Effect of production strategies on the performance of public water service provider firms in the Western Region, Kenya

Faith Nangami Makali[1]
Robert K. W. Egessa[2]
Jackline Odero[3]

[1] makalifaith210@gmail.com
[2] regessa@mmust.ac.ke
[3] jakoth@mmust.ac.ke

[1,2,3] Masinde Muliro University of Science and Technology, Kenya

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ABSTRACT

Production strategy is a critical aspect of the operational and financial sustainability of public water utilities, as the quality control of these water utilities, loss prevention, and security of infrastructure have a direct impact on service reliability and the value that can be derived from treated water. This study examined the effect of production strategies on the performance of public water service provider firms in Western Kenya. The study was guided by the product life cycle theory. The study was causal-explanatory and involved five public water service providers in Bungoma, Busia, Vihiga, Kakamega, and Trans-Nzoia. The sample consisted of 89 usable questionnaires out of 90, which gave a 98.9% response rate, with stratified random sampling and purposive sampling used to select the sample. The target population comprised employees of the five selected public water service provider firms drawn from production, customer service, human resource management, and different management levels. The data were collected by a structured questionnaire on a five-point Likert scale. The production-strategy scale had an acceptable internal consistency (Cronbach's alpha = .798). Descriptive statistics and simple linear regression were used for analysis. Respondents consistently reported that water quality testing, traceability of quality indicators, risk identification, infrastructure security, and timely repairs were being practiced, but risk reporting and evaluation were relatively underdeveloped. Regression results showed that production strategies had a positive and statistically significant effect on organizational performance (B = .268, beta = .341, t = 2.761, p = .008), with the model explaining 11.6% of the variation in performance (R^2 = .116). The study findings show that stronger production practices that are stronger will lead to better utility performance, but in parallel with other organizational determinants. Water service providers need to enhance their ongoing water quality monitoring, water loss control, preventative maintenance, rapid repair, and security of critical water infrastructure.

Keywords: Non-Revenue Water; Organizational Performance; Production Strategies; Public Water Service Providers; Water Quality; Western Kenya

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I. INTRODUCTION

The production system of the public water service providers is such that the quality of water produced is linked to the performance of the organization. Unlike companies that can delay production or remove a poor product, a water utility has to keep pumping water, cleaning up the water, carrying water, storing water, and delivering water to users, all of which are necessary to the lives of households, institutions, and businesses. Production strategy is thus related to the organization of scarce physical, technical, and financial resources to produce water reliably and safely. These choices have a direct effect on the continuity of services and financial results in this environment when considering issues such as quality assurance, loss control, maintenance, repair speed, and asset protection. Production strategy therefore offers an operational link between the technical capacity of the infrastructure and the expected performance of the public utility.

The regulatory framework in Kenya has a focus on operational indicators in assessing utility performance. The Water Services Regulatory Board assesses water service providers based on water quality, non-revenue water, hours of supply, water metering, water coverage, financial indicators, and water service indicators (Water Services Regulatory Board [WASREB], 2026). This regulatory approach is based on the proximity of the production process and its results to the actual customer. A provider may have sufficient treatment capability and may be losing a lot of water due to leakage, illegal connections, leaky pipes, or repairs that are done late but still do not perform well. Systematic monitoring and asset management can lead to better production input-to-dependable service-and-revenue conversion, which renders production strategy a relevant production organization performance variable.

The evidence also indicates that technical inefficiencies can have negative spillover effects on financial and customer results in Kenya. Non-revenue water showed a negative correlation with water-supply coverage and utility viability, and poor technical performance was correlated with low financial and customer-service performance (Otieno & Kasuki, 2022). Earlier evidence from a water provider in Vihiga County likewise identified high non-revenue water, low metering, high operation and maintenance costs, inadequate funding, and service-quality problems as constraints on sustainability (Kanda et al., 2018). These results suggest that production management should be viewed and integrated as a coordinated process and not as a set of engineering jobs. The strategic problem is how the production practices work together to create organizational performance.

For the present study, production strategy is defined as an integrated approach to water quality, prevention of water losses, and strengthening of the security of water infrastructure. The quality of water is a reflection of the quality of testing, chemical control, and tracking of important indicators. Loss prevention is related to the detection and mitigation of operational risks that can decrease water usage or billability. Infrastructure security includes safeguarding sensitive infrastructure in addition to repair timeliness and quality. The dimensions capture the measurement and operational logic of a public water utility, where the production of safe water must be kept protected from preventable loss and maintained with secure and functional assets. These production strategies are expected to impact revenue growth, customer-base growth, and customer satisfaction.

This article isolates the production-strategy component of a wider study of functional strategies among public water service providers in Western Kenya. This more limited approach has an analytical value, as production decisions can be looked at independently of organizational performance and customer-focus/human resource practices. It also enables the study to make a more direct message to utility managers related to treatment plants, distribution networks, maintenance, risk management, and infrastructure protection. The article focuses on one functional domain and examines whether there are differences in how the production-intervention strategies are implemented in the providers sampled that are statistically associated with performance and which of the operational practices are more or less effective within the providers. The findings can be used to inform specific management and policy interventions.

1.1 Statement of the Problem

Western Kenya is experiencing longstanding technical and organizational challenges that affect public water service providers and compromise service reliability and financial sustainability. Insufficient monitoring, physical losses, commercial unaccounted-for water, and infrastructure failure interruptions lower the value of the production resources. Kanda et al. (2018) noted technical and economic challenges in a Vihiga-based provider, such as high non-revenue water and low cost recovery. Recent Kenyan data also reveal that unreliable supply, aging pipes, and infrastructure coverage are ongoing water-security constraints (Ogaro et al., 2024). The conditions imply a practical need to ascertain if there is any meaningful association between production-management practices and organizational performance for providers in western Kenya.

Production and operations research typically associates structured processes, continuous improvement, and resource efficiency with improved firm performance, but water services have unique traits. Water is a critical service, which is delivered by capital-intensive networks, and after treatment, the production can be compromised due to leakage, damage to infrastructure, slow response to leakages, and weak operational control. Kenyan research has often focused on non-revenue water, utility viability, or specific technical constraints independently (Chea & Kidere, 2023; Otieno & Kasuki, 2022). This leaves only a small part of the evidence about water quality, loss prevention, and infrastructure security as an integrated construct and a direct link to Western Kenyan organizations’ performance.

1.2 Research Objective

The objective of the study was to determine the effect of production strategies on the performance of public water service provider firms in Western Kenya.

1.3 Research Hypothesis

H02: Production strategies have no statistically significant effect on the performance of public water service provider firms in Western Kenya.

II. LITERATURE REVIEW

2.1 Theoretical Framework: Product Life Cycle Theory

The product life cycle theory was the main theory guiding the study based on the original research framework. The theory suggests that products progress through development, introduction, growth, maturity, and decline stages and that the strategic needs vary for each stage (Kotler & Armstrong, 2006). Vernon (1966) also associated the evolution of products with changes in demand, standardization, production location, and competitive environment. In relation to production strategy, this perspective proposes that organizations cannot deal with outputs and processes as static systems. They have to adapt their production processes, quality assurance, resource use, and assets in response to evolving conditions. This is applicable to water suppliers that are constantly upgrading, maintaining, and renewing their production and distribution infrastructure.

A public water supply is a water supply system, and a life cycle approach is best understood as a production process and infrastructure life cycle rather than a market life cycle for water. Treatment technologies, pumps, meters, transmission lines, storage facilities, and distribution networks pass through the installation, stable operation, deterioration, rehabilitation, and replacement phases. In these phases, managers need to maintain the quality of the output and manage the escalating threat of losing production and service. Preventive maintenance, quality monitoring, timely repairs, and infrastructure security can therefore help to prolong the useful life and productivity of utility assets. The theory is used to back up the hypothesis that reliability, efficiency, customer confidence, and organizational performance should be enhanced if production practices are designed to match the changing asset condition.

Product life cycle theory, however, does not apply to an essential public service without its own limitations. Dhalla and Yuspeh (1976) warned that identification of life cycle stages may be problematic and life cycle stages may lead to a managerial focus that is too deterministic. Water demand is also not like the demand for a discretionary consumer product, as the service is socially required over time. The theory is therefore applied here as a lens for organizing, rather than as a portrayal of market phases to predict. Its contribution is to emphasize systematic process renewal and adaptation. The empirical study continues to focus on observable production practices, including quality management, loss prevention, and infrastructure security, and examines the relationship between observable production practices and performance at the sampled production facilities.

2.2 Empirical Review

Empirical evidence on water quality indicates that production performance is linked to operational control and management of service quality. In a case study of a water service provider in Vihiga County, Kanda et al. (2018) listed service-quality issues, production capacity issues, financial constraints, and high operation and maintenance costs as sustainability challenges. The study presents relevant evidence from Western Kenya but did not test water quality within an integrated production-strategy construct, only on one provider. This leaves gaps in the contextual and methodological dimensions related to how water-quality management supports the level of organizational performance among several public water service providers.

Empirical evidence provided by studies on water loss prevention is stronger. A study by Mutikanga et al. (2009) identified illegal connections, meter problems, weak data systems, and limited resources as major challenges to water-loss management in developing-country utilities. Research by Mutikanga et al. (2011) further showed that loss-reduction options can be prioritized using technical, economic, public-health, environmental, and social considerations. In Kenya, Chea and Kidere (2023) found inconsistent implementation of non-revenue-water reduction strategies and emphasized improved resource allocation, technology, and organizational arrangements. These studies together provide support for strategic loss prevention, though they do not explore the combined impact on organizational performance of strategic loss prevention, water quality, and infrastructure security.

There is limited evidence with respect to infrastructure security and reliability. Kanda et al. (2018) noted constraints on production, high maintenance expenses, and service-quality issues that can negatively impact the reliability of water services. More recent evidence suggests technology can support infrastructure monitoring efforts. According to Obunga et al. (2025), Internet of Things solutions can be used for leak detection, monitoring, and operational decision-making, and Silva et al. (2025) demonstrated that integration of flow and consumption data can assist in identifying the non-revenue water components. While these studies illustrate the significance of infrastructure monitoring, they offer little direct evidence concerning the security of physical infrastructure, the ability to repair it quickly, and the connection between physical infrastructure security and organizational performance among utilities.

Additional support for the current objective comes from research on technical operations and organizational performance. Research by Otieno and Kasuki (2022) showed that non-revenue water was inversely related to water-supply coverage and utility viability, and low technical performance was linked to poor financial and customer-service results. Also, Santos (2024) correlated water losses with the economic sustainability of the utilities. The results indicate that the production processes can have an impact on the results beyond the engineering function, such as financial viability and customer experience. Most previous studies, however, have focused on water quality or loss prevention indicators or on infrastructure security indicators alone, instead of a multidimensional production-strategy construct that is being implemented in the field.

The reviewed studies agree that effective operational control, water-loss reduction, monitoring, maintenance, and service-quality management are important to water-utility performance. However, there are methodological and contextual differences in the literature as well. Some studies are based on case studies, while others focus on technical indicators, technology, or non-revenue water as an individual. There is limited evidence specific to public water service providers from Western Kenya, and few studies examine an integrated production-strategy construct against revenue growth, customer-base growth, and customer satisfaction. This empirical gap is the aim of the present study, which tests the impact of production strategies on organizational performance in five firms operating in the public water service sector.

III. METHODOLOGY

3.1 Research Design

The study used a causal-explanatory research design that focused on the influence of production strategies on the performance of public water service provider firms in Western Kenya. The design was suitable because the study tried to find out if there was any relationship between the variation in the practices of production strategies and the variation in organizational performance. The respondents provided quantitative data, which were analyzed using descriptive and inferential statistics. Since the study was not experimental, as data were obtained with observation questionnaires, it was feasible to explain the hypothesized relationship, and the researcher could determine the direction and statistical significance of the association.

3.2 Study Area

The study was conducted among five public water service providers in Western Kenya, which include Bungoma Water and Sewerage Company Ltd, Busia Water and Sewerage Services Company Ltd, Vihiga Water Services Company Ltd, Kakamega County Water and Sanitation Company, and Trans-Nzoia Water and Sanitation Company. These companies are in counties where water production, distribution, maintenance, water loss control, and infrastructure protection are critical to service delivery and organizational sustainability. The study area was suitable because it offered the opportunity for the study of production-strategy practices in a multi-firm environment, rather than restricting analysis to data from a single water provider.

3.3 Target Population

The target population consisted of employees of the five selected public water service provider firms in Western Kenya. The respondents belonged to three functional areas of the organization, which entail customer service, production, and human resource management, and the three levels of management that involved junior, middle, and senior. The categories were deemed to be relevant since the production strategy influences the technical operation and operational performance of the organization, which necessitates information from those involved in the operation in a diversity of roles. The production-oriented analysis included respondents' evaluation of water quality practices, loss prevention activities, infrastructure security, infrastructure repair performance, and organizational performance.

3.4 Sampling and sample size

A sample of 90 respondents was drawn, with 18 respondents from each of the five water service providers and six respondents from each of the three functional sections within each provider. Stratified random sampling was used to ensure that the sample was representative of organizational levels and functional areas. Managing directors and chief executive officers were selected by purposive sampling, as they have strategic knowledge of the firm's operations and performance. Questionnaires were sent to the selected respondents, and a total of 89 (98.9%) questionnaires were returned. The high response rate ensured good coverage of the targeted sample and limited non-response issues.

3.5 Data Collection Instruments and Procedures

The primary data were obtained from a self-administered structured questionnaire with five-point Likert scales. The five-point Likert scale was suitable since it allowed respondents to indicate the degree of their agreement with each statement in a consistent and quantifiable manner. The production-strategy scale comprised six items covering water-quality testing and chemical monitoring, traceability of water-quality indicators, operational-risk identification, risk reporting and evaluation, security of sensitive infrastructure, and the speed and quality of repairs. Organizational performance was assessed using items relating to revenue growth, customer-base growth, and customer satisfaction. A pilot study involving nine employees was conducted in the Lake Victoria South Water Works Development Agency environment, which had characteristics similar to the study setting. The content validity was enhanced by the expert review prior to the main data collection exercise.

3.6 Data Analysis

Descriptive and regression statistics were used for analyzing the data. These were suitable methods since descriptive statistics illustrated the pattern of responses and regression analysis revealed the impact of production strategy on organizational performance. Frequencies, percentages, means, and standard deviations were used to summarize responses to the production-strategy indicators. Cronbach's alpha was used to determine the internal consistency. The production-strategy scale obtained an alpha coefficient of .798 and the organizational-performance scale an alpha coefficient of .835, which were considered acceptable for analysis. Simple linear regression was used to test the effect of production strategy on organizational performance using the model $Y = a + bX + e$. Model fit was assessed using R and R^2, while statistical significance was evaluated using the F statistic and p-values at the $\alpha = .05$ level.

3.7 Ethical Considerations

Ethical considerations were followed during the study. Before the data collection, the research was conducted in accordance with the approval procedures of the institutions and the national research regulations. Participation was voluntary, and the respondents were given information on the purpose of the study before completing the questionnaire. Confidentiality was adhered to by ensuring that information provided by participants was kept confidential and used in relation to the research purpose only. The anonymity of the respondents was also preserved, and a specific person was not identified in the presentation of the results. The purpose of these safeguards was to prevent unnecessary disclosure of information to participants, facilitate informed participation of participants, and ensure responsible collection, analysis, and reporting of data.

IV. FINDINGS & DISCUSSION

4.1 Findings

A total of 90 questionnaires were distributed, with usable responses received from 89, or 98.9% of the population, as indicated in Table 1. The production-strategy scale had an acceptable Cronbach's alpha of .798, and the organizational-performance scale was found to have an alpha of .835 (Table 2). The results suggest that the items within each construct measured related aspects of the variable, and the internal consistency of the items was acceptable. Broad coverage of the planned sample across the five firms and a high response rate were also obtained. The descriptive statistics of the six production-strategy indicators are shown in Table 3.

Table 1

Questionnaire Response Rate

Questionnaire Status	Count (n)	Percentage (%)
Distributed Questionnaires	90	100.0%
Returned & Usable Questionnaires	89	98.9%
Non-Response / Unusable	1	1.1%

Table 2

Reliability Analysis of Measurement Scales

Variable / Scale	Number of Items	Cronbach's Alpha	Internal Consistency Result
Production Strategies	6	.798	Acceptable
Organizational Performance	5	.835	Good

Table 3

Descriptive results for production-strategy indicators (n = 89)

Production-strategy indicator	Disagree/Strongly disagree. n (%)	Fairly agree. n (%)	Agree/Strongly agree. n (%)	Mean (SD)
Water-quality testing and chemical monitoring	7 (7.9)	33 (37.1)	49 (55.1)	3.48 (0.80)
Traceability of water-quality indicators	10 (11.2)	31 (34.8)	48 (53.9)	3.46 (0.87)
Operational risk identification	1 (1.1)	40 (44.9)	48 (53.9)	3.62 (0.67)
Risk reporting, evaluation, and action	16 (18.0)	31 (34.8)	42 (47.2)	3.30 (0.90)
Security of sensitive water infrastructure	3 (3.4)	39 (43.8)	47 (52.8)	3.57 (0.78)
Speed and quality of repairs	7 (7.9)	31 (34.8)	51 (57.3)	3.53 (0.83)

Note. Response categories are combined for compact presentation. Percentages and mean/SD were calculated from the 89 valid response frequencies reported in the field data. Source: Field data (2025).

Overall, there is a pattern of generally favorable assessments but some variation in the degree of agreement in the quality control, risk management, infrastructure security, and repair categories.

Moderately positive ratings were given to water-quality management. A total of 55.1% agreed or strongly agreed about the need to perform adequate water-quality testing and monitoring or to justify the use of chemicals, 37.1% fairly agreed, and 7.9% disagreed. The mean score was 3.48 (SD = .80). Similarly, 53.9% agreed or strongly agreed that the company ensured traceability of relevant water-quality indicators, with a mean of 3.46 (SD = .87). The findings indicate that overall, basic quality control systems were in place but not consistently strong. Documented traceability and continuous monitoring remain critical since water quality failure can impact the performance of water quality regulation and customer confidence.

The production dimensions were stronger in identifying risks and security of infrastructure. When asked about their organization identifying risks that could negatively impact operations, 53.9% agreed or strongly agreed with the statement and 1.1% disagreed, with the highest mean of the six items being 3.62 (SD = .67). Concerning security of sensitive water infrastructure, there was general agreement, with 52.8% agreeing or strongly agreeing, 43.8% fairly agreeing, and 3.4% disagreeing (mean = 3.57, SD = .78). The results indicate general awareness of the vulnerability of operations and asset protection. They are consistent with strategic water-loss approaches that focus on risk-based prioritization of interventions, not on purely reactive maintenance (Mutikanga et al., 2011).

Reporting, evaluation, and treatment of identified risks were the weakest. Although 47.2% agreed or strongly agreed that identified risks were reported, evaluated, and addressed, 18.0% disagreed and 34.8% fairly agreed; the mean was 3.30 (SD = .90), the lowest of all production indicators. This gap is key because identifying risks without a consistent and documented evaluation and corrective action is not valuable. This outcome indicates a potential disconnect in implementation from recognizing operational threats to closing the management loop. It is advisable to implement clear escalation, accountability, documentation, and follow-up systems in the production strategy so that identified risks lead to production decisions regarding maintenance, security, or production control.

The mean score on the repair performance was 3.53 (SD = .83), and a majority of respondents (57.3%) agreed or strongly agreed that this company's speed and quality of repairs contributed to water security. Effective and efficient solutions can minimize physical losses, minimize service outages, and prevent small issues from becoming costly infrastructure issues. This result aligns with the Kenyan evidence, which demonstrates that to reduce non-revenue water, adequate resources, technology, and organizational arrangements are required (Chea & Kidere, 2023). The descriptive findings suggest that there were some production controls in place; however, a more consistent approach was required regarding risk reporting and in converting identified production concerns to documented corrective action.

To test the descriptive pattern, simple linear regression was used, in which the descriptive pattern was found to have a statistically significant relationship to organizational performance. As shown in Table 4, production strategy was positively associated with performance ($R = .341$) and explained 11.6% of the observed variation in the performance composite ($R^2 = .116$; adjusted $R^2 = .101$). The overall model was significant, $F(1, 87) = 7.623$, $p = .008$. The unstandardized production-strategy coefficient was $B = .268$ ($SE = .097$), with a standardized coefficient of beta = .341, $t = 2.761$, and $p = .008$. The estimated regression equation was Performance = 2.744 + .268 (Production Strategy).

The coefficient shows that organizational-performance scores were higher with higher production-strategy scores. The null hypothesis was rejected due to a p-value of .008 being less than .05. The R^2 of .116 also indicates, however, that production strategy is no more than a part of performance and that 88.4% of the variation observed was due to factors not included in this simple model. This is of significance in terms of substance. The issues of water quality, loss prevention, and infrastructure security are important, but the performance is also greatly influenced by the financial aspects, customer management, workforce capacity, governance, tariffs, demand, and external operating conditions. The findings support investment in production strategy while cautioning against treating technical operations as a complete explanation of organizational performance.

The discovery supports evidence from the water sector, which suggests a link between technical performance and financial viability and customer outcomes. Otieno and Kasuki (2022) found that non-revenue water was negatively related to utility viability and coverage, while Santos (2024) similarly emphasizes the economic consequences of water loss. The use of finer-grained flow and metering data improves the ability to classify the non-revenue-water components, as demonstrated by Silva et al. (2025), while connected monitoring technologies offer operational benefits, as pointed out by Obunga et al. (2025). This result is extended in the present case to include value added in terms of water-quality control and infrastructure security in addition to loss prevention, meaning that coordinated production management can create even more value for the organization in terms of reliability, retained billable water, and customer confidence.

Table 4
Simple linear regression of organizational performance on production strategy

Term/statistic	B	SE	β / R^2	T / F	p
Model fit			.116	F (1, 87) = 7.623	.008
Constant	2.744	.346	—	7.927	< .001
Production strategies	.268	.097	.341	2.761	.008

Note. R = .341; adjusted R^2 = .101; standard error of estimate = .52216. Dependent variable: organizational performance. Source: Field data (2025).

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The study concludes that production strategies have a positive and statistically significant relationship with the performance of public water service provider firms in Western Kenya. The operating conditions that enable revenue growth, customer-base growth, and customer satisfaction are provided by a combination of water-quality control, loss-prevention practices, risk identification, infrastructure security, and repair capability. The regression coefficient was significant and positive, and the null hypothesis was rejected. Descriptive evidence also indicated that most production practices were generally in place, with less consistent reporting of risks and their subsequent assessment and follow-up. The results thus validate that operational strategy is an organizational performance question and not just a technical challenge for water utilities.

The study reveals that production strategy is a significant but partial variable that affects performance. The amount of variance in organizational performance explained by the model was 11.6%, suggesting that other functional, governance, market and institutional conditions are also influential. In practice, this means that utilities need to enhance their production systems while maintaining close links with finance, customer service, human resources and corporate governance. The product life cycle perspective underscores the importance of ongoing process improvement and asset replacement due to the ageing of the process and infrastructure and changing operating conditions. For sustainable performance, it is essential to keep production safe, manage losses that can be avoided, ensure protection of critical assets, and incorporate these activities in the larger picture of strategic management.

5.2 Recommendations

Public water service provider companies have to institutionalize production-strategy controls on four priorities. First, water-quality testing and chemical-control procedures should be scheduled, documented, traceable, and reviewed to meet regulatory requirements. Second, non-revenue-water programs must integrate water balancing, leak identification, meter improvements, pressure control, control of illegal connections, and quick corrective action. Third, critical infrastructure should be protected by means of preventive maintenance plans, physical security measures, asset registers, and risk-based plans for renewing assets. Fourth, the comparatively poor quality of the risk reporting should be tackled on a formalized basis by means of formal registers, assigned risk owners, escalation timeframes, and documented closure of corrective actions. These measures can be transformed into uniform performance improvements.

Managers and policymakers should also look to production indicators as a component of an integrated approach to utility performance management, instead of as standalone technical statistics. Interventions that benefit water quality, lower physical and commercial costs, maintain services, and enhance financial sustainability should be prioritized for investment decisions. WASREB benchmarking is helpful in this process by providing similar operational targets and sector performance data. Future research studies should examine the impact of production strategy enhancements on revenue, coverage, and customer outcomes using financial records, objective technical metrics, and a longitudinal utility record to test the hypothesis that production strategy enhancements come before financial performance and customer outcomes. Comparing governance models, adoption of technology, utility size, and funding capacity across regions could also determine if there is a moderating effect on the production strategy-performance relationship observed in western Kenya.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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