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Mathematical Logic as a Foundation for AI-Driven Decision-Making Systems

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ABSTRACT

Managerial decision-making constitutes a cornerstone of organizational success, particularly within increasingly intricate and data-intensive business environments. The escalating volume and diversity of available information necessitate the adoption of structured analytical frameworks, such as mathematical logic, to bolster the accuracy and consistency of managerial judgments. This study investigates the contribution of propositional and predicate logic comprehension to the enhancement of managerial capabilities in problem analysis, strategy formulation, and solution selection across a broad spectrum of business contexts. A quantitative research design was employed, encompassing a structured survey administered to 150 managers drawn from a diverse range of industries. The collected data were analyzed through Structural Equation Modeling (SEM) to assess the associative relationships between logical reasoning proficiency and decision-making effectiveness. The results indicate that elevated levels of logical reasoning are significantly correlated with enhanced competencies in problem structuring, scenario evaluation, and solution implementation. These findings underscore the imperative of incorporating mathematical logic into managerial training programs as a means of strengthening analytical thinking and mitigating the influence of cognitive biases. This study advances the existing body of literature by positioning logical reasoning as a fundamental competency for effective managerial practice, and further proposes that organizations can elevate decision-making quality by embedding logic-based frameworks within leadership development initiatives and decision-support systems.

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1. INTRODUCTION

Effective managerial decision-making constitutes a fundamental pillar of organizational success, as it enables managers to systematically analyze complex situations, formulate strategic responses, and implement solutions that are aligned with both short-term objectives and long-term organizational goals [1–3]. In the context of increasingly dynamic, uncertain, and data-intensive business environments, managers are required to process vast amounts of information while simultaneously addressing multifaceted challenges that demand pre-

cision, consistency, and accountability [4–6]. Consequently, the reliance on structured and logically grounded approaches to decision-making has become more critical than ever, as organizations strive to enhance their competitiveness and adaptability in rapidly evolving markets [7–9].

Mathematical logic, as a formal discipline concerned with systematic reasoning and the derivation of valid conclusions from well-defined premises, offers a robust analytical framework that can support managerial decision-making processes [10, 11]. Through its core components, particularly propositional logic and predicate logic, mathematical logic provides tools for structuring arguments, identifying relationships between variables, and evaluating the consistency and validity of different decision alternatives [12–14]. However, despite its theoretical strength and applicability, the integration of mathematical logic into managerial practices remains relatively underexplored, both in academic literature and in real-world organizational settings [5, 15, 16]. Managers frequently rely on intuition, experience-based judgment, or heuristic approaches, which, although efficient in certain contexts, may introduce cognitive biases and increase the likelihood of suboptimal or inconsistent decisions [17–19].

Given these considerations, it becomes essential to examine the extent to which a structured understanding of mathematical logic can enhance the effectiveness of managerial decision-making [2, 14, 20]. Logical reasoning frameworks have the potential to improve various dimensions of managerial performance, including problem identification, analytical reasoning, strategic planning, and the evaluation of alternative courses of action [11, 21, 22]. By adopting a more systematic and formalized approach to reasoning, managers may be better equipped to minimize ambiguity, reduce errors in judgment, and ensure that decisions are grounded in rational and evidence-based considerations [23–25]. This study, therefore, seeks to investigate the relationship between managers' understanding of mathematical logic and their ability to make effective and reliable decisions across diverse business contexts [2, 11, 26].

To fulfill this objective, the present study adopts an empirical approach to reconcile the gap between theoretical constructs in mathematical logic and their practical ramifications within the domain of management [27–29]. The resultant findings are anticipated to make meaningful contributions to both academic discourse and managerial practice by substantiating the relevance of logical reasoning as an indispensable competency in contemporary organizational settings [30–32]. Moreover, this study accentuates the necessity of embedding logic-based frameworks into managerial training curricula and leadership development programs, thereby cultivating more analytical, objective, and strategically oriented decision-making processes that can ultimately propel organizational performance and long-term sustainability [33, 34].

2. LITERATURE REVIEW

2.1. Foundations of Mathematical Logic in Analytical Reasoning

Mathematical logic constitutes a foundational branch of the formal sciences, centered on the principles of valid reasoning and the systematic derivation of conclusions from explicitly defined premises, encompassing key constructs such as propositional logic, predicate logic, and Boolean algebra [13, 14]. As underscored by [11, 35], mathematical logic furnishes a rigorous framework for appraising the validity and consistency of arguments through structured symbolic representations and rule-based inference mechanisms [36]. Specifically, propositional logic facilitates the examination of relationships between declarative statements, whereas predicate logic broadens this analytical capacity by integrating variables, quantifiers, and relational structures, thereby accommodating more nuanced and context-sensitive reasoning processes [37–39]. These logical systems have been extensively applied in domains such as computer science, artificial intelligence, and operations research, where precision and consistency are paramount; however, their systematic application within managerial decision-making contexts remains relatively limited, despite their strong potential to enhance analytical rigor and reduce ambiguity in complex organizational environments [2, 23, 40].

2.2. Managerial Decision-Making and the Role of Structured Reasoning

Managerial decision-making constitutes a central managerial function that involves a series of interrelated processes, including problem identification, evaluation of alternatives, and the selection of the most appropriate course of action under conditions of uncertainty and constraint [2, 8, 41]. According to [11, 42], decision-making in organizations is inherently complex, iterative, and often influenced by time pressure, incomplete information, and organizational dynamics, which may hinder the ability of managers to make fully rational choices. This perspective is further reinforced by theory of bounded rationality, which posits that

decision-makers operate under cognitive limitations that restrict their capacity to process information comprehensively, leading them to rely on heuristics or satisficing strategies rather than optimal solutions [17, 18, 43]. In this context, the incorporation of structured reasoning approaches, such as those offered by mathematical logic, becomes increasingly relevant, as they provide systematic tools for organizing information, clarifying assumptions, and evaluating decision alternatives in a more objective and transparent manner, thereby reducing the influence of cognitive biases and enhancing overall decision quality [14, 44, 45].

2.3. Integrating Mathematical Logic into Managerial Decision-Making: Evidence and Research Gaps

The integration of mathematical logic into managerial decision-making processes has been conceptually supported by various streams of research, particularly in the fields of decision support systems and artificial intelligence [14, 35], which demonstrate how logic-based models can enhance analytical capabilities and facilitate systematic problem-solving. For instance, [11, 22] emphasize the role of structured methodologies in improving decision support systems, enabling more consistent and data-driven managerial decisions. Furthermore, empirical studies, such as [2, 23], indicate that managers with stronger logical reasoning skills tend to exhibit higher levels of problem-solving effectiveness and decision accuracy, suggesting a positive relationship between logical competence and managerial performance. Additionally, the application of fuzzy logic highlights the potential of logic-based approaches in addressing uncertainty and ambiguity in complex decision environments [14, 28].

Despite these advancements, existing literature remains limited in providing comprehensive empirical validation of the direct impact of mathematical logic on managerial decision-making effectiveness, particularly within diverse organizational settings [18, 24]. Most prior studies tend to focus on theoretical models or specific technological applications, leaving a notable gap in understanding how foundational logical reasoning skills can be systematically integrated into managerial practices and training programs [29, 31, 46]. This gap underscores the need for further empirical investigation to examine the extent to which mathematical logic can serve as a core competency in enhancing managerial effectiveness, as well as to explore its practical implications for leadership development and organizational performance improvement [33, 34, 47].

3. RESEARCH METHODOLOGY

This study embraces a quantitative research design to scrutinize the relationship between the comprehension of mathematical logic and managerial decision-making effectiveness, with the primary objective of identifying the extent to which logical reasoning contributes to enhanced managerial performance within complex organizational environments. A correlational approach is adopted to examine the directional association between variables, facilitating a systematic evaluation of how variations in logical reasoning proficiency exert influence on decision-making outcomes. The target population is composed of mid- to senior-level managers drawn from a broad range of industries, ensuring adequate representation across diverse decision-making contexts, encompassing strategic planning, operational management, and risk assessment.

To guarantee the relevance and sufficiency of the data, a purposive sampling technique was utilized to recruit a total of 150 respondents who possess prior experience in managerial decision-making and demonstrate familiarity with analytical or logical reasoning processes. This sample size is deemed adequate for the application of Structural Equation Modeling (SEM), particularly when employing variance-based analytical approaches such as SmartPLS. The selection criteria were deliberately established to ensure that all respondents possess the requisite cognitive and professional background necessary to furnish substantive insights into the role of logical reasoning in managerial decision-making.

Data collection was conducted by means of a structured questionnaire disseminated through online professional networks to maximize both accessibility and response rates. The questionnaire was organized into three primary sections. The first section captured relevant demographic information, encompassing gender, age, industry sector, years of managerial experience, and educational background. The second section assessed respondents' comprehension of mathematical logic, with a particular emphasis on propositional logic, predicate logic, and overarching logical reasoning competencies. The third section evaluated managerial decision-making effectiveness, addressing key dimensions including problem identification, appraisal of alternatives, and decision implementation. All measurement items were rated using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), ensuring uniformity and comparability of responses across the sample.

Table 1. Measurement of Research Variables

Variable	Dimensions	Indicators	Scale
Understanding of Mathematical Logic	Propositional Logic	Ability to evaluate logical statements, identify truth values	Likert (1–5)
	Predicate Logic	Understanding of variables, quantifiers, and relationships	Likert (1–5)
	Logical Reasoning Skills	Ability to apply logic in problem-solving and analysis	Likert (1–5)
Managerial Decision-Making Effectiveness	Problem Identification	Ability to recognize and define problems accurately	Likert (1–5)
	Alternative Evaluation	Ability to assess multiple decision options systematically	Likert (1–5)
	Decision Implementation	Effectiveness in executing chosen solutions	Likert (1–5)

Table 1 presents the operationalization of the research variables, outlining the dimensions and indicators used to measure both constructs. The independent variable, understanding of mathematical logic, is represented through three dimensions reflecting structured reasoning capabilities, while the dependent variable, managerial decision-making effectiveness, is measured across the core stages of decision-making. The use of a Likert scale facilitates quantitative assessment and supports subsequent statistical analysis.

3.1. Sample Characteristics

Table 2. Sample Characteristics

Characteristic	Category	Frequency (n=150)	Percentage (%)
Gender	Male	90	60%
	Female	60	40%
Age	25–35 years	50	33.30%
	36–45 years	60	40%
	Above 45 years	40	26.70%
Industry	Manufacturing	35	23.30%
	Services	45	30%
	Technology	40	26.70%
	Others	30	20%
Managerial Experience	1–5 years	40	26.70%
	6–10 years	55	36.70%
	More than 10 years	55	36.70%
Education Level	Bachelor's Degree	70	46.70%
	Master's Degree	65	43.30%
	Doctoral Degree	15	10%

Table 2 presents a thorough depiction of the demographic distribution of the study respondents. The sample reflects a heterogeneous and professionally experienced managerial population, with the predominant proportion of participants possessing more than six years of managerial experience and holding at minimum a bachelor's or master's degree qualification. This demographic diversity serves to reinforce the generalizability of the research findings across a wide array of industries and managerial contexts.

3.2. Data Analysis Technique

Prior to hypothesis testing, the collected data underwent preprocessing procedures, including data cleaning, treatment of missing values, and assessment of data distribution to ensure analytical robustness. Descriptive statistics were first employed to summarize respondent characteristics and overall response patterns. Subsequently, inferential analysis was carried out through the application of Structural Equation Modeling (SEM) utilizing SmartPLS software, which is particularly well-suited for examining complex interrelationships among latent constructs in relatively small to medium-sized sample populations.

The SEM analysis was structured around two principal stages: measurement model evaluation and structural model evaluation. The measurement model was appraised by scrutinizing a set of reliability and validity indicators, encompassing Cronbach's alpha, composite reliability, and average variance extracted (AVE). The structural model was subsequently assessed by inspecting path coefficients, t-statistics, and p-values to ascertain the magnitude and statistical significance of the hypothesized relationships among the research variables.

3.3. Measurement Model Evaluation

Table 3. Measurement Model Evaluation

Construct	Cronbach's Alpha	Composite Reliability	AVE	Interpretation
Understanding of Mathematical Logic	0.89	0.92	0.68	Reliable and Valid
Managerial Decision-Making Effectiveness	0.91	0.93	0.71	Reliable and Valid

Table 3 demonstrates that all constructs meet the required thresholds for reliability and convergent validity. The values indicate strong internal consistency and confirm that the measurement items effectively represent their respective constructs, allowing for reliable structural model analysis.

3.4. Conceptual Framework and Hypothesis

The conceptual framework underpinning this study posits a direct and positive associative relationship between the comprehension of mathematical logic and the effectiveness of managerial decision-making. Logical reasoning, as operationalized through the constructs of propositional and predicate logic, is anticipated to augment managers' capacity to systematically structure problems, critically appraise available alternatives, and execute well-informed and effective decisions.

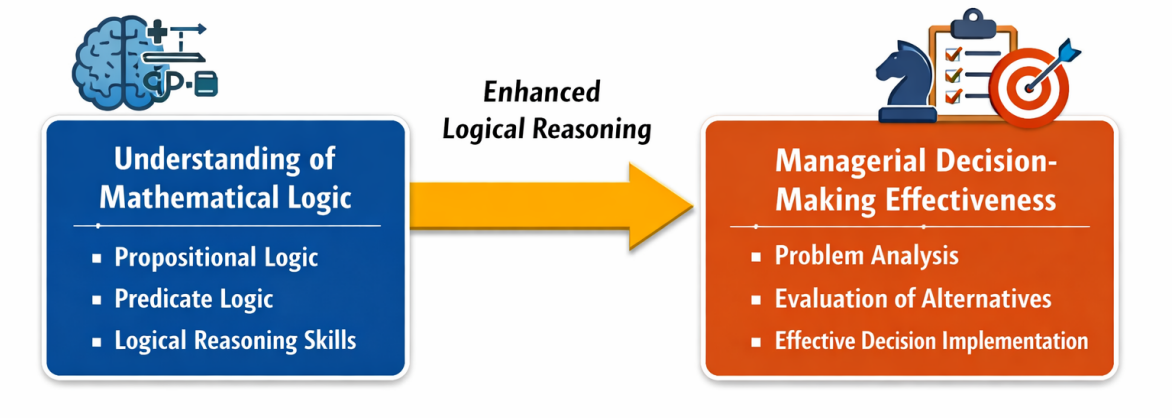

Figure 1. Hypothesis: Impact of Understanding Mathematical Logic on Managerial Decision-Making Effectiveness

Figure 1 illustrates the proposed hypothesis of the study. The relationship is represented as a directed arrow linking two key variables:

- Understanding of Mathematical Logic: This variable denotes the degree of managers' proficiency in logical reasoning, encompassing their foundational knowledge of propositional and predicate logic, as well as their capacity to apply these conceptual frameworks to practical problem-solving and strategic planning endeavors.

- Managerial Decision-Making Effectiveness: This variable captures the extent to which managers are capable of formulating well-informed, rational, and effective decisions within their respective organizational roles. It subsumes key dimensions such as problem identification, critical appraisal of available alternatives, and the implementation of optimal and contextually appropriate solutions.

The arrow indicates the hypothesized causal relationship, suggesting that a better understanding of mathematical logic positively influences managerial decision-making effectiveness. The figure accentuates the study's emphasis on exploring this associative connection and gauging the extent to which logical reasoning meaningfully contributes to more favorable decision-making outcomes. This hypothesis is consonant with established theoretical frameworks in decision science and formal logic, thereby furnishing a robust foundation for empirical validation through analytical methods such as correlation analysis and Structural Equation Modeling (SEM). The outcomes of this analytical process are intended to corroborate the proposed hypothesis and yield actionable insights pertinent to the advancement of managerial training and professional development initiatives.
H1: Understanding of mathematical logic has a positive and significant effect on managerial decision-making effectiveness.

3.5. Ethical Considerations

Ethical principles were rigorously upheld throughout the entirety of the research process. All participants furnished informed consent prior to their involvement and were comprehensively briefed regarding the purpose and scope of the study. Confidentiality and anonymity were safeguarded through the removal of personally identifiable information and the secure storage of all collected data. The study maintained strict adherence to established ethical research standards to preserve participant rights and uphold the integrity of the overall research process.

4. RESULTS AND DISCUSSION

4.1. Respondent Profile and Descriptive Analysis

This study examined data obtained from 150 managers representing a heterogeneous array of industries, encompassing manufacturing, services, and technology sectors, thereby ensuring a thorough and comprehensive representation of diverse managerial decision-making environments. The demographic profile of the respondents reflects a relatively equitable distribution with respect to gender, age, educational background, and managerial experience, with a substantial proportion of participants possessing in excess of six years of professional experience and holding at minimum a bachelor's or master's degree qualification. This compositional characteristic suggests that the respondents are sufficiently exposed to the complexities inherent in organizational decision-making processes, thereby bolstering the credibility and practical relevance of the resultant findings.

Descriptive statistical analysis further reveals that the majority of respondents demonstrate a moderate to high level of understanding of mathematical logic, particularly in relation to propositional logic, predicate logic, and the practical application of logical reasoning in problem-solving contexts. This finding indicates that, although not all managers may have formal training in mathematical logic, many possess an implicit understanding of logical structures through experience and professional practice. In parallel, the level of managerial decision-making effectiveness is generally rated as high, reflecting respondents' ability to identify problems accurately, evaluate alternative solutions systematically, and implement decisions effectively within organizational settings.

4.2. Inferential Analysis and Hypothesis Testing

The inferential analysis provides strong empirical evidence supporting the proposed relationship between understanding mathematical logic and managerial decision-making effectiveness. The correlation analysis demonstrates a positive and statistically significant association between the two variables, indicating that

an increase in logical reasoning proficiency is associated with improved decision-making performance. Further validation using Structural Equation Modeling (SEM) reveals a substantial and meaningful relationship, as indicated by the path coefficient ($\beta = 0.72$), which reflects a strong positive influence of mathematical logic understanding on decision-making effectiveness. This relationship is further supported by a high T-statistic (12.45), which exceeds the critical threshold, and a statistically significant p-value ($p < 0.001$), confirming the robustness of the findings. These results provide empirical support for the proposed hypothesis (H1), demonstrating that logical reasoning plays a critical role in enhancing managerial decision-making outcomes.

4.3. Discussion and Theoretical Implications

The findings of this study offer significant theoretical and practical insights into the role of mathematical logic as a fundamental component of effective managerial decision-making. The strong positive relationship identified between logical reasoning and decision-making effectiveness reinforces the argument that structured analytical thinking enhances managers' ability to process complex information, reduce ambiguity, and make well-informed decisions. These results are consistent with established theories in decision science, particularly Simon's concept of bounded rationality, which emphasizes the cognitive limitations of decision-makers and highlights the need for systematic approaches to improve decision quality.

Moreover, the results align with prior research in decision support systems and artificial intelligence, which demonstrates that logic-based frameworks can enhance analytical capabilities and improve decision outcomes. Managers with a deeper understanding of propositional and predicate logic are better equipped to evaluate assumptions, identify inconsistencies, and systematically compare alternative solutions. This capability is particularly valuable in dynamic and uncertain environments, where decision-making requires a high level of precision and adaptability.

Another important implication of the findings is the role of mathematical logic in mitigating cognitive biases, such as confirmation bias, anchoring, and overconfidence, which often influence managerial decisions. By adopting a structured reasoning approach, managers can critically evaluate information and reduce reliance on intuitive or heuristic-based judgments that may lead to suboptimal outcomes. This suggests that logical reasoning not only enhances decision accuracy but also improves the transparency and accountability of decision-making processes within organizations.

4.4. Practical Implications and Future Research Directions

From a practical perspective, the findings highlight the importance of integrating mathematical logic into managerial training and leadership development programs. Organizations can benefit from incorporating logic-based frameworks into decision-support systems and professional development initiatives, thereby fostering more analytical and objective decision-making practices. The development of structured training modules focusing on logical reasoning, critical thinking, and analytical problem-solving may significantly enhance managerial capabilities and overall organizational performance.

Despite the strong empirical support provided in this study, several limitations and opportunities for future research remain. First, this study is based on cross-sectional data, which limits the ability to establish causal relationships over time. Future research could adopt longitudinal designs to examine the long-term impact of logical reasoning on decision-making effectiveness. Second, expanding the scope of the study to include different cultural and organizational contexts may provide deeper insights into the generalizability of the findings. Finally, further studies could explore the effectiveness of intervention-based approaches, such as training programs or decision-support tools, in enhancing logical reasoning skills among managers.

5. MANAGERIAL IMPLICATIONS

The findings of this study offer several significant managerial implications for organizations seeking to enhance decision-making effectiveness in increasingly complex, uncertain, and data-driven environments. The strong positive relationship identified between the understanding of mathematical logic and managerial decision-making effectiveness suggests that logical reasoning should be recognized as a fundamental managerial competency rather than merely a technical or academic skill. In this regard, organizations are encouraged to systematically integrate mathematical logic particularly concepts such as propositional and predicate logic into leadership development initiatives and managerial training programs. By strengthening these competencies, managers are better equipped to structure problems in a more systematic manner, evaluate alternative courses

of action with greater objectivity, and reduce reliance on intuition-driven judgments that are often susceptible to cognitive biases.

Furthermore, the results indicate that organizations can significantly improve the quality and consistency of managerial decisions by embedding logic-based frameworks into their decision-support systems. The integration of formal logical reasoning into analytical tools, dashboards, and management information systems can facilitate more structured and transparent decision-making processes, particularly in areas such as strategic planning, risk management, and policy formulation. Such systems not only enhance the analytical capabilities of managers but also contribute to greater accountability and traceability in decision outcomes, which are essential in modern organizational governance.

In addition, this study underscores the importance of continuous learning and professional development as a means of strengthening managerial competencies. The evidence suggests that managers with prior exposure to mathematical logic demonstrate higher levels of decision-making effectiveness, especially when such knowledge is complemented by practical experience in real-world contexts. This finding implies that organizations should actively promote lifelong learning initiatives, including specialized workshops, training modules, and applied learning programs that focus on logical reasoning, critical thinking, and structured problem-solving. By fostering an environment that encourages ongoing skill development, organizations can ensure that their managerial workforce remains adaptive and capable of addressing evolving challenges.

From a broader strategic perspective, the adoption of logic-based decision-making practices has the potential to enhance organizational resilience and long-term performance. Organizations that cultivate a culture grounded in analytical thinking and evidence-based decision-making are more likely to achieve higher levels of adaptability, minimize decision errors, and respond more effectively to environmental uncertainties. This is particularly relevant in dynamic and volatile business contexts, where the ability to make rational, consistent, and well-informed decisions is critical for sustaining competitive advantage. Therefore, the integration of mathematical logic into managerial practices should be viewed not only as an operational improvement but also as a strategic investment in organizational capability and performance sustainability.

6. CONCLUSION

This study furnishes empirical evidence of a significant and positive associative relationship between the comprehension of mathematical logic and the effectiveness of managerial decision-making, thereby reinforcing the centrality of logical reasoning as an indispensable competency within contemporary management practices. The findings reveal that managers who possess a robust grounding in logical reasoning particularly in domains such as propositional and predicate logic are considerably better equipped to deconstruct complex problems, methodically appraise alternative courses of action, and execute decisions that are simultaneously rational and effective. These results underscore the instrumental role of structured analytical thinking in elevating the quality, consistency, and reliability of managerial decision-making processes.

Furthermore, the study emphasizes the importance of formal education and professional training in mathematical logic as a means of strengthening managerial capabilities. The evidence indicates that managers with prior exposure to logical reasoning concepts, whether through academic learning or professional development programs, tend to exhibit higher levels of decision-making effectiveness. In addition, managerial experience appears to complement logical reasoning skills, suggesting a synergistic relationship in which theoretical knowledge and practical experience jointly contribute to improved decision outcomes. This finding underscores the need for organizations to adopt a more integrated approach to managerial development that combines conceptual knowledge with experiential learning.

From a practical perspective, the study highlights the value of incorporating logical reasoning frameworks into organizational decision-making processes, including their integration into decision-support systems and leadership development initiatives. By embedding structured analytical approaches into managerial practices, organizations can enhance decision accuracy, reduce cognitive biases, and improve overall organizational performance. These insights provide a strong foundation for organizations seeking to develop more effective, transparent, and evidence-based decision-making cultures.

Notwithstanding its scholarly contributions, this study is not entirely devoid of limitations. The employment of a cross-sectional research design inherently constrains the capacity to establish causal relationships across temporal dimensions, while the relatively restricted sample size and industry scope may correspondingly limit the broader generalizability of the findings. In light of these constraints, subsequent research endeavors

are encouraged to embrace longitudinal methodological approaches, broaden the diversity of study samples across a wider spectrum of industries and cultural contexts, and investigate the efficacy of intervention-based models such as logic-focused training programs or decision-support tools in meaningfully augmenting the effectiveness of managerial decision-making.

In conclusion, this study demonstrates that the understanding of mathematical logic is not merely a theoretical or academic construct, but a practical and valuable skill that plays a crucial role in improving managerial decision-making effectiveness. As organizations continue to operate in increasingly complex and uncertain environments, the ability to think logically and make structured, evidence-based decisions will become an indispensable component of effective management. Accordingly, this study calls for greater recognition and integration of logical reasoning within both academic curricula and organizational practices as a strategic means of enhancing managerial performance and organizational success.

7. DECLARATIONS

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7.2. Author Contributions

Conceptualization: TL; Methodology: SM; Software: RG; Validation: NS and MS; Formal Analysis: TL and NS; Investigation: NS; Resources: TL; Data Curation: NS; Writing (Original Draft Preparation): TL and NS; Writing (Review and Editing): TL and NS; Visualization: NS; All authors, TL, RG, NS, and MS, have read and agreed to the published version of the manuscript.

7.3. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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7.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

REFERENCES

[1] G. M. Abashes, B. Elshqeirat, A. A. Abu-Shareha, and M. Alshraideh, "Beyond the noise: unveiling meaningful patterns in mobile payment data using fuzzy logic and svm," *J. Theor. Appl. Inf. Technol*, vol. 103, no. 1, pp. 266–284, 2025.

[2] M. Choiri, E. S. Pramudito, F. Sutisna, and R. S. Sean, "Business artificial intelligence for enhancing sustainable decision intelligence," *IAIC Transactions on Sustainable Digital Innovation (ITSDI)*, vol. 7, no. 1, pp. 106–116, 2025.

[3] A. Sutarman, R. Aprianto, R. Mitrev, R. Adyatama, and M. Yusup, "Influence of digital technology & data analytics on strategic decision making," *Startupreneur Business Digital (SABDA Journal)*, vol. 4, no. 1, pp. 12–23, 2025.

[4] J. Khalid, M. Chuanmin, F. Altaf, M. M. Shafqat, S. K. Khan, and M. U. Ashraf, "Ai-driven risk management and sustainable decision-making: Role of perceived environmental responsibility," *Sustainability*, vol. 16, no. 16, p. 6799, 2024.

[5] D. Balisa, A. Leffia, Y. Shino *et al.*, "Memanfaatkan fungsi sistem informasi manajemen: Prospek dan tantangan di dunia bisnis," *Jurnal MENTARI: Manajemen, Pendidikan dan Teknologi Informasi*, vol. 2, no. 2, pp. 123–133, 2024.

[6] H. Haryanto, A. Alvani, H. Azam, and S. Anyuniarwati, "Analisis big data dan bisnis intelegent melalui lensa baurang pemasaran pada industri manufaktur," *ADI Bisnis Digital Interdisiplin Jurnal*, vol. 5, no. 2, pp. 25–32, 2024.

[7] L. Broccardo, E. Ballesio, M. Z. Yaqub, and A. K. Mohapatra, "A bridge to success: the role of management accountants' intellectual capital in driving organizational decision-making through knowledge management," *Journal of Knowledge Management*, vol. 29, no. 5, pp. 1365–1411, 2025.

[8] K. Mirdad, A. R. Dina, and R. Haris, "Analisis tren pasar dan pengambilan keputusan berbasis data dalam meningkatkan daya saing bisnis," *ADI Bisnis Digital Interdisiplin Jurnal*, vol. 5, no. 2, pp. 72–80, 2024.

[9] G. Nicola and R. Setiawan, "Creating competitive advantage through digital innovation: Insights from startupreneurs in e-commerce," *Startupreneur Business Digital (SABDA Journal)*, vol. 3, no. 2, pp. 131–140, 2024.

[10] W. Usino, D. A. R. Kusumawardhani, T. Ramadhan, A. Pratiangga, and O. Qurotulain, "Big data analytics: Transforming business intelligence and decision making," *Journal of Computer Science and Technology Application*, vol. 1, no. 2, pp. 154–163, 2024.

[11] E. Sediyono, K. D. Hartomo, Y. A. Susetyo, and A. Setiwan, "The intelligence decision making on asset management using fuzzy clustering," in *2021 2nd International Conference on Innovative and Creative Information Technology (ICITech)*. IEEE, 2021, pp. 117–122.

[12] K.-H. Hu, F.-H. Chen, M.-F. Hsu, and G.-H. Tzeng, "Governance of artificial intelligence applications in a business audit via a fusion fuzzy multiple rule-based decision-making model," *Financial Innovation*, vol. 9, no. 1, p. 117, 2023.

[13] U. Rahardja, Q. Aini, A. S. Bist, S. Maulana, and S. Millah, "Examining the interplay of technology readiness and behavioural intentions in health detection safe entry station," *JDM (Jurnal Dinamika Manajemen)*, vol. 15, no. 1, pp. 125–143, 2024.

[14] U. Rahardja, O. Candra, A. K. Tripathi, M. M. A. Zahra, B. S. Bashar, I. Muda, N. K. A. Dwijendra, S. Aravindhan, and R. Sivaraman, "Mathematical modelling of engineering problems," *Journal homepage: http://iieta. org/journals/mmep*, vol. 10, no. 2, pp. 727–732, 2023.

[15] T. D. TRAN, T. D. TRUONG, T. V. PHAM, and D. H. PHAM, "Cognitive competency, problem-solving skills and decision-making: a case study of students' extracurricular activities in the distribution chains sector," *The Journal of Distribution Science (JDS)*, vol. 22, no. 2, pp. 71–82, 2024.

[16] M. H. R. Chakim, R. T. Utami, T. W. Sitanggang, A. Tanjung, A. Rizky, and E. A. Beldiq, "Innovation behavior research: Global trends and emerging themes in entrepreneurial business practices," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 6, no. 3, pp. 574–585, 2024.

[17] B. E. Sibarani, C. Anggreani, B. Artasya, and D. A. P. Harahap, "Unraveling the impact of self-efficacy, computer anxiety, trait anxiety, and cognitive distortions on learning mind your own business: The student perspective," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 6, no. 1, pp. 29–40, 2024.

[18] F. A. Rahardja, S.-C. Chen, and U. Rahardja, "Review of behavioral psychology in transition to solar photovoltaics for low-income individuals," *Sustainability*, vol. 14, no. 3, p. 1537, 2022.

[19] Á. Szukits, "The illusion of data-driven decision making–the mediating effect of digital orientation and controllers' added value in explaining organizational implications of advanced analytics," *Journal of management control*, vol. 33, no. 3, pp. 403–446, 2022.

[20] S. Tsyuh *et al.*, "The influence of management creativity on the optimality of management decisions over time: An innovative aspect," *Journal of Eastern European and Central Asian Research*, vol. 10, no. 3, 2023.

[21] H. Taherdoost and M. Madanchian, "Decision making: Models, processes, techniques," *Cloud Computing and Data Science*, pp. 1–14, 2024.

[22] C. Lukita, A. W. A. Rahman, I. N. Hikam, and U. Rahardja, "Integrating strategic management with sdg 10 for sustainable development and equity," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 7, no. 2, pp. 638–649, 2025.

[23] I. Sembiring, D. Manongga, U. Rahardja, and Q. Aini, "Understanding data-driven analytic decision making on air quality monitoring an empirical study," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 6, no. 3, pp. 418–431, 2024.

[24] M. B. Karo, B. P. Miller, and O. A. Al-Kamari, "Leveraging data utilization and predictive analytics: Driving innovation and enhancing decision making through ethical governance," *International Transactions on Education Technology (ITEE)*, vol. 2, no. 2, pp. 152–162, 2024.

[25] E. Susetyono, D. S. Priyarsono, A. Sukmawati, and P. Nurhayati, "Improving risk management maturity in ultra micro soe holding companies," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 8, no. 1, pp. 310–324, 2026.

[26] S. Vudugula, S. K. Chebrolu, M. Bhuiyan, and F. Z. Rozony, "Integrating artificial intelligence in strategic business decision-making: A systematic review of predictive models," *International Journal of Scientific Interdisciplinary Research*, vol. 4, no. 1, pp. 01–26, 2023.

[27] M. T. Mellaku and A. S. Sebsibe, "Potential of mathematical model-based decision making to promote sustainable performance of agriculture in developing countries: A review article," *Heliyon*, vol. 8, no. 2, 2022.

[28] U. Rahardja, I. D. Hapsari, P. H. Putra, and A. N. Hidayanto, "Technological readiness and its impact on mobile payment usage: A case study of go-pay," *Cogent Engineering*, vol. 10, no. 1, p. 2171566, 2023.

[29] T. Hariguna, U. Rahardja, and Sarmini, "The role of e-government ambidexterity as the impact of current technology and public value: an empirical study," in *Informatics*, vol. 9, no. 3. MDPI, 2022, p. 67.

[30] I. Nica, C. Delcea, and N. Chiriță, "Mathematical patterns in fuzzy logic and artificial intelligence for financial analysis: a bibliometric study," *Mathematics*, vol. 12, no. 5, p. 782, 2024.

[31] U. Rusilowati, U. Narimawati, Y. R. Wijayanti, U. Rahardja, and O. A. Al-Kamari, "Optimizing human resource planning through advanced management information systems: A technological approach," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 6, no. 1, pp. 72–83, 2024.

[32] R. E. A. A. Alsalhi, Y. Mustapha, and M. F. Hilmi, "Entrepreneurial and inclusive leadership in enhancing employee innovation in the uae oil and gas sector," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 8, no. 1, pp. 114–124, 2026.

[33] N. S. Lubis, S. Hanafi, and S. Hidayat, "Enhancing educator performance through edupreneurship in international baccalaureate programs," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 7, no. 2, pp. 343–359, 2025.

[34] R. D. Hadiwidjaja, A. I. Suroso, H. Siregar, and I. Sailah, "Performance paradigm: Entrepreneurial good university governance mediating leadership style in state universities," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 6, no. 3, pp. 492–508, 2024.

[35] W. Usino, M. M. Sari, F. P. Oganda, O. P. M. Daeli, and E. Smith, "Artificial intelligence integration for sustainable business model innovation insights from global startups," *Sundara Advanced Research on Artificial Intelligence*, vol. 1, no. 2, pp. 82–89, 2025.

[36] J. Crawford and M. Jabbour, "The relationship between enterprise risk management and managerial judgement in decision-making: A systematic literature review," *International Journal of Management Reviews*, vol. 26, no. 1, pp. 110–136, 2024.

[37] H. R. N. Azizah, T. G. Permatasari, A. Winarno *et al.*, "The relevance of logical principles as the basis for scientific thinking in the development of management science: A systematic study," *Journal of Studies in Academic, Humanities, Research, and Innovation*, vol. 2, no. 2, pp. 421–430, 2025.

[38] B. S. Riza, "Blockchain dalam pendidikan: Lapisan logis di bawahnya," *ADI Bisnis Digital Interdisiplin Jurnal*, vol. 1, no. 1, pp. 41–47, 2020.

[39] Q. Aini, N. Lutfiani, N. P. L. Santoso, S. Sulistiawati, and E. Astriyani, "Blockchain for education purpose: essential topology," *Aptisi Transactions on Management*, vol. 5, no. 2, pp. 112–120, 2021.

[40] N. Nisha and M. Abouagwa, "Mathematics: The backbone of smart business decisions," in *Marketing Strategies for Total Quality Management in Hospitality Excellence*. IGI Global Scientific Publishing, 2026, pp. 187–210.

[41] E. Arif, S. Suherman, and A. P. Widodo, "Analyzing public sentiment on digital banks in indonesia via social media x," *Aptisi Transactions on Technopreneurship (ATT)*, vol. 8, no. 1, pp. 253–267, 2026.

[42] M. Kamil, J. Rianto, and D. Suprayogi, "Management of deciding decision making final project advisor in optimizing learning," *Aptisi Transactions On Management*, vol. 2, no. 2, pp. 168–176, 2018.

[43] Y. Zhang, Z. Li, Y. Sha, and K. Yang, "The impact of decision-making styles (effectuation logic and causation logic) on firm performance: a meta-analysis," *Journal of Business & Industrial Marketing*, vol. 38, no. 1, pp. 85–101, 2023.

[44] M. Vasuki, A. D. Kumar, M. Celestin, and T. A. H. Alghazali, "Mathematical logic as the engine of autonomous decision intelligence in digital systems," *International Journal of Applied and Advanced Scientific Research*, vol. 10, no. 2, pp. 97–108, 2025.

[45] Q. Aini, H. D. Purnomo, I. Setyawan, D. Manongga, U. Rahardja, I. Sembiring, S. Maulana *et al.*, "The

effect of perceived costs on blockchain adoption intention: an empirical study," in *2023 11th International Conference on Cyber and IT Service Management (CITSM)*. IEEE, 2023, pp. 1–6.

[46] A. Ruangkanjanases, A. Khan, O. Sivarak, U. Rahardja, and S.-C. Chen, "Modeling the consumers' flow experience in e-commerce: The integration of ecm and tam with the antecedents of flow experience," *SAGE Open*, vol. 14, no. 2, p. 21582440241258595, 2024.

[47] Q. Aini, I. Sembiring, A. Setiawan, I. Setiawan, and U. Rahardja, "Perceived accuracy and user behavior: Exploring the impact of ai-based air quality detection application (aiku)," *Indonesian Journal of Applied Research (IJAR)*, vol. 4, no. 3, pp. 209–224, 2023.