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Sustainable Healthcare System Devolution Strategy Selection Using the AROMAN MCDM Approach

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ABSTRACT

The social pillar strategy has various components, including education, science and technology, and health. Health care in Kenya is now a devolved function under county governments. This study aims to establish the challenges facing the implementation of the social pillar strategy of the Kenya Vision 2030 in the devolved health sector in Kisumu County. In addition, the study aims to determine the strategies being put in place to address these challenges. The data used in this study are obtained by consulting experts in the considered field. The experts use a one-to-seven-point scale to determine criteria weights, while the Alternative Ranking Order Method Accounting for Two-Step Normalization (AROMAN) is applied to rank the strategies. While the most critical issues are insufficient human resources for health, deteriorated health infrastructure, and shortage of pharmaceuticals and non-pharmaceuticals, the alternatives to consider are increasing investment in information communication technology (ICT), developing leadership through continuous learning, and enhancing investments in human resources and health infrastructure. To test the stability of the AROMAN method, the authors conduct a sensitivity analysis. This research not only identifies and explains the challenges associated with the establishment of sustainable healthcare devolution in Kisumu County but also significantly contributes to the body of knowledge by outlining and prioritizing the strategies required to address these challenges.

1. Introduction

Implementing a strategy is the most significant challenge in strategic management. A brilliant strategy doesn’t guarantee success; implementation is tougher than formulation. On average, there

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is over 60% realized performance with less than 40% loss [1]. Frequently, over 60% of organizational strategies go unimplemented [2]. Reasons include deficient resources, bad leadership, communication issues, unclear accountability, and absence of motivation [3]. Each organization faces unique challenges, so tailored solutions are essential.

The social pillar of Kenya Vision 2030 seeks a just and unified society, with healthcare devolved to the 47 counties. Devolution involves transferring political, administrative, and fiscal powers. Global evidence suggests varied impacts on governance. Locally, devolving healthcare poses challenges: absence of experience, inadequate coordination, poor budgets, delayed payments, strikes, no human resource policy, and weak leadership [4]. Kisumu County stands out with high poverty, youth unemployment, collapsed industries, a substantial disease burden, and insufficient health infrastructure [5]. Despite the Kenya Health Sector Strategic Plan (KHSSP) 2013-2017 aiming for a significant reduction in maternal and child mortality, Kisumu faces high rates of infant, child, and maternal mortality. It also grapples with low immunization and contraceptive coverage [6].

Numerous studies have examined challenges in implementing strategies [7-9], with none specifically addressing issues in the decentralized health sector. Kisumu County faces challenges in implementing the KHSSP 2013-2017. Kilonzi and Ndungu [8] are the sole contributors addressing health sector devolution challenges in Kisumu County, but without proposing strategies to overcome them. To address these limitations, tackling health sector devolution for sustainable development requires a comprehensive managerial perspective, explicitly considering multiple criteria for better decision outcomes [10-15]. Multi-criteria decision-making (MCDM) techniques, adept at handling complex problems and diverse criteria, are well-suited for this purpose [16-21].

This study aims to identify effective strategies for addressing challenges in the sustainable devolution of the healthcare system in Kisumu County. It recognizes eight challenges, proposes a guiding framework, and employs the AROMAN methodology. The goal is to achieve sustainable healthcare system devolution by assigning varied weights to different criteria. The AROMAN method presents several advantages compared to other alternative ranking methods. These include: (i) facilitating both quantitative and qualitative assessment of alternatives, (ii) incorporating two distinct normalization processes for enhanced robustness and sensitivity analysis, (iii) providing a simple and practical alternative ranking technique without intricate computations, and (iv) allowing differentiation between cost and benefit-based criteria evaluations. This study contributes to: (i) Identifying challenges to sustainable healthcare system devolution through a comprehensive literature review, (ii) Ranking the relevance of criteria using expert interviews via a 7-point Likert scale, and (iii) Introducing the AROMAN method to the healthcare sector for the first time in the literature.

The rest of the paper is organized as follows: Section 2 is the literature review. Section 3 is the problem definition. In Section 4, the methodology. Section 5 is the application of the case study. Section 6 is the sensitivity analysis. Section 7 discusses the findings and discussion. Section 8 presents the managerial implications while Section 9 concludes the paper and gives future directions.

2. Literature Review

This section investigates the scientific literature in the field of healthcare sector devolution as well as the application of MCDM techniques to the healthcare sector.

2.1 Overview of Approaches related to Healthcare Sector Devolution

In Africa, healthcare system research, particularly focusing on devolution, has been conducted in various countries. For instance, Hendricks *et al.,* [22] investigated various approaches to implement a unified decentralization system designed to meet the health requirements of the community. Eboreime *et al.,* [23] examined how effectively a unified main healthcare governance policy was put into practice. Gadisa [24] discussed devolution and health sector reform. Boex *et al.,* [25] enhanced their comprehension of the distribution of public health resources from the district level to main health infrastructures. Sumah and Baatiema [26] aimed to assess how decentralization practices transfer managerial autonomy to subnational units. Inkoom and Gyapong [27] explored the decentralization of healthcare delivery systems in specific African contexts. Masaba *et al.,* [28] examined the developments and obstacles in Kenya's decentralized healthcare system. Wanzala and Oloo [29] investigated the decentralized governance of health systems in study synthesizing evidence.

2.2 Implementation of MCDM Approaches in the Healthcare Sector

The healthcare and medical sectors significantly contribute to enhancing living standards and the quality of human life [30,31]. Decision-making in the healthcare sector is often challenging due to its complexity and profound impact on individual life quality [32-34]. These decisions primarily strive to optimize health advantages, reduce health risks, enhance patient choice, increase physical involvement, address resource constraints, and uphold principles of fairness and equity [35-37]. For instance, Debnath *et al.,* [38] introduced a supplier choice procedure for healthcare testing edifices. Khan Mohammadi *et al.,* [39] evaluated service quality in hospitals. Akter *et al.,* [40] examined key risk factors affecting the supply chain of emergency life-saving drugs. Chakraborty *et al.,* [41] utilized an approach to address healthcare supplier selection issues. Ecer and Pamucar [42] determined the priority ranking of insurance enterprises in healthcare services. Torkayesh *et al.,* [43] assigned weights to healthcare parameters and assessed the healthcare performances of different countries. Yazdani *et al.,* [44] used an approach for deciding healthcare waste disposal areas. Puška *et al.,* [45] recommended a model for selecting incinerators to address healthcare waste. Pamučar *et al.,* [46] studied the selection of an efficient treatment for managing healthcare waste. Mishra *et al.,* [47] dealt with assessing healthcare in hazardous waste recycling. Pamucar *et al.,* [48] handled supplier choice during the COVID-19 pandemic. Shih *et al.,* [49] developed a strategy for platelet inventory management within the blood supply chain. Tavana *et al.,* [50] introduced a framework for assessing the performance of medical equipment suppliers. Table A1 in appendix provides an overview of MCDM approaches in the healthcare sector.

3. Problem Definition

This section defines the problem of sustainable healthcare system devolution.

Table A2 in appendix contains the definitions corresponding to the eight alternatives identified in Figure 1.

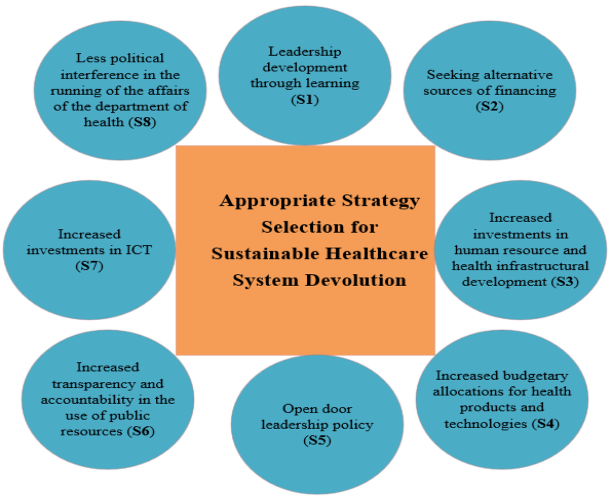

Fig. 1. Identified strategies for sustainable healthcare devolution

4. Methodology

In this research, the AROMAN method proposed by Bošković *et al.,* [51] and originally applied to the electric vehicle selection problem is used. The method can be described through the following phases [52]:

Step 1. In this phase, a decision-making matrix Y_{mxn} with the input data y_{11},..., $y_{2j}, \dots, y_{mn}$, is formulated (1):

$$Y = \begin{bmatrix} y_{11} & \cdots & y_{1j} & \cdots & y_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ y_{21} & \cdots & y_{2j} & \cdots & y_{2n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ y_{m1} & \cdots & y_{mj} & \cdots & y_{mn} \end{bmatrix}, i = 1,2, \dots, m, j = 1,2, \dots, \mathrm{n}. \tag{1}$$

Step 2. After defining the matrix of a decision-making problem, the second phase is to normalize the data. The AROMAN method combines two normalization techniques such as linear (2) and vector (3) and creates an aggregated normalized matrix (4).

$$P_{ij} = \frac{y_{ij} - \min_i y_{ij}}{\max_i y_{ij} - \min_i y_{ij}}, i = 1, 2, \dots, m;\ j = 1,2, \dots, n. \tag{2}$$

$$P_{ij}^{*} = \frac{y_{ij}}{\sqrt{\sum_{i=1}^{m} y_{ij}^2}}; i = 1, 2, \dots, m, j = 1, 2, \dots, n \tag{3}$$

$$P_{ij}^{norm} = \frac{\mu P_{ij} + (1-\mu) P_{ij}^{*}}{2}; i = 1,2, \dots, m;\ j = 1, 2, \dots, n. \tag{4}$$

where P_{ij}^{norm} denotes the aggregated averaged normalization. μ is a weighting factor varying from 0 to 1. In our case, the parameter μ is 0.5.

Step 3. This phase is computed by applying (5).

$$\widehat{P_{ij}} = W_{ij} \cdot P_{ij}^{norm}; i = 1,2, \dots, m;\ j = 1, 2, \dots, n. \tag{5}$$

Step 4. A sum of the normalized weighted values obtention. This can be computed by applying (6) and (7), respectively:

$$D_i = \sum_{j=1}^{n} \widehat{P_{ij}}^{(min)}; i = 1,2, \dots, m;\ j = 1, 2, \dots, n; \tag{6}$$

$$U_i = \sum_{j=1}^{n} \widehat{P_{ij}}^{(max)}; i = 1,2, \dots, m;\ j = 1, 2, \dots, n. \tag{7}$$

Step 5. Raise the obtained sum of $\mathbf{D_i}$ and $\mathbf{U_i}$ values to the degree of $\boldsymbol{\delta}$ and 1- $\boldsymbol{\delta}$, respectively.

$$D_i^{\wedge} = D_i^{\delta} = \left(\sum_{j=1}^{n} \widehat{P_{ij}}^{(min)}\right)^{\delta}; \tag{8}$$

$$U_i^{\wedge} = U_i^{1-\delta} = \left(\sum_{j=1}^{n} \widehat{P_{ij}}^{(max)}\right)^{1-\delta}. \tag{9}$$

where: δ is the coefficient degree structured between intervals 0 and 1.

Step 6. Calculate the difference between the values $\mathrm{U_i}^{\wedge}$ and $\mathrm{D_i}^{\wedge}$ and apply the final ranking equation S_i (10):

$$S_i = e^{(U_i^{\wedge} - D_i^{\wedge})} \tag{10}$$

5. Application of the AROMAN Method to Sustainable Healthcare System Devolution Strategy Selection

In this study, eight challenges linked to sustainable healthcare system devolution are identified, including human resources (C1), organizational structure (C2), central government financing (C3), leadership and governance (C4), health infrastructure (C5), political interference (C6), information and communication technology-ICT (C7), and pharmaceuticals and non-pharmaceuticals unavailability (C8). Correspondingly, eight strategies have been defined in Section 3. To ensure a reliable evaluation, five experts in the healthcare sector are consulted, with their background information detailed in Table A3 in the appendix.

5.1 Criteria Weights

Criteria are assessed on a one-to-seven-point scale, as outlined in Table 1. The calculated final weights are presented in Figure 2.

Table 1
Criteria assessment based on expert assessment

Crit.	E_1	E_2	E_3	E_4	E_5
C_1	6	5	7	6	7
C_2	3	6	3	4	4
C_3	6	7	6	6	5
C_4	3	6	4	5	6
C_5	5	7	6	6	7
C_6	7	5	7	7	3
C_7	4	6	5	5	3
C_8	6	7	6	6	6

As shown in Figure 2, the most crucial challenges for sustainable healthcare system devolution include insufficient human resources for health (C1), deteriorated health infrastructure (C5), and pharmaceuticals and non-pharmaceuticals unavailability (C8), each assigned a weight value of 0.145. Other criteria are ranked as follows: C3 > C6 > C4 > C7 > C2. The bureaucratic organization structure is the least significant criterion with a weight of 0.090.

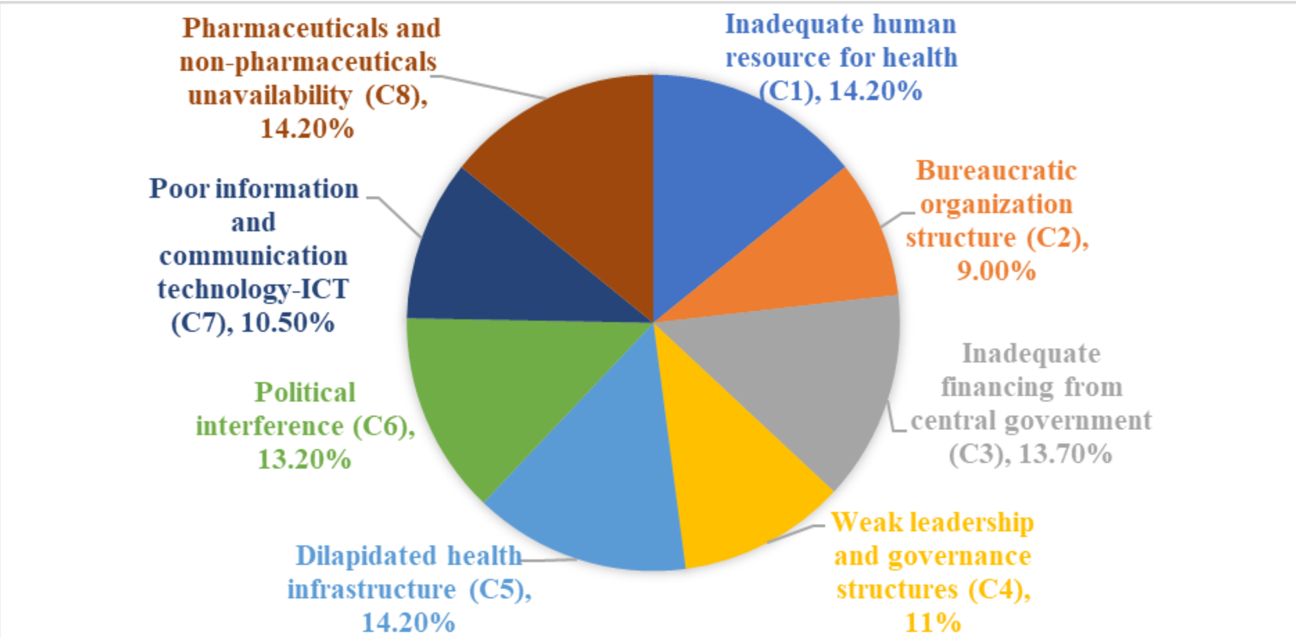

Fig. 2. Weights of criteria

5.2 Ranking Healthcare Strategy Devolution

The available options are measured against predefined criteria and evaluated using a scale ranging from one to seven points. The assessments provided by the five experts are provided in Table A4 in appendix. Utilizing the evaluations presented in Table A4, we have formulated the input-data matrix, which is depicted in Table 2.

Table 2
Initial decision-making matrix

Alt.	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
S_1	6	6	2.8	4.6	4.6	4.4	5	4
S_2	4	2.8	3.2	4	5.2	3.6	4.4	5.8
S_3	6.8	4.8	3.6	4.8	5.4	3.8	4	4.2
S_4	3.2	2.6	5.4	4.4	6.2	3.2	5	6.4
S_5	5.4	5.6	4.4	6.2	3	4.2	3.4	4
S_6	5.6	5	5.4	5.8	5.6	5.8	4.8	5.6
S_7	4.2	4.6	2.8	3.6	5.2	4	6.6	4.6
S_8	4.6	5.2	4.2	5.4	4.4	6	3.8	5.4

Following the establishment of the initial decision-making matrix, the subsequent step involved normalizing the input data. The resulting normalized values have been calculated and are presented in Tables A5 to A7 (see in appendix). The subsequent step involved multiplying the aggregated averaged normalized decision matrix by the criteria weights, as outlined in Table 3.

Table 3
Aggregated average weighted normalized matrix with summarized criterion types

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	L_i	A_i
S_1	0.0423	0.0331	0.0083	0.0196	0.0291	0.0257	0.0230	0.0099	0.0340	0.1569
S_2	0.0177	0.0061	0.0147	0.0121	0.0373	0.0141	0.0169	0.0409	0.0289	0.1309
S_3	0.0521	0.0230	0.0212	0.0221	0.0400	0.0170	0.0128	0.0133	0.0382	0.1633
S_4	0.0079	0.0044	0.0502	0.0171	0.0508	0.0084	0.0230	0.0512	0.0586	0.1544
S_5	0.0349	0.0297	0.0341	0.0396	0.0075	0.0228	0.0067	0.0099	0.0569	0.1282
S_6	0.0374	0.0247	0.0502	0.0346	0.0427	0.0459	0.0209	0.0374	0.0961	0.1977
S_7	0.0201	0.0213	0.0083	0.0071	0.0373	0.0199	0.0392	0.0202	0.0282	0.1452
S_8	0.0251	0.0263	0.0309	0.0296	0.0264	0.0488	0.0108	0.0340	0.0796	0.1522

With λ=0.5, the values of L_i and A_i are computed accordingly. The final ranking is then calculated, and the results are presented in Table 4 and Figure 3.

Table 4
L_i and A_i values, differences, and final rank

L_i	A_i	A_i-L_i	Rank
0.1843	0.3961	0.2118	1.2359
0.1699	0.3618	0.1919	1.2115
0.1955	0.4040	0.2086	1.2319
0.2420	0.3929	0.1509	1.1628
0.2385	0.3581	0.1196	1.1270
0.3100	0.4446	0.1346	1.1440
0.1679	0.3811	0.2132	1.2376
0.2822	0.3901	0.1079	1.1139

The obtained rank is S7> S1> S3> S2> S4> S6> S5> S8. The seventh strategy “S7-Increased investment in ICT”, the first strategy “S1-Leadership development through learning”, and the third strategy “S3-Increased investment in human resource and health infrastructural development” emerged as the top three appropriate strategies since they have the highest evaluation score, respectively.

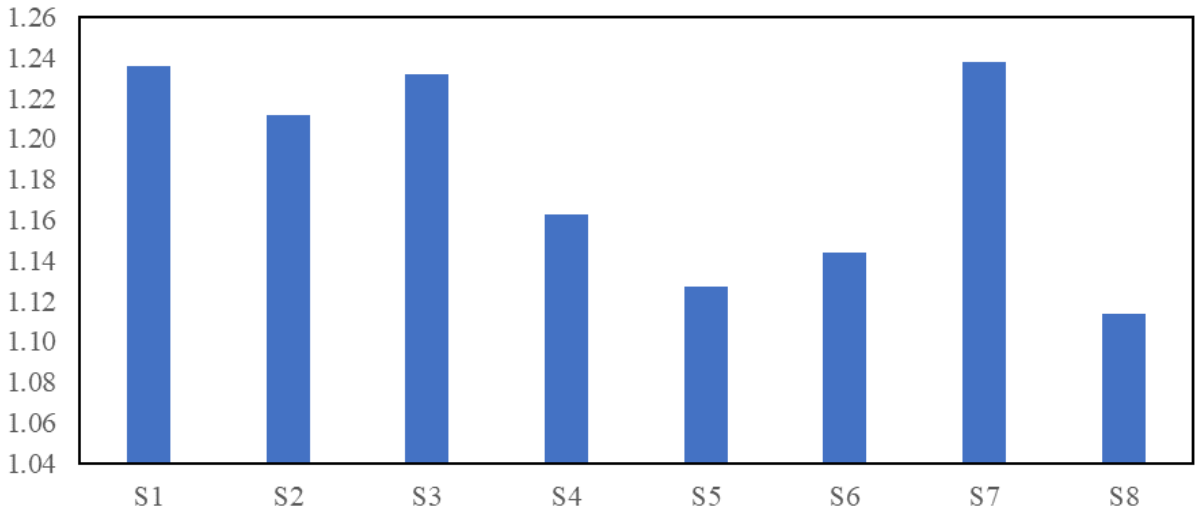

Fig. 3. Final rank of alternatives

6. Sensitivity Analysis

A sensitivity analysis was conducted, involving the incremental adjustment of the threshold value by 0.2, ranging from 0 to 1. The ultimate results are presented in Table 5.

Table 5
Sensitivity analysis results

λ	0	0.2	0.4	0.6	0.8	1
S_1	0.4304	0.7549	1.0732	1.4124	1.8657	2.6275
S_2	0.4193	0.7441	1.0545	1.3829	1.8353	2.6409
S_3	0.4331	0.7513	1.0684	1.4096	1.8636	2.6164
S_4	0.4293	0.7099	1.0045	1.3383	1.7948	2.5636
S_5	0.4182	0.6905	0.9743	1.2978	1.7545	2.5680
S_6	0.4483	0.7028	0.9863	1.3199	1.7674	2.4692
S_7	0.4254	0.7587	1.0771	1.4115	1.8632	2.6427
S_8	0.4283	0.6831	0.9605	1.2863	1.7404	2.5102

The results indicate that except for $\lambda=0$, where there is a slight variation in the ranking of alternatives, the overall ranking of alternatives remains consistent. A visual representation of alternative rankings is illustrated in Figure 4.

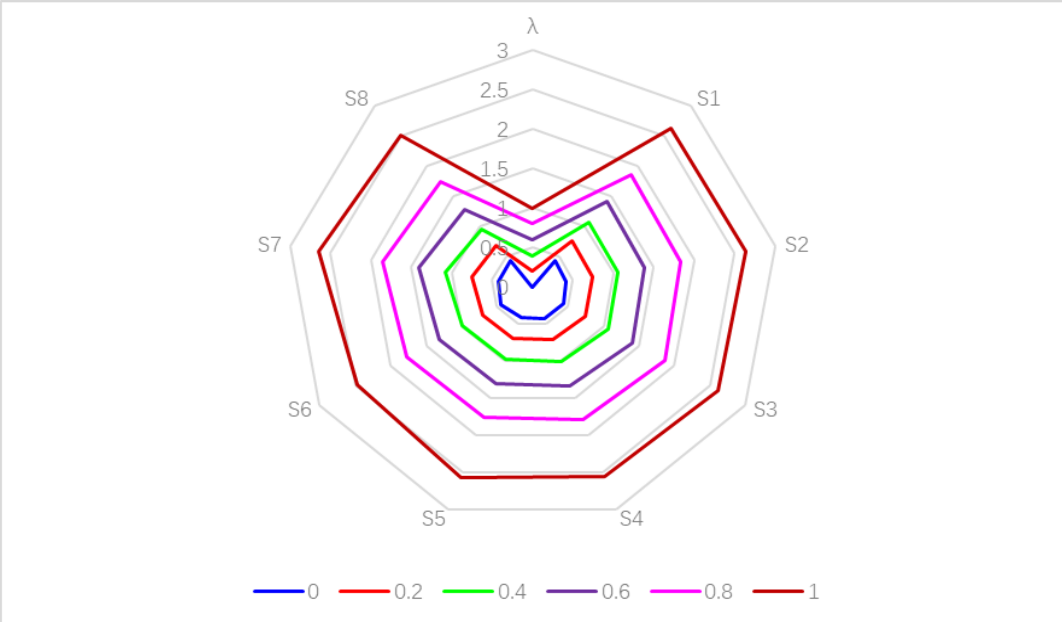

Fig. 4. Sensitivity analysis results

7. Findings and Discussions

After extensively reviewing existing literature and consulting with experts, it is apparent that several challenges are hindering the sustainable development of the healthcare system. Three primary obstacles have been identified, each with the potential to impede this development. To assess their significance, a one-to-seven-point scale was employed to establish criteria values.

Experts underscore the main challenge of insufficient human resources for health, in line with Nyawira *et al.,* [53], who identified a shortage of health workers impacting the health system's input mix. The scarcity of medical specialists has resulted in inappropriate task shifting, potentially affecting care quality and health outcomes negatively. Consequently, the Kisumu County government should strengthen the health workforce projection, ensure equitable distribution, and improve health information systems. For specialty improvement, revising specialist training entrance policies for increased capacity is recommended. Planning for heightened production and recruitment to support the health sector can reduce the workload on existing professionals. Establishing clear roles, responsibilities, and career pathways for each professional is essential for effective healthcare delivery.

The second critical challenge is deteriorated health infrastructure, in line with Awuonda [6] highlighting below-par health facilities in Kisumu County. The recommendation is for the county government to actively promote public-private partnerships (PPPs) to attract investments across various health service areas. Efforts should prioritize operationalizing malfunctioning facilities, expanding and upgrading existing ones, and constructing new facilities as needed. Judicious policies for effective equipment maintenance and procurement are essential. Establishing a functional transport management system for emergencies and addressing scarcities is crucial. Hospitals should acquire important equipment and dispose of inactive assets.

The third major issue involves the shortage of pharmaceuticals and non-pharmaceuticals, echoing the findings of Awuonda [6]. This scarcity in Kisumu County's health department is attributed to insufficient funds. Hospitals used to purchase these items using limited funds, with interviews indicating that they receive less than 50% of the required finances. To tackle this problem, it is suggested that the county explore alternative funding sources like donors and PPPs to address the financial shortfall.

Our methodology emphasizes key factors influencing the sustainable development of the health sector in Kisumu through devolution. It stresses the importance of increased investment in ICT, leadership development through continuous learning, and enhanced investments in human resources and health infrastructure. These findings stress the pivotal role of ICT systems in organizations for effective coordination and goal achievement. It is essential, firstly, to ensure the ICT department is well-equipped with necessary resources and interconnected across county departments and health facilities. Secondly, leaders should undergo high-level leadership training at renowned international institutions to enhance their competence. Finally, there is a need to develop human resource policies that improve service delivery efficiency, including strengthening supervision, recognizing performance, and collaborating with higher learning institutions for skilled workforce expansion and international exchange programs for specialized training.

8. Managerial Implications

This study is beneficial for policymakers in the Ministry of Health and Kisumu County government, providing valuable insights into challenges related to human resources, health infrastructure, and pharmaceutical availability. The suggested solutions offer practical guidance for addressing these issues, making it a pertinent resource for those involved in health policy decisions.

9. Conclusions and Future Recommendations

This study presents a method for determining the optimal strategy for implementing a sustainable healthcare system devolution, employing the AROMAN methodology. The practical utilization of this model was exemplified through a case study centered on Kisumu County. The outcomes revealed the primary challenges associated with healthcare system devolution, highlighting the top three. Furthermore, the research pinpointed the three most influential strategies based on the obtained findings.

The research offers two significant contributions. First, it introduces a framework specifically crafted to tackle the challenges associated with sustainable healthcare system devolution. Second, it contributes to scientific knowledge by pioneering the application of the AROMAN technique in the healthcare sector literature, particularly in the investigation of challenges related to sustainable healthcare system devolution in this specific geographic area.

Despite the noteworthy contributions of the study, it is essential to acknowledge its limitations. The proposed methodology lacks a comparative analysis with other multicriteria approaches specifically designed for addressing this issue. Additionally, it is crucial to note that the data collection process involved a restricted number of experts. Subsequent research endeavors should aim to address these limitations for a more comprehensive understanding of the subject.

The methodology and findings presented in this paper are crucial for policymakers at the Ministry of Health and the Kisumu County government. They offer a way to assess current challenges in healthcare system devolution. The results suggest that both entities should strengthen health workforce planning, ensure fair distribution, upgrade health information systems, activate inactive facilities, enhance existing ones, build new facilities as required, and explore alternative funding sources.

Appendix

Table A1
Applications of MCDM in the healthcare sector

Source	Focus	GDM	SA	Method
Debnath et al., [38]	Sustainable Supply choice for healthcare testing facilities	Yes	Yes	SWARA, WASPAS
KhanMohammadi, *et al.,* [39]	Healthcare service quality assessment	Yes	No	F-BWM
Akter *et al.,* [40]	Disruption risk factors assessment in the Emergency Life-Saving Drugs supply chains	Yes	Yes	G-DEMATEL
Chakraborty *et al.,* [41]	Healthcare supplier selection	Yes	No	MABAC
Ecer and Pamucar [42]	Healthcare service assessment during COVID-19 pandemic	Yes	Yes	IF-MARCOS
Torkayesh *et al.*, [43]	Healthcare sector assessment	Yes	Yes	BWM-LBWA-CoCoSo
Yazdani *et al.*, [44]	Healthcare waste disposal location decision assessment	Yes	Yes	IRNDBM, BWM
Puška *et al.*, [45]	Healthcare waste incinerator assessment and selection	Yes	Yes	FUCOM, CRADIS
Pamučar *et al.*, [46]	Healthcare waste management treatment selection	Yes	Yes	FRN, Aczel-Alsina function, OPA, MARCOS
Mishra *et al.*, [47]	Healthcare assessment in hazardous waste recycling	Yes	Yes	IVIF, COPRAS
Pamucar *et al.*, [48]	Supplier selection in healthcare supply chain management	Yes	Yes	FRN, MACBETH
Shih *et al.*, [49]	Platelet inventory management	No	Yes	PGP, NPGP, WOM
Tavana *et al.*, [50]	Medical equipment supplier assessment and selection	Yes	Yes	Z-DEA
Our study	Healthcare System Devolution Assessment	Yes	Yes	AROMAN

Note: BWM- Best Worst Method; CoCoSo- Combined Compromise Solution; COPRAS- Complex Proportional Assessment; CRADIS- Compromise Ranking of Alternatives from Distance to Ideal Solution; DBM- Dombi-Bonferroni Mean; DEA- Data Envelope Analysis; DEMATEL- Decision-making trial and evaluation laboratory; FRN- Fuzzy Rough Number; FUCOM- Full Consistency Method; IRN- Interval Rough Number; IVIF- Interval-Valued Intuitionistic Fuzzy; LBWA- Level Based Weight Assessment; MABAC- Multi-Attributive Border Approximation Area Comparison; MACBETH- Measuring Attractiveness by a Categorical Based Evaluation Technique; MARCOS- Measurement of alternatives and ranking according to COmpromise solution; NPGP- Non-Preemptive Goal Programming; OPA- Ordinal Priority Approach; PGP- Preemptive Goal Programming; SWARA- Stepwise Weight Assessment Ratio Analysis; WASPAS- Weighted Aggregated Sum Product Assessment; WOM- Weighted Objective Method.

Table A2
Alternative definition

Alternative	Explanation	Reference
Leadership development through learning (S1)	While some people may naturally exhibit leadership qualities, it is essential to undergo formal training in specific competencies. Acquiring or refining various leadership skills, including understanding laws, rules, and governance not inherently present in everyone, is crucial. Relying solely on instinct may bring initial success, but individuals may face unpreparedness in complex situations. Seeking resources urgently at that point may be too late to save careers. The current model of expecting professionals with mastery to intuitively become leaders when needed is no longer sufficient. Instead, a continuous influx of emerging leaders is necessary for clinical healthcare and academia, individuals equipped with additional skills from formal experiential training for success in new leadership roles.	[54]
Seeking alternative sources of financing (S2)	Despite ranking among Africa's top 10 economies in 2023, Kenya's health sector encounters a notable challenge with insufficient budgetary allocation from the central government. This obstacle impedes the delivery of quality healthcare, lacking adequate funds for drug procurement, infrastructure improvement, staffing, and research. With over 65% of the budget directed towards recurrent expenditures, there is a crucial need to explore alternative financing sources, such as public-private partnerships.	[55]
Increased investments in human resource and health infrastructural development (S3)	Strengthening investments in Kenya's human resources and health infrastructure involves prioritizing healthcare through policy reforms. It includes fostering public-private partnerships, increasing budget allocations for human resource development and infrastructure, and seeking international aid, particularly from global health initiatives. Vital aspects also encompass investing in healthcare professional training and incorporating technology for improved efficiency.	[56]
Increased budgetary allocations for health products and technologies (S4)	To increase budgetary allocations for health products and technologies, it is crucial to advocate for their significance and demonstrate their effectiveness through data-driven planning. Engage key stakeholders and prioritize these resources in healthcare strategies through policy advocacy. Invest in building the capacity of healthcare professionals and implement robust monitoring and evaluation mechanisms for accountability. Explore efficiency measures for optimal budget utilization and ensure long-term planning and alignment with healthcare goals for sustained improvement in accessibility and quality of healthcare.	[57]
Open door leadership policy (S5)	Communication is the conveyance of information between individuals in a specific environment, involving the sharing of ideas. In the implementation of organizational strategy, communication occurs downward, upward, and laterally. The organizational structure within the Health Department defines communication lines from top leadership to directorates, supplemented by an open-door policy.	[58]
Increased transparency and accountability in the use of	To promote transparency and accountability in public resource usage, it is crucial to establish an effective anticorruption committee that addresses complaints and recommends disciplinary measures. This involves conducting both external and internal audits at both the county health department and	[59]

Alternative	Explanation	Reference
public resources (S6)	individual hospitals. Additionally, implementing procurement procedures at each hospital and encouraging the formation of tendering and procurement committees are vital steps to enhance transparency and accountability.	
Increased investments in information and communication technology -ICT (S7)	ICT systems in organizations should support coordination and the attainment of objectives. The ICT department requires sufficient resources, both in equipment and budget allocations. Interconnecting information technology across county departments and health facilities facilitates the smooth coordination of health activities. Individual hospitals should implement their own ICT systems, especially for computerized patient data storage in outpatient departments. Striving for a paperless clerkship system is crucial, allowing online access to patient history, diagnosis, and medications. Hospitals should advance in computerizing operations, including online receipting and billing.	[60]
Less political interference in the running of the affairs of the Department of Health (S8)	To reduce political interference in the health sector, it is essential to prioritize transparent appointments, establish clear policies, and implement independent oversight mechanisms. Public awareness campaigns should be promoted, and legislation enforcing interference penalties should be rigorously enforced.	[61]

Table A3
Background information of experts

Expert	Gender	Occupation	Degree	Experience
E_1	Male	Health Administration	M.Sc.	7
E_2	Male	Health Administration	M.Sc.	10
E_3	Female	Hospital	M.Sc.	12
E_4	Male	Health Administration	M.Sc.	10
E_5	Male	Health Economist	Ph.D.	7

Table A4
Alternative evaluation

S_1	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
E_1	7	7	3	7	6	7	4	4
E_2	7	6	1	1	5	5	5	5
E_3	6	5	5	3	4	3	6	4
E_4	4	5	3	5	6	3	6	5
E_5	6	7	2	7	2	4	4	2
Average	6	6	2.8	4.6	4.6	4.4	5	4
S_2	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
E_1	6	2	7	6	7	1	7	7
E_2	2	3	2	6	6	6	6	7
E_3	5	4	4	3	1	6	3	7
E_4	5	4	2	4	6	4	5	6
E_5	2	1	1	1	6	1	1	2

Average	4	2.8	3.2	4	5.2	3.6	4.4	5.8
S_3	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
E_1	7	5	2	6	7	4	6	5
E_2	7	6	5	7	6	6	5	5
E_3	7	2	5	4	7	5	3	3
E_4	6	5	4	4	5	3	4	6
E_5	7	6	2	3	2	1	2	2
Average	6.8	4.8	3.6	4.8	5.4	3.8	4	4.2
S_4	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
E_1	2	1	7	4	7	1	7	7
E_2	2	1	3	3	5	5	3	7
E_3	2	3	6	5	6	6	3	5
E_4	4	4	4	4	6	3	5	6
E_5	6	4	7	6	7	1	7	7
Average	3.2	2.6	5.4	4.4	6.2	3.2	5	6.4
S_5	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
E_1	5	4	6	7	3	6	4	4
E_2	6	7	3	6	1	1	1	1
E_3	4	6	6	6	4	4	4	7
E_4	6	5	4	5	4	4	4	5
E_5	6	6	3	7	3	6	4	3
Average	5.4	5.6	4.4	6.2	3	4.2	3.4	4
S_6	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
E_1	6	3	6	7	7	6	4	7
E_2	7	6	7	6	7	7	7	7
E_3	6	5	4	6	3	4	5	3
E_4	4	4	4	4	5	5	5	5
E_5	5	7	6	6	6	7	3	6
Average	5.6	5	5.4	5.8	5.6	5.8	4.8	5.6
S_7	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
E_1	5	6	4	7	4	4	7	6
E_2	2	1	3	1	7	7	7	5
E_3	5	6	3	3	5	4	6	3
E_4	5	4	3	4	5	3	6	4
E_5	4	6	1	3	5	2	7	5
Average	4.2	4.6	2.8	3.6	5.2	4	6.6	4.6
S_8	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
E_1	7	4	7	7	7	7	7	7
E_2	2	6	3	6	3	3	3	6
E_3	5	5	3	4	5	7	3	6
E_4	5	5	4	4	6	6	5	6
E_5	4	6	4	6	1	7	1	2
Average	4.6	5.2	4.2	5.4	4.4	6	3.8	5.4

Table A5
Linear normalization of the initial decision-making matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
S_1	0.7778	1.0000	0.0000	0.3846	0.5000	0.4286	0.5000	0.0000
S_2	0.2222	0.0588	0.1538	0.1538	0.6875	0.1429	0.3125	0.7500
S_3	1.0000	0.6471	0.3077	0.4615	0.7500	0.2143	0.1875	0.0833
S_4	0.0000	0.0000	1.0000	0.3077	1.0000	0.0000	0.5000	1.0000
S_5	0.6111	0.8824	0.6154	1.0000	0.0000	0.3571	0.0000	0.0000
S_6	0.6667	0.7059	1.0000	0.8462	0.8125	0.9286	0.4375	0.6667
S_7	0.2778	0.5882	0.0000	0.0000	0.6875	0.2857	1.0000	0.2500
S_8	0.3889	0.7647	0.5385	0.6923	0.4375	1.0000	0.1250	0.5833

Table A6
Vector normalization of the initial decision-making matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
S_1	0.4162	0.4495	0.2417	0.3305	0.3232	0.3475	0.3748	0.2787
S_2	0.2775	0.2098	0.2762	0.2874	0.3654	0.2844	0.3298	0.4042
S_3	0.4717	0.3596	0.3108	0.3448	0.3794	0.3002	0.2998	0.2927
S_4	0.2220	0.1948	0.4661	0.3161	0.4356	0.2528	0.3748	0.4460
S_5	0.3746	0.4195	0.3798	0.4454	0.2108	0.3317	0.2549	0.2787
S_6	0.3885	0.3746	0.4661	0.4167	0.3935	0.4581	0.3598	0.3902
S_7	0.2914	0.3446	0.2417	0.2586	0.3654	0.3160	0.4947	0.3206
S_8	0.3191	0.3895	0.3626	0.3879	0.3092	0.4739	0.2849	0.3763

Table A7
Aggregate average normalization (β= 0.5)

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
S_1	0.2985	0.3624	0.0604	0.1788	0.2058	0.1940	0.2187	0.0697
S_2	0.1249	0.0671	0.1075	0.1103	0.2632	0.1068	0.1606	0.2885
S_3	0.3679	0.2517	0.1546	0.2016	0.2824	0.1286	0.1218	0.0940
S_4	0.0555	0.0487	0.3665	0.1559	0.3589	0.0632	0.2187	0.3615
S_5	0.2464	0.3255	0.2488	0.3614	0.0527	0.1722	0.0637	0.0697
S_6	0.2638	0.2701	0.3665	0.3157	0.3015	0.3467	0.1993	0.2642
S_7	0.1423	0.2332	0.0604	0.0647	0.2632	0.1504	0.3737	0.1426
S_8	0.1770	0.2886	0.2253	0.2701	0.1867	0.3685	0.1025	0.2399

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Conflicts of Interest
The authors declare no conflicts of interest.

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