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Multi-Criteria Decision Making (MCDM) for Student House Selection in Girei Adamawa Nigeria: A Case Study of Modibbo Adama University Students

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Abstract: One fundamental necessity that has an impact on social, economic, and numerous other significant facets of life is housing. House selection is becoming a problem in a recent time due to increase in population, standard of living and economic hardship that were set in compare to the previous years. Deciding on how to select a house as students for accommodation is often very difficult. The aim of the study is to use multi-criteria decision making in order to determine factors influencing students house selection in the study area. This study applied Analytical Hierarchy Process (AHP) in selecting house. The study considered the off-campus students of the study area. The research designed adopted was a survey research using Saaty nine scale point questionnaire. Convenient sample was used to sample 150 students for the study. Three criteria were chosen with four alternatives which formed part of the question framed in Google form and sent to students to answer. The filled questionnaires were extracted and analyzed using Excel software version 10.0. The results of the study revealed that security ranked 1st in all the other variables measured while semi-detached room ranked 2nd. The 3rd and 4th rankings were room and parlour and single room. The results showed that in building students' accommodation in the study area, priority should be given to security over light and cost of housing. We recommend same for public private partnership. We also recommend that university should prioritize students hostel over other social amenities to alleviate student's hardship in obtaining accommodation. University should liaise with private organizations to help in building affordable accommodation inside campus. This will be more secured than students living outside the campus.

Keywords: House selection, Analytical Hierarchy, multi-criteria decision making, Accommodation.

1 Introduction

One fundamental necessity that has an impact on social, economic, and numerous other significant facets of life is housing. The Nigerian economy, population, and urbanization have grown recently, so too has the need for housing in large cities [1]. This also goes to the number of school enrollments which is of the increase year in year out and this also put pressure on demand for accommodation by students. However, because of the concerning demands of accommodation, students tend to look for a house that can comfortably accommodate them to study.

Determining what to do and selecting the best out of the bests is more often a hurdle, bottleneck and this always put man at a crossroad. We always find ourselves in the midst of alternative choices and we must make the choice as sometimes we can't do without these alternatives. Where the choice is made in error, the cost is enormous, devastating, catastrophe and disastrous. People have choices in life, and most of them are made to improve their lives. One of the three fundamental human necessities is housing. Choosing a suitable home to live in comfortably is a difficult task. For instance, it can be difficult to choose affordable housing that satisfies the requirements of low-income individuals because the majority of people's decisions lacked the application or utilization of comprehensive information. The distribution of housing has an impact on people's social and economic lives. Making the correct housing selection is another difficult option [11].

We encounter and evaluate issues in daily life in order to determine the best course of action, or optimization. They are present in practically every setting, including the family, the economy, and technical systems. The study of multiple criteria and a number of constraints is usually the foundation for the decision-making process and the selection of the best option. Multi-criteria decision-making (MCDM) is a term that can be used to describe decision-making that applies multiple criteria [7].

In today's activities, choosing decisions is crucial. Several criteria must be taken into account while making a decision, and these criteria frequently conflict with one another. To identify effective ranking decisions, a lot of work has been done in the last several years to introduce MCDM methodologies [10].

Determining the criteria that the decision support system requires is one of the most important success aspects when

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choosing a home. The issue is determining which characteristics are necessary or impact the choice of home. Furthermore, ambiguity is the main source of decision-making issues when choosing a home. The inability to pinpoint a specific location creates uncertainty, suggesting that one of the factors in making a wise housing choice is the location of the property. Sometimes uncertainty makes a decision maker's final choices difficult and impractical [1].

Many people from the lowest, medium, and upper classes have an innate fondness for comfort. This is just one of the several factors contributing to the strong demand for housing in cities and for university students [12]. The demand for housing in metropolitan areas has risen above average as a result of the nation's population growth. Due to their incapacity to keep up with the market, low-income individuals even struggle to pay for their monthly increases in their housing budget. For instance, in the past two decades accommodation for students outside campus is rare because the numbers of student's enrollment were not as high as can be seen of recent years. Students find it difficult to decide whether to stay on or off campus; but nowadays the case is not there.

Some people believe that choosing a home is a straightforward issue, but when you are presented with a variety of geographical options, each with pros and cons, it may become extremely complex. [12]. The majority of selection issues arise from the sheer amount of criteria involved, which breeds ambiguity and can make the ultimate choice challenging and impractical. [2-4] assert that the selection criteria that the recommendation system requires are one factor that determines how successful a recommendation is. Although the best-worst MCDM has been applied extensively in house selection but the method has not been applied in the study area. Also, it application on students house selection have not widely been applied. The MCDM that were mostly applied in solid wastes management practices, the healthcare centres etc. Selecting or making a choice is always a hurdle for the decision make and is always under uncertainty. Since most selection problems involve uncertainty, the more criteria and options that must be taken into account during the selection process, the more difficult and unrealistic the final decision-making process will be. This is because the multi-criteria decision-making method, or MCDM, seeks to identify the best alternative by taking into account multiple criteria during the selection process. Therefore, putting in place a decision support system is one method to make the process of choosing criteria and making a final decision easier.

The majority of selections are based on a large number of criteria, which breeds ambiguity and can make the final choice challenging and impractical. A recommendation system for choosing housing places is one attempt to help the low-income people (LIP) find housing based on the specified criteria. Researches have shown that those with low incomes typically choose homes with a lot of amenities, which naturally cost more than those with moderate incomes. High-tasting people typically have little budgets. While having good taste in a home is not inherently bad, choosing one that is beyond your means is.

Saaty (1980) introduced the analytical hierarchy process (AHP), which is regarded as one of the pioneering techniques. The approach employs a pairwise comparison and assigns suitable weights to several criteria using a straightforward yet comprehensive methodology. The $\frac{n-1}{2}$ comparisons are typically used by AHP to determine the proper weights of the alternatives.

The AHP technique categorizes both qualitative and quantitative factors into hierarchies. It uses paired comparisons of homogenous items that are thought to share a common criterion or attribute to determine dominance priorities. The technique can further be extended by clustering non-homogeneous elements [5-6].

Numerous studies about using the AHP to tackle problems have also been published in specialized journals in fields including Operations Research, mathematical modeling, and socio-economic planning sciences, among others. Although there have been studies on the use of MCDM such as the Analytical Hierarchy Process (AHP) in housing selection but MCDM in housing selection has not been used extensively, particularly in the study area. Therefore, the multi-criteria decision-making approach is considered for this study.

Due to its structured pairwise comparison method, MCDM generates more consistent results and requires less data for evaluating organizations' research because it does not require a complete pairwise comparison matrix. The decision-makers also view it as straightforward and extremely similar to how they evaluate and reason while making decisions. In their study on the subject, [13-14] discovered that choosing a home, which many people believe to be straightforward and easy, can become challenging when presented with a variety of options, each of which must have pros and cons. They continued by explaining that the next step is to create a decision support system that can help people choose subsidized housing that meets their needs in order to make the process of choosing a home easier. Since most selection problems involve ambiguity, the ultimate decision-making process becomes more challenging and impractical the more criteria and options that must be taken into account during the selection process.

For instance, [13-14] applied decision support system for subsidized housing selection based on best-worst method and

simple additive weighting. Their study applied several methods and steps to evaluate and analyzed data collected. Criteria and expert were considered in the study. Their results revealed that MCDM such as Best-Worst method can serve as a decision support tool for choosing subsidized housing, assisting disadvantaged individuals who are typically less knowledgeable in making sensible choices.

[9] applied MCDM for in-house storage sites selection. The study used the additive ratio assessment and the combine compromise solution methods. They used expert judgment where expert or interested party can make corrections based on his/her opportunities. This is more often done to minimize biasness. The results showed that these two methods though rarely use but can be applied effectively in any selection case.

Price, land size, building size, number of bedrooms, security services, access to the main street, distance to work, distance to social facilities, and so forth are some of the numerous factors that influence people's decision to buy or rent a home, [5-6]. Furthermore, some of these characteristics are in opposition to one another, such as the size of the property and its price. Nonetheless, individuals tend to want large homes at the lowest possible cost. This decision-making activity involves multiple criteria or attributes. On the other hand, [10] claimed that because human competence is needed to address the house selection problem, it cannot be done with a general linear mathematical solution.

[8], reported that consumers typically seek guidance from consultants who play the role of experts or those who have expertise purchasing a home in order to minimize any complications. Such guidance is quite helpful, especially when it comes to the skills and information needed to solve the issue. Working with experts to make decisions can have certain potential drawbacks, though, such as varying levels of expertise or the lack of experts; lack of capacity due to physical or mental workload; failure to remember important details of a problem; inconsistent decision making in the same situation; inability to store and memorize all work-related information or inability to recall or understand large amounts of data in a short period of time; potential bias in decision-making due to personal factors; avoidance of responsibilities after making a decision; fraudulence, age factor, and other factors that may lower the expertise level [15-16]

2 Materials and Methods

The research designed adopted for this study is the survey research designed. This designed was adopted because we wanted to collect data that reflects the attitudes, behaviours, opinions, and beliefs of the population that cannot be directly observed. The second reason was that it has the advantage of systematically collecting data from a sample of entities (students) in order to create quantitative descriptors of the characteristics of the larger population of which the students are members and a true representative of our study.

The study population consists of undergraduate students (male and female) who are residing in off campus. The variables of the study are the goal, criteria and the alternatives with priority options under them (see conceptual diagram). Convenience sample was used to sample 150 students for the study. Three criteria were chosen with four alternatives which formed part of the question framed in Google form and sent to students to answer. The filled questionnaires were extracted and analyzed using Excel software version 10.0

The AHP questionnaire so designed was sent to students WhatsApp to fill. The filled questionnaires were vetted and verified. The responses were summarized which formed the pairwise comparison matrix (see Tables). The collected data were summarized based on the Saaty guidelines. For example, the pair-wise comparison matrixes were obtained from the questionnaire retrieved. If the respondents scale answered was in the opposite, the scale was not rejected but it would be recorded as the reciprocal of the scale value (See Tables). Each column of the pair-wise comparison matrix was summed and the total sum placed under each column.

The synthesized matrixes were obtained by dividing each column element by their respective column sum this is given by the formula $\boldsymbol{X_{ij}} = \frac{\boldsymbol{a_{ij}}}{\sum_{i=1}^{n} \boldsymbol{a_{ij}}}$. The prorioty vector is obtained by the row averages of the synthesized matrix. The weight is calculated by multiplying priority vector by each column of the pair-wise comparing matrix and the sum product become the weight. Lambda is however obtained by diving all the elements of the weighted sum by their respective priority vector element. The average of all the lambda value is the lambda maximum denoted by $\lambda_{\max}$. On the other hand, consistency index (CI) was calculated as $\frac{\lambda_{\max} - n}{n-1}$ where n is the number of criteria or alternatives as the case may be. The consistency ratio (CR) is obtained by dividing the consistency index by the random index. The summary of relative importance in which a decision maker can select and their explanation is seen in Table 1 below while summary of the analyses is provided in the preceding Tables.

Table 1: Scale of Relative Importance

Rank	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective.
3	Moderate importance of one over another	Experience and judgment strongly favour one activity over another.
5	Strong importance of one over another	Experience and judgment strongly favour one over another.
7	Very strong importance of one over another	An activity is strongly favored and its dominance demonstrated in practice.
9	Extreme importance of one over another	The evidence favoring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Weak, moderate, strong plus, very strong plus importance of one over another	When compromise is needed.
Reciprocal of the Non-zero	If activity I has one of the above Non-Zero numbers assigned to it when compared with activity J, then J has the reciprocal value when compared with I.	

Source: Saaty, 1980

Table 2: Saaty Nine Scale Ranking and its Associated Random Consistency Index

Scale	1	2	3	4	5	6	7	8	9
RCI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

The synthesis stage is performed following the comparison of the options according to each of the choice criteria and the derivation of the individual priority vectors. This should not be mistaken with the judgment matrices with the pairwise comparisons, the priority vectors are transformed into the columns of the decision matrix. Pairwise comparisons are also used to assess the criteria's weights of importance. The decision makers always formed a judgment matrix MXM and NXN for criteria (see conceptual framework below)

2.1.1 Model Formulation

After the decision matrix, the resulting priorities are given by the formula below:

$$A^{i}{}_{AHP}=\sum_{i=1}^{n} a_{ij}\, w_j \text{, for i = 1,2,…, m} \quad (1)$$

where: $A^{1}{}_{AHP}$ = the final priority

w_j = weight of the important criteria

a_{ij} = the judgment matrix

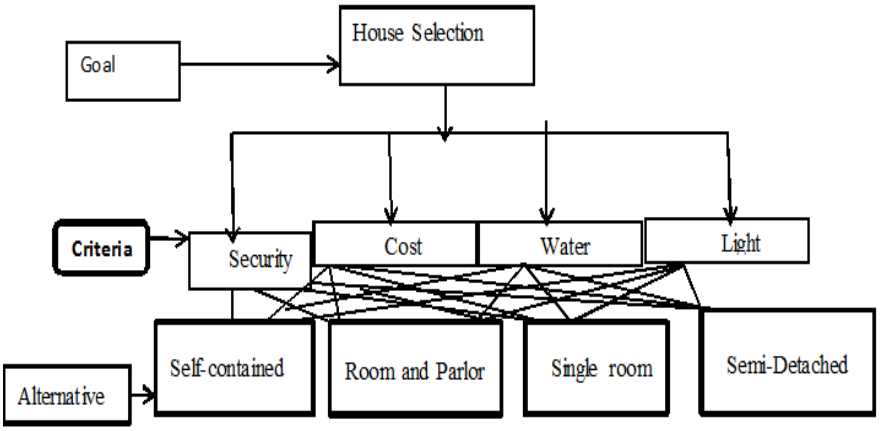

Fig. 1: Conceptual model of the goal, criteria and the alternatives

Table 3: The Pairwise Raw Matrix of the Variables

Criteria	**SC**	**RP**	**SR**	**SD**
SC	1	RP/SC	SR/SC	SD/SC
RP	SC/RP	1	SR/RP	SD/RP
SR	SC/SR	RP/SR	1	SD/SR
SD	SC/SD	RP/SD	SR/SD	1

KEY: Self- contained (SC), Room and Parlor (RP), Single room (SR), Semi-detached (SD)

2.1.2. Multi-criteria Decision-making Analysis Process

An MCDM problem is made up of some alternatives ($a_1, \ a_2, \ a_3, \ldots, a_m$), multiple criteria ($c_1 \ \ c_2 \ \ c_3 \ldots c_m$), and each alternative has score with criterion ($p_{11}, p_{12}, p_{13} \ldots, p_{mn}$) therefore, an MCDM problem can be shown as the following matrix shows:

$$A = \begin{array}{c} \\ a_1 \\ a_2 \\ a_m \end{array} \begin{array}{c} \begin{array}{cccc} c_1 & c_2 & \ldots & c_n \end{array} \\ \begin{pmatrix} p_{11} & p_{12} & \cdots & p_{1n} \\ \vdots & & \ddots & \vdots \\ p_{m1} & p_{m2} & \cdots & p_{mn} \end{pmatrix} \end{array} \tag{2}$$

The model in the matrix above can be re-written as:

$$v_i = \sum_{j=1}^{n} w_j p_{ij} \tag{3}$$

Where:

v_i = sum of a priority vector

w_j = weight of the priority matrix

p_{ij} = pair-wise comparison column matrix

Consistency Index (CI) is calculated using the formula given by;

$$C.I = \frac{\lambda_{\max} - n}{n-1} \tag{4}$$

Where n is the number of element and lambda max is the largest eigenvalue of the pairwise comparison.

The consistency ratio (CR) can be gotten by using the formula:

$$CR = \frac{CI}{RI} \tag{5}$$

Where R is the random index

CR value in the pairwise comparison matrix will indicate consistency when the value is less than 0.10

In order to normalize the matrix, we take the division of each column elements by its sum total see of equation 1 above say X_{1j} yielding the normalized equation and its matrix as seen below:

$$\boldsymbol{X_{ij}} = \frac{\boldsymbol{a_{ij}}}{\sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} \boldsymbol{a_{ij}}} \tag{6}$$

$$\begin{Bmatrix} X_{11} & X_{12} & X_{13} \\ X_{21} & X_{22} & X_{23} \\ X_{31} & X_{32} & X_{33} \end{Bmatrix} \quad (7)$$

The priority matrix of $nx1$ is calculated by dividing the row total of equation 7 by the number of its column. That is, we divide the row sum of the normalized matrix by the number of criteria (n) used to generate weighted priority matrix.

$$W_{ij} = \frac{\sum_{i=1}^{n} X_{ij}}{n} = \begin{bmatrix} W_{11} \\ W_{12} \\ W_{13} \end{bmatrix} \quad (8)$$

The weight W_{nm} is obtained by multiplying the priority vector of each row element to each column of the initial pairwise comparison matrix

$$W_{nm} = \alpha_i \sum_{i=1}^{n} \sum_{i=1}^{m} x_{ij} \quad (9)$$

Where α is the priority element of each row

The analysis and presentation of the results can be seen in the Tables that follows:

Table 4: Pairwise Comparison Matrix for the Cost Housing

Criteria	SC	SD	RP	SR
SC	1	1	1/2	1
SD	1/2	1	1	2
RP	1/2	1/2	1	3
SR	1/2	1/2	1/3	2
Total	**2.5000**	**3.0000**	**2.8333**	**8.0000**

Summary of the raw data gotten from the respondents by matching the responses with the Saaty nine scale points ranking.

Table 5: Synthesized Matrix for the cost of Housing

Alternative	SC	SD	RP	SR
SC	0.4000	0.3333	0.1765	0.1250
SD	0.2000	0.3333	0.3529	0.2500
RP	0.2000	0.1667	0.3529	0.3750
SR	0.2000	0.1667	0.1176	0.2500

The synthesized matrix is gotten by dividing each column element by the total sum element of the column matrix. From the synthesized matrix we got the priority vector, weight, lambda and the lambda maximum. The values of which formed the basis for the decision making (see Table 6)

Table 6: Priority, Weight and Lambda (λ) for cost of Housing

Alternatives	Priority vector	Weight	λ	Rank
SC	0.2587	0.6555	2.5337	3rd
SD	0.2714	0.7912	2.9153	2nd
RP	0.2721	0.7562	2.7787	1st
SR	0.2500	2.1179	8.4716	4th
			$\lambda_{max} = 4.1778$	

λ_{max} **= 4.1778, CI = 0.0583, CR= 0.0647 < 0.1 accepted**

The average of the lambda seen in column 4 is λ_{max}. The ranking above is based on the values of a priority vector. The preference choice of accommodation is room and palour,the second priority is semi-detached. While the 3rd and the fourth priority go to self-content and single room respectively.

Table 7: Pairwise Comparison Matrix for Security

Alternative	**SC**	**SD**	**RP**	**SR**
SC	1	2	1	2
SD	1/2	1	1/9	5
RP	1/2	1/9	1	3
SR	1/2	1/5	1/3	1
Total	**2.5**	**3.3**	**2.4**	**11**

Table 7 shows the summary of the respondents' responses. The table is based on the Saaty nine (9) points scale.

Table 8: Synthesized Matrix for security

Alternative	**SC**	**SD**	**RP**	**SR**
SC	0.4000	0.6040	0.4091	0.1818
SD	0.2000	0.3020	0.0455	0.4545
RP	0.2000	0.0336	0.4091	0.2727
SR	0.2000	0.0604	0.1364	0.0909

The synthesized matrix is gotten by dividing each column element by the column sum

Table 9: Priority, Weight, Lambda (λ) and rank for the Security of the House

Alternative	**PV**	**Weight**	λ	Rank
SC	0.3987	0.8324	2.0876	1st
SD	0.3246	1.2046	3.0211	2nd
RP	0.2927	0.8108	2.0335	3rd
SR	0.2500	3.5486	8.8998	4th
			λ_{max} = 4.0105	

λ_{max} **= 4.010, CI = 0.0350, CR= 0.0039 < 0.1 accepted**

The results in the above table revealed that in term of security, self-contained, semi-detached, room are to be prioritized most while room and parlour is least to prioritized by the respondents.

Table 10: Pairwise Comparison Matrix for Light

Alternative	**SC**	**SD**	**RP**	**SR**
SC	1	1/3	1	3
SD	1	1	1/3	1
RP	1/3	1/3	1	2
SR	1	1/2	1/2	1
Total	**3.3333**	**2.1667**	**2.8333**	**7.0000**

The table was gotten from the respondents' responses

Table 11: Synthesized Comparison Matrix for Light

Alternative	**SC**	**SD**	**RP**	**SR**
SC	0.3000	0.1538	0.3529	0.4286
SD	0.3000	0.4615	0.1176	0.1429
RP	0.1000	0.1538	0.3529	0.2857
SR	0.3000	0.2308	0.1765	0.1429

The synthesized matrix is gotten from Table 9 above by dividing each column element by the column total.

Table 12: Priority, Weight, Lambda (λ) and rank for the Light

Alternative	**Priority Vector**	**Weight**	λ	**Rank**
SC	0.2689	0.8113	3.0169	1st
SD	0.2555	0.5258	2.0578	2nd
RP	0.2231	0.6835	3.0632	3rd
SR	0.2125	1.7211	8.0982	4th
			λ_{max} =4.0591	

λ_{max} **= 4.0591, CI = 0.0197, CR= 0.0219 < 0.1 accepted**

The most prioritized accommodation is self-contained with 26.89% the next is semi-detached which ranked 2nd with 25.55% while the least prioritized are the room and palaour followed by single room which ranked 3rd and 4th with the percentage priorities of 22.31% and 21.25% respectively.

3 Results and Discussion

The numbers of enrollment in schools, economic hardship, urbanization, new habits, sanitary environment, security and light have become major necessity to people and especially students. Selecting a befitting place to stay or live is now a bottleneck. House selection is a complex decision-making problem. It is complex because its involved so many variables as enumerated above. This study considered off campus students in MAU on how they select accommodation to live in. The study employed AHP nine (9) scale point structured questionnaire. The data collected were subjected spreadsheet Excel software version 10.0

For example, the results for the cost of housing revealed that security ranked 1st followed by semi-detached which ranked second. This implies that students prefer to go for a house that has security in it than to go for any house they can stay in without security. Semi-detached house is also one of the house students prefer no matter what the cost may be. Room and palluor and single room were least preferred by students in this area. Furthermore, the results for security (Table 9) also revealed same with the Security ranking 1st with 38.84%. The rest of the variables were more less same as semi-detached and room and palour has a priority ranking of 28.46% and 28.42% while single room ranked 4th with a percentage ranking of 24.92% respectively. These results revealed the present scenario of insecurity in the nation hence, students are being careful in selecting house for their accommodation. Considering light, students still prefer security and semi-detached room which ranked 1st and 2nd with respective percentage ranking as 48.20% and 35.43% respectively.

The results are also in tandem with the results of Nazori and Rendra (2023), who used best-worst method AHP model for the houses recommendation system. Their results revealed that people tent to choose house that are of quality, in a specific location, land size, public facilities, booking facilities. Their variables are akin to having security because any house with these features can also have security in it. We can infer from the results that students prefer security than any other basics amenities in selecting house for their accommodation. Security of any community in the nation is as stake in a recent year. Without security their study may also be as stake.

Decision making is an irrevocable commitment today to results tomorrow Judge Kenedy (?). Making decision on house selection can be disheartening and frustrating. This study revealed that security and semi-detached room are what students preferred most to the cost of the accommodation and light in it. These are basic necessity in the present situation that the security of life and properties are not grantee. Hence, private land owner that will build house for accommodation should prioritized security and semi-detached while considering building house for students' accommodation in the study area. We also recommend that the university should consider building accommodation for students as the ones she has cannot accommodate students. This is necessary as the number of school enrollment keep increasing every. Al though there are private accommodations outside and close to school but this also has strain up due to increasing number of enrollments year in year out. University should liaise with public private partnership and lease them land to build accommodation for students with a certain number of years that when elapses, the university owns the accommodation. This method will ease or alleviate accommodation issues in university. We further recommend further research in the study area using best-worst method and or fuzzy logic AHP.

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Biography:

Danfulani Bitrus Usman is a lecturer in the Department of Operations Research of the Modibbo Adama University, Yola Adamawa State Nigeria. He was with the Taraba State Teaching Service Board and thereafter moved to National Gallery of Art where he served as Senior Research officer before joining the academic. Currently he is a Ph. D student at the Modibbo Adama University, Yola Adamawa State Nigeria. He haspublished several journals in both local and international journals including conference papers. His research areas are applied Mathematical Epidemiology, stochastic modeling, forecasting and multi-criteria Decision modeling

Mohammed Mijinyawa is a current Ph.D research fellow in Operations Research at the Modibbo Adama University, Yola – Nigeria. With more than decade in research teaching and supervision and mentoring for both undergraduate and postgraduate students. Mijinyawa has been a member Operational Society Uk Student Membership, Associate Fellow Institute for Operations research of Nigeria, (INFORN now ORIDSAN) published numerous journal papers, conference proceedings and book chapter. He is a reviewer of several international journals. His main research interest include: Optimization, Mathematical Programming, Stochastic Systems, Sustainability and Reliability. Machine Learning and Artificial intelligence.

Divine Ngozi Michael is a passionate writer, researcher, and advocate for the girl child. She is a graduate of operations Research from Modibbo Adama University, Yola. Divine has expanded her expertise beyond academics to explore critical social issues. With a Focus on relationship and marriage, she has conducted extensive research in areas such as the struggles and challenges faced by the girl child, the challenges of teenagers and youth and the causes of marital domestic violence