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A Proposed Model for Determining a Level of Corruptionin Nigeria Using Mamdani Fuzzy Inference Frawework

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ABSTRACT *:This paperproposed a model based on inference rule to model corruption and determine the level of corruption based on certain rules. It remains difficult to reduce corruption within the working class, but attempts have been made by various agencies to mitigate the menace. This paperanalyzed the inadequacies of the anti-corruption strategies and attempted to develop an artificial intelligence model based on fuzzy logic framework for the control of corruption in Nigerian. The methodology employed fuzzy rule-base inference system methodology using four inputs variables: funding, logistics and operational equipment (FLOE) condition of service, remuneration and motivation (CSRM); recruitment/employment, training and promotion (RTP); confidence and support by the community (CSC); were used to determine the corruption severity level. An output variable: corruption severity level (CSL) was adopted for the model development.*

KEYWORDS:*Corruption,Fuzzy, Level Mamdani, Model*

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I. INTRODUCTION

One of the greatest problems to economic and political development of any nation is corruption. The challenges of corruption remain a major negative issue facing a developing country like Nigeria since the colonial period, although, this phenomenon has become a cankerworm that has eaten deep into the fabrics of our system. Nevertheless, its solution rests in our hands and cannot be put off to another day. That is why many countries have put in place different mechanisms for checkmating the spate of corruption. In Nigeria for example, the menace of corruption has been discussed at different levels, yet this ugly incidence keeps surviving with the nation at all facets of endeavours, (Mohammed, 2013).

Obtaining robust measures of corruption is a very difficult task due to the very illicit and secretive nature of corrupt practices. Though, it is possible to quantify people's perception of corruption within a society or country. Various perception indices have been developed by several institutions and have been used by various researchers. Two (2) widely used of such indices are the International Country Risk Guide (ICRG) and the Transparency International Corruption Perception Index (TICPI), (Abdulrahman, 2014). The menace of corruption in Nigeria is endemic and on the increase despite several attempts even by successive governments to ameliorate the blight. The issue is global and it is without a uniform definition. In Nigeria, corruption has become the order of the day happening among the young and the old, the politician and the non-politician as well as military and the non-military. The unstoppable social economic scourge has suggested different meanings to different scholars from different schools of thought (Rotimi, Obasaju, Lawal, &IseOlorunkanmi, 2013).

II. RELATED WORK

Hoffmann and Patel (2017) in their report advocate that corruption is a destructive and complex practice is openly acknowledged in Nigeria, yet it remains ubiquitous in the functioning of society and economic life. The consequences of corruption for the country and its people are, moreover, indisputable. Acts of diversion of federal and state revenue, business and investment capital, and foreign aid, as well as the personal incomes of Nigerian citizens, contribute to a hollowing out of the country's public institutions and the degradation of basic services. All the same, corruption is perhaps the least well understood of the country's challenges.

Waykar (2013) In their paper they have studied the topic for measuring and removing corruption from the society by using mathematical modelling. They observed and concluded that the real world problem is “corruption” from the society they convert this problem in to mathematics problem then they get some models such as “Mathematical Corruption Model, Mathematical Corruption Control Model, Mathematical Corruption-Development Model, Mathematical Development Model and Mathematical E-virus Constant Model”. They are used for measuring as well as removing the corruption from the society of any country of the world. Schleifer (1993) shows that the effect of corruption on the economy is nonlinear and bounded by a corrupt-free output and a subsistence level of output. Since every government agent in an economy will not leave the productive sector to become corrupt, some level of output will be p

Morteza, Gholamreza, and Hamed (2013) Studied Administrative corruption by Providing a fuzzy inference system of good governance to combat corruption. The study aims to propose a comprehensive model to measure the administrative corruption through a widespread study in the review of literature of previous studies. In the study the definition of fuzzy systems of effective factors on administrative corruption including predictive variables of a good governorship of a world bank like: comment right and responding, political stability, lack of violence, the effectiveness of government, the quality of regulations, the authority of law and the control of corruption have been used. All various dimensions of a good governorship to fight against the corruption were used as an input of the fuzzy inference system and of corruption as an output of a system. Afterwards, the membership dependencies and fuzzy rules, the fuzzy inference system for measuring the administrative corruption was designed by using good governorship indicators. Finally, the output of the model was compared with the experts' opinion. Also rule formation was extracted by applying the opinion of five university professors. The results of the study showed that the results of experts' opinion and those of the fuzzy inference system were close together and this represents a high validity of a system. The study concludes that the validity lies in the identification of appropriate units of measurement for predicting. the study units of measurement were extracted from the World Bank.

Voinea (2013) developed Corruption Emergence Model an artificial society-based simulation model of the corruption emergence. The model considers the attitude change as a generative mechanism. The attitude changes are described and simulated with a set of self-organizing processes which feed on each other in a cross-recurrent setup. The simulation model investigates the connection between the dynamics of the processes describing the social trust, the cognitive dissonance of the agents, their honesty, fairness and responsibility degrees and the emergence of corruption in the artificial society. The results revealed that a global view over an artificial society in which corruption emerges in certain initial conditions (a certain number of agents, of common resources, of private resources and of certain values of the variables: trust, responsibility, honesty, fairness, and cognitive dissonance). The corruption level and its dynamics in the society prove to be path dependent. It has also revealed that, the artificial society used by the Corruption Emergence Model proves that the origins of corruption and its generating mechanism lies in the attitude change.

Maigari (2016) employed the use of Fuzzy Logic Control (FLC) methodology to design a system for the determination of severity level of Osteomyelitis in adults and children. He stated that Fuzzy models have the capability of recognizing, representing, manipulating, interpreting, and utilizing data and information that are vague and lack certainty in which medical field is not an exemption. In his model, he used four input (pain, swelling, fever and age) and one output (severity level). Multiple Input Single Output (MISO) rules fuzzy controller was designed and implemented, and will provide a valid fuzzy inference system that will determine the severity level of Osteomyelitis based on identified factors (input variables). The system developed will allow users to input symptoms in natural language term and not precise values and will make computer interaction easier by using linguistic variables which facilitates human description using natural language. The results show that work tries to eliminate the error-prone conclusion in decision making by modelling and developing several input cases, rules and the implementation.

III. MODEL FORMULATION

An expert system is a computer program that helps in solving problems demanding substantial human expertness by using explicitly exhibited domain knowledge and computational decision procedures. These are designed to make available some of the skills of an expert to non-experts, as they attempt to imitate the thinking patterns and logical decisions of an expert. The FES makes use of the theory of fuzzy reasoning. (Zadeh, 1983). Fuzzy inference is the process of developing the mapping from a given input to an output using fuzzy logic which then offers a base from which decisions can be made or patterns perceived. The classical logic has only two truth values, true or false, and so the process of inference is simplified as compared to fuzzy logic, where we have to be concerned not only with propositions but also with their truth values. Every FES has a fuzzy inference system that reasons using fuzzy logic membership functions, which refers to the degree to which the value of a particular attribute belongs to a set. The FES designed and employed in this research can be generalized by means of a simple structure as shown in Fig.3.1 below:

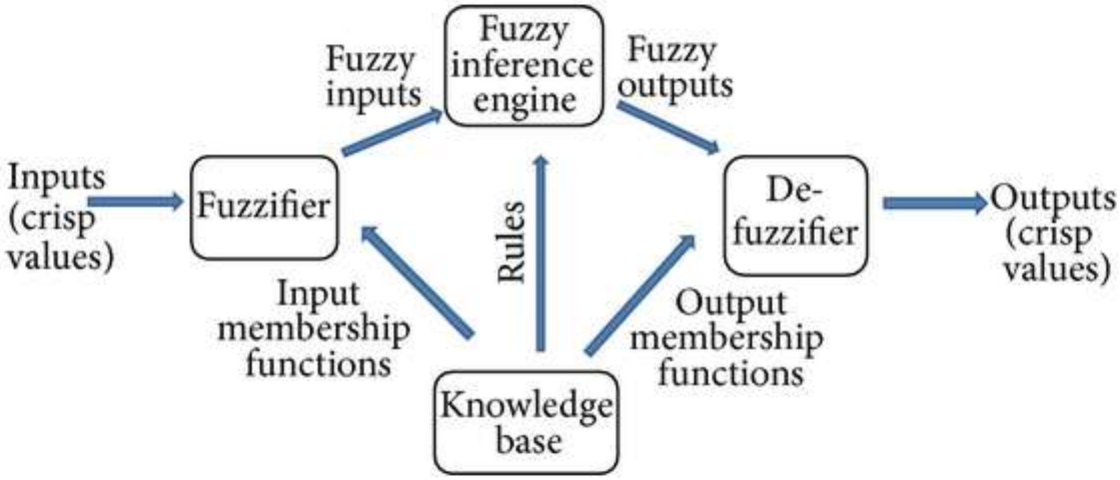

Fig. 3.1 Structure of the Fuzzy Expert System

The FES developed in this research employs the Mamdani type fuzzy inference technique. This technique is performed in four steps:

i) fuzzification of the input variables: done by the fuzzification module, which translates crisp inputs into fuzzy ones; that is, classical measurements are converted to fuzzy values through the use of linguistic variables;
ii) application of the Fuzzy operator and formation of rules for evaluation: done by a set of if-then fuzzy rule bases or knowledge bases, consisting of a set of conditioned fuzzy propositions;
iii) aggregation of the rule outputs: done by the fuzzy inference engine which has a specific inference method—here the Mamdani type. It applies fuzzy reasoning mechanisms to obtain outputs and carries out the computation using fuzzy rules;
iv) defuzzification: done by a defuzzification module which transforms fuzzy outputs back to crisp values.

The fuzzifier converts the crisp inputs which are supplied to the system to fuzzy inputs and also determine the degree to which these inputs belong to each of the appropriate fuzzy sets. These fuzzy inputs are then used in the inference engine to generate fuzzy outputs. For developing control tool for corruption in NPF, data is required that is capable of representing the menace as well as the severity of the corruption. Basically the data consists of opinion of the experts, corruption reports, journals, and other secondary sources. By consulting the experts and by analysing the data from the other sources mentioned four attributes wereconsidered and used as the inputs variables for determining the corruption severity levels. Fuzzy values were assigned for each of these input variables to get different fuzzy sets based on the expertise of the specialists and knowledge from the standard textbooks and journals. Triangular membership function was adopted for both inputs and output variables to simplify computation. The membership function parameters for the input variables and the membership function plots for the input variables and the output variable is given below:

i) Condition of Service, Remunerations and Motivation (CSRM) having linguistic variables and parameters as follows: Poor [0 2 4], Moderate [2 4 6], Good [4 6 8] and Excellent [6 8 10].

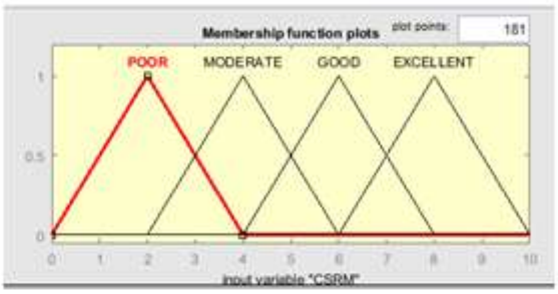

Fig. 3.2: Membership function for Condition of Service, Remunerations and Motivation (CSRM)

ii) Funding, Logistics and Operational Equipment (FLOE), having linguistic variables and parameters as follows: Inadequate [0 2.5 5], Relatively adequate [2.5 5 7.5], and Adequate [5 7.5 10]

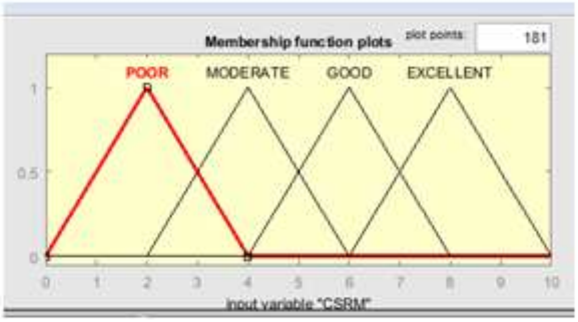

Fig. 3.3 Membership function for Funding, Logistics and Operational Equipment (FLOE)

iii) Recruitment, Training and Promotion (RTP), having linguistic variablesand parameters as follows: Poor [0 2 4], Fair [2 4 6], Good [4 6 8] and Excellent [6 8 10].

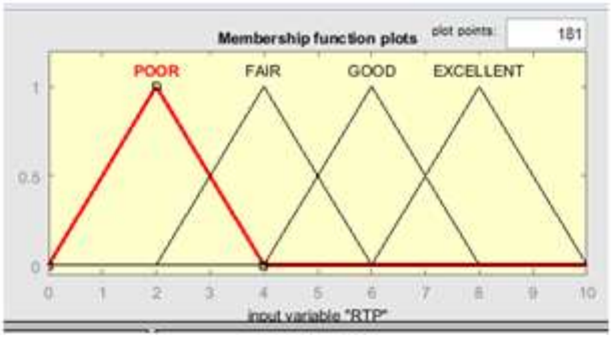

Fig. 3.4: Membership function for Recruitment and Training Promotion (RTP)

iv) Confidence and Support from Community (CSC), having linguistic variables and parameters as follows: Low [0 2 4], Moderate [2 4 6], High [4 6 8] and Very High [6 8 10].

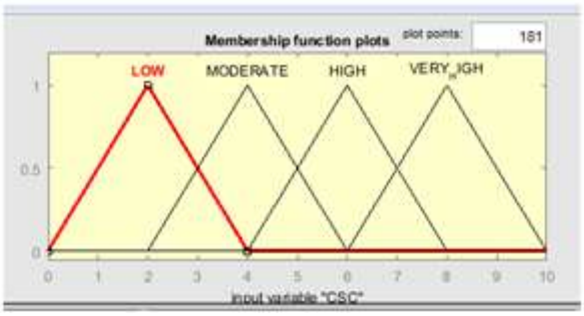

Fig. 3.5: Membership function for Confidence and Support by the Community (CSC)

v) The output variable Corruption Severity Level (CSL) parameters are defined based on the linguistic variables which are High [15 22.5 30] corruption level, Low (7.5 15 22.5) corruption level and Very low (0 7.5 15) corruption level.

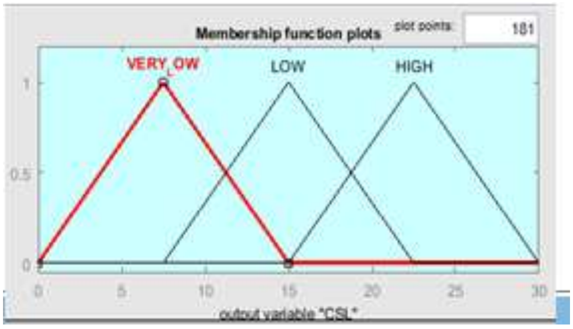

Fig. 3.6 Output membership function showing severity levels of corruption

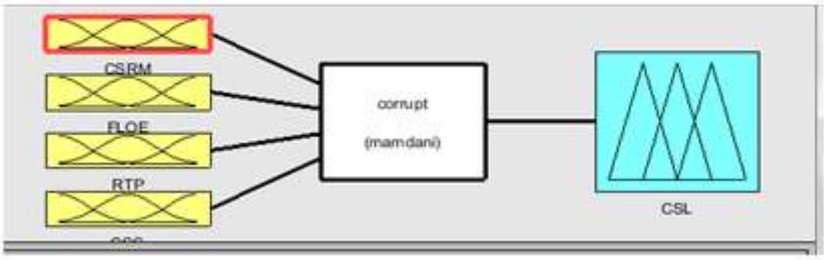

Fig. 3.7: Multi-input Single Output Corruption Control Model.

IV. RULE DETERMINATION AND EVALUATION

The basic requirement of rule-based systems is that the expert's knowledge and thinking patterns should be specified in an explicit manner. The set of rules in an FES is known as the rule base or knowledge base. Fuzzy rule-based systems, in addition to handling of uncertainties, also have several additional capabilities. Here approximate numerical values can be specified as fuzzy numbers. The performance of an FES mainly depends on its rule base so the optimization of the membership function distributions stored in the database is the most important process. The rules in a Fuzzy Expert System are in the form: If x is low and y is medium, then z is high, where x and y are input variables, z is an output variable, low is a membership function (fuzzy subset) defined on x, medium is a membership function defined on y, and high is a membership function defined on z. The antecedent or the preceding part (the rule's premise) describes the degree to which the rule applies, while the conclusion part (the rule's consequent) assigns a membership function to each of the output variables. If a fuzzy rule has more than one antecedent, the fuzzy operator AND or OR is used to obtain a single value that represents the result of the antecedent evaluation. Based on the descriptions of the input and output variables, 56 rules were constructed by selecting an item in each input and output variable box and one connection (AND). None was chosen as one of the variable qualities to exclude any of the variables from a given rule. The weight was specified to unity.

Aggregation Of Rule Outputs

It is the process of the unification of the rules. The membership functions of all the rule consequents previously clipped during rule evaluation are taken and combined into a single fuzzy set. In this process a number of clipped consequent membership functions are changed into one fuzzy set for each output variable. The inference methodology used is the Mamdani inference method.

Defuzzification Of The Output

The aggregate of a fuzzy set constitutes a range of output values, and so it must be defuzzified in order to resolve a single output value from the set. The defuzzification method used here was the centroid calculation, which returns the center of area under the curve. Every rule was examined for a given set of input values using the AND operation and the rule which satisfied the operational logic was used to generate the output for the inference system. The output given by each rule was aggregated and then defuzzified using centroid calculation to generate a single output which was a single number representing the Corruption Severity Level (CSL).

V. CONCLUSION

This paper aimed to develop a model to determine the corruption level in Nigerian. The researcher employed fuzzy rule-base inference system methodology. Four inputs variables; funding, logistics and operational equipment (FLOE) condition of service, remuneration and motivation (CSRM), recruitment, training and promotion (RTP), confidence and support by the community (CSC) were used to determine the corruption severity level. An output variable; corruption severity level (CSL) was adopted for the model development. The simulation was carried out with MATLAB 2015 for windows. The Variables SCRM, RTP and CSC were compared against FLOE as depicted in figures 4.2 (a, b, c, d and e) and discussed in section 4.3. The results revealed that it is very obvious for Nigeria as a country to have a society whose corruption severity level is low then:

i) Condition of service, remunerations and motivation has to be excellent or at least good;
ii) Funding, logistics and operational equipment has to be adequate or at least relatively adequate;
iii) Recruitment, training and promotion has to be excellent or at least good, and finally,
iv) Confidence and support by the community has to very high or at least high.

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