THE FUZZY LOGIC APPROACH TO PERSONNEL SELECTION AND PLACEMENT

(A CASE STUDY OF L’AINE SERVICES LIMITED)

By

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CERTIFICATION

I hereby declare that this submission is my own work towards the MPhil and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

A core competence within global competitive advantage is human capital, one of the most important activities carried out by human resource management. Traditional way of selecting personnel was through a group decision – making problem under multiple criteria containing subjectivity, imprecision and vagueness. To keep up with increasing competition of globalization and fast technological improvements and changes, world markets demand to have quality, minimize subjective value judgments, making more effective selection from the pool of applicants distinguishing between an appropriate and an inappropriate employee, the right person for the right position, to be very precise “the best fit” employee for a job vacancy.

A three level model proposed framework starts with a pool of job applications in a database, upon a requisition from an employer to minimize subjective judgment which implicitly defines the required qualifications for the job, applicants are short listed based on matching requisition attributes and preferences. At the second level imprecision is minimized, shortlisted candidates are invited to take certain test featuring (aptitude test, computer skills and temperament test). Fuzzy weights are assigned to linguistic variables using Simple Additive Weighting method.

A third and final level is to minimize vagueness by using the temperament fuzzy score to aid Decision – makers as to who is more suitable considering one’s natural abilities, before the oral interview factors (foreign language, Appearance, confidence level, composure etc) are pursued and candidates hired. A real case study is implemented to show the possible benefits of this proposed framework.

This research used a fuzzy approach to an applicant’s selection process from the time an application is sent to an agency to the time when the best applicant is selected to overcome the existing problems (subjective value judgement, biasness, vagueness, imprecision, complexity and
multivalencies of skills). This study thus presents a new dimension to aid in selecting personnel using a fuzzy logic by implementing the Fuzzy Simple Additive Method (FSAW) to overcome the problem of Decision-Makers Executive Judgement (DMEJ). Here the consideration of temperament to determine suitable applicants was paramount. A person with a combination of the right skills and natural tendencies or abilities will perform the job effectively, affecting the performance and competitive power of the organization. To increase the efficiency and ease-of-use of the proposed model a software system has been developed to overcome the limitations that come with using softwares such as MS Excel to evaluate the applicants based on criteria set forth by the employers.

Key words: SAW, Fuzzy numbers, Decision making, Ranking
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Chapter 1

1.0 Introduction

1.1 Where did Fuzzy Logic come from?

The concept of Fuzzy Logic (FL) was conceived by Lotfi Zadeh, (a professor at the University of California at Berkley) who presented the logic not as a control methodology, but as a way of processing data by allowing partial set membership rather than crisp set membership or non-membership. This approach to set theory was not applied to control systems until the 70's due to insufficient small-computer capability prior to that time. Professor Zadeh (father of fuzzy set) reasoned that people do not require precise, numerical information input, and yet they are capable of highly adaptive control. If feedback controllers could be programmed to accept noisy, imprecise input, they would be much more effective and perhaps easier to implement.

In recent times, fuzzy logic has rapidly become one of the most successful today’s technologies for developing sophisticated control systems. The reason for this is very simple. Fuzzy logic addresses such applications perfectly as it resembles human decision making with an ability to generate precise solutions from certain or approximate information. It fills an important gap in engineering design methods left vacant by purely mathematical approaches (e.g. linear control design), and purely logic-based approaches (e.g. expert systems) in system design.

While other approaches require accurate equations to model real-world behaviors, fuzzy design can accommodate the ambiguities of real world human language and logic. It provides both an intuitive method for describing systems in human terms and automates the conversion of those system specifications into effective models.
1.1.1 What is fuzzy logic?

In this context, FL is a problem-solving control system methodology that lends itself to implementation in systems ranging from simple, small, embedded microcontrollers to large, networked, multi-channel PC or workstation-based data acquisition and control systems. It can be implemented in hardware, software, or a combination of both. FL provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. FL's approach to control problems mimics how a person would make decisions, only much faster.

1.1.2 How different is Fuzzy from conventional control methods?

FL incorporates a simple, rule-based IF X AND Y THEN Z approach to a solving control problem rather than attempting to model a system mathematically. The FL model is empirically-based, relying on an operator's experience rather than their technical understanding of the system. For example, rather than dealing with temperature control in terms such as "SP =500F", "T <1000F", or "210C <TEMP <220C", terms like "IF (process is too cool) AND (process is getting colder) THEN (add heat to the process)" or "IF (process is too hot) AND (process is heating rapidly) THEN (cool the process quickly)" are used. These terms are imprecise and yet very descriptive of what must actually happen. As a hypothetical scenario, one would adjust the temperature of the shower if it were cold. FL is capable of mimicking this type of behavior but at very high rate.
1.1.3 What does it offer?

The first application of fuzzy theory was primarily industrial, such as process control for cement kilns. However as the technology was further embraced, fuzzy logic was used in more useful applications. Fuzzy logic was also put to work in elevators to reduce waiting time. Since then, the application of Fuzzy logic technology has virtually exploded, affecting things we use every day. An example in question is the fuzzy washing machine. The start button is pressed after clothes have been loaded. The machine begins to churn, and automatically chooses the best cycle to complete the washing task. The fuzzy microwave follows a similar set of functions to complete task.

The fuzzy car, maneuvers itself by following simple verbal instructions from its driver. It can even stop itself when there is an obstacle immediately ahead using sensors. But, practically the most exciting thing about it is the simplicity involved in operating it.

FL was conceived as a better method for sorting and handling data but has proven to be an excellent choice for many control system applications since it mimics human control logic. It can be built into anything from small, handheld products to large computerized process control systems. It uses an imprecise but very descriptive language to deal with input data more like a human operator. It is very robust and often works when first implemented with or no tuning.

1.1.4 Basic Definitions

Crisp Logic

Crisp logic where binary sets have two-valued logic i.e. true or false
Fuzzy Logic (FL)

A form of many valued logic deals with reasoning that is fixed or approximate rather than fixed and exact.

Fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. FL extended to handle the concept of partial truth where truth value may range between completely true and completely false.

Fuzzy Propositions

A fuzzy proposition is a statement that has a truth value associated with it. The statement “element x belongs to set A” has a truth value in the range of [0, 1].

A truth value of zero means that x does not belong to set A. Similarly, a truth value of one means that x completely belongs to set A. Truth values between zero and one, also known as partial truth, imply that x belongs to set A to some degree.

The partial truth of a fuzzy proposition is represented by a degree of truth similar to degrees of membership of elements to fuzzy sets.

A common type of proposition used in fuzzy logic is the conditional and unqualified proposition. The objective of this proposition is to denote a relationship between elements from either similar or different sets. Unconditional and unqualified propositions are used for imprecise reasoning to describe the decision process that human beings undergo to express cause and effect relationships.
Fuzzy Logical Operators

The three logical operators commonly used with fuzzy sets are the intersection (AND), union (OR), and complement (NOT). For fuzzy sets $A$ and $B$,

$$
\mu_A \cap B (x) = \min [\mu_A (x), \mu_B (x)] \quad \text{(the elements that are included in both sets)}
$$

$$
\mu_A \cap B (x) = \mu_A (x) \mu_B (x) \quad \text{(the elements that is included in both sets)}
$$

$$
\mu_A \cup B (x) = \max [\mu_A (x), \mu_B (x)] \quad \text{(Elements that are in either set)}
$$

$$
\mu_A \cup B (x) = \mu_A (x) + \mu_B (x) - \mu_A (x) \ast \mu_B (x) \quad \text{(Elements that are in either set )}
$$

$$
\mu_A - (x) = 1 - \mu_A (x) \quad \text{(All elements that are not in the set)}
$$

1.2 Scope of Study

There is an international core competition for human capital. “In order to keep up with technological improvement and changes, selecting the right person for the right position is very important. Many large-scale companies have professional HR departments to deal with this problem (Turkay Dereli, Alptekin Durmusoglu, Serap Ulusam Seckiner, Nevra Avlanmaz, 2010).”

However, there is still a lack of understanding, especially for the needs of changing job profiles and positions. In this paper, a new personnel selection framework is proposed for finding the “the best possible” personnel for a specific job. Human Resources Management (HRM) is a process of managing people through personnel selection, performance appraisal, reward systems, training and development. A common belief among business academics and practitioners is that HRM should be based on justice principles, particularly in hiring, performance appraisal and rewarding.
The justice principles are understood as the process of decision making to be carried out with the minimal influence of subjective judgments. The hiring procedure is the first contact of future employee with an organization. Recent research has shown that the employee’s commitment to the organization is dependent on the employee’s treatment in the hiring process. However, this research will study the weakness of other existing systems and consider how the inclusion of individual’s natural capabilities (or temperaments) plays a major role in job placement.

1.3 Objectives

The objectives of the research are divided into global and specific.

1.3.1 Global

This research seeks to contribute to the general research area in Fuzzy logic and contribute the new approaches for the selection of personnel using fuzzy sets.

1.3.2 Specific objectives

The research would specifically address the following:

1. To conceptualize the recruitment process from advertisement of job to a successful placement of personnel.

2. To determine how to match human natural capabilities with job position during the selection process.

3. To develop a fuzzy relational database system to implement a fuzzy query as its inference engine to support the conceptual framework.
1.4 Research questions

1. How would the database be constructed to logically respond to the fuzzy query?

2. What are the strategies to use for obtaining the correct fuzzy sets to match up the appropriate applicant for the right job?

3. How can the system ensure the fairness of employment?

4. What are the ways to conceptualize the recruitment process to ensure that companies send appropriate requirement to be fed into the system and applicants information are rightly placed to meet internal logic for selection.

1.5 Importance of this study

This study would focus on the development of a comprehensive system for recruitment agencies. The research would consider an in-depth analysis of fuzzy logic implementation in the selection and placement of personnel. Therefore, it is important for the following reasons:

1. To develop a valid and reliable system that would allow applicants to submit their applications for a particular job whilst the system logically analyzes the requirements as found in the fuzzy relational database.

2. For evaluating the overall suitability of job applicants, using fuzzy logic.

3. The system would send automatic SMS or E-mail alert to applicants short listed to continue with the selection process.

5. It would keep a history of applicants’ data so that it can be inferred for other preferences (i.e. jobs) when necessary.

6. The system would expertly choose weights for skills and tasks in advance of evaluation of applications since the fuzzy method achieves a rational basis for assessment.

7. It would enhance the general recruitment processes in Ghana.

8. Profitability would be enhanced in these ways:
   a. Companies who send their request for processing would save money
   b. The applicant needs to apply to the agency once.

1.6 Organization of the study

This research is organized into five chapters starting with an introductory chapter which presents a background to the entire work. Chapter 2 is a literature review on the concept of fuzzy logic. Chapter 3 explains the methodology employed in sourcing data. Chapter 4 is the results and discussion and chapter five is the conclusion and recommendation.
Chapter 2

2.0 Literature Review

2.1 Introduction

The role of Fuzzy logic in Personnel Selection Process Effective HRM practices have been proved to relate to company performance by contributing to the organization’s success in terms of customer satisfaction, profitability, innovation, quality, and so on. The hiring procedure is the first contact of future employee with an organization. Recent research has shown that the employee’s commitment to the organization is dependent on the employee’s treatment in the hiring process (Boran et al., 2011).

Personnel selection, followed by human resources planning and recruitment, is the activity in which organizations use various methods to judge whether candidates are suited for the positions needing to the occupied (Boran et al., 2011).

A person without the right skills or attributes will not perform the job effectively, and thus will affect the performance and competitive power of the organization. The remedy of this situation is either repeating the selection process and hiring a new employee or training the hired employee. Both cases strongly influence the effectiveness of HRM practices and require spending a great amount of resources especially time, effort, and money (Boran et al., 2011).
2.2 The Personnel Selection Process

Personnel selection process is hiring the right people to do the right job in order to increase the performance of a company to meet the demands of its customers. There are standard ways many organizations go through to select its employees. Some companies interview straight way qualified applicants and select the appropriate personnel for the job.

Other organizations also go through procedures that involve the applicants to write skill based examinations. The reason for this rigorous process is to reject inappropriate applicants.

According to (managementstudyguide, 2012) the personnel selection process takes place in the following order:

- **Preliminary Interviews-** It is used to eliminate those candidates who do not meet the minimum eligibility criteria laid down by the organization. The skills, academic and family background, competencies and interests of the candidate are examined during preliminary interview.

- **Application blanks-** The candidates who are successful in the preliminary interview are required to fill application blank. It contains data record of the candidates such as details about age, qualifications, reason for leaving previous job, experience, etc.

- **Written Tests-** Various written tests conducted during selection procedure are aptitude test, intelligence test, reasoning test, personality test, etc. These tests are used to objectively assess the potential candidate. They should not be biased.
• **Employment Interviews** - It is a one to one interaction between the interviewer and the potential candidate. It is used to find whether the candidate is best suited for the required job or not. But such interviews consume both time and money both. Moreover the competencies of the candidate cannot be judged. Such interviews may be biased at times. Such interviews should be conducted properly. No distractions should be there in room. There should be an honest communication between candidate and interviewer.

• **Medical examination** - Medical tests are conducted to ensure physical fitness of the potential employee. It will decrease chances of employee absenteeism.

• **Appointment Letter** - A reference check is made about the candidate selected and then finally he is appointed by giving a formal appointment letter.

### 2.3 Review of existing literature

#### 2.3.1 A fuzzy approach to personnel selection

Attempts to help decision makers minimize subjective values judgments and make more effective selection from the pool of applicants, under the various evaluation criteria. Exact evaluation of job applicants is a difficult process because of the complexity and multi-variances of their skills.

The basic postulate behind this work is that many real world problems have more to do with fuzziness than randomness as the major source of imprecision (Misha Lovrich, Sonja Petrovic-Lazarevic, Bruce Brown, 1999). In such situations, it is more appropriate to handle uncertainty by fuzzy set theory than by probability theory (Misha
Lovrich, Sonja Petrovic-Lazarevic, Bruce Brown, 1999). Tools employed the spreadsheet, single-skill task and multi-skills per task.

Decision makers allocate weights to each skill with its corresponding ranked fuzzy attributes, with the aid of a fuzzy dictionary in table 2.1 a fuzzy suitability table and a generalized fuzzy suitability table is constructed for single-skill and multi-skills respectively. From table 2.1 each linguistic value has its own assigned value when the degree of suitability is known.

Table 2.1: The Fuzzy Dictionary

<table>
<thead>
<tr>
<th>Linguistic Value</th>
<th>Degree of Suitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high (VH)</td>
<td>0.81 – 1.00</td>
</tr>
<tr>
<td>High (H)</td>
<td>0.61 – 0.80</td>
</tr>
<tr>
<td>Average (A)</td>
<td>0.41 – 0.60</td>
</tr>
<tr>
<td>Low (L)</td>
<td>0.21 – 0.40</td>
</tr>
<tr>
<td>Very low (VL)</td>
<td>0.00 – 0.20</td>
</tr>
</tbody>
</table>

Map fuzzy intervals into crisp numbers \( m:x \rightarrow [0,1] \). The unweighted score indicates the degree of the candidate’s suitability for the task.

Method Used

- Allocate weight, Determine skill weights with linguistic variable, Fuzzy dictionary is created, FST (Fuzzy Suitability Table) for Single – skill per task and GFST (General Fuzzy Suitability Table) for Multi – skills per tasks is constructed
- Easily implemented in any spreadsheet by decision maker
• Tackles tasks and skills by giving values, receives application from candidates,
candidates are evaluated and short listed for interview, after interview, refine fuzzy
scores or introduce new ones.

2.3.2 A fuzzy approach for personnel selection process

Turkay, et al. attempt to prevent wrong and inequitable employee selection
detriments by using the PROMETHEE (Preference Ranking Organization Method for
Enrichment Evaluation) method for the selection process, this is simpler than methods
for multi-criteria analysis. The “decision lab” is developed for applying PROMETHEE
method; Matlab FIS (Fuzzy Inference System) and Mamdani method are also used.

In Turkay, et al. preparation of evaluation table, criteria weights, preference
functions, indifference and preference threshold, evaluation and selection process
(fuzzification, rule evaluation, aggregation and defuzzification) are considered (Turkay
Dereli, Alptekin Durmusoglu, Serap Ulusam Seckiner, Nevra Avlanmaz, 2010).
The following process takes place before a candidate is selected using this approach
proposed by Turkay, et al.

A. Job Announcement (defines the required qualification for job)

• Decision makers rank the required attributes for that specific job

• PROMETHEE method is applied to these regarded features (experience, foreign
  language, age, etc) including certain weights of these attributes.

• Ranks and weights of each attribute are determined with some linguistic
  variables assigned to these attributes which gradually indicates level of
  qualification for that attribute.
B. Evaluating results of interview

Each attributes evaluated by 3 decision maker for each applicant is then entered into “Fuzzy Interface of Matlab Software” where 3 types of output is available (rejecting / accepting /Pending applicants)

Fuzzification

- Assigned crisp values to linguistic encoding to generate membership values
- Determine and range the most wanted features for the vacancy, interviews will be held with the suitable candidates and linguistic values will be given by 3 experts
- The best linguistic degree would be given the highest numerical value.
- Selection of candidates would be based on the maximum values.

2.3.3 Personnel selection fuzzy model

The main objective of this model is to minimize subjective judgment in the process of distinguishing between an appropriate employee and an inappropriate employee for a job vacancy. Labib et al., (1998) suggest that in the personnel selection process one should: break down a complex decision process into component criteria, arrange these criteria or variables into a hierarchic order, assigned numerical values to subjective judgments on the relative importance of each variable, synthesize the judgments to determine the overall priorities of the variables.

Analytic Hierarchy Process (AHP) of 3 levels, lowest level - short list procedure, second level – hiring decision (selector access his or her own expectations of the short
listed applicants), top level – expected utility of hiring the successful candidate as shown diagrammatically in figure 2.1.

Completion of application form, initial interview, employment test, background investigation, AHP is introduced which structures on several levels – break down reality into homogeneous levels and subdividing these levels into smaller ones. The main processes are shown in figure 2.1.

Figure 2.1: Diagrammatical structure of AHP
Multi – criteria fuzzy decision model based on AHP

- Multi – hierarchical models of decision – making
- Multi – objective decision – making problem

The AHP structures on several levels, of which level one comprises the expected utility, the lowest level comprises alternatives that would contribute to the expected utility “through their impact on the intermediate criteria” in the intermediate level). AHP has widespread application in decision problems involving multiple criteria in systems of many levels. The priority of each alternative and criterion is represented by the weight.

Accordingly summing the priorities of every alternative with the weights of every criterion creates a priority for the highest level such that summing through the whole hierarchical structure produces a synthesized judgment for all alternatives under the stated goal.

2.3.4 The Application of Fuzzy TOPSIS Approach to personnel Selection for Padir Company

The authors of the research paper attempts to achieve employing the potentially adequate personnel by performing the following:

- Determining the weight, construct a fuzzy decision matrix, normalize the fuzzy decision matrix, determine fuzzy positive-ideal solution (FPIS) and fuzzy negative-ideal solution (FNIS), calculate the distance of each alternative from FPIS and FNIS, obtain the closeness co-efficient (CC) and rank the order of alternatives. TOPSIS implies Techniques for order Preference by Similarity to
an Ideal Solution (Hassan Zarei Matin, Mohammad Reza Fathi, Mohammad Karimi Zarchi, Sirous Azizollahi, 2011).

- FPIS and FNIS. The basic principle is that the chosen point should have the “shortest” distance from the positive ideal and the “farthest” distance from the negative ideal solution.

2.3.5 Personnel Selection Based on Intuitionistic Fuzzy Sets

In this research paper the following methods was used in the selection process – Intuitionistic (Petrovic-Lazarevic, 2000). From the review, it was realized that

- The hesitation margin was used in attempt to deal with vagueness
- Different priority weights of each criteria, attributes and alternatives are calculated, BNP (Best Non-fuzzy Performance value)
- IFNs (Intuitionist Fuzzy numbers), IFPIS and IFNIS, calculate a separation method using Hamming distance, relative closeness, co-efficient, and rank the alternatives.
2.4 Conceptual framework

From the literature reviewed it was realized that a typical framework to deal with human subjectivity and vagueness has not been established. On this note in this research the conceptual framework shown in figure 2.2 is proposed. One major component that is vital in this framework is its ability to consider human natural tendencies in making decision in choosing the right person that fit the job. The framework in figure 2.2 is a modernized way of choosing a suitable applicant to fit the right job.

The fuzzy engine does all the computation by first obtaining the fuzzy scores from the various examinations taken by the applicant and the points assigned to the skills of the applicant. This framework reduces drastically the challenges associated with personnel selection (vagueness and imprecision).
Chapter 3

3.0 Analysis and Design

This chapter reviews the various methods of fuzzy implementation in personnel selection and crystallizes the problems associated with them. The possible solutions to those problems would be discussed. In addition, the analysis of the proposed system and the conceptual framework will be looked at in this chapter. The analysis will include both functional and non-functional requirements.

The hardware and software requirements for the usage of the propose system would be considered. The design of the system includes the design of the fuzzy relational database of the proposed system, the system model, and the Level 1 data flow diagram which will be based on the selected processing model.

3.1 The Methodology

The research will study and review already exiting formal documentation requirements and procedures, and research conducted by others.

This project would be developed using current tools and platforms which are mostly suited for such development of the fuzzy implementation in personnel selection. These tools are as follows: - Java (for the front end) and MySQL (for the database storage as back end). MathLab would be employed for some analysis and simulations when it becomes necessary. A graphical user interface (GUI) would be developed for all the relevant forms in order to effectively interact with the users of the system.
Experimental results using fuzzy classification membership function defined by the truth value of a fuzzy propositional function would also be used as part of the analysis and design.

The use of data modeling tools such as (data flow diagrams and entity relationship diagram, relational diagram) will enhance the interpretation of the fuzzy logic implementation of personnel selection.

3.2 Crystallizing the Reviewed Systems

The main drawback presented in the literature reviewed is that less emphasis was placed on personality trait required for specific job. In other words, individuals’ temperaments are not really considered in the personnel selection when implementing fuzzy theories by most authors. To totally overcome human subjectivity and vagueness a framework appropriate to consider all aspects of personnel selection including the type of job and the probable temperament is highly required.

Another drawback realized from literature is that there exist high rate of human subjectivity since short listings are done by decision makers which can grossly affect fairness. From the review, Lovrich et al., attempted to solve the problem of evaluating the applicants suitability for a job. In this attempt they sought to help decision-makers minimize subjectivity value judgments and make more effective selection from the pool of applicants to be selected. The authors did not consider dealing with vagueness and imprecision which can grossly affect the results of the selection.
It was also realized from the work of Turkay et al., they attempted to prevent wrong and inequitable employee selection detriments. From their work it was realized that there was much human subjectivity and procedures used has personal biases.

Considering the work of Chen and Cheng, it was clearly seen that they attempted to minimize subjective judgment in the process of distinguishing between an appropriate applicant and an inappropriate applicant for the job vacancy. Hence they could not overcome subjectivity and imprecision.

Finally, Martin et al., in their work they sought to achieve the flaws of human subjectivity by implementing the concept of selecting the potentially adequate personnel.

### 3.2 Users of the proposed system

The new system proposed in thesis would be used by administrators, human resource managers, staff, applicants and any authorized person mandated with the credentials to login in to use the system.

### 3.3 Benefits of the proposed system

For organizations to grow, qualified personnel must be selected for the right job. This is key and very important to business organizations, institutions and all government agencies especially to gain competitive advantage over other companies when they have a strong employee base. Business organizations are very much interested in customer satisfaction and employee data.

The personnel selection model developed in this research work would have numerous benefits to organizations that implement it.
- **Improves organizational integrity**: the accurate and correct data obtained in the company’s relational database would enhance its image and credibility. Personnel who apply to the company would gracefully welcome results at every stage of the selection process since there is a great deal of fairness in the computer base system used for the selection. Prospective applicants would trust the results of the selection since there would be less human subjectivity.

- **More precise results**: comparing to the existing methods, the data captured in this system makes it more efficient. This would enhance analysis since the personnel selection model would generate correct information which would enhance the results for reporting.

- **Ease-of-access**: The system is user friendly due to its flexibility. The graphical user interface (GUI) is greatly enhanced. It is very simple to use by all levels of users with little training.

- **Short list applicants**: the system looks at the various requirements set and short list applicants for examinations. This reduces the burden of decision makers having to sit down for hours to short list. The system is dynamic.

- **Ease of migration**: The system could easily be migrated to be used by academic institutions for selecting qualified students during admissions.

- **Saves time**: Applicant selection can be made quickly since the system uses little time to make decisions without compromising.
3.4 Data collection

Data to be collected for the system testing is obtained from L’aïne Company. This information is used largely for the purposes of testing the robustness of the system.

3.5 Analysis of the proposed personnel selection model

There are several methods (Fuzzy dictionary on a spreadsheet, PROMETHEE and Matlab Fuzzy Inference System (FIS), Analytical Hierarchy Process, Fuzzy TOPSIS Approach and the intuitionistic fuzzy numbers) of fuzzy implementation in personnel selection. These methods range from simple to complex calculations. The introduction of a temperament/suitability score which is deduced from a whole mix-up of english descriptive words is given linguistic variables when applied in the fuzzy simple additive weighted method (FSAW). Although this proposed framework to some extent might have limitations it could be adopted for use during personnel selection process.

3.6 Requirements Analysis

3.6.1 Functional Requirements

The functional requirements of the system include all the important aspects that meet the user’s specification. In this system the functional requirement includes:

- Access to the personnel selection main page.
- The administrator assigns roles to the human resource manager, examiner, applicant and the data entry clerk.
• The Human Resource Manager assigns and defines fuzzy points for qualification, gender, age and experience.

• The Examiner sets and edits questions on aptitude, computer skills and profile index/ temperament and assigns weights.

• The applicant logs in to write three test (i.e. Aptitude test, computer skills test and profile index/ temperant test).

• The data entry clerk enters all applicant records.

### 3.6.2 Non-Functional Requirements

It is important to discuss the non-functional requirements which are clearly different from the functional requirements of the system. For at least ten (10) or more applicants to access the test at the same time, the system can be run on the intranet. This system also is connected to a relational database that keeps record of all the data pertaining to the applicant. Once the system is connected to the database and duly connected to the interface, all its users can perform their functions appropriately.

**Hardware Requirement**

The main hardware requirement of this system is a basic network infrastructure that will support an intranet connection. A server may be required to enable the administrator set its privileges as well as the human resource manager assigning the fuzzy weights to all specified fields. The computers to be used should be at least Pentium IV with minimum speed of 1GHz with dual core or higher and a minimum of 512 MB of memory or higher. The network topology required could either be linear
(highly recommended) or star depending on the size of the room allocated for that purpose.

**Software Requirement**

The software required to run the system is a 32-bit operating system irrespective of the system type since the Java is platform independently. All platforms minimum required can effectively support the system. Example Microsoft Windows XP with Service Pack 2 and 3 or higher.

**3.6.3 Input Requirements**

The relational database used to support the system developed in this research is MySQL (phpMyAdmin). On the larger scale data collected from the applicants application form (filled) and curriculum vitae (CV) would be used as the source of input to the system.

**3.6.4 Processing requirements**

**Methodology**

To be studied and reviewed would be already exiting formal documentation requirements and procedures, and research conducted by others.

**Methods**

Evaluation and use of algorithmic approach can be blended with conventional techniques and experimental results using fuzzy classification membership function defined by the truth value of a fuzzy propositional function.
Tools

- Java for the interface design
- MySQL database for the back end
- Data model (data flow diagrams and entity relationship diagram, relational diagram).

3.7 Design of Proposed System

The proposed system deals extensively with the limitations discussed above. A new conceptual framework to aid in the personnel selection process and rank qualified applicants. When the qualified applicants have been ranked the system based on the assigned temperament selects the most suitable applicant for the job vacancy.

In the proposed system the following steps take place:

- There is a requisition placed by organizations with a job agency implementing the *RegiHR plus* system to look for suitable applicant(s) for a specific job.
- The job agency advertises the job vacancy for applicants to apply.
- Human Resource Manager sets all requirements for the job available.
- Applicants data is entered into the *RegiHR plus* system.
- When a match is found, applicants are short listed and email or SMS is sent to the applicant(s) to come for three (3) tests (that is aptitude, computer based and temperament).
- Applicants test scores including temperament test is fuzzified using the Simple Additive Weighting (SAW) and ranked based on suitability check.
- Ranked applicants who are suitable then proceed for interview.
• Applicants are accepted or rejected depending on the type of composure, appearance, foreign language and confidence level.

3.7.1 The Algorithm

1. Start.

2. Receive job applications.

3. Enter data of individual applicants.

4. Upon requisition from an employer, choose appropriate method to shortlist:
   a) Obtain parameters or attributes from requisition as shown in table 3.1

   Table 3.1: Parameters for short listing

<table>
<thead>
<tr>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Experience</td>
</tr>
</tbody>
</table>

   b) Rank the candidates based on attributes and preferences.

   c) If candidate is short listed perform test.

5. Test candidates in written form where each criteria will be given a score as shown in table 3.2 and compute aptitude test, computer skills and temperament.
Table 3.2: Type of Exams written by short listed applicants

<table>
<thead>
<tr>
<th>Written Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aptitude test</td>
</tr>
<tr>
<td>Computer skills</td>
</tr>
<tr>
<td>Temperament test / Profile index</td>
</tr>
</tbody>
</table>

6. Accept input from written test results

7. Evaluate the results of the written test using fuzzy SAW method.

8. Candidates are recommended to employers for oral interview and are interviewed based on the factors in table 3.3.

    Table 3.3: Factors for Interview

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign language</td>
</tr>
<tr>
<td>Appearance</td>
</tr>
<tr>
<td>Confidence level</td>
</tr>
<tr>
<td>Composure</td>
</tr>
</tbody>
</table>

9. Scores are given by panelist.

10. Communicate decision to selected candidates based on ranking and interview performance by sending email to each candidate.

11. Stop
3.7.2 Flowchart modeling the personnel selection process

Figure 3.1: The flowchart illustrating the algorithm

The algorithm discussed above is illustrated in diagrammatical form to show the interaction among the various components of the proposed system and the sequence of data flow. Figure 3.1 starts when a specific user logs in with the appropriate credentials (username and password). When a match is found the main graphical user interface is displayed to the user.
3.7.3 Weighted Fuzzy Points and Scoring

In order to overcome the deficiencies identified in the reviewed papers, this research paper places much emphasis on the fairness and drastically minimizes human subjectivity. To achieve this, weights are identified and each of the factors which are paramount in the selection process is assigned a fuzzy weight depending on the type of job. This flexibility of assigning scores to the membership function is the hallmark of the research. From the algorithm the parameters obtained from the requisition are as follows – qualifications, age, and gender and work experience.

These parameters are used in order to short list applicants. All short listed applicants write aptitude test, computer based test and temperament test. Since this research is basing the scoring on multiple attributes, the figures below illustrate the multiple attribute decision that needs to make in order to achieve the objective. Here different kinds of weights are assigned to the parameters in order of importance or ratings. The fuzzy weights when summed up should be less or equal to 1.0. In order to obtain the fuzzy score for the applicants, so that they can be ranked the attributes in figure 3.2 are assigned with fuzzy points. Each attribute is broken down into sub sections and a weight assigned.

These weights are either equal to 1.0 or less than 1.0. The corresponding fuzzy points under each category sum up to the weight assigned to the attribute in general as shown in figure 3.2.
Figure 3.2: General Structure for scoring candidates
From figure 3.3, a fuzzy weight \((W_1)\) of 0.2 is assigned to qualification and each attribute is reassigned a fuzzy score \((W_{11}, W_{12}, W_{13}, W_{14}, W_{15}, W_{16})\) based on the fuzzy weight since these weights when summed up should not exceed 0.2.

Figure 3.4 has a fuzzy weight \((W_2)\) of 0.15 out the maximum point of 1. Each of the fuzzy scores in \((W_{21}, W_{22}, W_{23}, W_{24})\) sum up to the total weight of \(W_2\). These weights cater for each category of age which is dynamic and could be changed depending on the priority place on age during a specific job search.
Figure 3.5: Work experience scoring method

Figure 3.5 has a fuzzy weight ($W_3$) of 0.15 out the maximum point of 1. Each of the fuzzy score in ($W_{31}, W_{32}, W_{33}, W_{34}$) sum up to the total weight of $W_3$ (work experience). These weights cater for each category of work experience which is dynamic and could be changed depending on the priority place on work experience during a specific job search.

Figure 3.6: Suitability skill dependency scoring chart

Figure 3.6 has a fuzzy weight ($W_4$) of 0.2 out the maximum point of 1. Each of the fuzzy score in ($W_{41}, W_{42}$) sum up to the total weight of $W_4$ (Suitability skill). These weights cater for each category of Suitability skill which is dynamic and could be changed depending on the priority place on Suitability skill test during a specific job search.
Figure 3.7: Gender scoring chart

Figure 3.7 has a fuzzy weight ($W_5$) of 0.1 out the maximum point of 1. Each of the fuzzy scores in ($W_{51}, W_{52}$) sum up to the total weight of $W_4$ (Gender). These weights cater for each category of Gender which is dynamic and could be changed depending on the priority placed on Gender during a specific job search.

Figure 3.8: Aptitude test scoring chart

Figure 3.8 has a fuzzy weight ($W_6$) of 0.1 out the maximum point of 1. Each of the fuzzy scores in ($W_{61}, W_{62}, W_{63}$) sum up to the total weight of $W_6$ (aptitude test). These weights cater for each category of aptitude test which is dynamic and could be changed depending on the priority placed on aptitude test during a specific job search.
Figure 3.9: Computer Skill test scoring chart

Figure 3.9 has a general weight ($W_7$) of 0.1 out the maximum point of 1. Each of the weights in ($W_{71}, W_{72}, W_{73}$) sum up to the total weight of $W_7$ (Computer Skill test). These weights cater for each category of Computer Skill test which is dynamic and could be changed depending on the priority placed on Computer Skill test during a specific job search.

### 3.7.4 Implementation of the algorithm

The above fuzzy point determined are useful in obtaining the various weight used for the ranking of applicants in the selection process. The computation starts when all attributes have been assigned and entered into the system. Each fuzzy point is multiplied by the general weight and summed up to obtain the weight of that attribute or parameter.
Deductions

Let the fuzzy score be represented as \( i \) and the fuzzy weight assigned to each parameter be represented as \( m \). By inference we multiply \( i \) by \( m \) (that is: \( i \times m \)).

Using the formula below each of the fuzzy point obtained in each category is summed up in order to obtain the total fuzzy point to rank the applicant. These scores are re-ranked based on the suitability skill in order to obtain the most suitable applicant.

\[
\sum_{i=1}^{n} \text{wt}_i \text{r}_{im}
\]

Table 3.4, table 3.5 and table 3.6 shows the values used to evaluate each of the three test scores the applicant obtains after taking the exams when short listed. The fuzzy scores in tables 3.4 to 3.6 are not static since they are determined based on the type of job and the position been determined. In determining the fuzzy score we first query all the various scores obtained by the applicant based on the specified parameters or attributes and test scores. The reason why this is paramount is that the system depends on all these individual fuzzy scores in order to obtain the total fuzzy points.

To illustrate this, the suitable skill, computer skill and aptitude test scores of applicants are queried as shown in the tables below. This is applicable for all other attributes of which management would demand report.
Table 3.4: Computer Skill test scoring

<table>
<thead>
<tr>
<th>Category</th>
<th>Average Range</th>
<th>Fuzzy score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Average</td>
<td>65 – 100</td>
<td>0.05</td>
</tr>
<tr>
<td>Average</td>
<td>41 – 64</td>
<td>0.03</td>
</tr>
<tr>
<td>Below Average</td>
<td>Below 40</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Table 3.5: Aptitude test scoring

<table>
<thead>
<tr>
<th>Category</th>
<th>Average Range</th>
<th>Fuzzy score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Average</td>
<td>65 – 100</td>
<td>0.05</td>
</tr>
<tr>
<td>Average</td>
<td>41 – 64</td>
<td>0.03</td>
</tr>
<tr>
<td>Below Average</td>
<td>Below 40</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Table 3.6: Temperament test scoring

<table>
<thead>
<tr>
<th>Category</th>
<th>Fuzzy score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suitable</td>
<td>0.07</td>
</tr>
<tr>
<td>Unsuitable</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Let the average test score be represented as $a_{TestScore}$

Let mark obtained be represented as $mark_{Obtained}$ and total mark assigned be represented by $t_{MarkAssigned}$

where $a_{TestScore} = (mark_{Obtained} / t_{MarkAssigned})$
From the above evaluation, $a_{TestScore}$ is assigned the respective fuzzy score depending on its value which is added up to the total fuzzy point. Since each question has its own weight, an applicants’ mark obtained is not dependent on the number of questions answered.

Determining the average of test using computer test as an example, we specify each point and multiples the fuzzy weight and the fuzzy score depending on the value assigned. This concept is dominant for all other test scores.

### 3.7.5 Performing Calculations to Rank Applicants

To illustrate how the algorithm works, the example below is used. The attributes are listed below and published:

**Job title:** Network Administrator and **Age:** between 28 and 45

**Qualification:** Bachelors or higher with CCNA or CISCO certification preferably

**Work experience:** over 3 years

**Gender:** Either Male or Female

**Skills required:** Leader, in-charge, competing, driving, exploitative, and dominant

Based on the attributes above the HR manager sets the specific requirement which meets the job specification. The under listed are assigned with high fuzzy scores for the purposes of selecting applicants who meet the criteria described below.

**Qualification:** CCNA/CISCO/Masters

**Age:** between 28 and 34
**Work experience:** between 4 to 6 years

**Gender:** Male

**Temperament:** Choleric

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Options</th>
<th>Fuzzy weight</th>
<th>Fuzzy score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification</td>
<td>Masters</td>
<td>0.2</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>Bachelors</td>
<td></td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>CCNA/CISCO</td>
<td></td>
<td>0.08</td>
</tr>
<tr>
<td>Age</td>
<td>28 and 34</td>
<td>0.15</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>35 and 40</td>
<td></td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>41 and 45</td>
<td></td>
<td>0.04</td>
</tr>
<tr>
<td>Work Experience</td>
<td>4 to 6</td>
<td>0.15</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>Above 6 years</td>
<td></td>
<td>0.07</td>
</tr>
<tr>
<td>Gender</td>
<td>Male/Female</td>
<td>0.1</td>
<td>0.06/0.04</td>
</tr>
</tbody>
</table>

The HR manager assigns fuzzy weights and fuzzy scores on all individual attributes based on the job requisition. The HR manager places higher values on the attributes he finds most appropriate for the job requisition. Based on the skills entered through the applicant control dialog, the table 3.7 is obtained. Each of the options is assigned a fuzzy score in order to calculate the total fuzzy point for the ranking of the applicants.
Table 3.8: Computer Skill scoring (0.1)

<table>
<thead>
<tr>
<th>Category</th>
<th>Average Range</th>
<th>Fuzzy score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Average</td>
<td>40 – 50</td>
<td>0.05</td>
</tr>
<tr>
<td>Average</td>
<td>30 – 39</td>
<td>0.03</td>
</tr>
<tr>
<td>Below Average</td>
<td>Below 30</td>
<td>0.02</td>
</tr>
</tbody>
</table>

In table 3.8, a fuzzy weight of 0.1 was assigned to the computer skill overall mark. A total of 50 points are assigned in this test. The marks obtained by the applicants within the range specified are assigned the fuzzy score within that category (above average, average, and below average).

Table 3.9: Aptitude scoring points (0.1)

<table>
<thead>
<tr>
<th>Category</th>
<th>Average Range</th>
<th>Fuzzy score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Average</td>
<td>45 – 60</td>
<td>0.05</td>
</tr>
<tr>
<td>Average</td>
<td>32 – 44</td>
<td>0.03</td>
</tr>
<tr>
<td>Below Average</td>
<td>Below 32</td>
<td>0.02</td>
</tr>
</tbody>
</table>

In table 3.9, the aptitude test is assigned a weight of 0.1 out of the total fuzzy weight of 1.0. In this test, 60 points are allocated for the questions asked. Each question has a different point depending on the marks assigned by the examiner. The mark obtained by the applicants within the range specified is assigned a fuzzy score within that category (above average, average, and below average).
Table 3.10: Suitability level (0.2)

<table>
<thead>
<tr>
<th>Category</th>
<th>Fuzzy score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suitable</td>
<td>0.15</td>
</tr>
<tr>
<td>Unsuitable</td>
<td>0.05</td>
</tr>
</tbody>
</table>

In table 3.10, the system classifies all the attributes into the four temperamental groups (melancholy, choleric, sanguine, and phlegmatic). The appropriate temperament for the job placement is determined by the HR and assigned during the initial process of the selection. The applicant during the examinations goes through the test and depending on the dominant features; weights are assigned and classified into suitability preferences and unsuitable preferences. Table 3.10 was obtained as a result of the classification of the temperaments in table 3.11. These are the main keywords that meet the target for seeking to work in reputable organizations.

Table 3.11: Types of temperaments

<table>
<thead>
<tr>
<th>Melancholy</th>
<th>Choleric</th>
<th>Sanguine</th>
<th>Phlegmatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chat the course</td>
<td>Dominant</td>
<td>Adapting</td>
<td>Receptive</td>
</tr>
<tr>
<td>Avoiding activity</td>
<td>Exploitative</td>
<td>Marketing</td>
<td>Supporting</td>
</tr>
<tr>
<td>Hoarding</td>
<td>Controlling</td>
<td>Influence</td>
<td>Steadiness</td>
</tr>
<tr>
<td>Conserving</td>
<td>Driving</td>
<td>Expressive</td>
<td>Relater</td>
</tr>
<tr>
<td>Analytical</td>
<td>In-charge</td>
<td>Team type</td>
<td>Behind the scenes</td>
</tr>
<tr>
<td>Thinker</td>
<td>Leader</td>
<td>Innovator</td>
<td>Yield</td>
</tr>
<tr>
<td>Visualizer</td>
<td>Competing</td>
<td>Collaborating</td>
<td>Accommodating</td>
</tr>
</tbody>
</table>
When the applicant writes the temperament test, several words are populated for the applicant to choose the words that best describes his human tendencies. The four temperament groups have 7 keywords each describing a temperament, thus a total of 28 keywords are mixed-up within the temperament test/suitability test. The applicant simply ticks the keywords that best describe him/her, not knowing which temperament type he/she falls in. The system picks these keywords, compares with the suitability skill set by the HR and the total number of keywords is given a fuzzy score which is then used for further calculation.

For example, if the HR set the temperament suitability level to Melancholy and the applicant checks only four (4) keywords out of the total number of keywords assigned for melancholy and six (6) keywords out of the number of keywords assigned for sanguine, then the system will automatically consider the applicant as exhibiting the characteristics of a sanguine based on the weights assigned to each of the keywords in each specified column. These keywords are listed in table 3.11.
Table 3.12: Applicant Records

<table>
<thead>
<tr>
<th>Applicant</th>
<th>Qualification</th>
<th>Age</th>
<th>Gender</th>
<th>Work Experience</th>
<th>Aptitude Score</th>
<th>Temperament (Suitability)</th>
<th>Comp Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nadia(A1)</td>
<td>Masters/CCNA</td>
<td>34</td>
<td>M</td>
<td>7</td>
<td>41</td>
<td>Choleric (Suitable)</td>
<td>44</td>
</tr>
<tr>
<td>Ama(A2)</td>
<td>Masters</td>
<td>37</td>
<td>F</td>
<td>6</td>
<td>44</td>
<td>Choleric (Suitable)</td>
<td>43</td>
</tr>
<tr>
<td>Narda(A3)</td>
<td>Bachelors/CISCO</td>
<td>36</td>
<td>F</td>
<td>4</td>
<td>38</td>
<td>Choleric (Suitable)</td>
<td>40</td>
</tr>
<tr>
<td>Nabil(A4)</td>
<td>Bachelors</td>
<td>30</td>
<td>M</td>
<td>4</td>
<td>35</td>
<td>Melancholy (Not Suitable)</td>
<td>41</td>
</tr>
</tbody>
</table>

The applicants shortlisted are sent an email or a message to write an examination. The final scores and applicant attributes are displayed in the table 3.12. Four applicants are shortlisted (A1, A2, A3 and A4). Based on the fuzzy scores obtained and the assigned fuzzy weights, the calculation below is used as an illustration to review how the system ranked these applicants.

**Calculations**

From the information provided in the tables above the score obtained by each candidate is calculated as follows using the formula below. The fuzzy weights are multiplied with the fuzzy score assigned by the

\[
\sum_{i=1}^{4} \left( \text{general points} \times \text{range points} \right)
\]
Applicant (A1) Scores

\[
\text{Score} = (0.2 \times 0.07) + (0.2 \times 0.08) + (0.15 \times 0.06) + (0.1 \times 0.06) + (0.15 \times 0.07) + (0.1 \times 0.05) + (0.2 \times 0.15) + (0.1 \times 0.05) \\
= 0.014 + 0.016 + 0.009 + 0.006 + 0.0105 + 0.005 + 0.003 + 0.005 \\
= 0.0955 \\
= 0.096
\]

Applicant (A2) Scores

\[
\text{Score} = (0.2 \times 0.07) + (0.15 \times 0.05) + (0.1 \times 0.04) + (0.15 \times 0.09) + (0.1 \times 0.03) + (0.2 \times 0.15) + (0.1 \times 0.05) \\
= 0.014 + 0.0075 + 0.004 + 0.0135 + 0.003 + 0.03 + 0.005 \\
= 0.048
\]

Applicant (A3) Scores

\[
\text{Score} = (0.2 \times 0.05) + (0.2 \times 0.08) + (0.15 \times 0.05) + (0.1 \times 0.04) + (0.15 \times 0.09) + (0.1 \times 0.03) + (0.2 \times 0.15) + (0.1 \times 0.05) \\
= 0.01 + 0.016 + 0.0075 + 0.004 + 0.0135 + 0.003 + 0.003 + 0.005 \\
= 0.059
\]

Applicant (A4) Scores

\[
\text{Score} = (0.2 \times 0.05) + (0.15 \times 0.06) + (0.1 \times 0.06) + (0.15 \times 0.09) + (0.1 \times 0.03) + (0.2 \times 0.05) + (0.1 \times 0.05) \\
= 0.01 + 0.009 + 0.006 + 0.0135 + 0.003 + 0.01 + 0.005 \\
= 0.0565 \\
= 0.057
Table 3.13: Ranking

<table>
<thead>
<tr>
<th>Applicants</th>
<th>Score</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>0.096</td>
<td>1</td>
</tr>
<tr>
<td>A2</td>
<td>0.048</td>
<td>4</td>
</tr>
<tr>
<td>A3</td>
<td>0.059</td>
<td>2</td>
</tr>
<tr>
<td>A4</td>
<td>0.057</td>
<td>3</td>
</tr>
</tbody>
</table>

The score of each applicant is shown in the table 3.13. From the table 3.13 if the vacancy available is only for three people, then it’s obvious that applicant A1, A3, A4 should be placed based on the ranks obtained. With regard to applicant A4 whose required skill is melancholy which is different from the required skill – choleric, decision makers need to explain why there is a need to choose A4 over applicant A2 who is a choleric.

Following the decision maker’s argument a choleric activity level is almost similar to melancholy since both have the same drive to work. This means that though applicant A4 is melancholic he would be chosen for placement. Here we realize that their main difference is related to their emotions.

As a matter of fact, it follows that the selection process starts when the job applications are received. When all requirements are met short listed applicants are called to write three tests (aptitude, computer and temperament). The research work extensively focused on the evaluation of the results based on the fuzzy simple additive weighted method. The applicants are then interviewed based on the following factors
(foreign language, appearance, confidence level and composure) by decision makers.

The final decision is communicated to the applicant.
3.7.6 Use Case diagram

There are *five (5)* main actors in this system. They are the System Administrator, Human Resource Manager, the Examiner, the Applicant and the Data entry personnel. The use case diagram is shown in figure 3.10. The actors in figure 3.10 are defined below.

**Definition of the actor**

- **Administrator:** The administrator assigns roles to various users and activates or deactivates users.
- **Human Resource Manager:** This individual assigns skills and add skills specific to the requisition and sets the required temperament.
- **Examiner**: The examiner sets all questions to test short listed applicants.
- **Data entry clerk**: A person who enters all records received from the applicant.
- **Applicant**: Anyone who is short listed writes exams.

Table 3.14: Defining the Use Cases used in the UML Diagram

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Login</strong></td>
<td>Any of the users (administrator, HR manager, Examiner, Data entry clerk, applicant) logins in to access appropriate menus assigned them. The system displays a nice graphical user interface for each of these users.</td>
</tr>
<tr>
<td><strong>Employer portal for definition</strong></td>
<td>All relevant skills are defined</td>
</tr>
<tr>
<td><strong>Examiner portal to set test</strong></td>
<td>Sets all test to be written by applicant (s)</td>
</tr>
<tr>
<td><strong>Applicant writes test</strong></td>
<td>Writes all relevant test</td>
</tr>
<tr>
<td><strong>Test processes</strong></td>
<td>Processes used in determining the fuzzy scores</td>
</tr>
<tr>
<td><strong>Interview report</strong></td>
<td>Generated for reporting purpose</td>
</tr>
<tr>
<td><strong>Applicant placed</strong></td>
<td>Qualified applicants are duly placed.</td>
</tr>
</tbody>
</table>
Table 3.14 shows the definitions of the use cases described in the UML diagram. Each of the process described details what the use case does. The UML diagram describes each of the actors and their respective roles in the system.

### 3.7.7 Context level for the personnel selection

![Diagram of the context level for personnel selection](image)

**Figure 3.11: Context level diagram**

Figure 3.11 illustrates the context level diagram which describes the interaction the user has with the system by sending or uploading the appropriate data and the responds the system provides to those request made.
3.7.8 The System Model

Figure 3.12: System model

Figure 3.12 shows the system model of the proposed system implementing fuzzy engine in personnel selection. The major roles played by the HR manager and the examiner are very important. All the points generated during the short listing and the scores obtained from the various levels is move into the fuzzification module where the points.
Figure 3.13: Data flow diagram

Figure 3.13 describes the data flow diagram representing how the various components in the fuzzy personnel system work. Each of the entity/component performs a specific role which communicates with the fuzzy engine and order to produce the desired result.
3.8 The Database

Figure 3.14: The database relationships

There are twenty four tables in the database. Figure 3.14 shows all the tables and their fields.
Chapter 4

4.0 Implementation

This Human Resource (HR) plus an ideal system for selecting personnel who fits the best position based on the specified criteria and job requirements. The implementation of fuzzy approach to an applicant’s selection process from the time that the application is sent to the agency to the time when the right candidate who best fit the job is selected. This system attempts to overcome the existing problems (subjective value judgement, biasness, vagueness, imprecision, complexity and multivalencies of skills). This is achieved through the coding of the pseudo-code algorithm inferred from the analysis in the previous chapter.

The programming language being used is Java using the Netbean integrated development environment (IDE). Java is portable and platform independent. It is secure and simple to use. Java supports hardware implementation in order to achieve the system's selection process based on the fuzzy approach. At the back end is a strong relational database that has been well normalized and has been related to each other in order to obtain a well structured activity.

This system is easy to use and learn on training. Organization who ventures into the usage of this fuzzy approach to personnel will maximize productivity and make will be highly fair to all applicants who send forth their applications to such agencies.
4.1 System Environment

The users of this system need to have access rights before they can use the features of the system. The system interacts with the database to obtain all the fuzzy points saved in the database as a result of various computations before ranking the applicants.

4.2 Graphical User Interfaces (GUIs)

To effectively use the system the following interfaces have been developed to meet the user specification. The graphical user interfaces (GUIs) describes the various procedures the user must implement to select qualified applicants for the job. Brief descriptions are given in order to clarify how these interfaces are operated.

4.2.1 The Login Interface

Appendix 1.0 shows the login interface which opens the main interface with access rights if a match is found. All the users of the system will use this interface as an entry point to using the fuzzy personnel selection system.

4.2.2 Main interface

Appendix 2.0 shows the main graphical user interface and main menu for the fuzzy personnel selection system where depending on the roles assigned to users, only the specific aspects are displayed to them. The System menu allows the administrator to assign various roles to the users of the system. The administrator can add, activate, deactivate and delete a user. The Human Resource (HR) menu is used to set all
attributes pertaining to the applicant. The HR sets all the fuzzy points for each
category in the selection of the applicant. These fuzzy points are dependent on the
type of job or job position that is been occupied. The HR is responsible to edit all the
fuzzy points any time the job placement changes. The Applicants control menu is
used to enter all the details of the applicant and

4.2.3 User Account Management

Appendix 3.0 shows user account management interface. Users can be added and
various roles assigned to them to access specific menu items. Here the administrator can
activate or deactivate a user and at the same time can edit user credentials.

To add a new applicant attribute, the HR uses the dialog box in Appendix 4.0. All the
attributes are entered and set based on the job profile and the specific skills that are
required from the applicant. When all these attributes have been set then the applicant’s
entries are made.

4.2.4 Applicant Record

When an advertisement is made and some people apply and send their application form, the
above form (Appendix 5) is used to enter the data obtained from the applicants form. On the
other hand Appendix 6.0 is the form which the data entry clerk uses to set the attributes that
pertains to the applicant. When the applicant’s ID is selected, the name populates in the text field
and the attributes are then set.
4.2.5 Communicating with short listed applicants

The system sends automatic email and SMS to all short listed applicants so that they can proceed to write the three tests. This is illustrated in Appendix 7.0. The email feature is powered by Gmail API. This means that it requires a g-mail user name and password before messages could be prospective applicants.

4.2.6 Examination Portal

Appendix 8.0 and 9.0 are used by the examiner to set all questions relating to the selection process. Weights of varying size are assigned to these questions depending on the discretion of the examiner. He also inputs the various characteristics concerning all the temperament.

4.2.7 Applicants Portal

To access the three tests, the applicant logs in to write the examinations. The applicant uses the user name and password generated by the system to access the test. Appendix 10 and appendix 11 show the computer test and temperament test respectively. The temperament test is sorted in alphabetical order. It is relevant to sort in ascending order so that temperament within one category do not align itself for easy of recognition.

4.2.8 Reports

The fuzzy personnel selection displays a crystal report. Appendix 12.0 shows the main menu for the reports. Applicants report, suitable or unsuitable applicants report, and qualified applicants report. Appendix 13.0 shows a dialog box that allows the user to specify the period in which the report is to be generated.
4.2.9 Close vacancy

Appendix 14.0 describes the dialog box used for closing vacancy period within with applicants record could be no longer entered into the system. From the research, it was realized that the system administrator could open the period for the process and close it within a period of time.
Chapter 5

5.0 Conclusion

5.1 Summary and Conclusion

The research work presented a new dimension to aid in selecting personnel using a fuzzy logic by implementing the Fuzzy Simple Additive Method (FSAW) to overcome the problem of Decision-Makers Executive Judgement (DMEJ). The method was applied on data obtained from L’aïne Services Limited in Kumasi. In this research much emphasis was placed on minimising human subjectivity (value judgements) and vagueness. These two factors affect personnel selection in most organizations leading to the selection of unqualified applicants’ over qualified ones mostly overlooking their natural tendencies.

To increase the efficiency and ease-of-use of the proposed model a software system has been developed to overcome the limitations that come with using software such as MS Excel to evaluate the applicants based on criteria set forth by the employers. The system factors about 90% of the tedious process of selecting applicants who qualify for the right job by way of ranking them based on the parameters and attributes discussed in the research, decision makers depend on the ranked suitability report to call for interview to evaluate applicants on other four important factors (foreign language, competence, composure and appearance).
The system adapted the use of fuzzy numbers by assigning each selection process a fuzzy number to aid in the selection of qualified applicants with their natural tendencies for the job. This method is very efficient and precise.

The goals for each of the entities and components in the research described in the framework met the desired target. The applicant’s history is kept and can be extracted from the database at any point in time. In this research, the major identified problem was considering someone’s natural ability in combination with an applicant’s CV before placing the person on the job.

Here the consideration of temperament to determine suitable applicants is paramount. As a result this fuzzy logic system was produced to aid in selecting the right person for a particular task based on the person’s temperament. A person with a combination of the right skills and natural tendencies or abilities will perform the job effectively, affecting the performance and competitive power of the organisation. Selecting the wrong person means repeating the whole selection process and hiring a new employee or training the hired person, results spending great amount of resources mostly on time, effort, and money.

The findings revealed that, placing applicants for a job position using this method other than the conventional method of selecting and placing applicants example unqualified family members (which normally has adverse effect on performance) and referrals is totally dealt with by the implementation of this new framework. The system evaluates applicants by matching all the skills or attributes entered into the system. Each of these factors is used to determine the scores which are used for evaluation, selection and ranking applicants by using the method presented in this research.
The method discussed in this research work for the evaluation of the applicants for job placement has the ability to be an effective tool which needs to be adapted by organizations involved in personnel selection in Ghana and other parts of the world to use.

5.2 Recommendations and future work

The implementation of fuzzy in personnel selection is becoming a major issue of concern since factors that influence the selection processes are taking care of. From the research and the implementation of the system the following are recommended:

- To further reduce human subjectivity the system could be developed to have on-line entrants, after shortlist applicants could take the other test on-line and receive automatic email when the fuzzy score has been determined and the applicants have been ranked. Depending on the ceiling, the required number of applicants is sent emails to come for the oral interview.

- Other factors apart from those strictly relating to HR decision making for employee selection could be included in the development of the system to influence the choice of selecting the best applicant for the right job. Example to test for a person’s loyalty, an individual’s background can be traced and weight assigned to it during the selection process.

- It is also recommended that an individual’s medical examination (medical tests that are conducted to ensure physical fitness of the potential employee/applicant) be factored and a fuzzy number assigned to influence applicants chance of
obtaining the job. This will greatly decrease chances of employee absenteeism which will eventually affect performance and the organization's turnover.
APPENDIX

1.0 The login interface

2.0 The main interface
3.0 User account management

4.0 Applicant skill window

5.0 Applicant’s Data Record
6.0 Applicant’s attributes form

![Applicant's attributes form](image1)

7.0 Communication form

![Communication form](image2)

8.0 Computer test interface

![Computer test interface](image3)

<table>
<thead>
<tr>
<th>question_no</th>
<th>question_type</th>
<th>question</th>
<th>answer</th>
<th>points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>computer test</td>
<td>What is a computer peripheral device?</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>computer test</td>
<td>What is used to display views... Monitor</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
9.0 Temperament test interface

10. Computer test interface

11. Temperament test interface
12. Reports menu

13. Reporting period dialog box

14. Close vacancy dialog box

15.0 Java Documentation (Javadoc) of Applicants Program

Below is the documentation of Applicants program generated in NetBean 6.9.2

Class AddApplicant

java.lang.Object

└── fuzzyproject.AddApplicant

All Implemented Interfaces:

java.awt.event.ActionListener, java.util.EventListener

public class AddApplicant
extends java.lang.Object
implements java.awt.event.ActionListener
## Constructor Summary

<table>
<thead>
<tr>
<th>Constructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>AddApplicant()</td>
</tr>
</tbody>
</table>

## Method Summary

<table>
<thead>
<tr>
<th>Method</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>void</td>
<td><strong>actionPerformed</strong>(java.awt.event.ActionEvent event)</td>
</tr>
<tr>
<td>HRInternalFrame</td>
<td><strong>addApplicantInternalFrame</strong>()</td>
</tr>
<tr>
<td>java.lang.String[]</td>
<td><strong>allCountries</strong>()</td>
</tr>
<tr>
<td>javax.swing.JPanel</td>
<td><strong>form</strong>()</td>
</tr>
<tr>
<td>javax.swing.JScrollPane</td>
<td><strong>viewAllApplicants</strong>()</td>
</tr>
</tbody>
</table>

## Methods inherited from class java.lang.Object
Constructor Detail

AddApplicant

public AddApplicant()

Method Detail

addApplicantInternalFrame

public HRInternalFrame addApplicantInternalFrame()

processAddition

public void processAddition(java.lang.String firstname,
                              java.lang.String surname,
                              java.lang.String other_names,
                              java.lang.String gender,
                              java.lang.String dob,
                              java.lang.String ploBirth,
                              java.lang.String arg_nationality,
                              java.lang.String argu_socal_security_no,
                              java.lang.String argu_national_id_no,
                              java.lang.String religiousAffiliation,
                              java.lang.String argu_tel,
                              java.lang.String argu_mobile,
                              java.lang.String argu_e_mail,
                              java.lang.String argu_address)

viewAllApplicants

public javax.swing.JScrollPane viewAllApplicants()

allCountries

public java.lang.String[] allCountries()
public javax.swing.JPanel form()

actionPerformed

public void actionPerformed(java.awt.event.ActionEvent event)

Specified by:

actionPerformed in interface java.awt.event.ActionListener

fuzzyproject
Class AddSkills

java.lang.Object

└ java.awt.Component
   └ java.awt.Container
      └ java.awt.Window
         └ java.awt.Frame
            └ javax.swing.JFrame
               └ fuzzyproject.AddSkills

All Implemented Interfaces:


public class AddSkills

extends javax.swing.JFrame

Nested Class Summary
### Nested classes/interfaces inherited from class javax.swing.JFrame

<table>
<thead>
<tr>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>javax.swing.JFrame.AccessibleJFrame</td>
</tr>
</tbody>
</table>

### Nested classes/interfaces inherited from class java.awt.Frame

<table>
<thead>
<tr>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>java.awt.Frame.AccessibleAWTFrame</td>
</tr>
</tbody>
</table>

### Nested classes/interfaces inherited from class java.awt.Window

<table>
<thead>
<tr>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>java.awt.Window.AccessibleAWTWindow</td>
</tr>
</tbody>
</table>

### Nested classes/interfaces inherited from class java.awt.Container

<table>
<thead>
<tr>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>java.awt.Container.AccessibleAWTContainer</td>
</tr>
</tbody>
</table>

### Nested classes/interfaces inherited from class java.awt.Component

<table>
<thead>
<tr>
<th>Class</th>
</tr>
</thead>
</table>

### Field Summary

### Fields inherited from class javax.swing.JFrame

<table>
<thead>
<tr>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>accessibleContext, EXIT_ON_CLOSE, rootPane, rootPaneCheckingEnabled</td>
</tr>
</tbody>
</table>
Fields inherited from class java.awt.Frame

CROSSHAIR_CURSOR, DEFAULT_CURSOR, E_RESIZE_CURSOR, HAND_CURSOR, ICONIFIED, MAXIMIZED_BOTH, MAXIMIZED_HORIZ, MAXIMIZED_VERT, MOVE_CURSOR, N_RESIZE_CURSOR, NE_RESIZE_CURSOR, NORMAL, NW_RESIZE_CURSOR, S_RESIZE_CURSOR, SE_RESIZE_CURSOR, SW_RESIZE_CURSOR, TEXT_CURSOR, W_RESIZE_CURSOR, WAIT_CURSOR

Fields inherited from class java.awt.Component

BOTTOM_ALIGNMENT, CENTER_ALIGNMENT, LEFT_ALIGNMENT, RIGHT_ALIGNMENT, TOP_ALIGNMENT

Fields inherited from interface javax.swing.WindowConstants

DISPOSE_ON_CLOSE, DO_NOTHING_ON_CLOSE, HIDE_ON_CLOSE

Fields inherited from interface java.awt.image.ImageObserver

ABORT, ALLBITS, ERROR, FRAMEBITS, HEIGHT, PROPERTIES, SOMEBITS, WIDTH

Constructor Summary

AddSkills()
### Methods inherited from class javax.swing.JFrame

addImpl, createRootPane, frameInit, getAccessibleContext, getContentPane, getDefaultCloseOperation, getGlassPane, getGraphics, getJMenuBar, getLayeredPane, getRootPane, getTransferHandler, isDefaultLookAndFeelDecorated, isRootPaneCheckingEnabled, paramString, processWindowEvent, remove, repaint, setContentPane, setDefaultCloseOperation, setDefaultLookAndFeelDecorated, setGlassPane, setIconImage, setJMenuBar, setLayeredPane, setLayout, setRootPane, setRootPaneCheckingEnabled, setTransferHandler, update

### Methods inherited from class java.awt.Frame

addNotify, getCursorType, getExtendedState, getFrames, getIconImage, getMaximizedBounds, getMenuBar, getState, getTitle, isResizable, isUndecorated, remove, removeNotify, setCursor, setExtendedState, setMaximizedBounds, setMenuBar, setResizable, setState, setTitle, setUndecorated

### Methods inherited from class java.awt.Window

addPropertyChangeListener, addPropertyChangeListener, addWindowFocusListener, addWindowListener, addWindowStateListener, applyResourceBundle, createBufferStrategy, createBufferStrategy, dispose, getBufferStrategy, getFocusableWindowState, getFocusOwner, getFocusTraversalKeys, getGraphicsConfiguration, getIconImages, getInputContext, getListeners, getLocale, getModalExclusionType, getMostRecentFocusOwner, getOwnedWindows, getOwner, getOwnerlessWindows, getToolkit, getWarningString, getWindowFocusListeners, getWindowListeners, getWindows, getWindowStateListeners, hide, isActive, isAlwaysOnTop, isAlwaysOnTopSupported, isFocusableWindow, isFocusCycleRoot, isFocused, isLocationByPlatform, isShowing, pack, postEvent, processEvent, processWindowFocusEvent, processWindowStateEvent, removeWindowFocusListener, removeWindowListener, removeWindowStateListener, reshape, setAlwaysOnTop, setBounds, setBounds, setCursor, setFocusableWindowState, setFocusCycleRoot,
setIconImages, setLocationByPlatform, setLocationRelativeTo, setMinimumSize, setModalExclusionType, setSize, setSize, setVisible, show, toBack, toFront

**Methods inherited from class java.awt.Container**

add, add, add, add, add, addContainerListener, applyComponentOrientation, areFocusTraversalKeysSet, countComponents, deliverEvent, doLayout, findComponentAt, findComponentAt, getAlignmentX, getAlignmentY, getComponent, getComponentAt, getComponentAt, getComponentAt, getComponentCount, getComponents, getComponentZOrder, getContainerListeners, getFocusTraversalPolicy, getInsets, getLayout, getMaximumSize, getMinimumSize, getMousePosition, getPreferredSize, insets, invalidate, isAncestorOf, isFocusCycleRoot, isFocusTraversalPolicyProvider, isFocusTraversalPolicySet, layout, list, list, locate, minimumSize, paint, paintComponents, preferredSize, print, printComponents, processContainerEvent, remove, removeAll, removeContainerListener, setComponentZOrder, setFocusTraversalKeys, setFocusTraversalPolicy, setFocusTraversalPolicyProvider, setFont, transferFocusBackward, transferFocusDownCycle, validate, validateTree

**Methods inherited from class java.awt.Component**
References


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