	0.8302	0.7424	0.8230	1.7420	0.8044
A10	0.7738	0.8255	0.8042	0.7182	0.8245	0.7507	0.6957	0.7971	0.8070	1.6877

Table 5: The Normalized decision matrix

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
A1	0.7762	0.9181	0.9293	0.8186	0.9003	0.8791	0.8200	0.8877	0.8813	0.8733
A2	0.7843	0.7101	0.8088	0.6824	0.7745	0.7808	0.7234	0.7661	0.7974	0.7528
A3	0.7600	0.8275	0.7312	0.7253	0.8236	0.7554	0.7381	0.7733	0.7683	0.7916
A4	0.7493	0.7818	0.8157	0.6223	0.7752	0.7423	0.6976	0.7550	0.7579	0.7768
A5	0.8010	0.8040	0.8483	0.7338	0.7282	0.7947	0.7327	0.7765	0.7921	0.7843
A6	0.8003	0.8179	0.8271	0.7274	0.8303	0.6930	0.6995	0.7890	0.8134	0.7898
A7	0.7798	0.8018	0.8443	0.7451	0.8361	0.7628	0.6434	0.8109	0.8173	0.8089
A8	0.7121	0.7776	0.7730	0.6852	0.7743	0.7265	0.6391	0.6474	0.7421	0.7275
A9	0.8348	0.8691	0.8820	0.7795	0.8423	0.8302	0.7424	0.8230	0.7420	0.8044
A10	0.7738	0.8255	0.8042	0.7182	0.8245	0.7507	0.6957	0.7971	0.8070	0.6877

Table 6: The ranking and cause/effect for each barrier

	R	C	R+C	RANKING	R-C	CAUSE/EFFECT
A1	8.6838	7.7716	16.4554	1	0.9122	Cause
A2	7.5805	8.1334	15.7139	5	-0.5528	Effect
A3	7.6944	8.2640	15.9584	3	-0.5696	Effect
A4	7.4739	7.2377	14.7116	10	0.2361	Cause
A5	7.7954	8.1092	15.9046	4	-0.3138	Effect
A6	7.7876	7.7154	15.5030	6	0.0722	Cause
A7	7.8504	7.1319	14.9823	9	0.7185	Cause
A8	7.2047	7.8260	15.0307	8	-0.6212	Effect
A9	8.1497	7.9188	16.0685	2	0.2310	Cause
A10	7.6846	7.7972	15.4818	7	-0.1126	Effect

The Bipolar Pythagorean Neutrosophic Set-DEMATEL analysis provides a nuanced understanding of barriers affecting young entrepreneurs in digital social innovation projects. The top-ranked barrier, "Limited Access to Funding" (A1), holds significant influence (16.4554) and is identified as a prominent cause, emphasizing its pivotal role in impacting other barriers. Conversely, "Regulatory and Compliance Challenges" (A2) is positioned as an effect (15.7139), indicating its interdependence with other factors. "Technological Infrastructure Gaps" (A3) follows suit, highlighting its interconnectedness with other barriers as an effect (15.9584). "Skill Gaps and Educational Deficiencies" (A4), ranked 10th, emerges as a cause (14.7116), showcasing the positive influence of addressing educational challenges on other barriers.

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"Issues with Intellectual Property" (A5) is a significant effect (15.9046), emphasizing the need for a comprehensive strategy to address intertwined challenges. "Lack of Mentorship and Expert Guidance" (A6) serves as a cause (15.5030), underscoring the instrumental role of mentorship. "Market Understanding and Access" (A7) emerges as a cause (14.9823), highlighting its substantial impact on other barriers. "Cultural and Societal Resistance" (A8) is positioned as an effect (15.0307), emphasizing the broader cultural context in shaping strategies. "Networking and Collaboration Challenges" (A9) is a major cause (16.0685), showcasing its significant influence on other barriers. Lastly, "Sustainability and Scalability Concerns" (A10) is categorized as an effect (15.4818), signalling its dependence on other factors. Overall, this analysis provides actionable insights for strategic interventions in fostering a conducive environment for digital social innovation.

Table 7: The relationship between barriers.

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
A1	0	1	1	1	1	1	1	1	1	1
A2	0	0	1	0	0	0	0	0	1	0
A3	0	1	0	0	1	0	0	0	0	1
A4	0	0	1	0	0	0	0	0	0	0
A5	1	1	1	0	0	1	0	0	1	0
A6	1	1	1	0	1	0	0	0	1	0
A7	0	1	1	0	1	0	0	1	1	1
A8	0	0	0	0	0	0	0	0	0	0
A9	1	1	1	0	1	1	0	1	0	1
A10	0	1	1	0	1	0	0	1	1	0

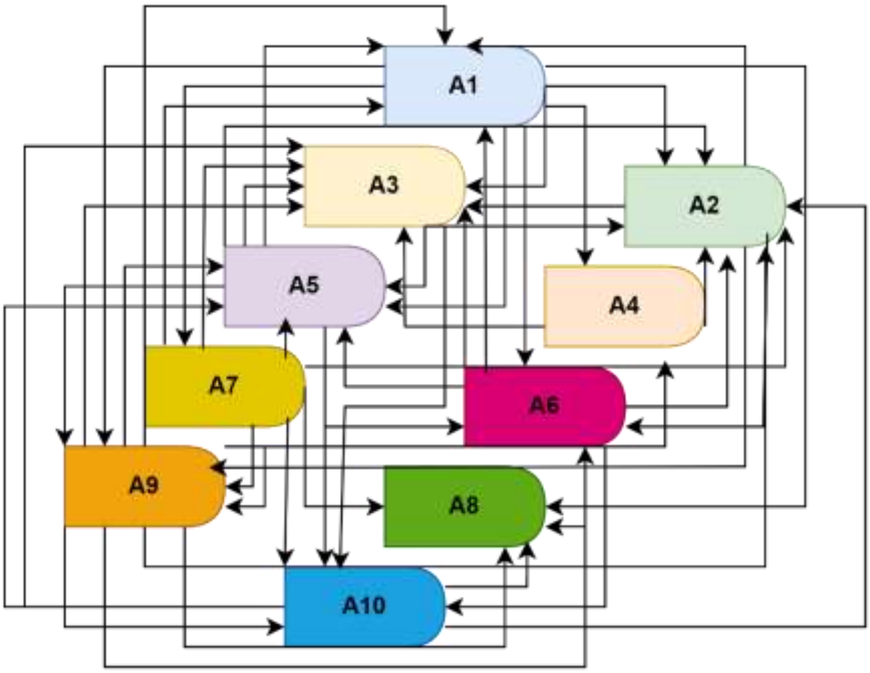

Figure 1: Causal diagram

Table 7 and Figure 1 illustrate a comprehensive overview of barriers to digital social innovation and their causal relationships. Limited Access to Funding (A1) emerges as a central factor, acting as a cause for a myriad of challenges. It is identified as a trigger for Regulatory and Compliance Challenges (A2), Technological Infrastructure Gaps (A3), Skill Gaps and Educational Deficiencies (A4), Intellectual Property Issues (A5), Lack of Mentorship and Expert Guidance (A6), Market Understanding and Access challenges (A7), Networking and Collaboration Challenges (A9), and Sustainability and Scalability Concerns (A10).

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Regulatory and Compliance Challenges (A2) also play a role as a cause, notably influencing Technological Infrastructure Gaps (A3) and Networking and Collaboration Challenges (A9). Meanwhile, Technological Infrastructure Gaps (A3) serve as a cause for Limited Access to Funding (A1), Regulatory and Compliance Challenges (A2), Intellectual Property Issues (A5), and Sustainability and Scalability Concerns (A10). Skill Gaps and Educational Deficiencies (A4) do not appear as a cause for any other identified barrier.

Intellectual Property Issues (A5) are associated with Limited Access to Funding (A1), Technological Infrastructure Gaps (A3), and Networking and Collaboration Challenges (A9). Lack of Mentorship and Expert Guidance (A6) is identified as a cause for multiple challenges, including Limited Access to Funding (A1), Regulatory and Compliance Challenges (A2), Technological Infrastructure Gaps (A3), Intellectual Property Issues (A5), Market Understanding and Access Challenges (A7), and Networking and Collaboration Challenges (A9).

Market Understanding and Access (A7) is a notable cause for Limited Access to Funding (A1), Regulatory and Compliance Challenges (A2), Technological Infrastructure Gaps (A3), Intellectual Property Issues (A5), Networking and Collaboration Challenges (A9), and Sustainability and Scalability Concerns (A10). Cultural and Societal Resistance (A8) does not exhibit causal relationships with other identified barriers.

Networking and Collaboration Challenges (A9) are identified as a cause for Limited Access to Funding (A1), Regulatory and Compliance Challenges (A2), Technological Infrastructure Gaps (A3), Intellectual Property Issues (A5), Lack of Mentorship and Expert Guidance (A6), Market Understanding and Access Challenges (A7), and Sustainability and Scalability Concerns (A10). Lastly, Sustainability and Scalability Concerns (A10) emerge as a cause for Limited Access to Funding (A1), Regulatory and Compliance Challenges (A2), Technological Infrastructure Gaps (A3), Intellectual Property Issues (A5), Lack of Mentorship and Expert Guidance (A6), Market Understanding and Access Challenges (A7), and Networking and Collaboration Challenges (A9).

5. Conclusions

In conclusion, the Pythagorean Neutrosophic Bonferroni Mean (PNBM) - DEMATEL analysis provides a comprehensive understanding of the barriers confronting young entrepreneurs in the Digital Social Innovation (DSI) domain. The identification of Limited Access to Funding as the most influential barrier underscores its pivotal role in shaping and influencing other obstacles within the DSI landscape. Regulatory and Compliance Challenges emerge as interdependent factors, revealing their intricate connections with other barriers. This study contributes nuanced insights into the significance, ranking, and cause-and-effect relationships of each barrier, offering strategic guidance for interventions in the DSI ecosystem. The paramount importance of addressing Limited Access to Funding is highlighted, given its catalytic impact on various challenges faced by young entrepreneurs engaged in DSI projects. Furthermore, recognizing the interconnected nature of Regulatory and Compliance Challenges emphasizes the necessity for holistic strategies to navigate these complexities. In addition to shedding light on specific barriers, this research underscores the significance of employing the Pythagorean Neutrosophic Bonferroni Mean (PNBM) in DEMATEL analysis. The utilization of PNBM enhances the robustness of the analysis by effectively managing uncertainties and providing a nuanced representation of decision-making dynamics. This approach contributes to the methodological advancement in understanding the complexities of DSI barriers. Efforts to strengthen the support system for young entrepreneurs in DSI should prioritize strategies addressing Limited Access to Funding, promoting collaboration, and navigating regulatory complexities. This research significantly contributes to informing policy initiatives, funding programs, and mentorship efforts tailored to the distinctive challenges faced by young innovators in the digital social innovation space. Ultimately, fostering a conducive environment for DSI initiatives necessitates a comprehensive and collaborative approach, and the utilization of Pythagorean Neutrosophic Bonferroni Mean in DEMATEL emerges as a valuable tool in this pursuit.

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Enhancing Digital Social Innovation Ecosystems: A Pythagorean Neutrosophic Bonferroni Mean (PNBM) -DEMATEL Analysis of Barriers Factors for Young Entrepreneurs

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Abstract

Author keywords

Sustainable Development Goals

SciVal Topics

Metrics

Abstract

This study employs a Pythagorean Neutrosophic Bonferroni Mean (PNBM)-Decision Making Trial and Evaluation Laboratory (DEMATEL) approach to analyze barriers faced by young entrepreneurs in Digital Social Innovation (DSI). Pythagorean Neutrosophic Set (PNS) enriches the analysis, accommodating uncertainties in the complex socio-economic context. Limited Access to Funding emerges as the most influential barrier, showcasing its pivotal role in impacting other DSI challenges. Regulatory and Compliance Challenges are identified as interdependent, emphasizing their interconnected nature with broader barriers. Neutrosophic elements elucidate the uncertainties surrounding financial constraints, regulatory frameworks, and mentorship dynamics. The study contributes to a nuanced understanding of DSI challenges and pioneers the application of neutrosophic logic in socio-economic research. It advocates for a more inclusive decision-making methodology, fostering adaptability in addressing the indeterminate nature of barriers faced by young entrepreneurs navigating the digital social innovation landscape. The findings aim to enhance support systems, fostering a conducive environment for DSI initiatives and encouraging future research in neutrosophic decision-making methodologies.

Author keywords

Barrier Analysis; DEMATEL; Digital Social Innovation (DSI); Pythagorean Neutrosophic Bonferroni Mean (PNBM); Young Entrepreneurs

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