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Fuzzy Classifier Approach in Determining Viable Hospital Situating Regions in River State (Nigeria)

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Abstract

Hospital situating and location has been an integral part of health care delivery of any nation, contributing to economic growth and success. It provides an avenue where health care delivery can be harnessed quickly and it is afforded, in addition to numerous lives which will be saved. The approach adopted and currently on the ground in River State is subjective at best; which can be influenced based on politics, nepotism and tribalism. Therefore we propose an objective approach based on fuzzy classifier, with the aim of quick and objective recognition of situating regions for hospitals, based on available objective decision variables, parameters or criteria.

Keywords: Fuzzy Classifier, Fuzzy Logic, Fuzzy Cluster, Hospital Criteria, Situating, Set theory

1.0 Introduction

Hospital situating and location has been an integral part of health care delivery of any nation, contributing to economic growth and success. It provides an avenue where health care delivery can be harnessed quickly and it is afforded, in addition to numerous lives which will be saved [1]. A well situated hospital should possess relevant state-of-the-art equipment for relevant surgery and regular power supply to ensure optimal functioning of relevant equipment or stored away drug for emergency. Hospitals examine the processes that impact interventions and ultimately outcomes, addressing gaps in resuscitation and health care are critical operational functions. Finding ways to deliver consistent, high-quality CPR, responding rapidly throughout a hospital, and accurately measuring performance are just the beginning. Impacting outcomes takes an integrated approach that addresses and strengthens each link in the Chain of Survival [2]. Some of this equipment's includes:

a. Defibrillators and AEDs defibrillators and AEDs are available in many models and with hundreds of customizable features, functions, and languages to address the unique needs or organizations and clinicians everywhere.
b. Temperature Management: Intravascular Temperature Management system provides the power and control you need to rapidly, safely, and effectively manage the core body temperature of critically ill or surgical patient

Hospital equipment is useful and critical in saving life but is useless in poorly situated hospital facilities. In situating hospital several factors must been consider which includes [3]

a. **Young Mother:** Young mother are hospital concerned, because of their young children and lack of experience in handling certain medical conditions prevalent to young children. Therefore situating a hospital, in an area with increase population of young mother will in no small measure increase the viability of such hospital.
b. **First Time Mothers:** First time mother are very careful and timid in term of medical care. The ability to spend any amount of money in protecting their children is optimal in their heart and mind. An area with in-flock of first mother is an integral framework for success if a hospital can be situated in such areas.
c. **Young Children:** Young Children usually bring joy to parent and most importantly grand-parent. The excitement are usually wonderful and breadth taken. Any fragile of health upset usually in most cases drop them in the hospital theaters for medical checkup and treatment. Population of such ones produces seriously hospital situating criteria.
d. **Age persons:** Age person usually have fragile health and as such are in and out of hospital frequently. Chronic diabetes, glaucoma, frequent malaria, cramped joints and poor eyesight are illnesses associated with the elderly. These ones want quick treatment and not prolonged health issues. They old age also foster quick medical treatment and not unusual delay. If a hospital is sited very close to these elder people in enormous population success is the prime for such hospital.
e. **Chronic illness:** Some sickness such as Alzheimer and Diabetes are chronic illness which require frequent monitoring and management which in-turn is largely dependent on proper situating of relevant hospital.

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h. **Accessibility:** Accessibility is key, to hospital situating without which shortest path or distance to retrieving quick medical care will be totally impossible. Therefore while require hospital situating criteria are checked, accessibility is one of the most important for viable hospital placement factors.
i. **Social Economic Factors:** How is the mentality of the population toward western treatment and drug? Are they naïve? Are they open-mined? These relevant question must been answered for it determine successful of failure of such hospital.
j. **Steady GDP:** Steady GDP tell the money allocation and available of money fund without the locality. It is relevant in other to foster easy running of the hospital.

Nigeria is a nation with numerous tribe, political base, parties and influence which has in no small way hamper the situating of relevant hospitals in providing relevant health care delivery. Implementing a Fuzzy classifier approach is the focal point of this research paper utilizing fuzzy logic which will help build an objective system in situating hospitals in various communities in River State eliminating nepotism, tribalism and political influences in situating these hospitals.

2.0 Review of Related Literature

The approach on ground in River State (Nigeria) for situating relevant hospitals is subjective at best; based on political influence, nepotism and tribalism and not based on any objective techniques [1, 2].

A **Fuzzy *classifier*** is an algorithm that assigns a class label to an object, based on the object description. It is also said that the classifier *predicts* the class label [4]. The object description comes in the form of a vector containing values of the features (attributes) deemed to be relevant for the classification task [5]. Typically, the classifier learns to predict class labels using a training algorithm and a training data set. When a training data set is not available, a classifier can be designed from prior knowledge and expertise. Once trained, the classifier is ready for operation on unseen objects [6].

Classification belongs to the general area of pattern recognition and machine learning [7].

a. *Soft labelling.* The standard assumption in pattern recognition is that the classes are mutually exclusive. A standard classifier will assign a single *crisp* label (rain). A fuzzy classifier can assign degrees of membership (*soft* labels) in all four classes {rain, clouds, wind, sunshine}, accounting for the possibility of winds and cloudy weather throughout the day. A standard classifier can output posterior probabilities, and offer soft-labelling too. However, a probability of, say, 0.2 for cloudy weather means that there is 20% chance that tomorrow will be cloudy. A probabilistic model would also assume that the four classes form a full group, i.e., snow; blizzards or thunderstorms must be subsumed by one of the existing four classes. Soft labelling is free from this assumption. A fuzzy classifier, D , producing soft labels can be perceived as a function approximator $D:F\rightarrow[0,1]c$, where F is the feature space where the object descriptions live, and c is the number of classes. While tuning such a function approximator outside the classification scenario would be very difficult, fuzzy classifiers may provide a solution that is both intuitive and useful [8].
b. *Interpretability.* Automatic classification in most challenging applications such as medical diagnosis has been sidelined due to ethical, political or legal reasons, and mostly due to the *black box* philosophy underpinning classical pattern recognition. Fuzzy classifiers are often designed to be *transparent*, i.e., steps and logic statements leading to the class prediction are traceable and comprehensible [8].
c. *Limited data, available expertise.* Examples include predicting and classification of rare diseases, oil depositions, terrorist activities, natural disasters. Fuzzy classifiers can be built using expert opinion, data or both.

2.1 Fuzzy Rule-Based Classifiers

The simplest fuzzy rule-based classifier is a fuzzy if-then system, similar to that used in fuzzy control. Consider a 2D example with 3 classes. A fuzzy classifier can be constructed by specifying classification rules, e.g.

IF X1 is medium and X2 is small Then Class is 1
IF X1 is Medium and X2 is large Then Class is 2
IF X1 is large and X2 is small Then Class is 2
IF X1 is Large and X2 is small Then class is 3
If X1 is small and X2 is large Then Class is 3

The two features $x1$ and $x2$ are numerical but the rules use *linguistic values*. If there are M possible linguistic values for each feature, and n features in the problem, the number of possible different if-then rules of this conjunction type (AND) is Mn. If the fuzzy classifier comprises of all such rules, then it turns into a simple look-up table. Unlike look-up tables, however, fuzzy classifiers can provide outputs for combinations of linguistic values that are not included as one of the rules. Each linguistic value is represented by a membership function.

3.0 Methodology

The methodology adopted in this research paper is geared toward specifying fuzzy rules utilizing fuzzy set theory application. We utilize several criteria for hospital siting (Criteria (C): Young Mother, First Time Mother, young children, Age persons, Chronic illness, Access ability, Social Economic Factor and Steady GDP). Each of these criteria fall into a rule (P01-P09) and the fuzzy rules thus specifies:

a. IF area (community) exhibit $C \leq 3$ and each $C \geq (50\%)$ THEN Redraw Situating of Proposed Hospital
b. IF area (community) exhibit $C = 4$ and each $C \geq (50\%)$ THEN Might Situate Proposed Hospital
c. IF area (community) exhibit $C \geq 5$ and each $C \geq (50\%)$ THEN Situate Proposed Hospital.

In set theory, the union (denoted by ∪) of a collection of sets; is the set of all distinct elements in the collection. It is one of the fundamental operations through which sets can be combined and related to each other. The initial ∪ is initialized as P ∪∅ = P, for the set P. Therefore the fuzzy set rules are thus:

P0: P ∪∅
P01: {∅∪ Young Mothers} = Redraw Situating of Proposed Hospital
P02: {∅∪ Young Mother} ∪ First Time Mother = Redraw Situating of Proposed Hospital.
P03: {∅∪ Young Mothers ∪ First Time Mothers} ∪ Young Children = Redraw Situating of Proposed Hospital.
P04: {∅∪ Young Mothers ∪ First Time Mothers ∪ Young Children} ∪ Age Persons= Might Situate Proposed Hospital.
P05: {∅∪ Young Mothers ∪ First Time Mothers ∪ Young Children ∪ Age Persons} ∪ Chronic illness = Situate Proposed Hospital.
P06: {∅∪ Young Mothers ∪ First Time Mothers ∪ Young Children ∪ Age Persons ∪ Chronic illness} ∪ Accessibility = Situate Proposed Hospital.
P07 {∅∪ Young Mothers ∪ First Time Mothers ∪ Young Children ∪ Age Persons ∪ Chronic illness ∪ Accessibility} ∪ Social Economic Factor = Situate Proposed Hospital.
P08 {∅∪ Young Mothers ∪ First Time Mothers ∪ Young Children ∪ Age Persons ∪ Chronic illness ∪ Accessibility ∪ Social Economic Factor} ∪ Steady GDP growth = Situate Proposed Hospital.

4.0 Simulation Result

The simulation Results were based on the dataset derived online pertaining to two main communities (Choaba and Ozuoba,) in River State.

Table1: Dataset for Choaba

Fuzzy Codes	**Fuzzy Set**	**Online Values Pertaining to Fuzzy Set pertaining to Choaba (%)**	**Membership Function (Scale Value 0.00 -1.0)**
P01	Young Mother	70	0.70
P02	First Time Mother	80	0.80
P03	Young Children	90	0.90
P04	Age Persons	40	0.40
P05	Chronic illness	20	0.20
P06	Accessibility	50	0.50
P07	Social-Economic. Factors`	10	0.10
P08	Steady GDP	50	0.50

Table 1, represents the degree of membership function for hospital situating criteria in choaba community in River State, for instance, P05 in Column 4, we notice it has 0.20. In percentage, it can be represented as 20% that is 20% of the populations in choaba community are chronic illness persons. This means that the degree of membership function of P05 matches **0.20 of the fuzzy scaled ranged values for chronic illness person.** The Fuzzy clustering graphical distribution shown Figure 1, depicts five criteria with high degree of membership function for "Situate Proposed Hospital", one criterion for "Might Situate Proposed Hospital " and two criteria igniting "Redraw of Situating Proposed Hospital".

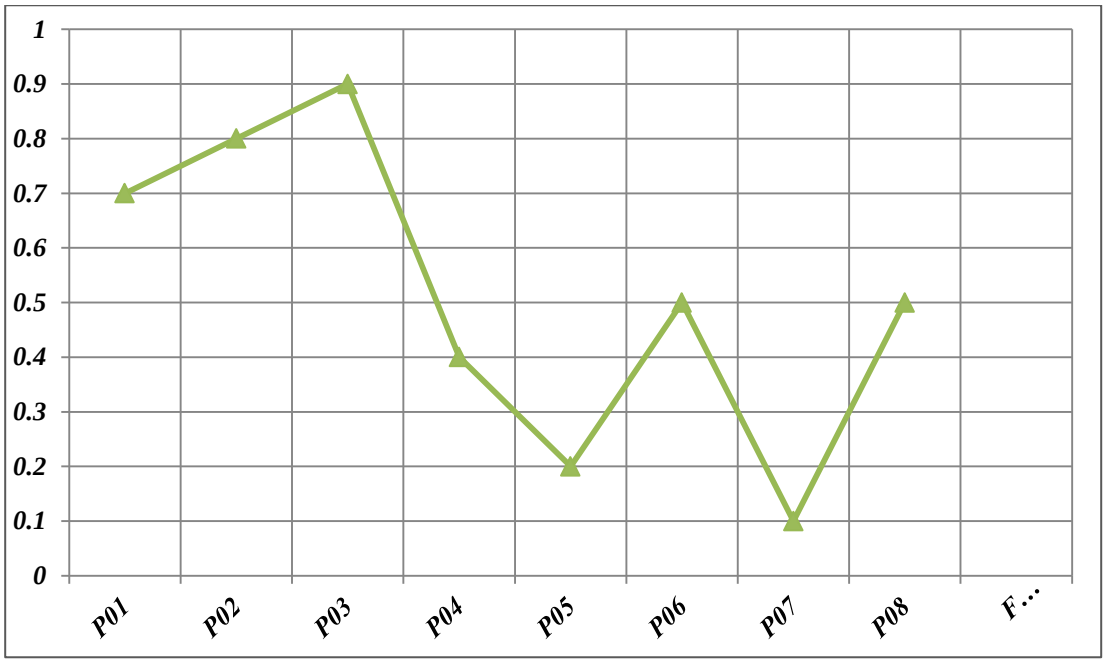

Figure 1: Graphical Fuzzy Distribution for Chaoba

Based on the predefined fuzzy rules specified and the online dataset retrieved:

a. IF area (community) exhibit C ≤ 3 and each C ≥ (50%) ***THEN*** Redraw Situating of Proposed Hospital
b. IF area (community) exhibit C = 4 and each C ≥ (50%) ***THEN*** Might Situate Proposed Hospital
c. IF area (community) exhibit C ≥ 5 and each C ≥ (50%) ***THEN*** Situate Proposed Hospital.

Choaba community is a viable location in situating Proposed Hospital.

Table 2: Dataset for Ozuoba

Fuzzy Codes	**Fuzzy Set**	**Online Values Pertaining to Fuzzy Set pertaining to Ozuoba (%)**	**Membership Function (Scale Value 0.00 -1.0)**
P01	Young Mother	30	0.30
P02	First Time Mother	30	0.30
P03	Young Children	10	0.10
P04	Age Persons	40	0.40
P05	Chronic illness	20	0.20
P06	Accessibility	50	0.50
P07	Social-Economic. Factors`	10	0.10
P08	Steady GDP	50	0.50

Table 2, represents the degree of membership function for hospital situating criteria in Ozuoba community in River State, for instance, P06 in Column 4, we notice it has 0.50. In percentage, it can be represented as 50% that is 50% of Ozuoba community has accessible road network. This means that the degree of membership function of P06 matches **0.50 of the fuzzy scaled ranged values for access road.** The Fuzzy clustering graphical distribution shown Figure 2 depicts two criteria with high degree of membership function for "Situate Proposed Hospital", one criterion for "Might Situate Proposed Hospital " and five criteria igniting "Redraw of Situating Proposed Hospital".

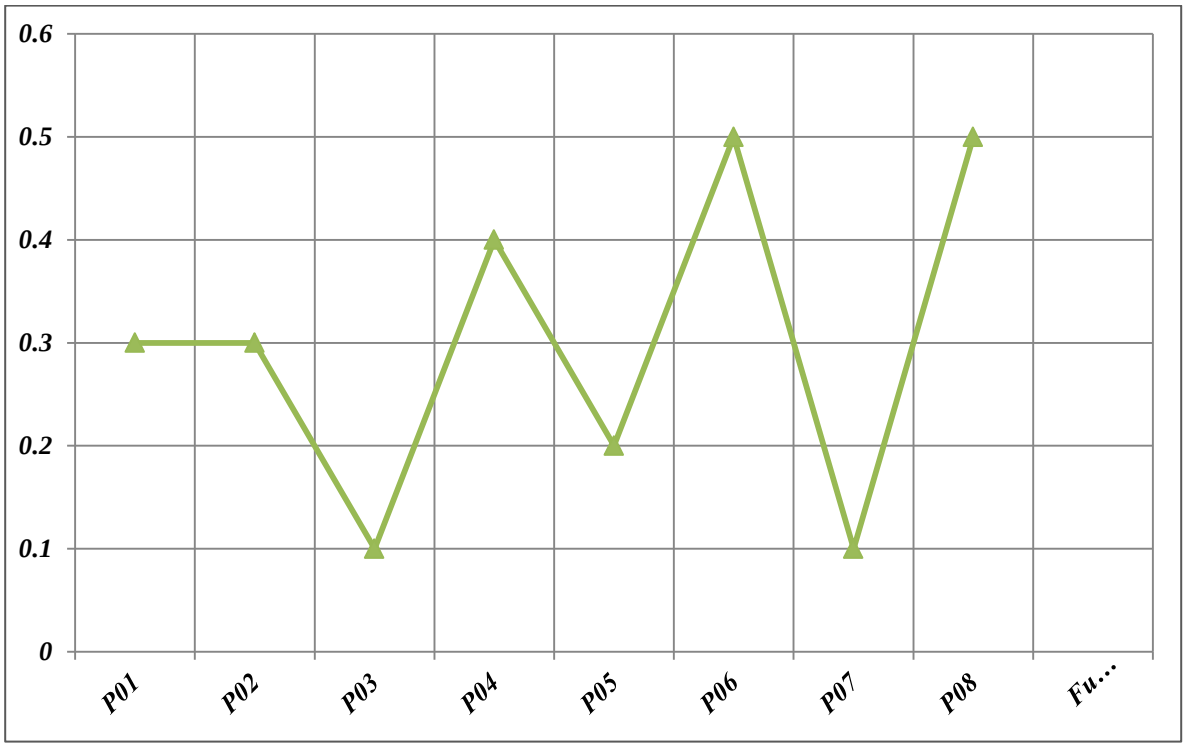

Figure 2: Graphical Fuzzy Distribution for Ozuoba

Based on the predefined fuzzy rules specified and the online dataset retrieved:

a. IF area (community) exhibit C ≤ 3 and each C ≥ (50%) ***THEN*** Redraw Situating of Proposed Hospital
b. IF area (community) exhibit C = 4 and each C ≥ (50%) ***THEN*** Might Situate Proposed Hospital
c. IF area (community) exhibit C ≥ 5 and each C ≥ (50%) ***THEN*** Situate Proposed Hospital.

Ozuoba community is a viable location in situating Proposed Hospital.

5.0 Discussion

The main focus of our approach is geared toward recognizing appropriate communities for hospital situating in River State utilizing the rich facilities of fuzzy set theory application which is more pivotal in nature, flexible and robust. Unlike previous approaches which are times consuming and quite expensive because of political undertones, nepotism and tribalism this approach tunes up decision variables exhibited within each region in achieving objectives results.

6.0 Conclusion

An objective approach in situating relevant hospitals cannot be over-emphasized. Therefore we have objectively appraised a fuzzy classifier approach for hospital situating in relevant communities in River State utilizing the rich facilities of fuzzy logic sub-domain fuzzy classifier with the aim of sub-dividing criteria occurrence or decision variables into varied classes which is more precise than the previous approaches in which situating of proposed hospital were based on majorly political influences, tribalism and nepotism and not on the decision variable (parameters) for situating hospital exhibited by a particular region or community.

7.0 References

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