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Examining Females Participation in Engineering as a Discipline: A Case Study of Uganda and Nigeria

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Abstract

Engineering is traditionally perceived as a discipline peculiar to the male folks and women are under-represented in all engineering fields. Could it be that women are less confident about their abilities? Or are men more qualified than women for engineering based on physical strength? Could it be based on societal values placed on the male child above the female child in most African societies? This research work seeks to address the above questions. It focuses on the factors hindering women from adopting engineering as a discipline in Uganda and Nigeria. Data were gathered from university convocation proceedings and questionnaires have been generated to harvest information from the larger populace which includes female students studying engineering, female engineering lecturers, and female engineers. The research work also recommends measures to foster/encourage the interest of female folks in

engineering. To explain the trend of females' degree of participation in engineering in Africa, data collected from respondents from both Nigeria and Uganda Universities and the graduation lists of universities in Nigeria were analyzed using SPSS and Python. The results show that socio-cultural beliefs and the lack of female engineer role models are key factors influencing the participation of females in engineering. Generally, the percentage of females who graduated and practiced engineering is low compared to their male counterparts. It was observed that female participation is more pronounced for computer and biomedical engineering, while for mechanical engineering is negligible. Thus, this present research indicates the most prevailing factors affecting the participation of females in engineering in Africa and provides recommendations for a possible measure that may strengthen the increase in the participation of females in engineering in Africa.
Keywords: Engineering Education, Female Gender, Uganda, Socio-Cultural Belief, Nigeria

Introduction

Engineering is a profession that is typically male-dominated and women's participation remains low(Seema &Sarah, 2019). An ever-growing body of research exists on women and their advancement in higher education, yet very little research considers women engineers. The classical explanation for the low representation of women in education and employment is the traditional differentiation between production and reproduction. Globally, women carry the responsibility of keeping the home and in most countries, employment is taken as a secondary responsibility to them (Seema &Sarah, 2019). They decide to leave their secondary responsibility at any time to focus on their role as a homemaker, this may however obstruct the overall performance of women's economic activity. Engineering as a profession is related to machines based on the reality that it sometimes involves hard, tough, and physically demanding work. This influences the opinion of engineering as masculine.

The low participation of women in engineering can also be attributed to the gendered organization, an organizational structure where a leader represents a hero figure at the top of a power hierarchy, a hierarchy that remains male-dominated. The implications of such a masculinist organizational structure are most directly felt by women. Women tend to be clustered in entry-level positions and are rewarded for loyalty and supporting roles, whereas men tend to enter positions that foster opportunities through exposure, visibility, information, and connections (Seema &Sarah, 2019). The first significance of this study is to understand the barriers contributing to the low participation of women in engineering, the perceived ability of women, and the existing organizational structure that has promoted low participation of women. The second significance of this study will be to highlight the need for policy and organizational reform that not just encourages women but promotes gender inclusivity for women in engineering. The last significance of this study is to address existing systemic challenges that have resulted in low participation of women in engineering.

Overview of Gender Disparities in Engineering and STEM Fields Globally

Globally, the participation and increase of women in the field of Engineering continues to be a prominent issue, although progress and efforts to bridge the gap and increase participation like every other academic and career profession, there is still a significant gap when it comes to representation and the number of women graduates, we have in the field every year.

Decades ago, women remained underrepresented in almost all fields both in academics and in career but that has shifted today(Odebiyi &Iwuagu 2018), thanks to the role gender equality plays today, women's underrepresentation has shifted drastically to the STEM disciplines both in academia and industry. According to a research article published by the (UNESCO Institute for Statistics 2020) women account for only 28.8% of researchers globally despite the important role researchers play in the world today when it comes to knowledge creation and problem-solving.

This imbalance has been particularly pronounced in STEM fields with engineering taking a chunk of it and when narrowed down when it comes to race and continent African women seem to be taking the larger share. Taking a look at the work of (Fletcher, Jefferson et al. 2023) women of color compared to men have always been way behind in number of the engineering graduates produced with the paper highlighting and comparing the overall percentage of engineering degrees awarded to men and women of color detailed in figure 1-3. In 2014 the paper highlighted that 19.9% of engineering degrees were awarded to Black women and 80.1% to Black men while in 2015, the paper highlighted that 20.0% of engineering degrees were awarded to Black women and 80.0% to Black men, In 2016 the paper highlighted that 20.9% of engineering degrees was awarded to black women and 79.1% to black men while in 2017 the paper highlighted that 21.3% of engineering degrees was awarded to black women and 78.7% to black men and in 2018 the paper highlighted that, 21.9% of engineering degrees was awarded to black women and 78.1% to black men this gender gap as seen can be attributed to a lot of actors such as gender bias, lack of resources and motivation amongst another factor.

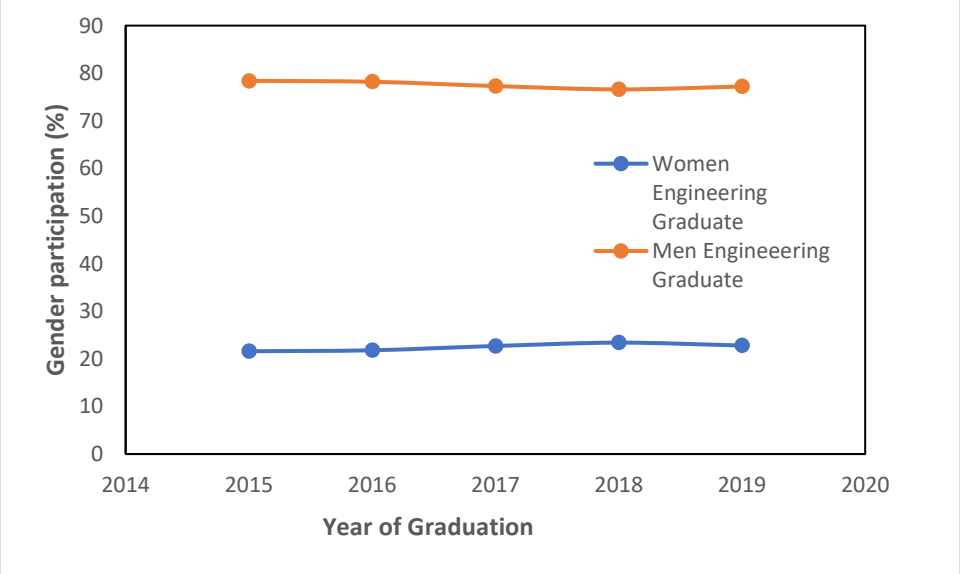

Figure 1: Graph of Gender Participation in Engineering (Data obtained from (Fletcher, Jefferson et al. 2023)

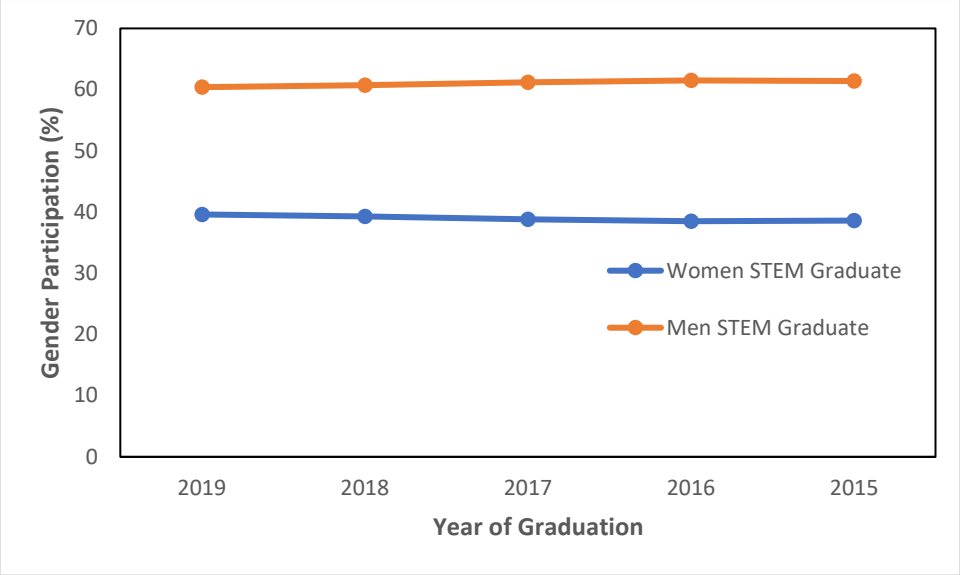

Figure 2: Graph of Gender Participation in Engineering (Data obtained from (Fletcher, Jefferson et al. 2023)

From Figure 1-3, women are seen participating more actively in non-STEM courses/professions than men but men are seen above them in STEM courses/professions with considerable gaps. However, the gap seen in engineering courses/fields is nothing to write home about

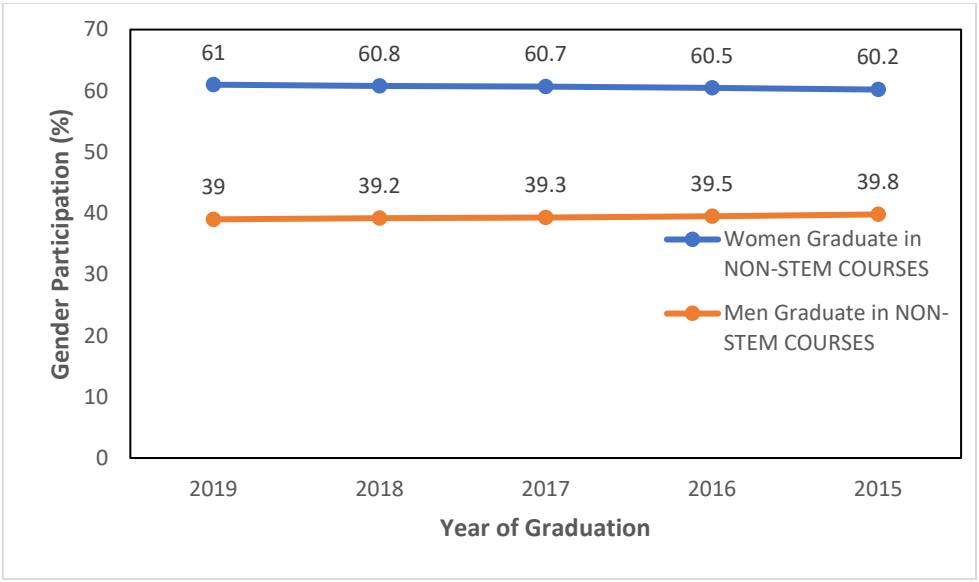

Figure 3: Graph of Gender Participation in Engineering (Data obtained from (Fletcher, Jefferson et al. 2023)

(Kevin Miller 2018) found that gender bias is a major factor affecting hiring decisions in academia, with women being perceived as less competent than their male counterparts despite having the same or identical qualifications to support this claim, the (UNESCO Science Report 2021) shows that women make up only 28% of graduates in engineering and 40% of those in computer sciences globally. Women also account for only 22% of professionals with AI skills worldwide. When this is narrowed down to Africa, Africa According to (World

Economic Forum 2021) Women are grossly underrepresented in STEM fields in sub-Saharan Africa and the number of females graduating from tertiary education is below 30% for many sub-Saharan African countries.

With barriers to entry into STEM fields, especially the engineering fields starting early in education, Stereotypes and biases are also factors that have brought about those above statistics with young girls being discouraged from pursuing careers in engineering fields, and even when they do, they face challenges in terms of career advancement and opportunities for leadership roles.

Factors Contributing to the Gender Gap in Engineering and STEM Education and Careers
As seen in the statistics and Figure 1-3, the gender gap of black women has improved but remains a persistent problem due to the stagnant and not growing number, various factors contribute to this disparity. Four factors that contribute to this gap and disparity in African women participating in the engineering career will be looked at. These factors include societal stereotypes and biases, lack of female role models, cultural and societal expectations, and limited access to education and resources.

Double Role as Homemakers and Engineers
In almost all countries in the world, women regard working outside the home (paid employment) as a secondary responsibility. They believe their primary responsibility is in the home front as a homemaker, they believe the success and stability of their home rest more on their shoulder than their male partner. However, they easily decide to leave their secondary responsibility to focus on their primary role as a homemaker. This hinders, the performance of a large percentage of female engineers in their respective fields of engineering, some even quit the profession (Seema &Sarah, 2019). Instead of this, young girls are discouraged from embracing engineering as a discipline. The discipline is tagged as most suitable for males. Engineering has to do with machines and the practical aspect involves tough, hard, and physically demanding effort or work which is associated with being masculine.

Cultural and societal expectations are another factor that contributes to the gender gap in engineering education and careers, in Africa, many societies continue to uphold traditional gender roles, with women often expected to prioritize caregiving roles over careers in engineering and STEM fields. An article published by (CNBC Africa 2022) shows that Girls in Africa who spend 28 hours per week on household duties and caregiving attend school 25% less than those who spend just 10 hours per week on domestic chores. These traditional expectations over time according to (Main 2023) have dissuade women from pursuing engineering as they face resistance and criticism for choosing a non-traditional career path. Additionally, the demanding nature of engineering careers, which may require long hours or relocation also clashes with societal expectations for women to prioritize family responsibilities.

The survey carried out in Monash University Australia (over the last thirty years) on the participation and status of females in the engineering department was investigated. However, from the statistical result, it can be drawn that engineering is seen as a male occupation and

women who are in the minority always find it hard to effortlessly fit into the male-oriented and dominated structure (Duyen, 2000)

Unfavorable Curriculum

The ways the engineering curriculums of many schools were being designed have put many female students at a disadvantage and also led to discouragement in the field. The curriculum has been tuned and developed to perfectly suit the male students not putting the female students into consideration. For instance, several girls in the engineering field in India admitted that they have been left handicapped and incapacitated in the field due to their limited physical strength when working in workshops or laboratories (Duyen, 2000)

Psychological Influence

Women are often shaped to have the mindset that they do not have what it takes (skills and qualities) to take up their careers in the engineering field. It has cut across different races and continents that females are usually better than males in reading comprehension, verbal fluency, clerical skills, and finger dexterity. On the other hand, it is widely opined that males perform more excellently in speed and coordination of large body movements, in mathematical reasoning and calculations, mechanical and problem-solving or difficult tasks. Girls are seen to perfectly fit into and be useful in courses or fields like mass communication, Linguistics, and social skills. This explains why we have a few numbers of females in the engineering field. (Lewis, 1991)

Gendered Norms

The reasons why females decide to let go of their engineering courses or careers are multifaceted and complex. Girls tend to lose their self-efficiency or confidence and identity as a result of the stereotypes and gendered norms associated with engineering. This has an overall effect on their choice of discipline and careers. An unnoticed gendered practice that occurs from childhood could be seen in the toys girls are encouraged to play with, the words their parents use to paint or describe the world to them, their parents' career dreams or desire for them, etc. reflects how deep-rooted gendered opinion has affected the everyday lives of females, their opinion, confidence, aspirations, and perception (EngineeringUk briefing, 2017). In African society, Societal stereotypes and biases still play a significant role in perpetuating the gender gap we see in engineering education and careers between males and females. These stereotypes are majorly associated in the areas of logic, rational thinking, and technical proficiency and these are associated with masculinity, This stereotype believes that women are more emotional and fragile and thus can't do well in such fields. This bias over time has led to women being excluded from opportunities, receiving less mentorship, and facing discrimination both professionally and in education (Makarova, Aeschlimann et al. 2019) noted that these gender stereotypes and biases are prevalent among students and teachers, and has overtime influence students' self-concept, interest, and career aspirations in engineering and the STEM fields at large.

A large survey on public perception of engineering in the UK; Evidence from 'Engineering Brand Monitor' (EBM)has shown that the low participation of women in engineering is not just peculiar to Nigeria and Uganda but it is also a concern in developed countries. The EBM revealed that 42% of girls around age 19 saw the engineering profession as a good choice while 66% of their male peers viewed engineering as their desirable profession only 25%of girls considered engineering as a profession when asked if they could consider a career in

engineering while 52% of boys are definite on becoming engineers. (Engineering Uk briefing, 2017) recorded that only 12% of those working as engineers are females compared to 47% of the whole UK force. This gap can be seen as a result of the low percentage of women's participation in the engineering field. Though girls perform better academically in engineering-related courses or subjects (GCSE and A-level STEM) than boys and are perceived to be more likely to progress into higher education in engineering, very few decide to study engineering (EngineeringUK briefing, 2017). However, it can be safely said that the low participation of girls in engineering reflects gender differences in the understanding of the interest in the profession, self-efficacy, and identity. It also reflects the extent to which girls are likely to be involved or attracted to the engineering field in the future.

Absence of Female Role Models and Career Advice

Another important factor contributing to the gender gap in engineering is the lack of female role models. In every field, Role models serve as an inspiration and representation for individuals aspiring to enter a particular field. When looking at the engineering field where women are underrepresented, it leads to a lack of motivation and visibility for potential female engineers the lack of representation has reinforced in most women, especially in Africa the notion that engineering is not a viable and reliable career option for women. (González-Pérez, Mateos de Cabo et al. 2020) noted that having relatable and successful female engineers as role models can help challenge these perceptions and encourage more women to pursue engineering courses and careers.

It is obvious that few girls who might be inclined to study engineering are less aware of the pathway to take. EBM revealed that 28% of girls agreed that they knew what to do next to become an engineer compared with 46% of boys. (EngineeringUK, briefing, 2017)

It is noticeable that the absence of a good number of female engineers at the top hierarchy of the field to serve as role models to young girls who are interested in the career path can silently discourage girls from embracing engineering as a career. According to a study by Microsoft, 70% of girls surveyed revealed that they would feel more confident in choosing STEM careers if they were aware that men and women are equally employed in these careers. The absence of a good number of female role models also influenced their career choices. (EngineeringUK briefing,2017)

Gendered Organization

One of the reasons for the few number of women in engineering can be attributed to gendered organization. An organizational structure where the leader is represented as a hero figure at the top of a power hierarchy that remains male-dominated is mostly felt by women and it announces their underrepresentation the more. Women tend to be clustered in entry-level positions and are rewarded for loyalty and supporting roles. Whereas, men tend to get positions that foster opportunities through exposure, connections, visibility, and information (Seema&Serah, 2019)

Methodology

The method used for this research work involved administering questionnaires to female graduates (practicing and non-practicing Engineers) and engineering students in Nigeria and Uganda and collecting data from university convocation proceedings. The data was analyzed

using Python, SPSS statistical tools, and Microsoft Excel. The method of analysis is explained in this section.

Mixed Methods Analysis

The research used a mixed-methods analytical technique. Demographic data collected from respondents was represented in Microsoft Excel using charts and graphs, offering a fundamental comprehension of participant attributes. SPSS (Version 27) was used to do comprehensive statistical analysis on the Likert-scale questionnaire replies and Python Programming language to perform sentiment analysis and key-phrase extraction for the open-ended question. This included cross-tabulations and inferential tests to discern important patterns or connections within the data, particularly concerning demographic variables, so augmenting the analytical depth of issues influencing female involvement in engineering.

Sentiment Analysis of Open-Ended Responses

The responses to the open-ended question were examined using Python's extensive Natural Language Processing (NLP) and the Textblob module, an open-source sentiment analysis tool that applied machine learning to get insight into underlying emotions. Here's a breakdown of the various steps and libraries used:

- The data cleaning and processing were done using Pandas and re-library to remove irrelevant characters from the text, extra symbols, and whitespace.
- StopWords Filtering and Lemmatization: The text was standard for machine learning processes by removing common stopwords in the English language sing *nltk.corpus.stopwords*. Additionally, *WordNetLemmatizer* from the NLTK library was used to reduce terms to their basic forms, resulting in uniformity and increasing the emphasis of the textual analysis.

Sentiment Classification and Polarity Analysis

Researchers such as Yamauchi et al. (2021), employed a similar technique of analysis to study the decisions made by Japanese women with breast cancer, employing a mixed-methods approach and open-ended web-based replies. The sentiment analysis was carried out to investigate the emotional tones and themes in their comments. Furthermore, Okada & Sheehy (2020), investigate student involvement in online learning using a mixed-methods approach, which includes sentiment analysis of open-ended replies. Automated sentiment scoring revealed insights regarding students' attitudes toward online learning sessions. These studies employ a variety of approaches to analyze qualitative responses, emphasizing emotional and thematic trends across open-ended questions.

Results and Discussion

This section presents the analysis of the results gathered from the questionnaires using Python, SPSS, and Microsoft Excel.

From Table 1, the participation of females in engineering is low generally for all the engineering courses offered at Modibbo Adama University. Agricultural engineering and mechanical engineering graduates over the years considered are very poor.

Table 1
Graduating List of Engineering Students in Modibbo Adama University of Technology(MAUTECH)Yola, Nigeria

	AGRIC ENGINEERING		CHEMICAL ENGINEERING		CIVIL ENGINEERING		ELECT. ENGINEERING		MECH ENGINEERING	
YEAR	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
2016/2017	14	0	16	1	45	2	35	2	18	0
2017/2018	19	0	13	4	28	0	30	1	18	0
2018/2019	16	2	11	2	46	1	52	2	33	1
2019/2020	14	0	27	2	52	2	60	3	28	1

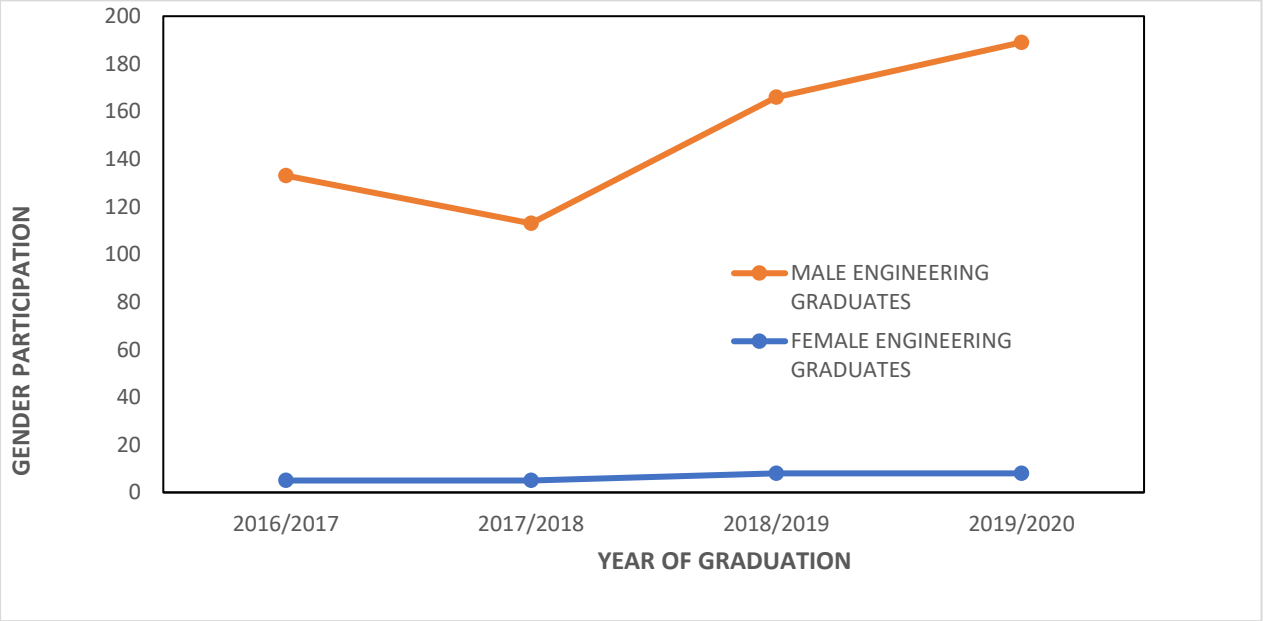

Figure 4: Graph of male and female engineering graduates in MAUTECH, Yola Nigeria from 2016-2020 Convocation Proceedings

From Figure 4, it can be inferred that the participation of females in engineering is very poor considering the gap between the two genders for the years considered

Analysis And Discussion of Questionnaire Findings

This section is structured to contain the presentation and analysis of the demographic variable of respondents, an analysis of the research hypothesis, and a discussion of findings.

Demographic Variable of Respondents

The personal variables of respondents are analyzed and presented in this section. Data collected on the personal data through the administration of the questionnaire were presented in Figure 5-11, followed by an analysis of the items using visualization.

Distribution of Respondents by Religion

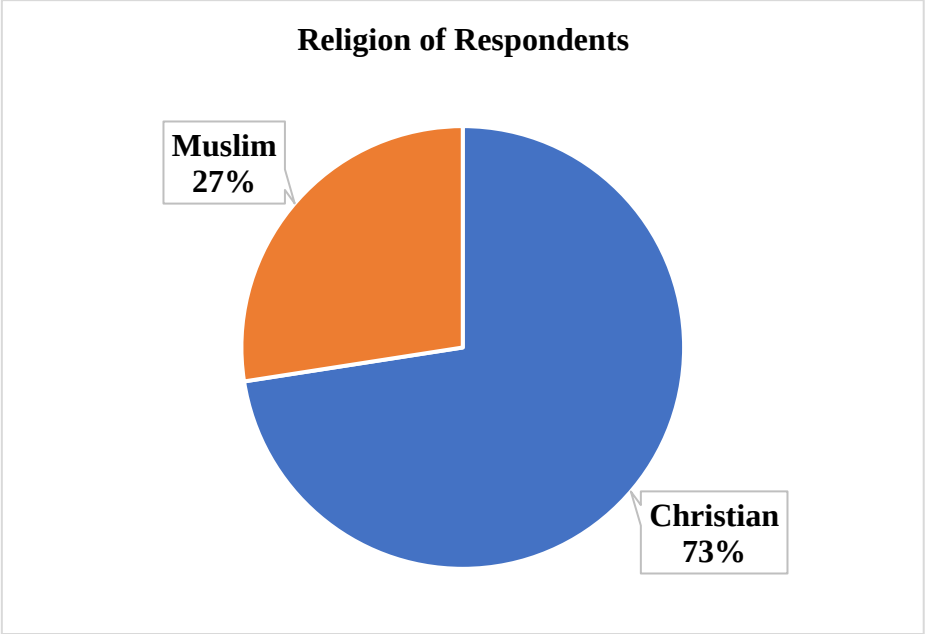

Figure 5:Source: Researcher's Field Survey, 2022

Analysis of the figure shows the religious group of the respondents. 27% (28) of the respondents are Muslim and 73% (74) of the respondents are Christians. This result shows that the majority of the respondents in the study are Christians.

Distribution of Respondents by Marital Status

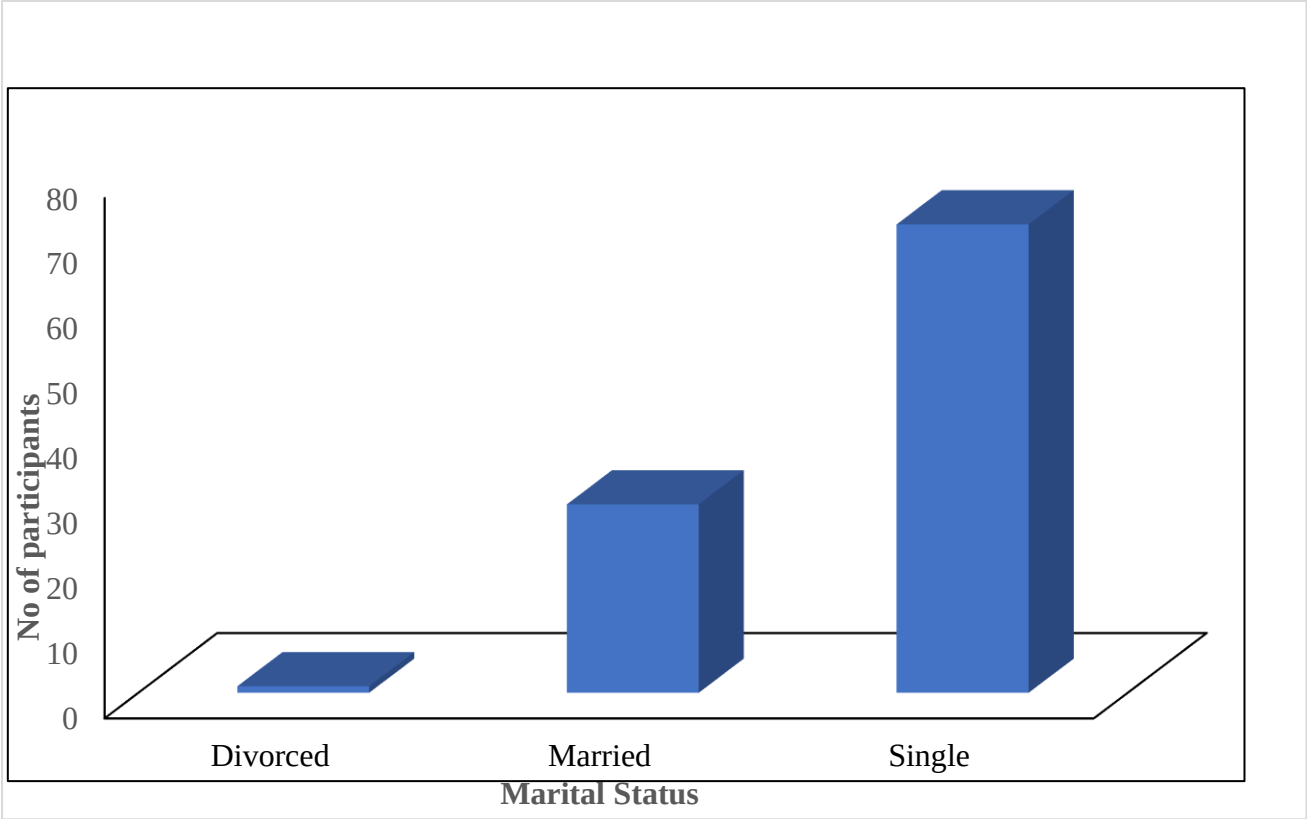

Figure 6:Marital distribution Source: Researcher's Field Survey, 2022

Analysis of Figure 6 above revealed that 1% (1) of the respondents are divorced, 28.4% (29) are married and 70.6% of the respondents are married. This finding shows that the majority of the respondents are still single.

Distribution of Respondents by Age

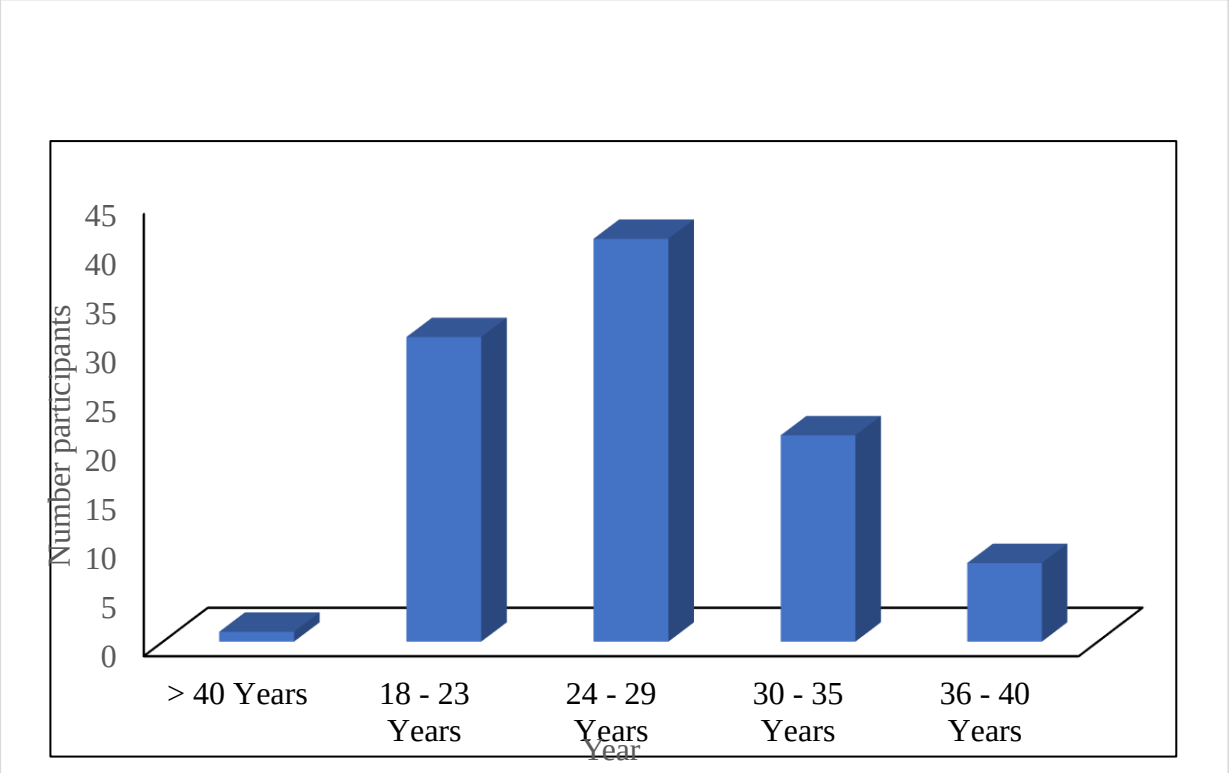

Figure 7: Age Distribution of Respondents(Source: Researcher's Field Survey, 2022)

Figure 7 result shows that only 1% (1) of the respondents are over 40 years old, while 30.4% (31) of the respondents are between 18-23 years, 40.2% (41) are between 24-39 years, 20.6% (21) are within 30-35 years and 7.8% (8) are between 36-40 years old. This finding revealed the majority of the respondent of this study are between 24-29 years old.

Distribution of Respondents by Occupation

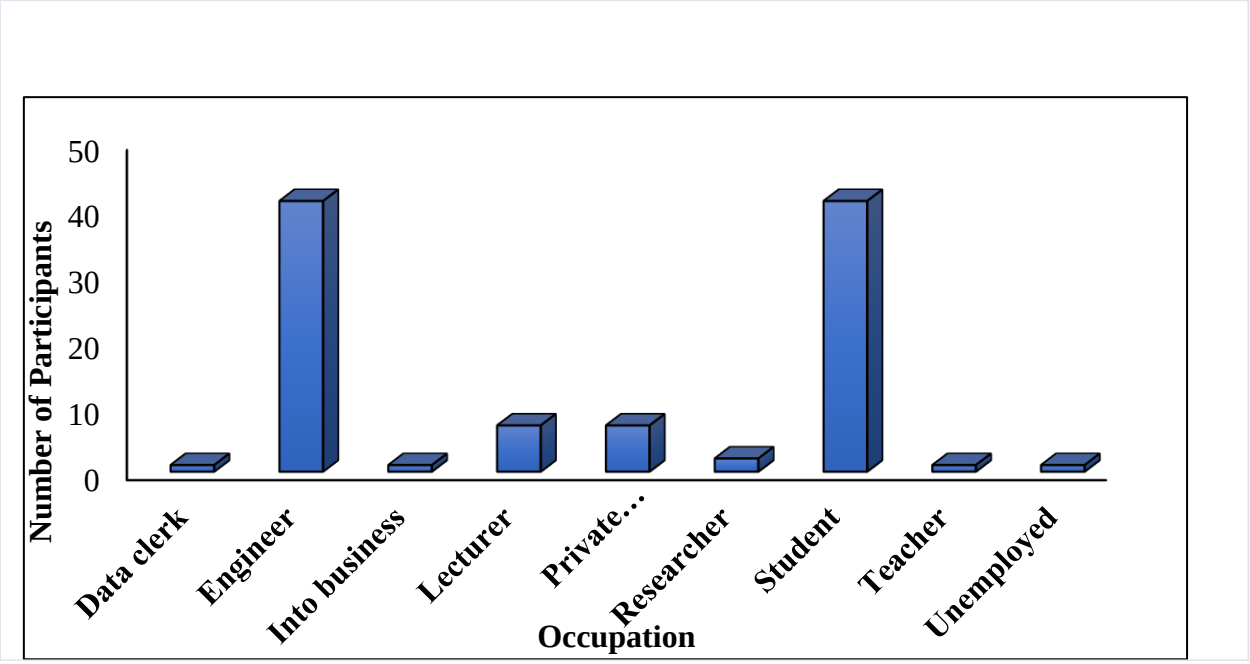

Figure 8: **Occupation Distribution of Respondents(** *Source: Researcher's Field Survey, 2022)*
Analysis of figure 8 shows that 40.2% (41) of the respondents are engineers, while 1% (1) are data clerks, 1% (1) are into business, 6.9% (7) are lecturers, 6.9% (7) are in the private sector, 2% (2) are researchers, 40.2% (41) are students and 1% (1) are teachers. The result of this analysis shows that the majority of the respondents are engineers and students.

Distribution of Respondents by Educational Qualification

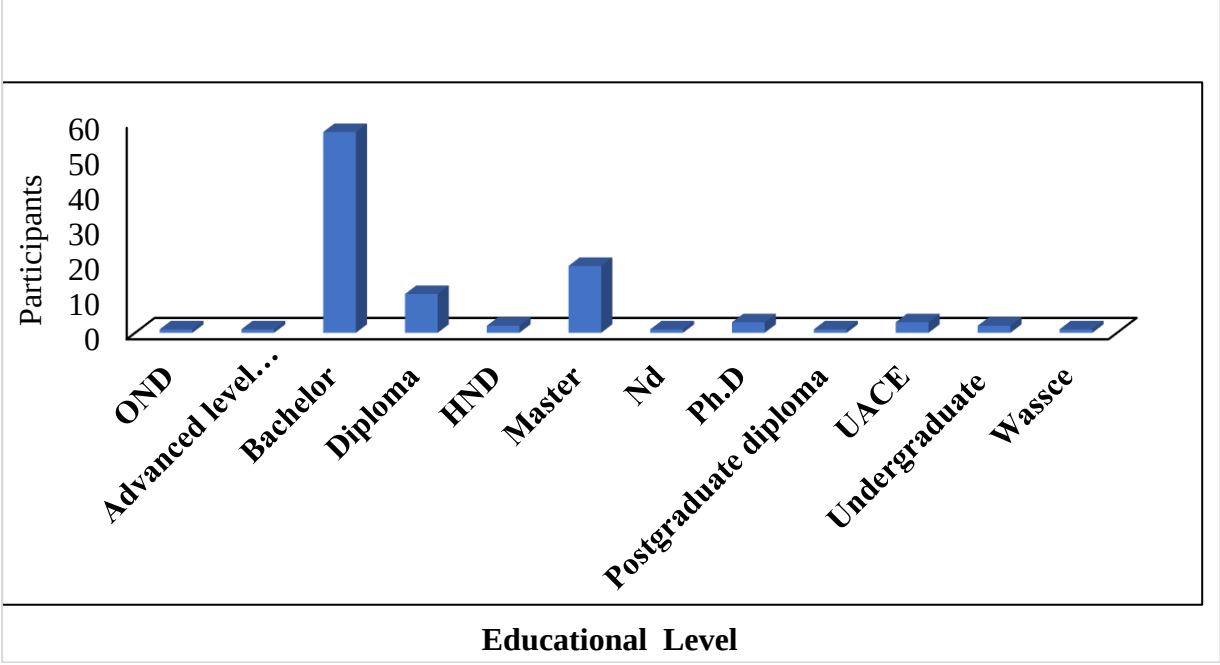

Figure 9: Educational Level of Respondents (*Source: Researcher's Field Survey, 2022)*
Figure 9 result shows that the majority of respondents level of education has a Bachelor's degree 55.9% (57), while 10.8% (11) have a Diploma, and 18.6% (19) have a Master's Degree.

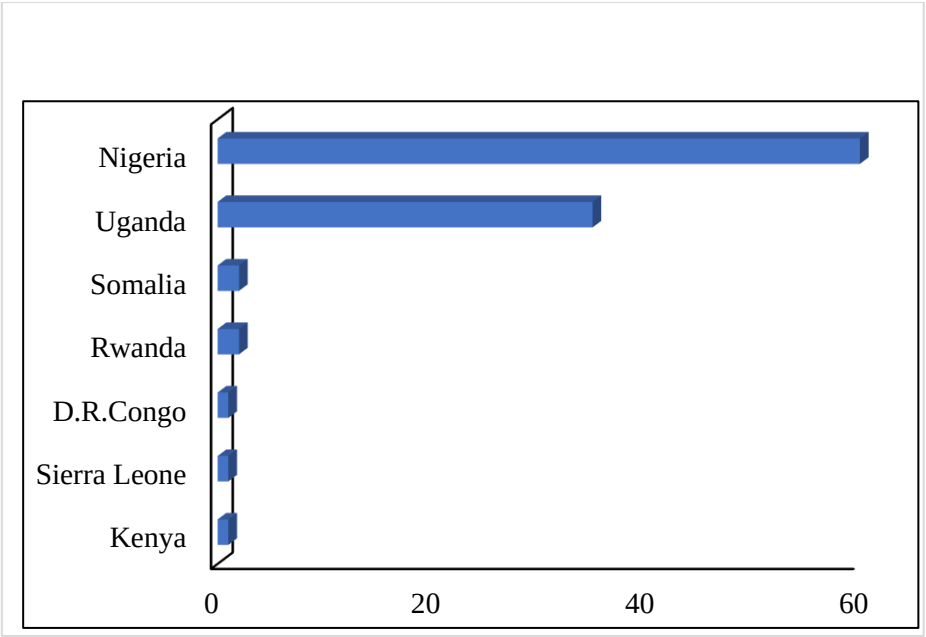

Figure 10: Country of Respondents (Source: Researcher's Field Survey, 2022)

Analysis of figure 10 shows that Nigeria 58.82% (60) has the most respondents in this study, while Uganda 34.31% (35) of the respondents.

Distribution of Respondents by Country

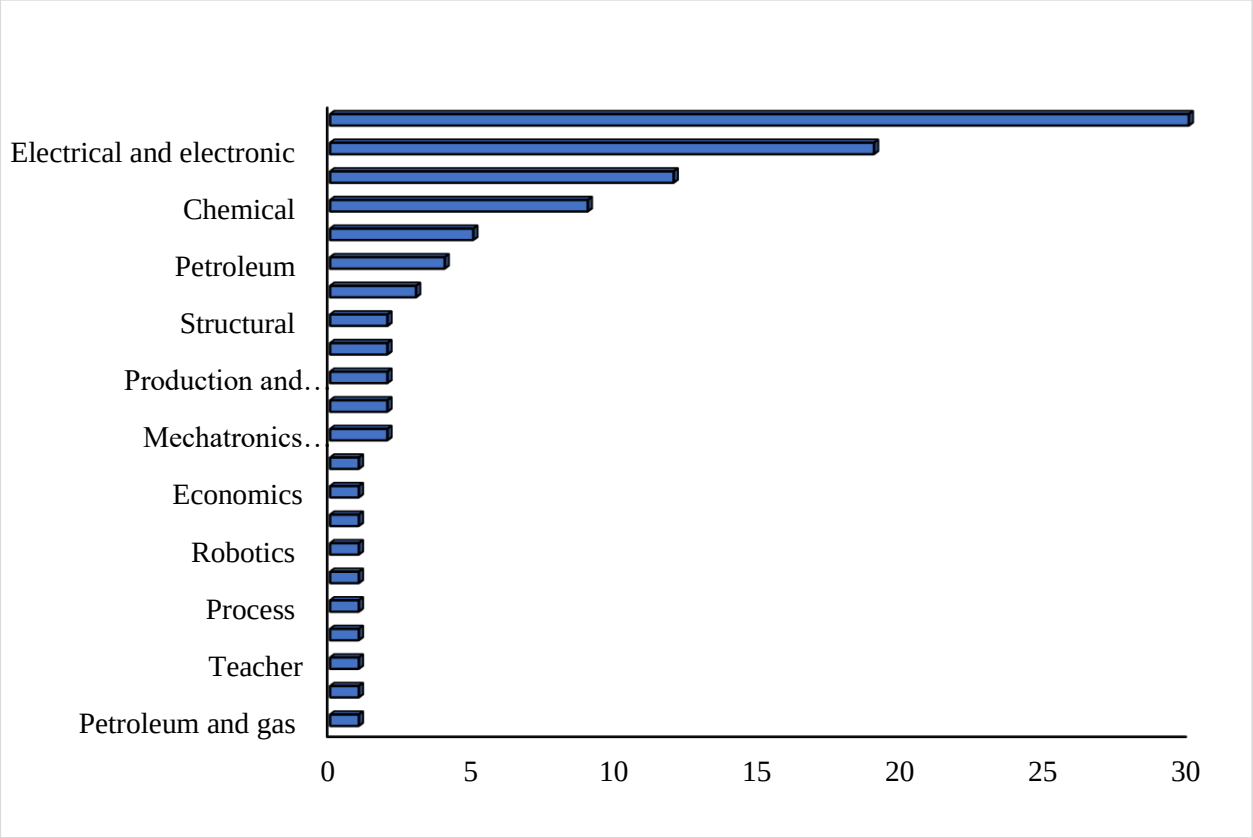

Figure 11: Engineering field(*Source: Researcher's Field Survey, 2022)*

Analysis of Figure 10 shows that 29.41% (30) of the respondents are Civil engineers, 18.63% (19) are Electrical and electronic engineers, and 11.76% (12) are Mechanical engineers.

Analysis of Questionnaire Items

The purpose of this section is to present and analyze the questionnaire items as contained in section two of the research instrument. We will reject any values less than three (3) standard deviations.

Table 2
Analysis Questionnaire Items

ITEMS	SA	A	N	D	SD	X	STD	Remark
I enjoyed science subjects right from primary school	55	32	7	4	4	4.27	3.88	Agreed
My knowledge of Mathematics influenced my decision to study engineering	46	23	18	10	5	3.93	3.60	Agreed
My parents influenced my choice to study engineering	8	12	23	27	32	2.38	2.21	Disagreed
My science teachers motivated me to study engineering	7	21	28	29	17	2.73	2.46	Disagreed
My primary school friends and classmates influenced my choice of engineering	0	6	14	50	32	1.94	1.58	Disagreed
My parents' socioeconomic status positively influenced my decision to study engineering	9	19	26	28	20	2.70	2.47	Disagreed
My parent's socioeconomic status negatively influenced my decision to study engineering.	1	7	19	36	39	1.97	1.69	Disagreed
There are fewer female teachers in Engineering-related subjects at higher levels of Education	57	36	4	3	2	4.40	3.96	Agreed
There is a lack of resources and equipment with the potential to stimulate interest in Engineering subjects among females.	26	40	15	17	4	3.66	3.32	Agreed
There is a lack of funds for female researchers in Engineering	5	34	19	14	30	2.71	2.52	Disagreed
Teaching and learning materials permeate gender stereotypes.	10	27	33	24	8	3.07	2.75	Disagreed
Gender-responsive career counseling, scholarship, and mentoring opportunities remain limited.	23	43	17	16	3	3.66	3.30	Agreed
Less female participation in Engineering fields caused a lack of role models for young girls.	36	43	15	6	2	4.03	3.62	Agreed
Socio-cultural belief has contributed to the choice of	22	40	21	12	8	3.58	3.24	Agreed

females in adopting certain engineering disciplines								
Socio-cultural beliefs and other factors lead to gender differences in subject preferences and academic performance in engineering.	18	46	23	12	3	3.63	3.24	Agreed
The societal value placed on male children above female children affects female participation in engineering	30	35	22	10	5	3.74	3.39	Agreed
Men are more physically and mentally alert when it comes to studying in the field of engineering	13	21	19	30	19	2.79	2.59	Disagreed
Catching up with my male colleagues in this field has been challenging	8	25	22	32	15	2.79	2.54	Disagreed
I sometimes felt relegated when it comes to some issues because I am a woman.	10	40	14	24	14	3.08	2.82	Disagreed
My religious beliefs and faith affect what I can do as a female engineer	8	11	12	32	39	2.19	2.05	Disagreed

According to the analysis of Table 2 above, most women in engineering (Mean = 3.88, STD > 3) loved science topics since primary school, and they agreed that their understanding of mathematics influences their decision to study engineering (Mean = 3.93, STD >3.60). Also, respondents disagreed that their parents did not influence their decision to pursue a career in engineering (Mean =2.38, STD < 3) and that their science teachers did not inspire them to study engineering (Mean = 2.73, STD 3).

Furthermore, respondents agreed that fewer female teachers in Engineering-related subjects at higher levels of education (Mean = 4.40 and STD > 3.96) has an impact on their decision to study engineering, while the absence of resources and equipment has the potential to stimulate female interest in Engineering subjects (Mean 3.66, STD > 3). Moreover, less female participation in engineering fields results in a lack of role models for young girls interested in studying engineering (Mean = 3.66, STD > 3), and socio-cultural beliefs are one of the factors that cause gender differences in the field and academia section of engineering (Mean = 3.63, STD > 3).

Furthermore, the respondents in this study said that males are more physically and intellectually alert while studying the subject of engineering (Mean = 2.79, STD 3) and agreed that keeping up with male colleagues in this profession is difficult (Mean = 2.79, STD 3). Furthermore, respondents disagreed that their religious beliefs and faith limit what they may perform as female engineers.

Furthermore, the respondents in this study disagreed that males are more physically and intellectually alert while studying the subject of engineering (Mean = 2.79, STD < 3) and disagreed that keeping up with male colleagues in this profession is difficult (Mean = 2.79, STD < 3). Furthermore, respondents disagreed that their religious beliefs and faith limit what they may perform as female engineers.

Analysis of Respondents' Feedback

During the administration of our questionnaire, the respondents were asked to provide further suggestions on the factors influencing low women participation in engineering. To analyze this, the researcher made use of Natural Language Processing of Python programming to analyze this textual column to perform key phrase extraction. The reason for using this method is to bring innovation to this analysis and get the most important factors influencing the participation of women in engineering.

The researchers perform tasks such as data preprocessing, removing stopwords, creating polarity, and keyphrase extraction. Similar methods were also performed by researchers such as Naresh & and Venkata Krishna (2021). Sentiment analysis, often regarded as opinion mining, is a natural language processing (NLP) method for identifying the positivity, negativity, or neutrality of data.

Table 3
Before Data Preprocessing

Text
Enjoy young women to participate, provide resources and learning materials you aid learning, and goof role models in their field of choice.
Let the female understand that she can do anything if she puts her to it.
Getting more role models so that the girls can know that it is possible
By getting good guidance and counseling at the secondary school level.
The ability of women should not be limited, there should be equality among both genders, they should be encouraged and given every needed support for them to see more reasons to engage themselves in the engineering field.
By providing scholarships
It can be improved by encouraging more females to participate in the Engineering domain via waivers, scholarships, grants, free exchange study, free conferences, free symposia, and workshops._x000D_

Also, the researchers used any text data with polarity less than 0 as Negative, greater than 0 as positive, and any values other than the stated as Neutral for creating the sentiment column in *Table 4.0.*

Table 4
After Data Preprocessing

text	Polarity	Sentiment	Keyphrases
Enjoy young women participate provide resources…	0.25	positive	young women, resources learning materials, lea...
Let females understand anything puts	0	neutral	
Getting role models girls know the possible	0	neutral	role models girls
Getting good guidance counseling secondary sch…	0.2	positive	secondary school level
Ability women limited equality among genders e…	-0.07143	negative	ability women, support order, engineering field

Source: This study Researcher's Field Survey, 2022

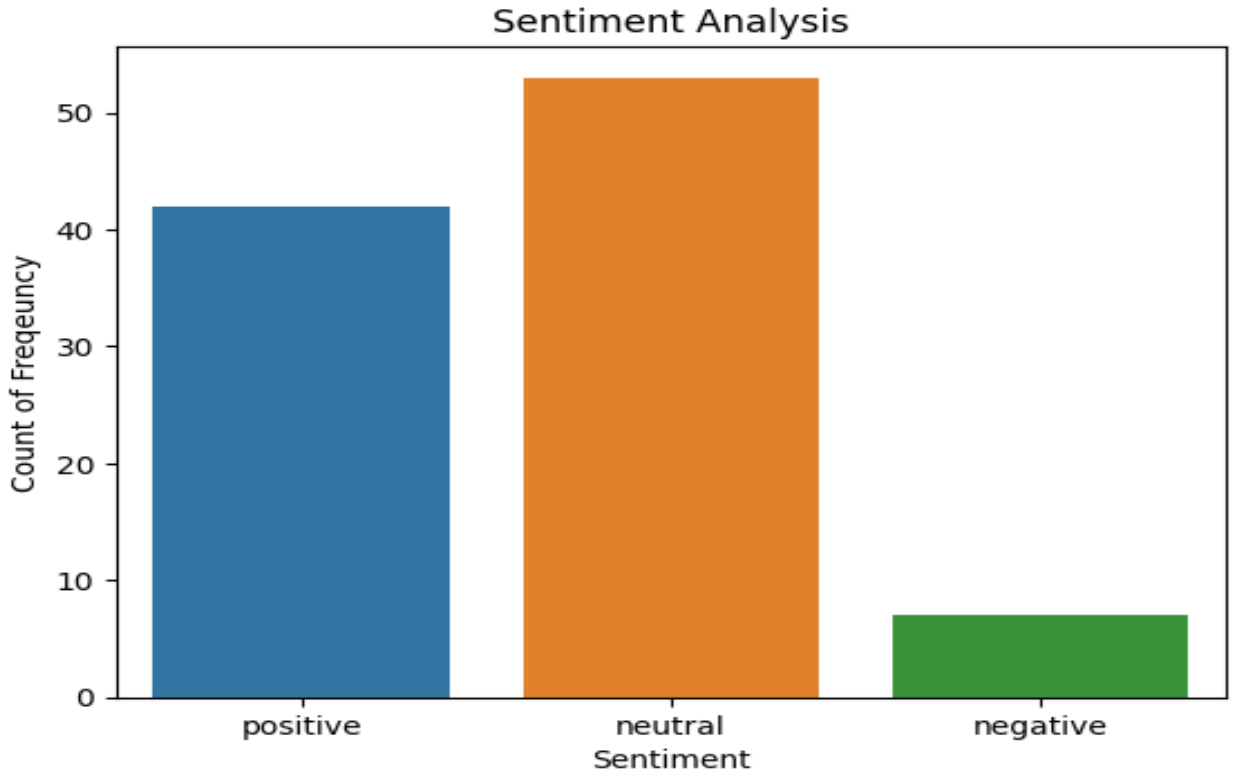

Figure 12: Distribution of Respondents by Country *Source: Researcher's Field Survey, 2022*

The analysis (Figure 12) of the respondent's feedback shows intriguing patterns in the text feedback. 52% (53) of the feedback was categorized as neutral, which is the majority. Furthermore, 41.2% (42) of the respondent's opinions were labeled as positive, and 6.8% (7) of the respondents' feedback was classed as neutral. The much-increased proportion of positive, and neutral feedback and low negative opinion of respondents' feedback suggests that a significant proportion of users expressed positive sentiments in their view of the participation of women in engineering. This result implied that there was a predominance of

optimism, hope, or positive reactions among the respondent's opinions at the time of data collection.

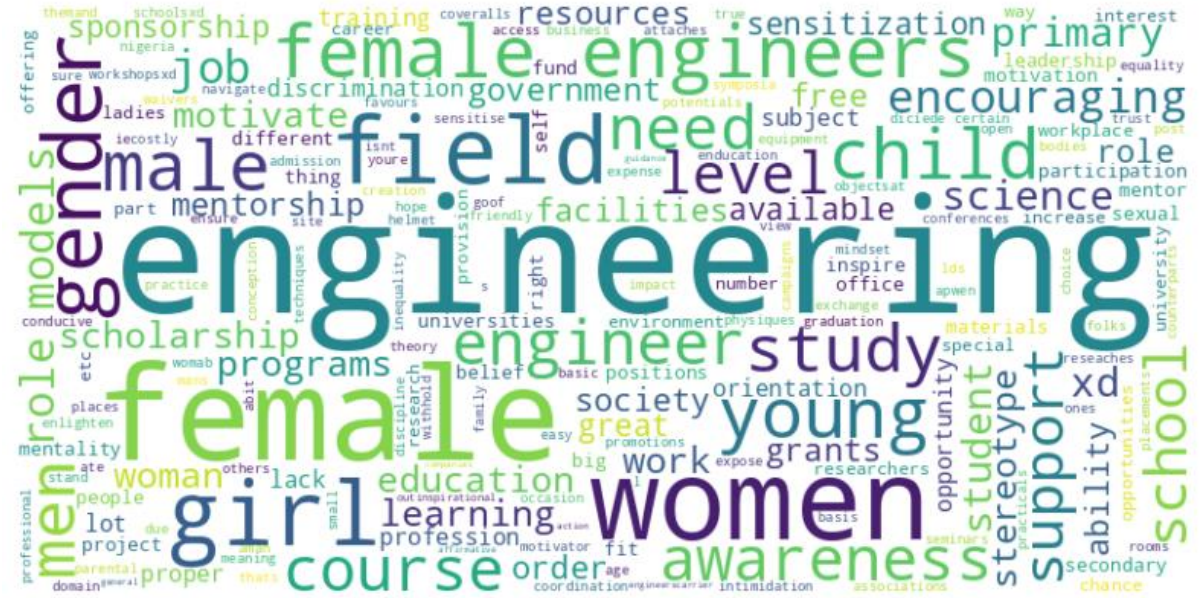

Figure 13: Respondent's Key Phrases Analysis (Source: This present Researcher's Field Survey, 2022)

The analysis of the key phrases in Figure 13 is used to determine the most important phrases within the opinion of women of participation in the field of engineering. The combination of these key phrases serves to deepen our understanding of key factors affecting women's participation in engineering, offering a more intricate insight. Notably, the term "gender discrimination", "female", "awareness", "women", "engineering", "stereotype", and "female motivator" or "special scholarship" stands as the pivotal counter piece, mirroring their significance on factors affecting women participation in engineering. This implies factors such as gender discrimination, lack of awareness, stereotyping, and the creation of special scholarships for female engineers are influencing factors affecting the participation of women in engineering.

Hypothesis Testing

H_0: There is no significant relationship between Background, University Environment, Social Cultural Beliefs, and Ideas on women's participation in engineering.

The researchers made use of multiple regression for the hypothesis testing using SPSS as shown in Table 5

Table 5
The Model summary, ANOVA, and Coefficient of the Hypothesis testing

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.820a	0.67	0.66	0.35

Source: Researcher's Field Survey, 2022

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	25.24	3.00	8.41	67.00	.000b
Residual	12.30	98.00	0.13		
Total	37.54	101.00			

Source: Researcher's Field Survey, 2022 for this study

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.036	0.245		0.147	0.883
Background	0.252	0.060	0.251	4.180	0.000
University Environment	0.440	0.050	0.525	8.758	0.000
Socio-Cultural Beliefs and Idea	0.328	0.049	0.397	6.648	0.000

Source: Researcher's Field Survey, 2022 for this study

The result of Table 5.0 above revealed the significant relationship between Background, University Environment, Social and Cultural Beliefs, and Ideas on women's participation in engineering.

Firstly, the analysis of the impact of background on women's participation in engineering shows a coefficient and probability value of $\beta = 4.180$, $p < 0.05$. This implied that there is a significant relationship between background on women's participation in engineering. Secondly, the analysis revealed that the University Environment also has a significant impact with $\beta = 8.758$, $p < 0.05$. Lastly, the analysis of the table revealed that there is a significant relationship between Socio-Cultural beliefs and ideas on the participation of women in engineering with $\beta = 6.648$, $p < 0.05$.

Conclusion

In conclusion, the gender gap in engineering education and careers has been influenced by multiple factors as discussed, Societal stereotypes and biases over the years continue to give a negative perception of women in engineering, while the lack of female role models, Cultural

and societal expectation has limited the representation and inspiration in women for these courses and career parts leading women to opt for other career choices. Addressing these factors and issues women face in the field of engineering is essential to creating a more balanced system where both women and men alike have an equal playing ground in the field of engineering which will help create an environment that encourages and supports women to pursue engineering careers. Lastly, Access to education and resources has also stood as a blockade and a tool that increases the gender gap in engineering. In many regions of Africa and academic disciplines generally, women face barriers to accessing quality education. Regarding engineering, they face a stronger barrier in accessing resources necessary for pursuing a career. These barriers are not limited to accessing opportunities for girls to study engineering and other STEM subjects in schools, a lack of funding for women pursuing higher education, and an insufficient support network.

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