T.C.

İSTANBUL KÜLTÜR UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

APPLYING MULTI-CRIATERIA ANALYSIS TO SELECT THE LOCATION FOR POULTRY FARM: A CASE STUDY IN SOMALIA.

MASTER OF SCIENCE THESIS

MOHAMED ABDULKADIR MOHAMED

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DEPARTMENT: INDUSTRIAL ENGINEERING

PROGRAM: ENGINEERING MANAGEMENT

SUPERVISOR: ASSIST. PROF. İLAYDA ÜLKÜ

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FEBRUARY 2025

ACKNOWLEDGEMENT

I would like to thank all those who helped me in completing this study. First, I would like to express my heartfelt thanks to my supervisor, Assist. Prof. Dr. İlayda Ülkü, for her helpful comments and instructions during this thesis. Her feedback and guidance were priceless and improved my dissertation by leaps and bounds. I know her words of wisdom will undoubtedly Contineo to inspire and guide me in my professional future.

Finally, I want to express my deepest gratitude to all my lecturers who constantly provided support and encouragement throughout the years. Their influence and advice have helped me immensely not only in my studies but also in building the foundation of this dissertation.

I would like to thank my family in particular. My father and my late mother (may Allah grant her the highest of Heaven and eternal peace) to whom I owe everything. I am also thankful to my grandmother, my uncles, aunts, brothers and sisters. I have found my greatest strength through your constant love, prayers, and encouragement.

Thank you to everyone who had a part in me going out and following my dreams and achieving my dreams**.**

Date: FEBRUARY 2025

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LIST OF SYMBOLS

A Controller system matrix

B Controller input matrix

£ Three-dimensional Euclidean Space

G Plant input matrix

Gj Plant disturbance input matrix

ÜNİVERSİTE	**: İSTANBUL KÜLTÜR ÜNİVERSİTESİ**
ENSTİTÜ	**: LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ**
ANABİLİM DALI	**: ENDÜSTRİ MÜHENDİSLİĞİ**
PROGRAMI	**: MÜHENDİSLİK YÖNETİMİ**
TEZ DANIŞMANI	**: DR. ÖĞRETİM ÜYESİ İLAYDA ÜLKÜ**
TEZ TÜRÜ VE TARİHİ	**: YÜKSEK LİSANS – ŞUBAT 2025**

ÖZET

KANATLI HAYVAN ÇIFTLIĞI YERI SEÇIMINDE ÇOKLU CRIATERIA ANALIZININ UYGULANMASI: MOGADIŞU, SOMALI'DE BIR VAKA ÇALIŞMASI

MOHAMED ABDULKADIR MOHAMED

Bu araştirma, Somali'nin Mogadişu kentindeki kümes hayvani çiftliği yer seçiminin önündeki engelleri ele almakta ve bu alanda çok kriterli karar verme (MCDM) yaklaşimlarinin nadiren kullanildiği bir boşluğu doldurmaktadir. Çalişma, alti temel kriteri analiz ederek sürdürülebilir operasyonel başariyi artirmayi amaçlamaktadir: arazi maliyeti, ulaşim erişilebilirliği, pazara yakinlik, güvenlik, kamu hizmetleri ve biyogüvenlik. Analitik hiyerarşi süreci (AHP) ve ideal çözüme benzerlik sirasina göre tercih tekniği (TOPSIS) yöntemleri kullanilarak, dört alternatif yer (A_1) Markazka, (A_2) Daaru Salaam (A_3), Hilwaa ve (A_4) jaziira uzman görüşlerine dayali olarak titizlikle analiz edilmiştir. Bulgular, hilwaa'nin altyapisi, pazara erişimi ve güvenliği nedeniyle Safa şirketi için enuygun seçenek olduğunu göstermiştir. Sinirli altyapisina rağmen Jaziira, biyogüvenlik ve düşük arazi maliyeti açisindan ikinci sirada yer almiştir. Markazka, altyapi geliştirmeleriyapilmasi durumunda potansiyele sahipken, Daaru Salaam biyogüvenlik eksiklikleri veyüksek arazi maliyeti nedeniyle en az çekici alternatif olarak değerlendirilmiştir. Buçalişma, kümes hayvani çiftliği yer seçiminde MCDM yöntemlerinin pratik değerini ortayakoymakla kalmayip, ayni zamanda gelecekteki çalişmalar için kullanilan kriterleringeliştirilmesi ve genişletilmesine yönelik bir temel oluşturmaktadir

Anahtar Kelimeler: Tavuk çiftliği, yer Seçimi, AHP, TOPSIS, MCDM, Mogadişu, Karar Verme.

Bilim Dali Sayısal Kodu: 90602

UNİVERSİTY	**: İSTANBUL KÜLTÜR UNIVERSITY**
INSTİTTUTE	**: INSTİTUTE OF GRADUATE STUDIES**
DEPARTMENT	**: INDUSTRIAL ENGINEERING**
PROGRAM	**: ENGINEERING MANAGEMENT**
SUPERVİSOR	**: ASSİST. PROF. İLAYDA ÜLKÜ**
DEGREE AWARDED AND DATE	**: MS – FEBRUARY 2025**

ABSTRACT

APPLYING MULTI-CRIATERIA ANALYSIS TO SELECT THE LOCATION FOR POULTRY FARM: A CASE STUDY IN MOGADISHU, SOMALIA

MOHAMED ABDULKADIR MOHAMED

This research addresses the challenges of poultry farm site selection in Mogadishu, Somalia, by filling a gap where multi-criteria decision-making (MCDM) approaches have been rarely applied. The study aims to enhance sustainable operational success by analyzing six key criteria: land cost, accessibility of transportation, proximity to the market, safety, utilities, and biosecurity. Applying analytic hierarchy process (AHP) and technique for order of preference by similarity to ideal solution (TOPSIS), four alternative sites (A_1) Markazka, (A_2) Daaru Salaam, (A_3) Hilwaa, (A_4) Jaziira, were carefully analyzed based on expert opinions. The findings indicate that Hilwaa is the most suitable option for Safa company due to its infrastructure, access to market, biosecurity and safety. Despite its limited infrastructure Jaziira ranked second driven by it is strong biosecurity and low land cost. Markazka shows potential if infrastructure improvements are made, while Daaru Salaam was considered as the least attractive due to biosecurity and high land cost. This study not only demonstrates the practical value of MCDM methods in poultry site selection but also sets the way for future studies to expand and refine criteria used in similar studies.

Keywords: Poultry Farm, Site Selection, AHP, TOPSIS, MCDM, Mogadishu, Decision-Making.

Science code: 90602

1. INTRODUCTION

1.1 Background of the Study

Poultry farming is an essential component of the global agricultural industry, providing vital protein sources such as eggs and meat to populations across the world. The Demand for poultry products continuous to grow, driven by changing dietary habits and increasing populations. Poultry farms play a significant role in food security, offering affordable and reliable sources of protein to communities. Also, poultry farms make up a substantial portion of global meat consumption, particularly in developing countries (Efremova, 2019).

Despite its importances, there has been relatively less focus on the use of systematic methods for selecting ideal locations for poultry farms, specifically through Multi-Criteria Decision-Making (MCDM) methods.

The global literature on poultry farming site selection is equally limited. In Africa, researchers primarily focused on enhancing production practices, disease control, and better-quality feed. Although there is a notable gap in consideration of aspects, with a specific geographical dimension, for instance, biosecurity issues, accessibility of transportation, and proximity to the market (Habte, et al., 2017).

Neglecting these criteria during site selection process has negative potential impact on health and operational efficiency of the poultry farm (Sonaiya, et al., 2022).

Countries like Somalia, especially Mogadishu, which is the center of internal displaced people, poultry farming offers a fantastic opportunity to address ongoing food security, malnutrition problems especially in Mogadishu. As highlighted, one of the main causes of malnutrition in Somalia is the scarcity of protein rich food sources, the most affordable and efficient of animal protein is poultry (Lemma, et al., 2023).

In addition, poultry farms also create jobs and contribute to local economies, which plays crucial role in poverty alleviation in urban and rural areas. The lack of research for location selection in the poultry industry is a critical challenge in ensuring the sustainability of these farms.

Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), are one of Multi-Criteria Decision Making (MCDM) methods that provide a coherent way to assess and prioritize alternative of poultry farm locations. These allow decision-makers to assess a range of criteria, including proximity to markets, land cost, utilities, safety, and biosecurity. It is possible to select the optimal location for poultry farm by utilizing these strategies after evaluating all significant factors (Arabeyyat, et al., 2024).

This study presents a solution to the research gap that exists regarding the optimal location of poultry farms in Somalia. To fill the gap, this research focuses on the site selection process for Safa company located in Mogadishu, Somalia, and utilizing Multi-Criteria Decision-Making (MCDM) methods to obtain the optimal location of the poultry farm.

1.2 Problem Statement

The selection of the site for poultry farms is a multi-facet decision dependent on various crucial elements like land cost, market access, transportation, infrastructure, biosecurity, safety, and availability of utilities. In Mogadishu, where the economy is still recovering and infrastructure developing, poultry farms must select the right site in order to be successful. Safa Company is planning to set up a poultry farm needs to identify a location to optimize balancing between the various conflicting components to ensure that it continues to function sustainably.

The absence of clearly defined criteria for selection of poultry farm locations in Mogadishu makes the selection of sites for poultry farms challenging. Systematic decision-making approaches such as Analytical Hierarchy Process (AHP) and Technique for Order and Preference by Similarity to Ideal Solution (TOPSIS) have not been applied in previous studies of agricultural and poultry farming, to determine the placement of agricultural and poultry production, paving the way for better decision. As a result, decisions are often based on intuition or insufficient facts, increasing the conscience of selecting a poor site, which can result in greater expenses, reduced market access, and health risks for poultry.

This study tackles these challenges by using MCDM approaches to assess the suitability of four potential locations for Safa Company`s poultry farm: A_1 Markazka, A_2 Daaru Salaam, A3 Hilwaa, and A4 Jaziira. Using AHP and TOPSIS, this study provides data-driven recommendations for identifying the most suitable site.

1.3 Aim of the Study

The study`s major goal is to develop decision support concept based on multi-criteria decision approach in the planning phase for poultry farms and practical to test the developed concept on real case for Safa Company`s poultry farm in Mogadishu, Somalia, and select the best location using AHP and TOPSIS methodologies. The precise aims include.

1. Identify and analyze the important factors impacting poultry farm site selection, such as land cost, accessibility of transportation, proximity to markets, safety, utilities, and biosecurity.

2. Use the AHP approach to give weights to each of these criteria based on expert opinion.

3. Use the TOPSIS approach to rank the four alternative locations (Markazka, Daaru Salaam, Hilwaa, and Jaziira) according to the weighted criteria.

4. Make a recommendation on the best location for Safa Company`s poultry farm, considering all relevant considerations.

5. To promote MCDM methods in site selection for poultry farms in the planning phase,

1.4 Research Questions

This study aims to address the following questions:

1. What are the key factors for choosing a poultry farm location in Mogadishu?

- These include land costs, transit access, proximity to markets, safety, utilities, and biosecurity.

2. How can MCDM approaches (AHP and TOPSIS) be used to assess poultry farm locations?

- This question focuses on the process of applying MCDM techniques to systematically examine different locations.

3. Which of the four potential locations (Markazka, Daaru Salaam, Hilwaa, and Jaziira) is the most suited for developing Safa Company`s chicken farm?

- The goal here is to choose the ideal site for the farm depending on the weight parameters.

4. How do factors such as land cost, accessibility of transportation, proximity to the market, safety, utilities, and biosecurity influence the ranking of these sites?

- This question explores the impact of each criterion on the final ranking and selection of the site.

1.5 Significant of the Study

This research makes theoretical and practical contributions. From a theoretical standpoint, it expands the use of MCDM approaches for poultry farm site selection in an area where this approach is neglected. The research also emphasizes the need to consider multiple variables while making decisions, ensuring that the chosen site balances economic, logistical, and safety considerations.

From a practical aspect, the research provides Safa Company with clear systematic methods for determining the optimal location for it is poultry farm. The lessons learned can also help other poultry farm investors in Mogadishu or comparable areas by offering a reproducible framework for site selection.

Furthermore, the findings of this study help to advance Somalia`s larger goals of food security and economic growth. Poultry farming can help combat hunger, provide jobs, and serve as a steady source of income for many families. As a result, making informed judgements about the site of poultry farms is critical to achieving these advantages.

1.6 Scope of the Study

This study is focuses on evaluating four possible locations for Safa Company`s poultry farm in Mogadishu: Markazka (A_1), and Daaru Salaam (A_2), Hilwaa (A_3), and Jaziira

(A_4). The research considers six criteria: land cost, accessibility of transportation, proximity to the market, utilities, safety, and biosecurity.

The research uses Analytical Hierarchy Process (AHP) and Technique for Order and Preference by Similarity to Ideal Solution (TOPSIS), to rate these sites and recommend the most optimal location.

While this study provides useful insights into site selection for poultry farming, it does not dive into financial feasibility, or environmental consequences beyond the boundaries of six criteria. Additionally, the findings are limited to the sites in Mogadishu and similar regions.

1.7 Limitation of the Study

The study has a few drawbacks. First, the evaluation of criteria weights based on expert opinions, which introduces an element of subjectively, although efforts were made to ensure that the experts consulted had relevant knowledge in agriculture, veterinary, urban, logistic, and economics, different experts may have provided different weightings, potentially affecting the results.

Secondly the research main challenge were lack of previous studies or documents regarding of poultry site selection in Somalia context. But the research was heavily relied on MCDM methodologies such as AHP, and TOPSIS. While this gap was filled in literature, more researchers are needed to expand and use these approaches in similar environments.

2. LITERATURE REVIEW

2.1 Overview

Over the last few decades, poultry farming sector landscape in Somalia has experienced changed dramaticaly, with greater emphasis on optimazing site selection to improve operational efficiency, economic viability, and enviromental sustainablility. Historically, site sellection has not been considered a critical component of the poultry secter, and resulted diseasses and airpolution to control thess effects, optimizing the site selection process for poultry farms has emerged as a critical component of agricultural planning and policy development. The purpose of this review of the littrature is to offer a detailed summery of the work that has been done on site selection for poultry farms, with a particular focus on the similar researches of site selection used by MCDM methods around the world, giving the luck of specific research in site selection of poultry farm by MCDM context, The review exmines specific methodologies, models, and important factors used in previose research to identify patterns, gaps, and areas that require further investigation.

Enviromental conservation, and agricultural productivity, agricultural planners, policymakers, and researchers must have a thorough understanding the dynamics of choosing location for poultry farms.

The study will look at the significance of poultry farm location and the effeciency of MCDM mthods in site selection, and technological brakethroughs that have transformed the global poultry industry landscape, as well as provide historical context. It will also look at the charechtristics that envuluance the viability of poultry farming sites, such as proximity to resources, biosecurity, logistics, and community impact.

to improve the location selection for poultry farms. Understanding the advantages and limitations of diverse techniques, allows for more exact and trustworthy site selection models that are tailored to the spacifities of different agricultural systems can be The literature study will also look at the variouse Multi-Criteria Decision Making (MSDM) strategies that hase been developed. These strategies span from classic Analytic Hierarchy Process (AHP) models to sophisticated Geographic information systems (GIS) integerated with MCDM techniques.

Given the shortage of detailed study on poultry site selection specific to MCDM context.

The findings gained from litrature review will drive future research activities and policy suggestions as the country attempts to stike a balance between agriculture and productivity and sutainabilty.

By cultivating a better understanding of the complexities associated with the prediction and optomization of poultry farm site selection globally, interested parties in Somalia can make informed decisions, that align with the country`s agricultural goals and support a more sustainable and robust agricultural future.

2.2 importance of site selecton for poultry farm.

Over the last few decades, the poultry farming sector in the region, notably in Mogadishu, Somalia, has face substantial obstacles, the researcher highlighted theree main issues: lack of knowladge, access to feeds, and utillities such as water, power, and biosecurity (Mio, et al., 2022)

Aggricultural Machines (AM) in China experienced high fuel cosumption and causes signifcant opraional inefecience yet no study focused on site selection for Aggricultural Machines (AM). A research have been employed on TOPSIS and MCGG utilized to analyze oprational factors: fuel conception rates, agricultural machine dispatching, cost, and timeliness. Experts computed weights using the Fozy delph technique then TOPSIS and MCGG were used to rank the options. Similarly site selection for poultry farm oprations must be considered such measures and factors like biosecurty, transportaion, and utilities, also ethical considerations such as: interaction with communities and animal walfare for a holistic appeoach in sitel selection (Mirkouei, et al., 2017).

The significance of site selection cannot be over stetted, study showed that site selection is the most important aspect of any project and listed several criteria, including logistics infrastructural, political, oceanographic, biological, and environmental (Benatti, et al., 2010).

A study argues that picking location for poultry farm is more than just choosing the best location; it is a complicated choice that affects all aspects of farm operations from disease management to resource availability and community relations (Elahi, et al., 2024).

Site selection is essential to minimize the distance from the raw supplies, lowering transportation costs, and resolving logistical issues. Also, the optimal site selection is based on a hybrid technique such as entropy based multi-attribute utility theory to maximize economic advantages by considering infrastructure and resource availability, strategically placing facilities improve energy security by harmonizing with policy. MCDM techniques are unique to address both practical applications and production potential, ensuring sustainable and efficient results (Emeksiz & Yuksel, 2022).

A suitable site is critical for ensuring long-term business operations. It entails for social, economic, and environmental issues to achieve sustainability. In order to validate the performance of the proposed location based on the sustainable parameters and to find the ideal site, methodologies for TOPSIS and AHP were employed in the study (Govindan, et al., 2016).

Selecting poultry farm sites should also take into account environmental factors. Feed production and on-form emissions are considerable drivers, highlighting the importance of sustainable operations. How environmental impacts from the energy of generation and cooling operations at slaughterhouses can be significant and supporting site sustainability, as well as its need to reduce total environmental effects (López-Andrés, et al., 2018).

If improperly managed, poultry farms pollute water, air and land, mainly because of manure emissions and western management practices. These pollutants result in nitrogen pollution, which impacts both the environment and human health (Ghaly & Ramakrishnan, 2015).

waste management thus decreasing the risk of associated hazards associated with the poultry and slaughterhouse industries. This reduces the farm's ecological footprint, including water, soil and air pollution and associate health risks (Mozhiarasi & Natarajan, 2022).

The poultry industry requires effective disease control and biosecurity measures, but the gaps exist. Choosing good sites can help minimize disease outbreaks by putting farms a safe distance away from other farms and from wildlife. Doing so ensures high biosecurity standards are kept and the risk of infection spread is minimized (Yitbarek, et al., 2016).

Poultry farms must be continuously healthy and consistently productive; therefore site selection is significant. Proper location of poultry farms will prevent biosecurity problems and diseases transmission (Rimi, et al., 2017).

In site selection process environmental issues are critical for the sustainability of a farm. Poultry farms nearby lakes can pollute these water spots. This closeness leads to significant environmental degradation and public health risks due to inadequate waste management practices (Hu & Tao, 2017)

Proper selection of the site is essential in the construction of sheds for poultry as it can help to maintain a heath habitat of poultry and the surrounding ecosystem. The site for poultry house construction should be regionally suitable with good drainage and low flood risk. Inadequate site selection can lead to potentially significant pollution problems, especially in waterlogged areas, compounding issues surrounding waste management and impacting surrounding water sources. Many times, proper geographical conditions can help to reduce environmental impacts of poultry (Mallin, et al., 2015).

Even natural ventilation and proper temperature conditions with selected sites can greatly reduce the dependence of artificial air conditions, energy saving, and equipment operating costs. It allows for ideal conditions for poultry production using surroundings to take advantage of environmental factors, thus enhancing poultry housing sustainability (Gad, et al., 2020).

Location of the poultry farming is vital for sustainable operation with limited adverse environmental and social impacts. When choosing a proper site, you need to take into consideration a lot of things such as accessibility of water supplies, waste management facilities, residential areas, environmental requirements, suitable site can help reduce pollution hazards and prevent contamination of air, soil and water. However, proper site selection can minimize disturbance by nearby communities, optimize operational efficiency, minimize transportation costs, and ultimately increase farm productivity. For this reason, site selection is a key element of poultry production which merits careful consideration and planning to guarantee long-term viability (Gržinić, et al., 2023).

The near location of the feed source reduces the transportation cost and assures the continuous supply of the feed, which is essential for the growth and operational of the poultry farm (Wongnaa, et al., 2023).

In addition, the accessibility of local laborers save costs and makes sure that skilled workers are there to manage successful farm operations (Hagan, 2020).

Key components such as these resources should be easy for the farm to access and increase the efficiency of a farms activities as a correct site selection ensures (Martinelli, et al., 2020).

The urgency for quick access to veterinary care and emergency assistance highlights the importance of logistical considerations (Rao, et al., 2015).

Thus, strategically located poultry farm assures accessibility of help in case disease outbreak or any other emergency, thereby minimizing potential losses and disruption (Islam, 2020).

Somalia is a nation with a nascent poultry farming sector, and therefore there are lessons to learn from global best practices. For example, locations with similar climatic conditions and resources limits can provide models for successful site selection and farm management (Mohamed, et al., 2016).

By incorporating advanced tools such as the multi-criteria decision-making method and geographic information system especially google earth pro, Somalia agricultural planners can identify optimal sites that makes easy to make an informed decision-making (Alkaradaghi, et al., 2019).

The considerations of ethical environmental issues especially waste management, energy use, and biosecurity, can result innovative ideas such as implementing an aerobic digestion system for waste treatment that can produce biogas emissions, reducing reliance on external energy sources and lowering greenhouse gas emissions. Such innovation will improve operational efficiency and overall farm sustainability (Naidu, et al., 2024).

As Somalia continues to grow its poultry industry sector, there is a need for a continual study and adoption of global best practices to local conditions, creating collaboration with international agricultural organizations can aid this process. Somalia can promote environmental conservation and economic growth through smart site selection of poultry industry (Barre, et al., 2023).

2.3 International Policies on Poultry Farms' Site Selection

The ability to determine the site for the poultry farm is a strategic action that influences the success and sustainability of poultry farming businesses globally (Vaarst, et al., 2015).

Depending on the region, there are different methodologies to optimize site selection, such as taking into account economic viability, social factors, and logistical requirements, for which multicriteria decision making methods have demonstrated their applicability worldwide for systematically evaluating such diverse factors which enable stakeholders in making informed decisions (Rezaeisabzevar, et al., 2020).

A 42-day data study examined the incidence of footpad dermatitis in broilers housed in dark and open-sided poultry housing. AHP indicated that dark dwellings were linked with less footpad lesions which shows the effectiveness of systematic MCDM methods (Garcia, et al., 2019).

MCDM approaches have been widely used in the agricultural context, especially in optimizing the location of a soil that is most suitable for a given crop. AHP and TOPSIS are significant tools according to the study AHP assists in organizing these factors like socio-economic, executive, environmental, and political…etc. these also called relative importance is taken into consideration. To find viable alternatives, TOPSIS ranked alternatives according to their proximity to the ideal solution (Özkan, et al., 2019).

Referring to the MCDM methods used to determine optimal locations for rain harvesting in Iran, the research suggests MCDM methods as a solid framework of spatial analysis suitably addressing assessment of GIS-based data regarding to various aspect thereof (Aghaloo & Chiu, 2020).

These techniques could identify poultry farm sites particularly in places where biosecurity sustainability, the environmental and operational efficacy has the utmost importance (Peng, et al., 2014).

In Selection of MCDM approaches for sites of livestock in the European Continent and in its conclusion, it emphasized the importance of taking community interaction, environmental legislation, and animal welfare requirements into consideration during decision-making. The study also found that while MCDM methodologies like AHP are capable of evaluating multiple criteria, involving stakeholders who select the location is also in accordance with broader socio-economic objectives (Calafat-Marzal, et al., 2021).

Applications of MCDM methods in agriculture, discussed the strengthening of these methods over recent years, and highlighted how technological progression regarding data collection and processing has increased the accuracy and consistency of MCDM methods, while the review also emphasized a relative deficiency in direct applications of MCDM to site selection in poultry farms, methodologies within allied sectors of agriculture are by-and-large consistent with those applied in this review, providing a strong basis for future investigations (Rouyendegh & Savalan, 2022).

2.4 Key factors affecting site suitability for poultry farms

Accessibility to utilities such as water, electricity and feed are one of the most important aspects in establishing of a site for poultry farms (Kato, et al., 2022).

The need to have access to basic resources such as water, feed, and electricity for poultry farms operations. In areas where water scarcity is a concern, the availability of a consistent water source is critical, also the cost and availability of feed are important issues especially in rural locations where road infrastructure are not constructed or not well maintained roads, proximity to feed providers may save transportation costs while also ensuring a consistent supply of feed, which is critical for sustaining poultry production and health (Meseret, 2016).

In addition to resource availability the importance of biosecurity in site selection for poultry farms, biosecurity refers to the measures taken to prevent the entrance and spread of illnesses within the farm, and maintains that the site of poultry farm should be chosen with biosecurity in mind, especially in areas prone to disease outbreaks, Farms located near to the poultry farm operations or in regions with significant bird papulation may face higher risk of disease transmission, indicates that separation from other farms and control over access points are essential biosecurity considerations that should impact site selection (Osman, et al., 2021).

Logistics is important factor that can have a significant impact on the operational efficiency and profitability of poultry farms. proximity to transportation networks, such as railways, roads, and ports, can influence the speed and cost of moving both inputs (such as feed and equipment) and outputs (such as eggs and meat) to and from the farm, farms in remote places may face greater transportation costs and longer delivery periods, reducing their competitiveness, this might reduce their competitiveness, farms located near major transportation hubs on other hand, benefit from faster access to markets and suppliers, lowering operational costs and enhancing overall efficiency, (Moonsri, et al., 2020).

One of the most important factors is the potential impact on the surrounding community, poultry farms have potential social and environmental effects on the live of local communities, noise, odor and waste produced by the farm may become a source of conflicts or problems for close-by communities, especially if the area is heavily populated, besides the environmental consequences of poultry farming like water pollution and land degradation need to be taken into account in order to prevent harmful outcomes regarding the community as well as the farm. According to the study, engagement with the local community and environmental impact assessments are key elements of a site selection process that ensures the farm functions in harmony with the local environment (Baskin-Graves, et al., 2019).

In places such as Somalia, where the issues of safety and potential for war and theft are common, these concerns are especially paramount in the site selection process stress that ensuring the safety of the farm and its employees is vital in areas susceptible to instability, the research also demonstrate that poultry farms in combat zones face distinct challenges, including the risk of theft, damage of property, and possibly life. Consequently, it also is vitally important to select an appropriate venue with proper security precautions, including being near secure zones or local police departments (Barclay, 2016).

2.5 Methods for site selection multi-criteria decision-making (mcdm).

The process of selecting best site for poultry farm is a complex process with numerous factors influencing the decision such as location, close to nearby resources, Logistics, biosecurity, Regional safety concerns and community impact, as well as Multi-Criteria Decision Making (MCDM) methods, such as the Analytic Hierarchy process (AHP), the Technique for Order of Preference by similarity to Ideal Solution (TOPSIS, etc. Serve as a guide for handling complexity. Each technique has its own attributes that can be mixed and matched to enhance the decision-making process as a whole.

AHP is essential in determining weights for different criteria given by different experts based on their knowledge (Parekh, et al., 2015).

Leverage GIS for spatial analysis to identify optimal locations Additionally illustrate TOPSIS that may assess potential locations with respect to their distance to an ideal solution that maximizes positive criteria and minimizes negative criteria (Bedewy & Al-Timimy, 2023), (Karim & Karmaker, 2016).

Thus poultry farm site selection It becomes difficult and time-consuming to select the optimal location, with every method differ in terms of advantages and disadvantages, in short, it provides a framework of the systematic decision-making in which both qualitative and quantitative data can be used and the group of experts can be used to weight the different constants (Sahoo & Goswami, 2023).

Because AHP is heavily-dependent on perceptual logical values, it can be biased, especially when decision-makers are not consistent as shown in a literature review. In contrast, GIS has powerful spatial analysis capabilities, enabling the visualization of spatial relationships and patterns that were previously obscured (Das & Kanungo, 2022).

GIS can be data-heavy and require a lot of computing power, which makes it unsuitable in resource-limited environments (Wang, et al, 2015).

TOPSIS has been praised in part due to the simplicity and clear ordering of alternatives, but has also said it does not always correctly take into account parameters of even importance unless they are weighted at the worst (Yadav & Desai, 2018).

By leveraging the strength of each method, a composite method that includes GIS, AHP, and TOPSIS can enhance the site selection process. think. For starters, narrowing the number of sites to consider should be possible using geographic information systems [GIS], which could point to the most favorable sites based on spatial data, like land use, transportation networks, and proximity to water sources. Then system approach to hierarchy process (AHP) used to determine relative weight for respective criteria to assigned their respective weight, as this helps to articulate the relative importance of various criteria in the decision-making process and finally technique for order of preference by similarity to ideal solution (TOPSIS) order the respective site as per its corresponding closeness to the ideal solution and provides a simple solution strategy for comparison of options in determine best locations for poultry farm (Sheikh, et al., 2020).

Such integration not only maximizes the merits of every approach but also addresses their individual shortcomings leading to more informed and accurate decision-making bespoke to the complexities of site selection, African continent based poultry farms (Vahidnia, et al., 2022).

2.6 Areas of MCDM Methods: A Holistic Approach to Site selection Across Various Fields

MCDM methods have been widely utilized across various fields, demonstrating their capacity to resolve complex decisions involving numerous conflicting criteria. Various methodologies, including Analytic Hierarchy Process (AHP), Geographic Information System (GIS), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), among other analytical procedures, often serve as robust references for comprehensive and equitable decision making, particularly regarding site selection. A wealth of studies on MCDM implications indicates that they have been successful across an extensive spectrum of domains, from environmental management, urban, energy generation, and infrastructure development [5]; to therapy, ensuring their potential utility in enhancing siting for poultry farming and similar practices.

2.6.1 Urban Planning and Infrastructure Development

MCDM techniques are extensively used for urban planning and infrastructure development. hit on spatial locations data coupled with AHP, and TOPSIS for determining respectively ideal locations for urban institutions, i.e. hospitals, schools, and parks. By integrating geographic analysis with expert judgment, which takes into account factors like accessibility, land use compatibility, environmental impacts, and cost, this approach enables planners to identify the most strategic locations, enhances decision-making, and ensures that selected sites meet the various needs of urban communities. One of the most renowned applications of MCDM methods has been within urban planning, as seen in places like Istanbul, Turkey (Foroozesh, et al., 2022).

Data for Spatial location, AHP, and TOPSIS was employed in selecting the best site for urban Smart cities, with the highest step toward enhancing quality for the environment and public accessibility. MCDM approaches have been useful in identifying locations for transportation and logistics facilities in infrastructure development (Sisman & Aydinoglu, 2020).

utilized combinations of Spatial locational data, AHP, and ROC for assessing prospective sites for new airport in Libya according to factors like distance to population centers, environmental impact, and construction expenses. Subtly popping sustainable development goal (Erkan & Elsharida, 2020).

A study showed the application of MCDM for location selection for bike station where Spatial data, Experts opinion, AHP and TOPSIS helped to prioritize economic benefits, environmental sustainability and social acceptance to align infrastructure investment better (Bahadori, et al., 2022).

2.6.2 Environmental Management and Conservation

Widespread applications of MCDM techniques have been recorded in environmental management and conservation, as these theories address complex selection problems which combine ecological, social, economic, AHP and TOPSIS in Adana, Turkey to assign appropriate site location for onshore wind projects with 15 criteria were took into account prove effectiveness of this methodology is ensure that all relevant factors are considered which has made it a tool of my focus in rational onshore wind decision-making process In renewable energy, MCDM approaches have been proven very important to determine the appropriate sites for a wind farm, solar panels, and hydraulic turbine (Yaman, 2024).

Analysis of multi-criteria parameters like slope, water discharge, environmental impact using expert judgment, AHP, TOPSIS for finding the best sites for hydropower projects in Iligan city, Philippines showed that the combination of these different methods gave a thorough indication of locations, reducing both environmental footprint and operational costs (Badang, et al., 2018).

2.6.3 Disaster Management and Risk Assessment

In the area of disaster management, MCDM approaches have proven beneficial for the selection of locations for emergency shelters, evacuation routes, and disaster response facilities. AHP and TOPSIS were applied or location selection of emergency shelters in earthquake and flood-prone areas in Van, Turkey: proximity to vulnerable populations, accessibility, safety, and resource availability were some of the criteria used for evaluation, the success of this approach in optimizing the placement of shelters has resulted in a marked increase in the effectiveness of response efforts and preparedness for disasters (Ilerisoy, et al., 2022).

The studies used combinations of AHP and TOPSIS for locating emergency shelters of Wenchuan, China, with a focus on features including, height, river distance, access to roads, and more effective disaster risk management strategies (Liu, 2022).

2.6.4 Health Care and Medical Facility Planning

MCDM approaches were leveraged to determine the ideal location for new health facilities such as hospitals and clinics. used GIS, and AHP to select new healthcare center locations in Turkey based on factors like competitor, demand, environmental conditions, accessibility, rule, and regulations. MCDM methods are successful in this context due to their ability to handle multiplecriteria problems while enabling equitable and effective resource allocation in health care.

(Şahin, et al., 2019).

TOPSIS is used with spatial data to determine optimal health care facility location using cost, transport, geological, land use and demographic factors, enabling google to point and click center locations that have optimal service coverage while minimizing operational cost, enrich health care planning and utilizations (Adalı & Tuş, 2021).

2.6.5 Agricultural and Rural Development

Utilizing Spatial data and TOPSIS as MCDM approaches for selecting agricultural location in dry regions of Iran based on crop duration and harvest index etc. with the aim of site-selection in agriculture and rural development context trying to achieve higher agricultural production with less environmental impact, demonstrate wide applicability of MCDM tools in site-selection problems even in adverse conditions (Seyedmohammadi, et al., 2018).

Using a fuzzy-based multi-criteria decision-making approach for GIS of evaluates potential shrimp farming sites in Iran; water quality, infrastructure, roads, and temperature were assessed found applications of this method allow the comprehensiveness of the analysis leading to aquaculture with better sustainability (Vafaie, et al., 2015).

Similarly, Spatial data, and MCDM method used to identify Potato growing locations in West Bengal India, based on soil fertility, food hazard, water availability, etc., (Poddar, et al., 2023).

2.6.6 Industrial Development and Logistics

MCDM approaches are widely used in industrial development and logistics to discover the best locations for factories, warehouses, and distribution hubs, utilized MCDM techniques to choose industrial facilities in Turkey, considering characteristics including accessibility to raw materials, transportation networks, and labor availability the success of these strategies proven to be beneficial in terms cost efficiency and operational performance, making the essential instruments for industrial site selection (Ulutaş & Karakuş, 2021).

Logistics illustrate the application of MCDM approaches such as GIS Goal Programing, AHP, and TOPSIS to optimize the site of distribution center in Turkey, considering aspects such as client demand, transportation costs, and service quality. The use of these strategies has allowed logistics organizations to lower operating costs, increase service delivery, while boosting the overall efficiency of the supply chain (Polat, 2022).

2.7 The Suitability of AHP and TOSIS

AHP and TOPSIS proved that they are more efficient when data is reliable and the criteria are defined clearly, making them appropriate for systematic decision-making scenarios (Chakladar & Chakraborty, 2008).

Other MCDM methodologies such as FUZZY AHP and FUZZY TOPSIS handles with significance uncertainty circumstances dealing with complex interdependence and linguistic criteria (Beskese, et al., 2015).

AHP effectively incorporates with reliable experts input systematically that makes suitable for site selection, while TOPSIS is appropriately integrates with weights resulted from methods such as AHP, utilizing the two methodologies allows to reach a logical and precise choice (Sharma, et al., 2020).

3. METHODOLOGY

This study uses a Geographical Information System (GIS), Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to find and rank the best locations for poultry farms in Mogadishu, Somalia. The response integrates these methodologies so as to provide a comprehensive evaluation of integrated google earth pro, expert opinion, and multi-criteria decision-making of the candidate locations for ranking based on their sitiabilibty. As discussed in the previous section, it is composed of three main modules: GIS for identifying potential sites, AHP for criterion weighting, and TOPSIS for site ranking.

3.1 GIS for Identifying Alternatives Sites

Using the Geographic Information System (GIS), potential locations throughout Mogadishu were mapped and evaluated. Google Earth Pro was utilized to gather spatial data and visually represent alternative sites based on predefined criterion. GIS analysis aids in the visual portrayal of alternative sites, allowing decision-makers to understand the geographical context of each choice.

3.2Analytica Hierarchy Process (AHP) for Criteria Weighing

3.2.1 Overview of AHP

The Analytical Hierarchy Process (AHP) is a decision-making process innovated by Thomas L. Saaty in the 1970s, that employs pairwise comparisons and statistical computation to determine priority. AHP enables decision-makers to arrange complicated situations in Hierarchical fashion and give weights to criteria using expert opinion (Aczél & Saaty, 1983).

3.2.2 AHP Method Steps and Formula

Step 1: Decision Matrix by Calculating Expert Judgment

- Nine professional judges will offer pairwise comparisons for each criterion.
- Create decision matrix by aggregating expert judgements using geometric mean methods A

1. Create the Pairwise Comparison Matrix:

$$A = \begin{bmatrix} 1 & a_{12} & a_{13} & \cdots & a_{1n} \\ \frac{1}{a_{12}} & 1 & a_{23} & \cdots & a_{2n} \\ \frac{1}{a_{13}} & \frac{1}{a_{23}} & 1 & \cdots & a_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \frac{1}{a_{3n}} & \cdots & 1 \end{bmatrix} \quad (1)$$

Where $a_{ij} = \frac{1}{a_{ji}}$ and $a_{ii} = 1$.

Step 2: Normalize the Matrix

- Normalize the decision matrix by dividing each member by the sum of its column. This procedure a normalized $A_{norm.}$

$$A_{norm} = \begin{bmatrix} \frac{a_{11}}{\sum_{i=1}^{n} ai1} & \frac{a_{12}}{\sum_{i=1}^{n} ai1} & \frac{a_{13}}{\sum_{i=1}^{n} ai1} & \cdots & \frac{a_{1n}}{\sum_{i=1}^{n} ain} \\ \frac{a_{21}}{\sum_{i=1}^{n} ai1} & \frac{a_{22}}{\sum_{i=1}^{n} ai1} & \frac{a_{23}}{\sum_{i=1}^{n} ai1} & \cdots & \frac{a_{2n}}{\sum_{i=1}^{n} ain} \\ \frac{a_{31}}{\sum_{i=1}^{n} ai1} & \frac{a_{32}}{\sum_{i=1}^{n} ai1} & \frac{a_{33}}{\sum_{i=1}^{n} ai1} & \cdots & \frac{a_{3n}}{\sum_{i=1}^{n} ain} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \frac{a_{n1}}{\sum_{i=1}^{n} ai1} & \frac{a_{n2}}{\sum_{i=1}^{n} ai1} & \frac{a_{n3}}{\sum_{i=1}^{n} ai1} & \cdots & \frac{a_{nn}}{\sum_{i=1}^{n} ain} \end{bmatrix} \quad (2)$$

Step 3: Calculate the Weights

- Calculate weights by averaging the normalized values for each row
- ensure total weight equals 1.

$$W_i = \frac{1}{n}\sum_{j=1}^{n} A_{norm}\,(i,j) \tag{3}$$

Where W_i is the weight of the i^{th} criterion.

Step 4: Calculate the Weighted Sum

- Multiply the original pairwise comparison matrix A by the obtained weighted sum.

$$\text{Weighted Sum} = A \times W \tag{4}$$

Step 5: calculate $\boldsymbol{\lambda_{max}}$

- calculate λ_{max} by dividing each member of the weighted sum by its corresponding weight.

$$\lambda_{max} = \frac{Weighted\ Sum_i}{W_i} \tag{5}$$

- Average all the values of λ_{max}.

Step 6: Consistency Index (CI)

- Compute the Consistency Index (CI) using the following formula:

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{6}$$

Where n is the number of criteria.

Step 7: Consistency Ratio (CR)

- Compute the Consistency Ratio (CR) to see if the pairwise comparisons are consistent. apply the formula:

$$CR = \frac{CI}{RI} \tag{7}$$

Where RI is the Random Index, a constant derived from the Criteria. If CR<0.1, the matrix is consistent.

3.3 TOPSIS Method by Ranking Alternatives

3.3.1 Overview of TOPSIS

TOPSIS, created by Hwang and Yoon in 1981, is a system for ranking options based on their distance from an ideal and negative ideal solution. The ideal solution increases benefit criteria and minimizing cost criteria, whereas the negative ideal archives the reverse (Hwang & Yoon, 1981).

3.3.2 TOPSIS Steps and Formula

Step 1: Construct the Decision Matrix:

1. Define the decision matrix D, with each row representing an alternative and each column representing criteria. Alternatives are graded on a scale from 1 to 5 for qualitative criteria, and accrual values are used for quantitative variables like land price.

$$D = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \dots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \tag{1}$$

$where\ x_{ij}\ represents\ the\ performence\ of\ the\ i^{th}\ alternative\ on\ the\ j^{th}\ citerion$

Step2: Normalize the Decision Matrix

1. $Normalize\ each\ member\ x_{ij}\ utilizing\ formuala$:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{2}$$

$$\text{for each element } i = 1,2,3,\ldots,m \text{ and } j = 1,2,3,\ldots.,n$$

These processes transform the performance matrix to a normalized matrix R.

Step 3: Construct the Weight Normalized Decision Matrix

1. Multiply each member of the normalized decision matrix R by the appropriate weight w_i of the AHP-derived Criteria:

$$v_{ij} = w_{ij} \,.\, r_{ij} \tag{3}$$

for each element i=1,2, 3…, m and j=1,2, 3, n

This generates the weighted normalized decision matrix V.

Step 4: Determine the Positive Ideal and Ideal Solutions

1. identify the positive ideal solution A^+ and the negative ideal solution A^-:
   - Positive Ideal Solution:

$$A^+ = \left(max_i v_{ij} if\ j \in J, min_i v_{ij}\ if\ j \in J`\right) \tag{4}$$

   - Negative Ideal Solution:

$$A^- = \left(min_i v_{ij}\ if\ j \in J, max_i v_{ij}\ if\ j \in J`\right) \tag{5}$$

Where J is the set of benefit criteria and J` is the set of cost criteria.

Step 5: Calculate the Separation Measures

1. Compute the Euclidean distance of each option from the positive ideal solution S_i^+ and the Negative Ideal Solution S_i^-:
   - Separation from Positive Ideal Solution:

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - A_j^+)^2} \tag{6}$$

   - Separation from Negative Ideal Solution:

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - A_j^-\right)^2} \tag{7}$$

Step 6: Calculate Relative Closeness to the Ideal Solution

1. Compute the Relative Closeness C_i of each alternative to the Ideal Solution:

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \tag{9}$$

for each alternative $i = 1,2,3, \dots, m$

- The higher the C_i, the closer the alternative is to the ideal solution.

Step 7: Rank the Alternatives

1. Rank options by their relative closeness C_i values, with larger values demonstrating better alternatives.

4. IMPLEMENTATION AND RESULTS

4.1 Study Area: Mogadishu, Somalia

Mogadishu, Somalia`s capital, serves as a crucial hub for the country`s political, economic, and social activity. Mogadishu, situated in southern Somalia on the Indian ocean, has long history as a major port city in the region. Over time, it has developed into a hub for trade and business, supporting not just the surrounding rural areas but also the country`s foreign trading interests. The city's geographic location provides access to lush agricultural fields, which are crucial for sectors such as farming and poultry production.

Despite the problems that Mogadishu has encountered in recent decades, including internal conflicts and times of insecurity, the city continues to grow particularly in terms of infrastructure, urban growth, and economic activities. This expansion is aided by upgrades in road infrastructure and the restoration of essential utilities and services in numerous sections of the city. Mogadishu's various industries and rapidly rising population provide continual demand for agricultural products, particularly poultry, making it a perfect site for such operations.

Mogadishu is a significant urban center in Somalia, covering a total area of 370KM^2. The city is organized into districts with varying populations, infrastructure, and land availability. The coastline position provides strategic advantages for commerce, with easy access to local as well as global markets. The city`s expansion and urban development have risen for accessible property, especially in regions with strong infrastructure and improved availability of services.

Mogadishu`s populations has continually expanded, with estimates ranging from 2.5 to 3 million people. This makes it the most populated metropolis, with a varied mix of urban and rural areas. The city`s population is made up of both locals and individuals who have moved from other parts of Somalia in search of better opportunities of job, education, and access to services. The rising population increases demand for food goods, notably poultry making Mogadishu an important market for agricultural firms.

The city`s fast urbanization has, in certain cases, overtaking infrastructural development, creating both benefits and drawbacks. Certain areas of Mogadishu have more established road networks, easier access to utilities like energy and water, and are closer to the demand markets. These qualities make such places appealing for enterprises, like poultry farming, but they also result in increased land prices. In contrast, more outlying sections of the city may have lower land prices but potentially encounter challenges including infrastructure, biosecurity, and market access.

As Safa company investigates prospective locations for constructing a poultry farm, Mogadishu offers various benefits. Firstly, the population assures a constant local need for poultry production, such as meat and eggs. Furthermore, Mogadishu`s location along the coast as shown in Figure 1, as well as roadways making it a hub for moving commodities not just inside the city but also to nearby regions. This is crucial for firms that want to grow and expand into larger markets over time.

Mogadishu`s tropical and semi-arid environment promotes agricultural operations. While the town has periods of drought, its proximity to agricultural areas such as Afgoye allows for the procurement of raw resources such as animal feed locally. Irrigation and water management will be critical for guaranteeing long-term operations, especially during dry periods. However, overall, the environmental conditions are favorable for poultry production.

Figure 1. Study area

Currently there are six large scale poultry farms in the area as shown in Figure 2.

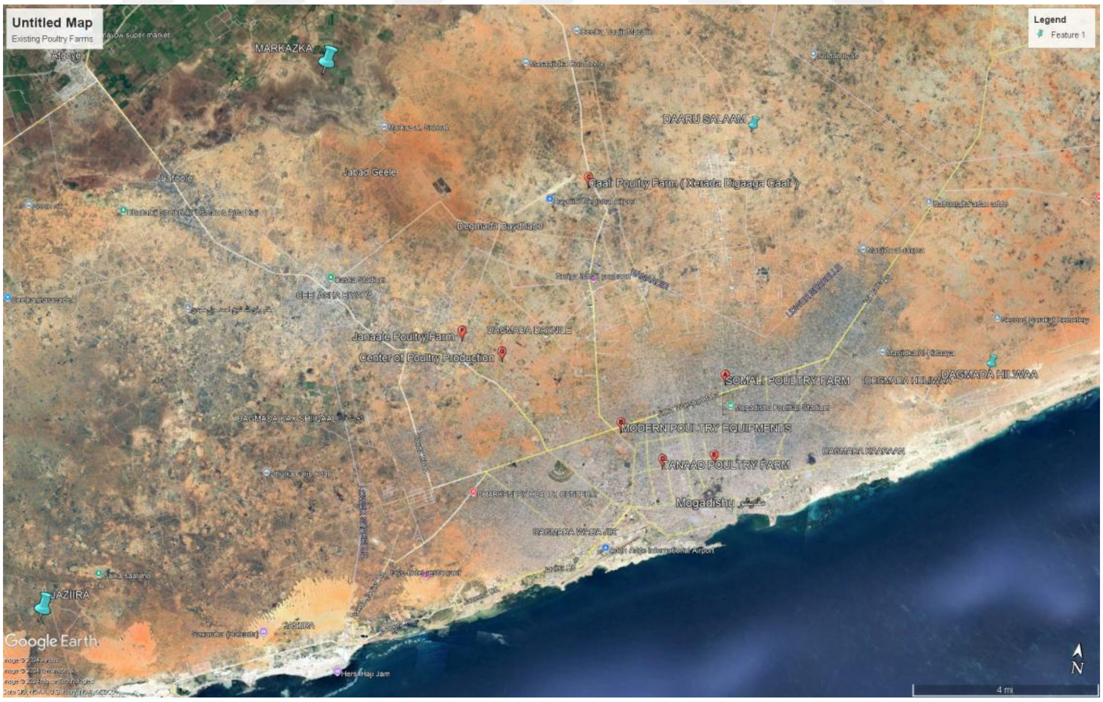

Figure 2. existing poultry farms in the area

In this area we have four alternatives for poultry farm in the area shown in Figure 3.

Figure 3. the four alternative sites.

4.2. Criteria for Poultry Farm Location

Six key variables must be considered when selecting the best location for a poultry farm. These criteria include both operational and logistical requirements of a poultry farm, to guarantee the selected site is suitable for success and secure operations. Each condition will be discussed in the following:

1. Land Cost

Land cost is one of the most important considerations when selecting sites for any business, including poultry farming. It relates to the price of the land in a certain location and has a direct influence on the initial investment required to start the farm. Land cost in Mogadishu fluctuates depending on proximity to major areas, infrastructure, and demand. Sites with lower land costs may provide a more affordable starting point, but this should be balanced against other operational aspects such as infrastructure availability and future expansion possibilities.

2. Accessibility of Transportation

Transport availability is essential for the movement of inputs (feed, equipment, and supplies) and outputs (poultry products) to and from the farm. A well-connected site to road networks allows improving logistics, which will result in lower transport costs and time. In poultry farming, transportation accessibility is important that timely deliver products to markets can have an impact profit. In Mogadishu, proximity to major roads or highways makes a location more attractive for meeting a supply chain effectively.

3. Proximity to the Market

This closeness to market it refers to how close a poultry farm to the consumers or merchants. Proximity to metropolitan areas or market hubs reduces transportation costs and allows for speedier delivery of fresh products. Because poultry goods have short lives, closer distances to markets can increase the product’s quality and freshness, leaving the farm with a competitive edge. For Safa company near Mogadishu's metropolitan population is an important factor in making chicken products easier and faster to reach their customers.

4. Safety

Safety Ensuring that the site mitigates threats to the poultry farm’s infrastructure and employees. This criterion also includes political stability and safety of the area, protection from theft, vandalism and natural disasters. In Mogadishu, the need for sites with comparatively low crime and higher overall security is vital for protecting the company and maintaining smooth operations. In addition, safety could affect the availability of trained individuals to do farm work.

5. Utilities

Poultry farming operations need utilities such as power, water, and waste management. Reliable access to these utilities is key for day-to-day operations, including providing clean water for chickens, maintaining a comfortable temperature with proper airflow and managing waste. Inconsistent or defective utilities can disrupt operations, adding costs and endangering animal health. Areas with existing utilities infrastructure will need to spend less in the first instance compared to those where a lot of ground needs to be laid.

6. Biosecurity

Biosecurity security is a prevention taken for protecting poultry farms from disease threats and pests. These can be detrimental to productivity. The site must be as isolated from other poultry farms or industrial areas as possible to minimize biosecurity. In Mogadishu, distance from livestock markets, other poultry farms, and industrial pollutants are among the variables balancing strong biosecurity standards, essential to both birds' health and the viability of poultry farms.

The land prices, transportation accessibility, closeness to the market, safety, utilities, and biosecurity are the six criteria that are necessary for making an informed decision related to the site selection of the poultry farm of Safa company. Balance between each of these criteria in regard to operating costs, long-term viability and logistics, which can help to sustain the poultry farm in general.

4.3. Alternatives of the Poultry Farm

In this section, we discuss the four potential sites for the poultry farm proposed by Safa Company in Mogadishu. Six criteria land cost, transit accessibility, proximity to market, safety, utilities, biosecurity, are utilized in examining the options A1 (Markazka), A2 (Daaru Salaam), A3 (Hilwaa), A4 (Jaziira). Different characteristics of each area will be positively analyzed to find out the suitable location for Safa Company milk poultry farm.

A1: Markazka

- **Land Cost**: Markazka is not the most affordable land but being positioned strategically next to the key agricultural region of Afgoye, gives some benefits, especially to farming businesses such as Safa Company.
- **Accessibility of Transportation**: The transportation alternatives in Markazka are fairly restricted. While roads link it to Mogadishu, the infrastructure is less advanced than other locations. This may result in greater logistical costs and sometimes delays particularly when shipping poultry or feed.

- **Proximity to the Market:** Markazka is moderately near to Mogadishu provides Safa Company with good access to major markets. The site is not the closest to agricultural fields but its relative nearness could ease the handling of farm supplies and may off-set what otherwise would be a greater distance to metropolitan markets.
- **Safety:** Due to its rural area Markazka does provide overall peaceful area, but additional protection is required to get help in case of any unforeseen event such as emergency. The semi-isolated site offers certain safety advantages, but it also requires Safa Company to consider potential external hazards.
- **Utilities:** are quite limited in Markazak`s, basic services like electricity and water are provided, infrastructure may need further expansion to accommodate a large-scale poultry operation.
- **Biosecurity:** a semi-rural environment the foot, which is critical for poultry production. Firstly, separation from metropolitan areas minimizes potential biosecurity risks, and therefore is easier to manage, observe and preserve a safe agricultural setting.

A2: Daaru Salaam

- **Land Cost**: In terms of land price, Daaru Salaam is the most costly places. However, the increased expenditure may be justified by its solid infrastructure and near to Mogadishu, ensuring long-term investment for Safa Company,
- **Accessibility of Transportation**: Daaru Salaam`s transport system provides huge benefits. The roads are advanced, allowing easy transit of products and services.

- **Proximity to the Market**: Daaru Salaam, located west-north of Mogadishu, with less access to the city`s marketplaces. This distance increases transportation expenses.
- **Safety**: Daaru Salaam is normally a safe area because of its proximity to the city. The area benefits from Mogadishu`s security presence, which reduces the need for extra farm security measures. This foundation of stability is critical to the efficient operation of the firm.
- **Utilities**: One of Daaru Salaam`s main features are its consistent availability to utilities. The neighborhood has well-developed infrastructure, so water and energy will be readily available. This is crucial for regular activities at the poultry farm, which relies on a constant supply of both.
- **Biosecurity**: while Daaru Salaam`s urban closeness raises the danger of disease transmission; its infrastructure enables the implantation of efficient biosecurity controls. Safa Company will need to invest in rigorous processes, but its connected position facilities the effective control of biosecurity threats.

A3: Hilwaa

- **Land Cost:** Hilwaa provides affordable priced land, making it an appealing choice for Safe Company, the smaller initial investment in ‘land allows for future growth or reallocation of finances to other operating requirements.
- **Accessibility of Transportation:** Hilwaa, being in an urban region, benefits from a well-established transportation system. This lowers logistical challenges, ensuring that products and services are transported efficiently and affordably, its downtown position provides easier access to markets than rural alternatives.
- **Proximity to the Market:** Hilwaa northern location in Mogadishu allows them easy access to main markets. This results in reduced trip times and lower transport costs, allowing Safa Company to effectively distribute fresh products to the local.
- **Safety**: In terms of safety, Hilwaa offers a solid environment for farming activities. Because of its distance from the metropolitan core, it avoids some of the hazards associated with city congestion and instability. However, due to its rural location, it might need extra safety precautions.

- **Utilities:** Hilwaa has great access to utilities. The urban setting guarantees that water and electricity are always accessible, which is essential for sustaining poultry farming operations at peak performance. This makes Hilwaa a good candidate for infrastructure.
- **Biosecurity:** Biosecurity in Hilwaa may be difficult owing to it is urban surroundings and increase human activities. However, by using suitable practices, Safa Company may efficiently handle these risks. The city`s infrastructure also enables faster adoption of biosecurity measures, which can assist alleviate some of the issues faced by the large number of residents.

A4: Jaziira

- **Land Cost:** Jaziira provides the most affordable land of all the possibilities. The affordable cost makes it a feasible alternative for a large-scale business. Allowing Safa Company to devote more resources to infrastructure improvements or capacity expansion,
- **Accessibility of Transportation**: Jaziira`s transportation system is in adequate, establishing logistical challenges, however, road conditions may cause price to go high as well as delaying the transit of goods with the proper investment this might improve.
- **Proximity to the Market**: Jaziira is further from Mogadishu than other candidates, making it less access to markets. The greater distance will most likely raise transportation costs and slow the delivery of items to the market.
- **Safety**: Jaziira`s coastline position provides safety benefits due to its remoteness. However, its isolation from metropolitan areas necessitates additional security measures to protect the farm from any external dangers.
- **Utilities:** The utilities in Jaziira are undeveloped. The lack of consistent access to water and power is a big disadvantage, and Safa Company would need to invest in infrastructural upgrades to guarantee the farm has the resources it requires to operate.
- **Biosecurity:** Jaziir`s remoteness protects the farm from the biosecurity hazards that is related proximity to populated areas. These restrictions from the human and animal population minimize the possibilities of disease transmission, that

makes an excellent candidate for biosecurity. Yet, the company needs to establish strict guidelines to protect the farm.

Finally, each site provides specific benefits and negative as well depending on the six criteria. Markazka offers a combination of cost and agricultural benefits, but infrastructure developments are required, Daaru Salaam stands out for its outstanding accessibility of transportation, but at a higher cost and distance to the market. Hilwaa offers affordable and reasonable infrastructure. Jaziira provides the most affordable land, but its infrastructure is underdeveloped, demanding significant investment. Safa Company sites will be Applied to AHP and TOPSIS methods in the following parts to make an informed decision about which site is the most appropriate for their poultry farm.

4.3 Application of the AHP Method

In this part, the Analytic Hierarchy Process (AHP) is utilized to find the criteria weights for the poultry farm. AHP is a systematic multi-criteria decision-making technique, that involves pairwise comparisons for the criteria, following the calculation of weights and at the end consistency checks. The six criteria which is considered for site selection are land cost, accessibility of transportation, proximity to the market, safety, utilities, and biosecurity. The procedures were carried out utilizing expert judgment, decision matrices, and consistency checks. The following are step by step explanations of the AHP processes.

Step 1: Pairwise Comparison Matrix

The first step in using AHP is to establish a pairwise comparison matrix based on expert evaluations. Nine experts offered input, and the geometric mean of their responses was used to form the final pairwise comparison matrix. This matrix shows the relative importance of each criteria on a scale from 1 (equal importance) to 9 (extreme importance).

Table 1: Pairwise Comparison by 9 experts (Geometric Mean)

Pairwise Comparison						
	C1	C2	C3	C4	C5	C6
C1	1	1.739472241	1.61562	0.80556	0.44611	0.47622
C2	0.615418385	1	1	1	1	1.69645
C3	0.618956117	0.885088152	1	1.44225	1.19581	0.83625
C4	1.241365817	1.195813175	0.69336	1	1.44225	1.44225
C5	2.241577369	1.241365817	0.83625	0.69336	1	1.12983
C6	2.09985894	0.77600366	1.19581	0.69336	0.88509	1
Sum	7.817176629	6.837743045	6.341049	5.634536	5.969265	6.581002

Step 2: Normalizing the Decision Matrix

The second step utilizes normalizing the pairwise comparison matrix to allow for comparison criteria. This is accomplished by dividing each element in the matrix by the total sum of the corresponding column. Table 2 demonstrates the normalizing matrix, making sure each column sums to 1.

Table 2: Normalized Decision Matrix

Normalizing the Matrix						
	C1	C2	C3	C4	C5	C6
C1	0.127923424	0.254392748	0.25479	0.14297	0.07474	0.07236
C2	0.078726427	0.146247087	0.1577	0.17748	0.16752	0.25778
C3	0.079178986	0.129441564	0.1577	0.25597	0.20033	0.12707
C4	0.158799766	0.174884193	0.10934	0.17748	0.24161	0.21915
C5	0.286750252	0.181546134	0.13188	0.12306	0.16752	0.17168
C6	0.268621145	0.113488274	0.18858	0.12306	0.14827	0.15195
	1	1	1	1	1	1

Step 3: Calculating Priority Weights

The priority weights for each criterion are generated by taking the averaging of the values in each row of the normalized matrix. These weights show the relative relevance of each criterion and are essential for further investigations. The weights are adjusted to ensure they add to 1, validating that they are correct.

Table 3: Calculating priority weights

Calculating the Priority Weight							
	C1	C2	C3	C4	C5	C6	Weights
C1	0.127923424	0.254392748	0.254788	0.142969	0.074735	0.072363	0.154528618
C2	0.078726427	0.146247087	0.157703	0.177477	0.167525	0.25778	0.164242899
C3	0.079178986	0.129441564	0.157703	0.255966	0.200328	0.12707	0.158281329
C4	0.158799766	0.174884193	0.109345	0.177477	0.241613	0.219153	0.180211968
C5	0.286750252	0.181546134	0.131879	0.123056	0.167525	0.171681	0.177072743
C6	0.268621145	0.113488274	0.188583	0.123056	0.148274	0.151953	0.165662442
Total Weight							1

Step 4: Calculating the Weighted Sum

The weighted sum for each criterion is calculated in two stages

1. **Original Pairwise Comparison:** The pairwise comparison matrix and priority weights are multiplied calculated in Step 3.

2. Summing Rows: The sum of each row in the resulting matrix are resulting in, the weighted sum.

Table 4: Original Pairwise Comparison with weights

Calculating Consistency						
	C1	C2	C3	C4	C5	C6
C1	1	1.739472241	1.615623	0.805564	0.446114	0.476222
C2	0.615418385	1	1	1	1	1.696448
C3	0.618956117	0.885088152	1	1.44225	1.195813	0.836251
C4	1.241365817	1.195813175	0.693361	1	1.44225	1.44225
C5	2.241577369	1.241365817	0.836251	0.693361	1	1.129831
C6	2.09985894	0.77600366	1.195813	0.693361	0.885088	1
Criteria Weight	0.154528618	0.164242899	0.158281	0.180212	0.177073	0.165662

Table 5: Summing Rows to Get Weighted Sum

Calculating Weighted Sum							
	C1	C2	C3	C4	C5	C6	Weighted Sum
C1	0.154528618	0.285695964	0.255723	0.145172	0.078995	0.078892	0.999006816
C2	0.095099753	0.164242899	0.158281	0.180212	0.177073	0.281038	1.055946387
C3	0.095646433	0.145369444	0.158281	0.259911	0.211746	0.138535	1.009489148
C4	0.191826544	0.196403823	0.109746	0.180212	0.255383	0.238927	1.172498153
C5	0.346387853	0.203885521	0.132363	0.124952	0.177073	0.187171	1.171831599
C6	0.3244883	0.127453091	0.189275	0.124952	0.156725	0.165662	1.088555719

Step 5: Calculated $\boldsymbol{\lambda_{max}}$

To calculate λ_{max}, the weighted sum of each criterion is divided by the corresponding priority weights. The average of these values gives λ_{max} which is basic for the consistency check.

Table 6: Calculating $\boldsymbol{\lambda_{max}}$

Calculating λ_{max}		
Criteria Weight	Weighted Sum	Ratio W S/ W C
0.154528618	0.999006816	6.464866048
0.164242899	1.055946387	6.429175275
0.158281329	1.009489148	6.377815711
0.180211968	1.172498153	6.506216914
0.177072743	1.171831599	6.617797725
0.165662442	1.088555719	6.570926417
λ_{max}		6.494466348

Step 6: Consistency Index (CI)

The Consistency Index (CI) is calculated to analyze the consistency of the expert inputs. The formula for CI is:

$$CI = \frac{\lambda_{max} - n}{n - 1} \qquad (6)$$

Where n is the number of criteria (6 in this case). The calculated CI is demonstrated in Table 6.

Table 7: Consistency Index

Consistency Index	
CI	0.09889327

Step 7: Consistency Ratio (CR)

To check the matrix is consistent, the Consistency Ratio (CR) is analyzed. The CR is results by dividing the CI by the Random Index (RI), which is a standard value based on the number of criteria.

Table 8: Random Index (RI)

Random Index Table										
N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Table 9: Consistency Ratio (CR)

$$CR = \frac{CI}{RI} \tag{7}$$

A CR value below 0.10 indicates that the comparisons are consistent.

Consistency Ratio	
CR	0.079752637

The AHP method was successful, and the consistency ratio of 0.07975263 assures that the pair wise comparisons were consistent. The priority weights found will be utilized in the upcoming parts for extended analysis by TOPSIS method, which will rate the four candidate sites considering the AHP-resulted weights.

4.4 Applying TOPSIS Method to Rank the Alternatives

In this part, the study utilizes the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) approach to rate the four candidate sites for Safa Company`s poultry farm using the AHP weights found in the previous part. The six criteria are land cost, accessibility of transportation, proximity to the market, safety, utilities, and biosecurity, were evaluated by nine expert judges using a scale 1 to 5 to demonstrate the pairwise comparison of each alternative, except for land cost, which was collected from real estate agents.

The candidates for Safa Company`s poultry farm are as follows

- A1: Markazka
- A2: Daaru Salaam
- A3: Hilwaa
- A4: Jaziira

The following steps outline the process of implementing the TOPSIS method to rank these alternatives, with final goal of identifying the most suitable site for Safa Company`s poultry farm.

Step 1: Constructing the Decision Matrix and Determining the Weight Criteria

The first step is to establish a decision matrix using the expert assessments for each criterion. The experts rated each possibility on a scale from 1 to 5, with 1 indicates the least importance, and 5 indicates the least importance. The previously determined AHP weights are added to the criterion, reflecting their relative importance in the final decision.

Table 10: Decision matrix and Criteria Weight

Criteria	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**
Weights	0.154528618	0.16424	0.15828	0.18021	0.17707	0.16566
A1	10000	2.66667	2.66667	2.66667	3	3.22222
A2	15000	3.44444	3.66667	3.55556	4	3.22222
A3	6000	3.33333	3.33333	3.66667	3.66667	3
A4	4000	3	2.77778	2.77778	3.66667	3.55556

Step 2: Calculating the Normalized Decision Matrix

This stage normalizes the decision matrix, ensuring that all criteria are stated in comparable units. The normalized matrix is computed by dividing each value in the decision matrix by the square root of the sum of squares of the corresponding criterion.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \text{ for each element } i = 1,2,3, \dots, m \text{ and } j = 1,2,3, \dots., n \quad (2)$$

Table 11: Normalized Decision Matrix

Criteria	C1	C2	C3	C4	C5	C6
Weights	0.154528618	0.16424	0.15828	0.18021	0.17707	0.16566
A1	0.515026203	0.42654	0.42493	0.4169	0.41647	0.49481
A2	0.772539304	0.55094	0.58428	0.55587	0.55529	0.49481
A3	0.309015722	0.53317	0.53116	0.57324	0.50902	0.46068
A4	0.206010481	0.47985	0.44263	0.43427	0.50902	0.54599

Step 3: Criteria Weights Times Normalized Decision Matrix

Before obtaining the Positive Ideal Solution (PIS) and the Negative Ideal Solution (NIS), multiply each normalized decision matrix value by the corresponding AHP-derived weight for that criterion. This stage guarantees that the criteria weights are applied to reflect the relative importance of each criterion in the decision-making process.

Table 12: Weighted Normalized Decision Matrix

Max/Min	Min	Max	Max	Max	Max	Max
Criteria	C1	C2	C3	C4	C5	C6
A1	0.079586287	0.07006	0.06726	0.07513	0.07375	0.08197
A2	0.119379431	0.09049	0.09248	0.10017	0.09833	0.08197
A3	0.047751772	0.08757	0.08407	0.1033	0.09013	0.07632
A4	0.031834515	0.07881	0.07006	0.07826	0.09013	0.09045

Step 4: Determining the Positive Ideal and Negative Ideal Solution

Determining the Positive Ideal Solution (PIS) and the Negative Ideal Solution (NIS) for each criterion. The PIS reflects the worst possible values.

- PIS: is the maximum value for the favorable criterion.
- NIS: sets the minimum and maximum values for advantageous criteria and non-beneficial criteria, respectively.

Table 13: Positive and Negative Ideal Solutions

A+	0.031834515	0.090488	0.09248	0.103305	0.098327	0.090451
A-	0.119379431	0.070056	0.067258	0.075131	0.073746	0.076318

Step 5: Calculating the Separation Measures from the Ideal Solutions

For each alternative, the separation measures from positive ideal solution (PIS) and the negative ideal solution (NIS) are computed. The separation measurements S^+ and S^-, represent the Euclidean distance between each alternative and the PIS and NIS, respectively.

Table 14: Separation Measures (Positive and Negative)

Alternatives	S+	S-
A1	0.069309592	0.04019
A2	0.088010343	0.04814
A3	0.024483575	0.08235
A4	0.036514093	0.0907

Step 6: Calculated the Relative Closeness to the Positive Ideal Solution

The relative closeness indicates how near each alternative is to the ideal solution. The greater the C_i value, the better the alternative is.

Table 15: Relative Closeness to Positive Ideal Solution

	Ci
A1	0.36704884
A2	0.353559166
A3	0.770835461
A4	0.712974619

Step 7: Ranking the Alternatives

Ultimately, the candidates are sorted according to their relative closeness values, with alternatives having the greatest C_i value selected as the best appropriate location for Safa Company`s poultry farm.

Table 16: Ranking Alternatives

	Ci	Rank
A1	0.36704884	3
A2	0.353559166	4
A3	0.770835461	1
A4	0.712974619	2

4.5 Results

Here are presented the site selection analysis for Safa Company`s poultry farm. The review was conducted utilizing excel 360, AHP and TOPSIS techniques, using data gathered from specialists with diverse professional backgrounds. The purpose of this research was to rank the four potential locations A1 (Markazka), A2 (Daaru Salaam), A3 (Hilwaa), and A4 (Jaziira) based on six criteria: land cost, accessibility of transportation, proximity to market, safety, utilities, and biosecurity.

4.5.1 Expert Demographic and Specialization

The expert panel was made up of nine experts with various titles and areas of competence, 55.6% had the title of Mrs. 11.1% were named Miss, and 11.1% were titled of Dr., the remaining 22.2% were classed and virous titles. This variety of expertise ensured that the analysis incorporated perspectives from individuals with varied professional occupations as shown in figure 4

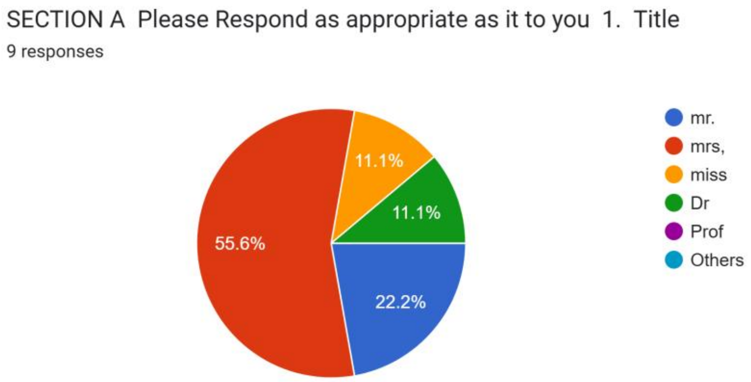

Figure 4. Expert Titles

Professional expertise was evenly distributed across important areas. 22.2% of the experts specialized in agriculture. Another 22.2% were veterinary medicine experts, 22.2% were logistics specialists, and 11.1% focused on economics. This diversity guaranteed that all key factors of poultry farm site selection such as land cost, market access, biosecurity, utilities and transportation were carefully considered as shown in figure 5.

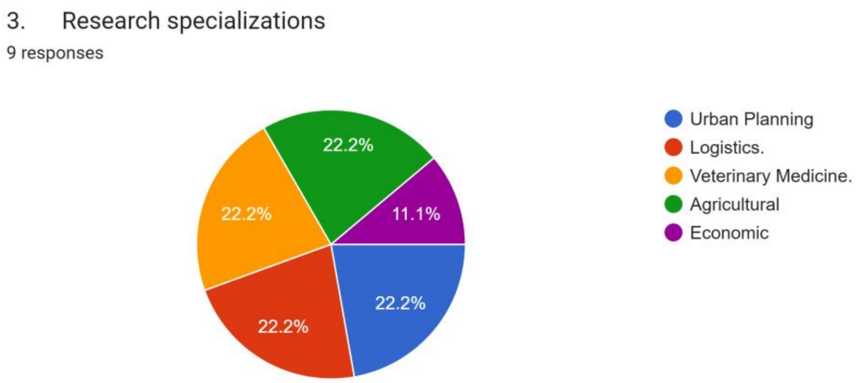

Figure 5: Research Specialization

4.5.2 Work and Site Selection Expertise

The specialist years of work experience also help to deepen the analysis. 44.4% of the specialists had fewer than ten years of expertise, while 55.6% had five to ten years. This distribution implies that the majority of the panel members were well-versed in their respective professions, contributing significant knowledge to the site selection process as shown in Figure 6.

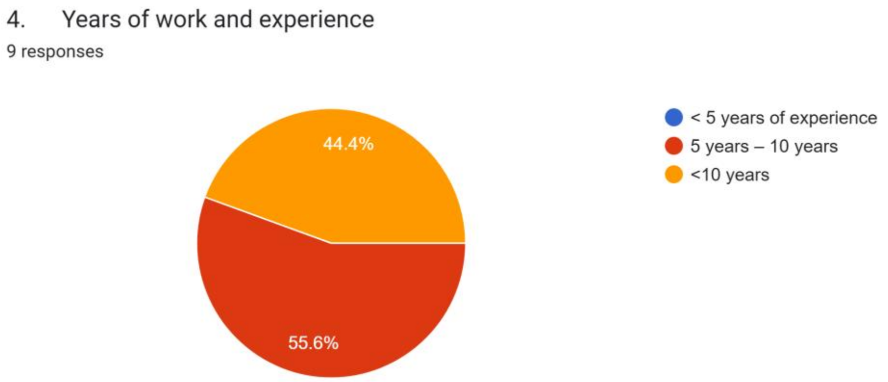

Figure 6. Years of Work and Experience

All of the specialists (100%) had prior expertise in site selection, ensuring that the evaluations were influenced by personals who understand the problems and concerns involved in choosing ideal sites for agricultural or commercial operations. This high degree of expertise increased the reliability of expert feedback as shown in figure 7.

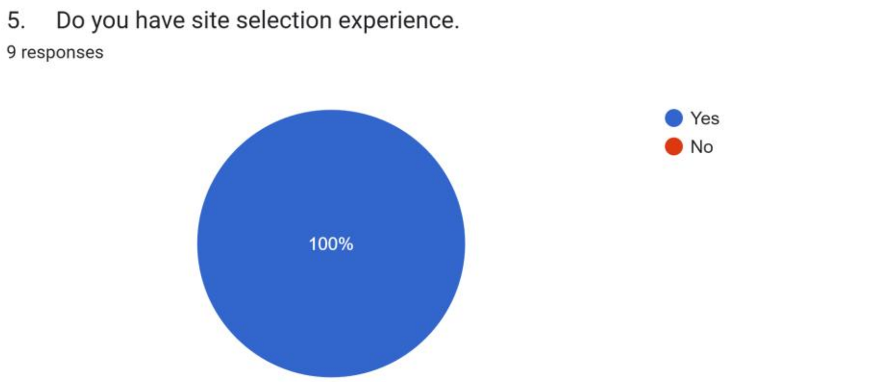

Figure 7. Site Selection Experience

4.5.3 Analysis Process

The AHP approach was used by excel 360 to generate the weights for the six criteria based on the expert responses. The result consistency ratio of 0.079752637 shows that the expert judgements were consistent and trustworthy, as the ratio was less than 0.1 threshold commonly used to measure consistency in AHP analysis.

These AHP derived weights were then utilized in TOPSIS technique to rank the following alternatives: A1 (Markazka), A2 (Daaru Salaam), A3 (Hilwaa), and A4 (Jaziira). The research found that A3 (Hilwaa) was the optimal site for Safa Company`s poultry farm. It is access to the important markets, utilities, safety, and biosecurity made as an appealing alternative for the company.

Jazira A_4 ranked second, for it is land cost, Safety and overall biosecurity, although it lacks well maintained roads and the distance from the main market make it the second-best alternative.

Markazka A_1 was ranked the third, due to it is land cost and biosecurity, it is distance from the main market, moderate safety makes it less attractive than Hilwaa and Jazira.

A_2 Daaru Salaam ranked fourth, although it is advanced infrastructure, safety, utilities, it is biosecurity and other considerations limited it is attractiveness compared to other candidates.

4.5.4 Tools for Data Collection

The expert input was gathered through Google Forms, which made the data collection easier. The questionnaires were analyzed by Microsoft Excel 365, that made it simple for the calculation of Analytical Hierarchy Process (AHP) and Technique for Order and Preference by similarities to Ideal Solution (TOPSIS). Also, the Geographical Information System (GIS) tools, especially Google Earth Pro, were utilized to gather alternative sites for exact betrayal of site locations and associated infrastructure.

To make an informed decision regarding Safa Company's poultry farm the combination of quantitative, expert insights techniques and spatial visualization plays a critical role in such selections. After analyzing data, the study demonstrated that Hilwaa A_3 ranked first while Jazira, Markazka were second and third respectively meanwhile Daaru Salaam was ranked fourth, both AHP and TOPSIS shows a powerful data driven way of ranking the alternatives making the decision site selection process for Safa Company more straightforward.

5. CONCLUSION

In this chapter will be presented the review of the study and focuses on a site selection for a poultry farm in Mogadishu, Somalia. Also, demonstrates results of the study, practical suggestions, limitations, as well as recommendations for Safa Company and the upcoming studies. Analytic Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) methods were utilized to analyze four potential locations, including A_1 Markazka, A_2 Daaru Salaam, A_3 Hilwaa, and A_4 Jaziira, which were evaluated according to six criteria for the poultry farm site.

5.1 Overview of the Study

The main objective of the research was to select a location for Safa Company's poultry farm by applying Multi-Criteria Decision-Making (MCDM) methods, four alternatives and six criteria were considered as follows:

1. Land Cost
2. Accessibility of Transportation
3. Proximity to the Market
4. Safety
5. Utilities
6. Biosecurity

These criteria were essential to maintain operational efficiency of the poultry farm. The Analytical Hierarchy Process (AHP) was utilized to make pairwise comparisons to those criteria and the resulted weight was assigned to Technique for Order and Preference to the Ideal Solution (TOPSIS) to rank the four alternatives.

5.2 Important Findings

Analytical Hierarchy Process (AHP) and Technique for Order and Preference by Similarity to the Ideal Solution (TOPSIS) approaches were applied to Analyze the sites and contribute to the process of site selection for the poultry farm. And the findings of results are follows

1. **Hilwaa (A_4)** turned out as the most optimal site driven by it is, infrastructure, utilities, proximity to the market and biosecurity, that enhances the operational efficiency which is the priority for the company. Hilwa was ranked first, for its overall safety, moderate biosecurity, utilities, and market access.

2. Jaziira (A_3) was rated second. Despite it is coastal location and having affordable land, the distance from Mogadishu`s major market and lack of infrastructure make it less attractive. However, the site`s biosecurity potential and affordability make it the second alternative, particularly if initial investment costs are a major issue.

3. Markazka (A_1), rated third. Despite its affordable land and proximity to Afgoye, which lies in an agricultural location, regardless of those advantages the site possesses challenges including lack of infrastructure and limited transportation accessibility. As well as demanding significant investments particularly utilities and transportation to become a fully operational poultry farm.

4. Daaru Salaam (A_2) rated forth. Regardless of having great road infrastructure and easy access to transportation, Daaru Salaam`s costly land and distance to a major market as well as biosecurity made it the least favorable alternative. The land price and biosecurity overshadow the advantages such as accessibility of transportation as well as its excellent utilities.

5.3 Research Contributions

This research contributes significantly to both the academic department and realistic decision-making processes in poultry farm site selection:

1. Promoting the MCDM in Site Selection: the research effectively demonstrated the use of AHP and TOPSIS to solve a challenging site selection problem, using these methodologies, the study offers a clear, structured, and quantitative strategy to make informed decisions relied on multiple criteria. This systematic method might be a useful model for organizations and studies encountering such difficulties.

2. Insights for Decision-Makers in Mogadishu: this study gives the region-specific perception into the components influencing poultry farm selection in Mogadishu. The research focused on Somalia`s especial socio-economic challenges, particularly the need to balance land and costs with biosecurity, infrastructure. Also, access markets. The methodology proposed in this study can help decision-makers to choose locations for future farm operations or other agricultural initiatives.

3. Expert-Based Evaluation: The study depends on the knowledge of specialists in agriculture, veterinary care, logistics, and economics. Their expertise guarantees that the decision-making process regards all necessary aspects for functioning poultry farm. The experts` reviews were important in initiating the weightings of the criteria and offering a strong analysis of the candidates.

5.4 Practical Implementation

The study`s results provide essential useful suggestions for Safa Company and others in the poultry farming industry. According to the study, Safa Company should prioritize especial locations while anticipating specific aspects for each site. The upcoming practical suggestions are proposed:

1. Select Hilwaa (A_3) as the Primary Site: showing it is proximity to urban, utilities, safety, and accessibility to the market Hilwaa should be the first choice Safa Company. Its solid infrastructure and market access make it perfect for the company`s sustainability and development. This site reduces operational difficulties associated with utilities and logistics and guarantees accessibility of important markets in Mogadishu.

2. Consider Jaziira (A_4) for Cost-Effective Operations: if the primary goal is reducing land cost. Jaziira offers a solid option. The along-shore environment and affordable land are benefits, especially if Safa Company invest in infrastructure to assist the farm`s activities.

Also, Jazira offers strong biosecurity which is essential poultry health and safety perspectives.

3. Improve Infrastructure for Markazka (A_1): At this stage Markazka is not ranked as Hilwaa or Jaziira, it stays as strong candidate if Safa Compony is ready to invest in road infrastructure and utilities which is out of it is capacity, the agricultural area encourages poultry farming, and with the infrastructure developments, Markazka potentially becomes a competitive option.

4. Avoid Daaru Salaam (A_2) for Poultry Farm: Its urban settings moreover, close to existing poultry farms reduced its biosecurity, Daaru Salaam is not proposed as an option for Safa Company`s poultry farm. The cost of buying land and biosecurity will totally affect this location of the farm, making other alternatives more appealing.

5.5 Limitations of the Study

While this study offers an understanding assessment of poultry farm location selection in Mogadishu, numerous constraints must be considered:

1. Limited Data Availability: The study depends on expert opinions to analyze the candidates. Although it was effective for this study, future studies might utilize machine learning by examining historical data using optimization algorithms, or regression models.

2. Weighting of Criteria: The AHP technique utilized to generate weight for the criteria by expert input. The upcoming studies might investigate alternate weightings systems.

3. Dynamic Market Conditions: Poultry farming sector is affected by modification in market needs, transportation infrastructure, and land use limitations. While the research offers an overview of present situations, these criteria may change over the period, which makes future studies adopt those changes.

5.6 Recommendations for the Future Studies

The findings of this research point to numerous areas of future studies that might promote MCDM methods for poultry farm site selection:

1. Explore Alternative MCDM Methods: While AHP and TOPSIS were successful in this study, the upcoming researchers which are facing challenges such as uncertainty might consider different MCDM methods, like FUZZY AHP, FUZZY TOPSIS, or

Goal Programing for uncertainty. These approaches enhance decision making by imprecision in expert judgements and fuzziness might offer more understanding of interdependence among the different aspects affecting site selection process.

2. Consider Broader Geographical Regions: This research concentrates four different locations in Mogadishu, Somalia. The upcoming studies might develop the geographical range to add neighboring countries, to investigate of site selection criteria over various environments.

3. Incorporate Environmental and Social Factors: while the research concentrates on operational and economic issues, future studies should include social and environmental considerations, like community affects, climate impacts, and sustainability.

4. Longitudinal Studies on Site Success: Future researchers might examine the sustainability of poultry farms based on site selection. This would offer useful information about the trustworthy and applicability of MCDM approaches for forecasting operational performance in poultry farms.

5. Environmental Considerations: Safa Company should implement sustainable farming practices at the selected site, including efficient waste management systems, conservation of water resources and measures to mitigate any potential degradation caused by farm operations.

6. Interacting with the Community: Addressing the challenges that community faces regarding the poultry, while contributing to the local neighborhood initiative developments will enhance the company to make strong relationships with the nearby communities.

7. Operational Standards and Animal Welfare: The structural of the poultry farm must be ensured to meet the standards of animal welfare, such as biosecurity measures, ventilation, space, and waste management.

5.7 Final Results

The research was effectively utilized AHP and TOPSIS approaches to obtain the most appropriate site for Safa Company`s poultry farm in Mogadishu, Somalia. This study subsequently focused on four sites based on the findings of six criteria, the results present that Hilwaa was ranked first, while Jaziira and Markazka were ranked second and third respectively, and Daaru Salaam Ranked fourth. The study seeks to advance poultry farming sector in Mogadishu, Somalia, by creating decision support that can be used in such contexts. Safa Company has been provided with obligatory information to make a wise decision about the location of the poultry farm, to ensure economic and operational sustainability while considering environment as well as animal welfare standards.

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