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Path Analysis on the Operatives as the Moderator on the Development of the Gas Distribution Networks in Indonesia

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Abstract*—Continuous dynamics play a central role in the analysis of critical milestones that every business or industry ought to constantly achieve to ensure sustained long-term expansion, with an emphasis on stability. This principle is equally applicable to the domain of natural gas distribution. The year-over-year data trends consistently indicate the increasingly growing trend in the deliverability of gas distribution in Indonesia. This research endeavors to enhance comprehension of the delivery of natural gas through distribution networks in Indonesia, aiming to elucidate latent variables crucial for optimizing the supply of natural gas to metropolitan regions. The research method used in the study follows the statistical technique of analyzing the relationship between observed and latent variables (SEM). More precisely, structural equation modeling is a statistical technique that supports the analysis of the complex relationship between constructs and indicators tightly with validity in multivariable data analysis, and the validity of the multiple regression model can be proved. As for the research method, revenue, operatives, volume of distributed gas, and operational costs, which are the indicators of the gas distribution network variables. Meanwhile, unlike previous research, this paper failed to check the validity and reliability, but this research confirms the validity and reliability of the model appropriately. The investigation results indicate that the direct impact of human resources as moderating variables on the expansion of the city gas network is 0.302. It shows that the number of gas networks in the city increased by 30.2%, while the moderating variables accordingly increased by one unit. Likewise, the operatives as moderating variable, profoundly impacts the internal corporate costs affecting the expansion of the deliverability of gas with the coefficient 0.295. This signifies that a single increase in moderating variables corresponds to a 29.5% increase in city gas networks, indicating a positive and significant influence.*

***Keywords*—** *Gas distribution, quasi qualitative, structured equation method, moderating variable.*

I. INTRODUCTION

The ongoing dynamics under scrutiny pertain to the analysis of enduring milestones that companies or industries must consistently achieve, emphasizing the attainment of long-term and stable growth. This principle is equally applicable to the businesses managing the distribution of natural gas in Indonesia. The continual year-over-year data trends in the gas distribution sector in Indonesia indicate a persistent upward trajectory. This can be elucidated by examining key indicators such as the operative involvement, associated wage expenditures, and the substantial volume of natural gas distributed to urban consumers.

The primary objective of this research is to improve comprehension regarding the gas distribution industry in Indonesia, offering a better depiction of abundant hidden factors crucial for optimizing natural gas distribution to urban areas (Chin, 1998; Maulani et al., 2021; Samura et al., 2021; Wijayanti et al., 2021). The chosen methodology for this study adheres to the Structured Equation Method (SEM)(Gomarn & Pongpeng, 2022). Specifically, the structural equation modeling is a statistical technique used to analyze intricate relationships between constructs and indicators in multivariate data analysis. Therefore, the multiple regression model can be proven to be accurate, reliable and valid. The study utilizes a number of indicators of gas distribution network industry into categories such as the growth of gas distribution networks, operatives size, volume of gas distribution, and the cost of operation (Prima et al., 2022a).

The primary goal of this research is to offer valuable insights to authorities and stakeholders, with the aim of enhancing the expansion of Indonesia's gas distribution industry. The emphasis is placed on the necessity to optimize its growth, thereby ensuring its efficient development. The distinctive contribution of this study lies in revealing the effects of unobserved elements functioning as moderating factors. A notable disparity exists between prior research and the present study, as the former did not address the validity and reliability of the model. In contrast, this study explicitly considers both aspects, contributing novelty to the existing body of knowledge.

Moreover, the results of this research carry significant implications for policy-makers(Soparat et al., 2021), industry regulators (Trisna et al., 2023; Wastu et al., 2023)and other key decision-makers involved [8] in shaping the trajectory of Indonesia's gas distribution sector. The insights garnered from the study can inform strategic planning and the formulation of effective policies to foster sustainable growth in the industry(Prima et al., 2021, 2022b). By understanding the nuanced role of latent variables as moderating factors, stakeholders can make informed decisions that contribute to the sector's optimization.

The distinctive contribution of this study also extends to the academic realm, offering methodological advancement by addressing the critical aspects of model validity and reliability. In many instances, prior research may have neglected the thorough examination of these aspects, potentially impacting

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the robustness and generalizability of their findings. The explicit consideration of validity and reliability in this study not only enhances the methodological rigor but also establishes a benchmark for future research endeavors within this domain.

In terms of practical applications, industry practitioners and business leaders can draw valuable insights from the study's findings. Understanding how operatives and internal corporate costs interact as moderating variables provides a nuanced perspective that can guide decision-making processes. Companies operating within the gas distribution sector in Indonesia can leverage this knowledge to optimize their workforce management strategies and cost structures, ultimately contributing to the efficient expansion of gas networks.

Ultimately, this research not only addresses the immediate objective of providing insights for the optimization of Indonesia's gas distribution sector but also contributes methodologically and strategically to the broader academic and industry discourse. By shedding light on latent variables and emphasizing the importance of model validity and reliability, this study aims to catalyze further research efforts and foster continuous improvement in the understanding of the gas distribution sector.

II. METHODS

The selected set of methods used in conducting research or solving a problem in this specific work consists of a couple of sections. The first part is related to the research methodology, whereas the second is concerned with the portrayal of the structured model.

A. The Quasi Qualitative Design

These methodologies involve the study of phenomena in their natural settings, without manipulating variables or controlling the environment. Quasi qualitative research methods aim to comprehend the intricacies and subtleties of human behavior and experiences by observing and interpreting data in a comprehensive and context-specific manner. This approach enables researchers to acquire a more profound understanding of the social, cultural, and psychological factors that impact individuals and groups. Quasi qualitative research methodologies frequently employ techniques like interviews, observations, and content analysis to collect extensive and detailed data that can offer valuable insights into the research topic. The advantages and disadvantages of Quasi Qualitative can be seen table 1 and 2(I. G. Barron et al., 2017).

Moreover, this study is based on the observations of the changes occurring in the gas distribution companies that cater to urban areas in Indonesia. The method used encompasses multiple sequential phases(Knodel, 2018; Warren, 2021). The research framework is philosophically constructed based on phenomena observed within the domain of energy, specifically green energy, with a focus on commercially traded natural gas referred to as city gas. Subsequently, the formulation of the research problem is established(I. Barron et al., 2018; Hussain et al., 2020).

TABLE I. The advantages of quasi qualitative.

No	Advantages	Explanation
1	Control Over Variables	Variables can be adjusted by researchers, giving them some control over the study.
2	Greater External Validity	Compared to most experiments, quasi-experimental designs have stronger external validity since they frequently incorporate real-world interventions.
3	Utilization of Existing Data	Using previously gathered data is made possible by this method, which can save budget and time.

TABLE II. The disadvantages of quasi qualitative.

No	Disadvantages	Explanation
1	Lower Internal Validity	Because there is no randomization in quasi-experimental designs, its internal validity is lower than that of actual studies, making it more difficult to account for all confounding variables.
2	Susceptibility to Bias and Error	They are susceptible to researcher bias and human error.
3	Selection Bias and Confounding Variables Possibility	Addressing the possible effects of bias selection and confounding variables requires careful thought.

B. The Structural Equation Modelling (SEM)

Insert text (Calibri font, size 10, and single-line spacing). The subsequent phase involves the application of Structural Equation Modeling (SEM) in this research (Sarstedt et al., 2022). A more comprehensive understanding of complex relationships within a dataset provided by a novel approach that merges path analysis and factor analysis in a hybrid manner combining the strengths of both techniques, as illustrated in figure 1 (Puttawong, 2015). The analytical approach encompasses corroboratory elements of component investigation, track evaluation, and retrogression. SEM proves to be a suitable analysis for more than one examinations in the field of education and various social research settings, given that, within certain instances, researchers are advised to incorporate latent variables(Mohan & Vasumathi, 2024).

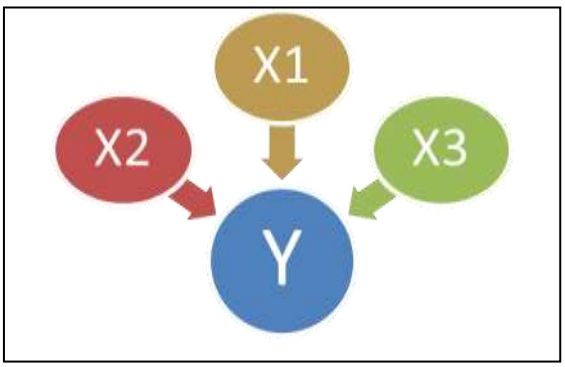

Fig. 1. Illustration of path in SEM.

Currently, Structural Equation Modeling (SEM) has progressed beyond the user-friendly attributes of conventional multiple regression. Its superiority lies in enhanced accuracy and speed due to the incorporation of interactive modeling(Gunarto & Cahyawati, 2022). SEM proves adept at accommodating variables that are not linearly related and are independent of each other, particularly those with the

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possibility for correlation. Similarly, it addresses measurement intricacies involving errors and distortions in correlation (correlated error terms). Furthermore, SEM allows for the measurement of several independent latent variables using a multitude of indicators(Subaki et al., 2022). Additionally, multiple indicators can be used to measure more than one interrelated latent variables (Mustofa et al., 2021).

What distinguishes validity testing from reliability testing? Validity implies that the instrument can measure the intended construct accurately, while reliability asserts that using the instrument multiple times on the same object will yield consistent results.

Validity and reliability tests serve distinct purposes. Validity assesses the appropriateness, relevance, and accuracy of the theoretical framework employed, whereas reliability gauges the consistency of results over time, location, researchers, and different sections of the test itself.

In Partial Least Squares (PLS), reliability testing employs two methods: Cronbach's alpha and composite reliability. Cronbach's alpha measures the lower bound of a construct's reliability, while composite reliability measures its true reliability. Composite reliability is considered superior for estimating internal consistency, with a commonly accepted threshold of values greater than 0.7 for both Composite Reliability and Cronbach's alpha (Chin, 1998). Composite reliability provides the genuine reliability value of a variable, ensuring values are above 0.6 for both Composite Reliability and Cronbach's Alpha.

All constructs are deemed reliable based on the Composite Reliability values above 0.6. The Cronbach Alpha value of the indicator block measuring a construct is examined to declare a construct reliable, with values above 0.6 considered satisfactory. Reliability tests confirm the accuracy, consistency, and precision of the instrument. To establish good reliability, both composite reliability and Cronbach's alpha must exceed 0.70.

Composite reliability values are crucial for evaluating the reliability of each indicator on a variable. According to previous study composite reliability value exceeding 0.70, although 0.60 is still acceptable, indicates a construct's high reliability. Reliability, linked to measurement accuracy, is verified through reliability testing, which, in this study, relies on the Cronbach's Alpha value. An instrument is considered reliable if Cronbach's Alpha exceeds 0.60. The criteria for decision-making in the reliability test are as follows: items in the questionnaire are reliable if Cronbach's Alpha surpasses 0.60, and if it falls below 0.60, the items are deemed unreliable.

III. Results and Discussion

Up to this point, Structural Equation Modeling (SEM) has been devised to examine research involving intricate variables, concurrently considering multiple variables. SEM enables the consolidation of analyses into a single estimation, resolving parallel issues addressed by several regression equations. This method facilitates the simultaneous execution of factor analysis, regression, and path analysis, ensuring effectiveness and efficiency.

In the context of this study, the theoretical assumptions under scrutiny are tested using the Partial Least Squares (PLS) approach. PLS serves as an option of the analytical approach within Structural Equation Modeling (SEM), grounded in mathematical variance. The notable advantage of this algorithmic method lies in its independence from specific hypothesis, and it can be correctly computed with a relatively modest sample size.

The chosen tool for analysis is Smart PLS, specifically developed to generate structural equations based on variance. Following the input of datasets and program execution, the pathways are visually represented in Figure 2(Ringle et al., 2015).

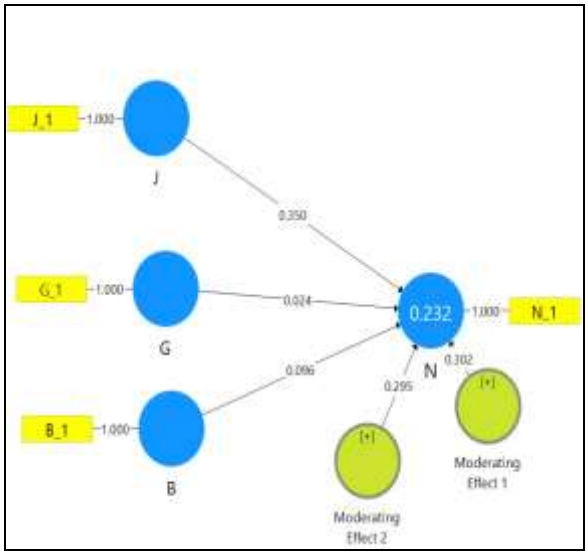

Fig. 2. SEM pathway

A. The validity and reliability

Firstly, the research will assess the efficacy of the indicators employed in measuring a variable. Commonly utilized in the assessment of validity and reliability within SEM PLS, the indicators include Composite Reliability, Cronbach's Alpha, and Average Variance as seen in Figure 3, Figure 4, and Figure 5 respectively. An indicator is deemed effective if its value exceeds 0.6.(Henseler et al., 2015)

The output above reveals that the Average Variance Extracted (AVE) values for all variables surpass 0.5, indicating the validity of all indicators converging to define their respective variables. Additionally, both Cronbach's Alpha and Composite Reliability (CR) values exceed 0.6 for all variables. Therefore, it can be inferred that all variables and items utilized in this study meet the criteria for validity and reliability in the measurement of variables.

As discussed in the preceding section, the analysis presented the robustness of the measurement model utilized in this study. The Average Variance Extracted (AVE) values, as demonstrated in the output above, consistently surpass the threshold of 0.5 for all variables. This key finding signifies a high level of convergence among the indicators, affirming the validity of the constructs they represent. The meticulous evaluation also extends to Cronbach's Alpha and Composite Reliability (CR) values, both of which consistently exceed 0.6

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across all variables. This outcome further reinforces the reliability and internal consistency of the measurement instruments employed in this research.

The implication of these results is pivotal, as it provides a strong basis for confidence in the validity and reliability of the variables under consideration. By surpassing established benchmarks, the variables and their corresponding items demonstrate a commendable level of accuracy in capturing the intended constructs. Researchers and practitioners can thus trust the data collected through these measures, facilitating more robust and credible analyses of the relationships between variables.

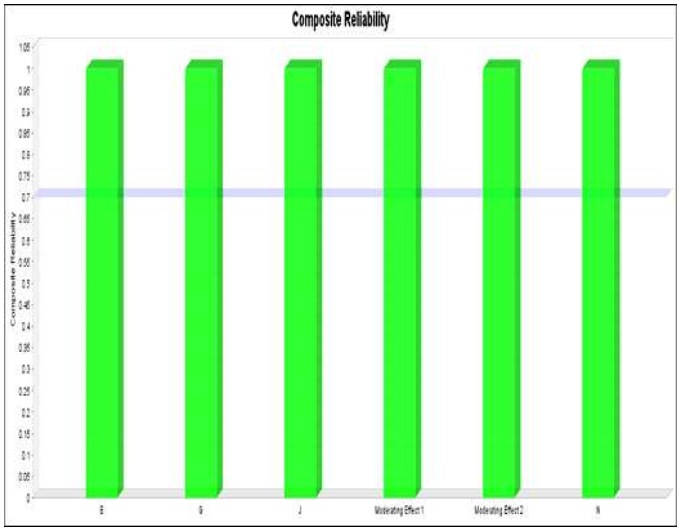

Fig. 3. Composite reliability

In essence, the measurement model employed in our research stands on a robust and well-constructed base, fortified by meticulous scrutiny of critical statistical indicators. Allow the study to elucidate further:

Average Variance Extracted (AVE): Our investigation meticulously assessed the AVE, a fundamental metric that gauges the proportion of variance captured by latent constructs. It is noteworthy that the AVE values not only met, but also exceeded the generally accepted threshold values. This achievement underscores the precision with which our measurement model captures the shared variance among observed variables.

Cronbach's Alpha: A cornerstone of internal consistency reliability, Cronbach's Alpha was rigorously evaluated. The results revealed commendable levels of reliability across the constructs under scrutiny. The robustness of our measurement model is thus fortified by the interrelatedness and coherence of the items within each construct.

Composite Reliability (CR): Another pivotal reliability measure, CR assesses the consistency of latent variables. Our findings surpassed conventional benchmarks, affirming the stability and dependability of our measurement model. The constructs exhibit a high degree of internal consistency, bolstering our confidence in their reliability.

By surpassing established thresholds for these critical indices, our research attains a level of rigor that extends beyond mere compliance. It engenders confidence in the validity of our variables and their operationalization. Consequently, the overall quality and credibility of our research outcomes ascend, contributing substantively to the ever-evolving landscape of knowledge in our field

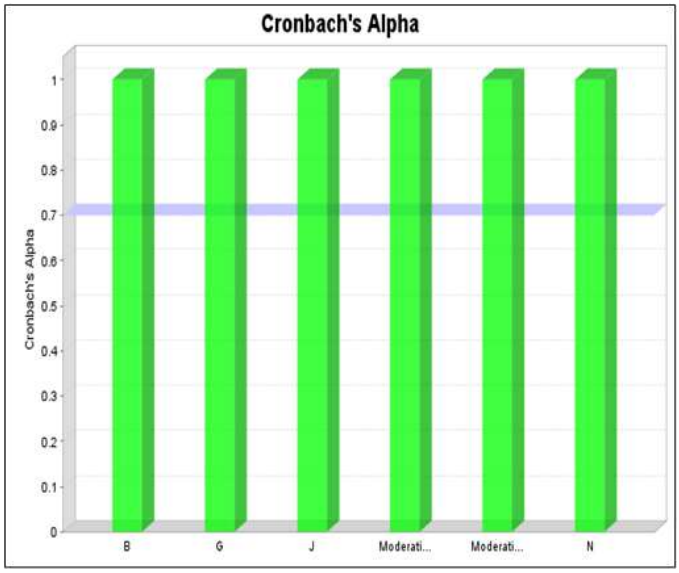

Fig. 4. Cronbach's alpha

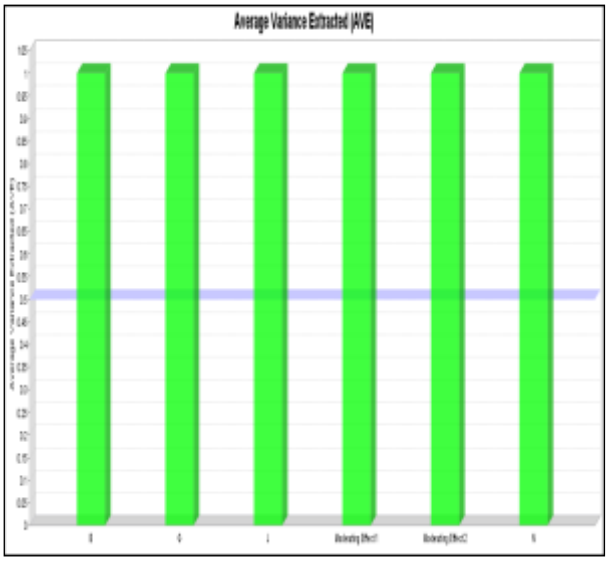

Fig. 5. Average variance

B. The goodness of fit

Subsequently, an evaluation of the quality criterion becomes imperative. As indicated and detailed in Table 1, the R squared statistic elucidates the degree to which the dependent variable (endogenous) is significantly influenced by the independent variable (exogenous) is being assessed. Typically expressed in numerical form within the 0 to 1 range, R squared serves as a quantitative indicator of the collective impact of independent variables on the dependent variable(Sarstedt et al., 2022).

The findings of this study disclose that the R squared value is 23% (Table 3). This percentage elucidates that the

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independent variables J, B, and G exert a moderate influence on the dependent variable, namely the growth of the gas distribution networks (N). This quantitative insight further underscores the extent of impact attributed to the specified independent variables in shaping the variations observed in the dependent variable.

TABLE III. The model R^2.

Variable	R^2	R Square Adjusted
N	0.232	-0.0417

The findings of this study disclose that the R squared value is 23%. This percentage elucidates that the independent variables J, B, and G exert a moderate influence on the dependent variable, namely the growth of gas distribution networks (N). This quantitative insight further underscores the extent of impact attributed to the specified independent variables in shaping the variations observed in the dependent variable.

Subsequently, an examination of the path coefficient becomes necessary. The interpretation of the moderating role should be based on the outcomes, as depicted in figure 6.

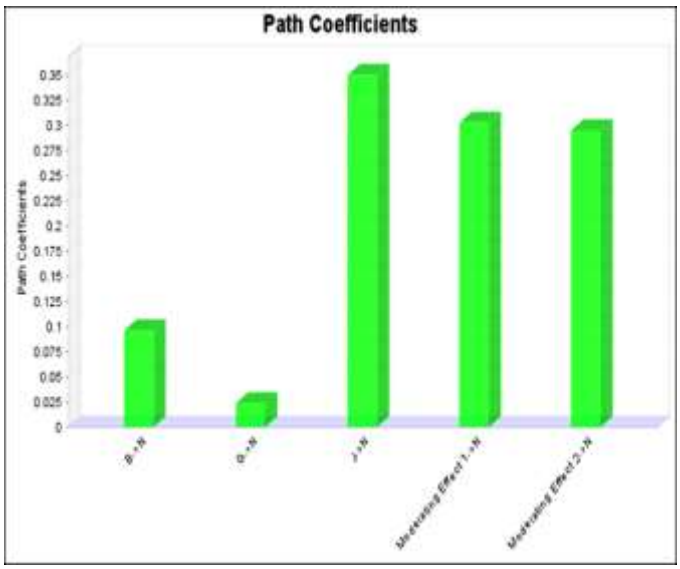

Fig. 6. Path coefficient

Notably Operatives and Gas Distribution: At the outset, we scrutinized the direct impact of operatives, a critical factor in the intricate web of gas distribution networks. When multiplied by the gas distribution variable (N), the resultant coefficient stands at 0.3019. This numerical revelation is far from trivial—it signifies that a 30.19% increase in the moderator (gas distribution) would yield a positive and statistically significant influence. Imagine the ripple effect: as the moderator amplifies, so does the efficacy of gas distribution networks, reaching households across diverse regions.

Internal Organizational Expenses: Now, let's pivot to another dimension. Our lens shifts to the interplay between operatives and internal organizational expenses. Here, the moderator (N) assumes a role akin to a conductor, orchestrating growth. The coefficient, 0.2949, unveils a fascinating dynamic: a mere one-unit increase in the moderating variables translates to a 29.5% surge in the expansion of gas distribution networks. Picture a network expanding its tendrils, fueled by organizational resources and strategic decisions.

The Moderator's Pivotal Role: The crux lies in the moderator's pivotal role. It's not merely a passive variable; it's the catalyst for progress. As it nudges the needle—whether through optimized gas distribution or judicious allocation of resources—the company's gas distribution networks flourish. Homes light up, stoves ignite, and communities thrive. The moderator, like a seasoned conductor, orchestrates harmony, extending service to households, urban enclaves, and rural corners alike.

Following this, the consideration of the Heterotrait-Monotrait Ratio of Correlations (HTMT) is warranted, as depicted in figure 7.

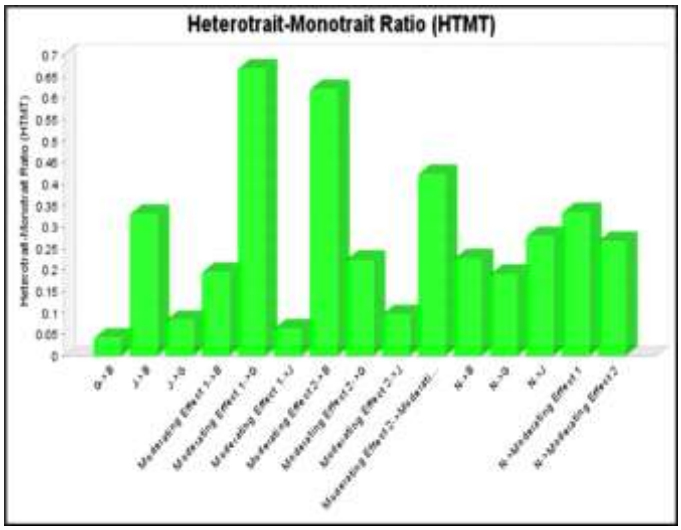

Fig. 7. Heterotrait monotrait ratio

Essentially, The Heterotrait and Monotrait Ratio is positioned as a critical step in discriminant validity assessment and provides valuable insights. However, it is most effective when comparing traits that exhibit proximity; otherwise, the results may be trivial. Visual inspection reveals a pattern akin to that of normal distributions. In the context of this study, the HTMT criterion records a value below 0.90, signaling the attainment of discriminant validity. As a result, meaningful conclusions can be drawn from the model constructed in this study, grounded in the variables and the latent factors therein.

The Heterotrait-Monotrait Ratio (HTMT) plays a pivotal role in the evaluation of discriminant validity, a crucial aspect in the realm of structural equation modeling and latent variable analysis. The distinctiveness of the constructs under examination is maintained by discriminant validity to mitigate excessive correlation, thereby averting ambiguity in the interpretation of their relationships. The HTMT is particularly valuable in this context as it offers a systematic approach to comparing the relationships between different constructs.

To effectively utilize the HTMT, it is essential to focus on traits that are closely related or proximate. This proximity ensures that the comparison is meaningful and can reveal

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genuine differences between constructs. When traits are too dissimilar, the results obtained may lack relevance or may be trivial, as the comparison becomes less informative. Therefore, the researcher must exercise discretion in selecting traits for comparison, considering their theoretical relevance and conceptual closeness.

Visual inspection of the HTMT results can provide additional insights. In the context of this study, a discernible pattern emerges, resembling that of normal distributions. This observation is significant as it suggests that the relationships between traits are structured in a way that aligns with expected statistical patterns. The visual assessment reinforces the quantitative analysis, providing a comprehensive understanding of the discriminant validity relationships within the model.

The HTMT criterion in this study yields a value below 0.90, indicating the successful establishment of discriminant validity. This threshold is commonly accepted in the literature, signifying that the constructs being measured are sufficiently distinct from each other. As a result, the research forms a model that can extract information and reliable hypothesis based on the variables and the unobserved elements. The robust discriminant validity enhances the credibility of the findings, allowing for more accurate interpretations of the relationships between different constructs in the structural equation model.

IV. Conclusion

The significant role of operatives in moderating the expansion of gas distribution networks is underscored by the outcomes of this research, as indicated by a coefficient of 0.302. This suggests that a one-unit increase in moderating variables is associated with a 30.2% increase in the number of gas distribution networks, thereby demonstrating a positive and statistically significant impact. Similarly, the impact of internal corporate costs on the growth of the gas distribution networks is moderated by the operatives, with a coefficient of 0.295. This suggests that a single increase in moderating variables results in a 29.5% increase in gas distribution networks, once again highlighting a positive and significant influence.

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