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# Creating a gender-inclusive mining industry: Uncovering the challenges of female mining stakeholders

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ABSTRACT

The global mining industry is male dominated. In the US, women constitute 13% of the mining workforce and 16% of mining related college programs. Similar trends exist globally. Efforts are being made by educational institutions, mining companies and professional organizations to attract women to the industry to achieve a gender inclusive industry. Such efforts have yielded minimal dividends partly due to insufficient reliable data on challenges confronting female miners. To provide empirical data to guide such efforts, we undertook a survey to understand the reasons for low female participation in the industry with participants from Ghana, USA, Ireland, Canada and other countries. The survey sought to identify challenges faced by female mining stakeholders and availability of support facilities for handling these challenges. Open and closed ended questionnaires were administered through online platforms. The responses were analyzed quantitatively using summary statistics and qualitatively using thematic analysis. About 38% of the respondents expressed satisfaction with their current jobs. The high dissatisfaction rate stems from lower salaries compared to male counterparts (29%), gender-based discrimination (53%), sexual harassment (37%) and sexual demands during hiring (17%). The key hindrances to a gender inclusive mining sector have been grouped into seven themes including discrimination, harassment, gender ideologies, and lack of support. We propose a four-way mind map model requiring commitment from government, companies, chambers of mines, and employees to ensure a gender inclusive mining industry.

## 1. Introduction

Historically, many engineering fields have been male dominated. Fig. 1 shows that women constitute between 80% and 90% of undergraduate degrees in health and medical sciences (American Academy of Arts and Sciences, 2017). On the sharp contrary, women constitute less than 20% of engineering bachelor's degrees. The share of women representation in engineering bachelor's degrees reached an all-time high of above 20% in the early 2000s but declined consistently after that. Recently, there has been a slight increment in women representation in engineering, but it is barely achieving any gender balance. Similar trends exist in countries such as Japan and Switzerland which had 12.5% and 14%, respectively of engineering graduates in 2013 being women (Royal Academy of Engineering, 2016). Only a few countries in the world have achieved a near gender balance in engineering education. For example, Myanmar, Honduras, and Tunisia have 65%, 42% and 41% of engineering graduates being female (Royal Academy of Engineering, 2016). The available data shows that "the gender gap is biggest in Ghana and Saudi Arabia" (Royal Academy of Engineering, 2016).

The reasons for the chronic underrepresentation of women in STEM education, despite efforts being made to encourage more female participation, are somewhat personal, complex, unclear, and multifaceted, making it difficult to pinpoint its root cause and panacea. Hill et al. (2010) suggest that the critical factors perpetuating gender gap in STEM education, include gender stereotypes, male-dominated beliefs, fewer role models, and math anxiety. They argued that people view STEM programs as masculine, thus teachers and parents often undermine girls' potentials in math classes as early as preschool. Thus, in their formative years, women are discouraged from participating in the foundational classes of STEM programs. A similar viewpoint was shared by Nimmesgern (2016, p.1) that "people still tend to associate the STEM disciplines with men and to hold negative opinions of women in 'masculine' careers, with women who are successful in those positions

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judged to be less likeable."

Some of the proposed solutions to help increase female participation in STEM programs, include family and academic support for female students (Starobin, 2004), more women role models in STEM programs (Nimmesgern, 2016; Fisher et al., 2019), support systems which enable women to pursue careers and still have family (Nimmesgern, 2016), community colleges (Starobin and Laanan, 2008), and positive peer connections (Robnett, 2016; Brenøe and Zölitz, 2020). It is worthy to note that the effectiveness of these solutions can be inhibited by several factors, including family structures, financial constraints, health concerns, community, etc. For instance, Brenøe and Zölitz (2020) indicate that the popular notion that having more female role models in STEM would encourage more girls to enroll in STEM programs may not hold true for every situation. Using Danish administrative data, the study revealed that having a larger proportion of female peers reduces women's probability of enrolling in and graduating from STEM programs. Thus, causative factors of gender gap in STEM education vary from place to place.

Similar trends are observed at the professional level. Among the various STEM fields, engineering has less representation of female professionals. For instance, women account for only 13% of the engineering workforce in the US (Silbey, 2016). Despite significant efforts to encourage more women to pursue STEM careers, many of them end up leaving engineering for other fields.

Among engineering bachelor's degrees in the US, mining ranked 5th lowest in terms of the percentage of bachelor's degrees awarded to women (Fig. 2). At the master's level, mining ranked as the lowest in terms of female participation (Fig. 3). This is similar to observations that 16% of college mining engineering students in the US are female while only 13% of the US mining workforce is female (Mines Magazine, 2019). Also, Informa Insights (2014) shows that the representation of women keeps declining up the mining professional ladder. Women are dramatically underrepresented in mining, oil and gas, construction, and transportations and utilities (Richman et al., 2011). Thus, mining is one of the industries where gender disparity is highly prevalent. This disparity appears to widen up the professional and educational ladder.

There is gender imbalance in the mining industry in terms of the number of stakeholders and the roles that each gender group (male/female) plays in the industry. While the large-scale mining sector has a high male dominance, the small-scale mining sector has a near gender balance. Globally, women constitute less than 10% of the large-scale mining (LSM) workforce (Rickard et al., 2017), while women constitute greater than 40% of the artisanal and small-scale mining (ASM) sector (Bansah et al., 2017, Khan, 2013, Sharma, 2010, Sumbas, 2020, Yakovleva, 2007). In the US, women constitute 13% of mining workforce (Mines Magazine, 2019) which is predominantly large-scale, while in Ghana, female participation in LSM is estimated at 10% (Rickard et al., 2017). Even mining related university programs are male-biased. Women only constitute 16% of mining engineering students in the US (College Factual, 2019), with similar demographics in Ghana. The low female enrollment in mining related university programs led the University of Mines and Technology (UMaT) to institute the Gender Mainstreaming program. This program subjects female applicants for undergraduate mining related programs to less stringent admission requirements than their male counterparts in an attempt to achieve gender balanced enrollment. After over 10 years of its implementation, the university, which offers mainly STEM programs, still has just about 20% of its students being female. Thus, the root causes may have not been identified and well defined. The Gender Mainstreaming program assumes that less stringent admission requirements will attract women to engineering programs. Conversely, health related university programs (e.g. medicine, pharmacy, and nursing), which typically have the same or more stringent admission requirements, are able to attract a high percentage of women. Ofori (2007) and Frimpong (2016) indicate that nursing in Ghana is a female dominated field. Why are women going into the health sector, which has stricter admission requirements, while there is a low female participation in engineering, with admission requirements made less strict? The root causes of low female participation in mining and engineering in general appear not to be well defined yet, despite the numerous studies in this area.

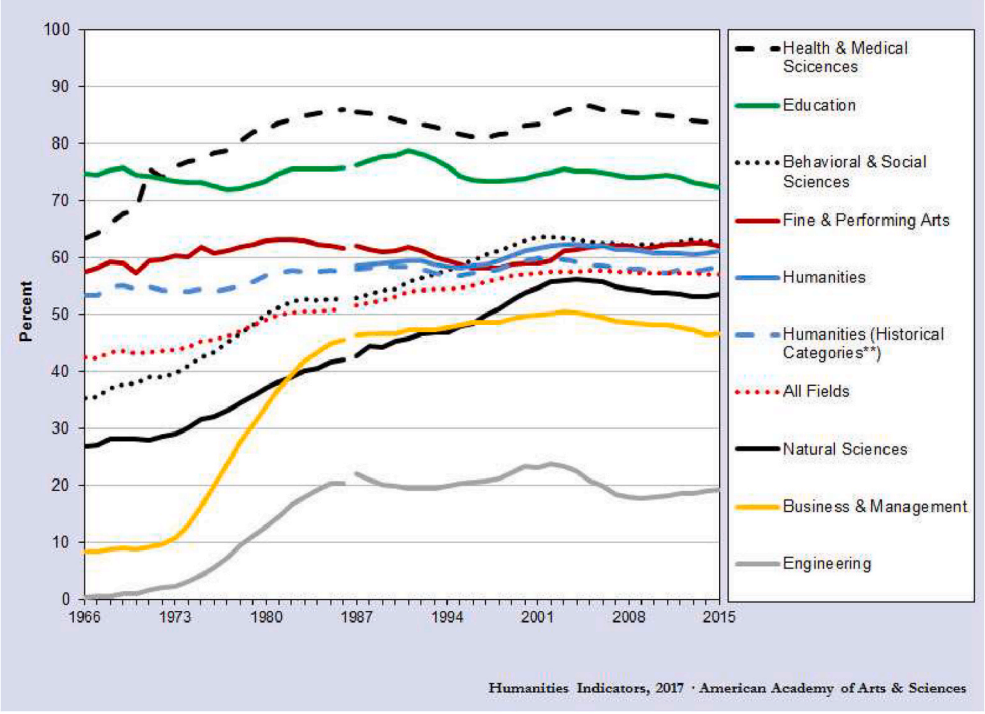


**Fig. 1.** Bachelor's degrees awarded to women in selected academic fields (American Academy of Arts and Sciences, 2017).

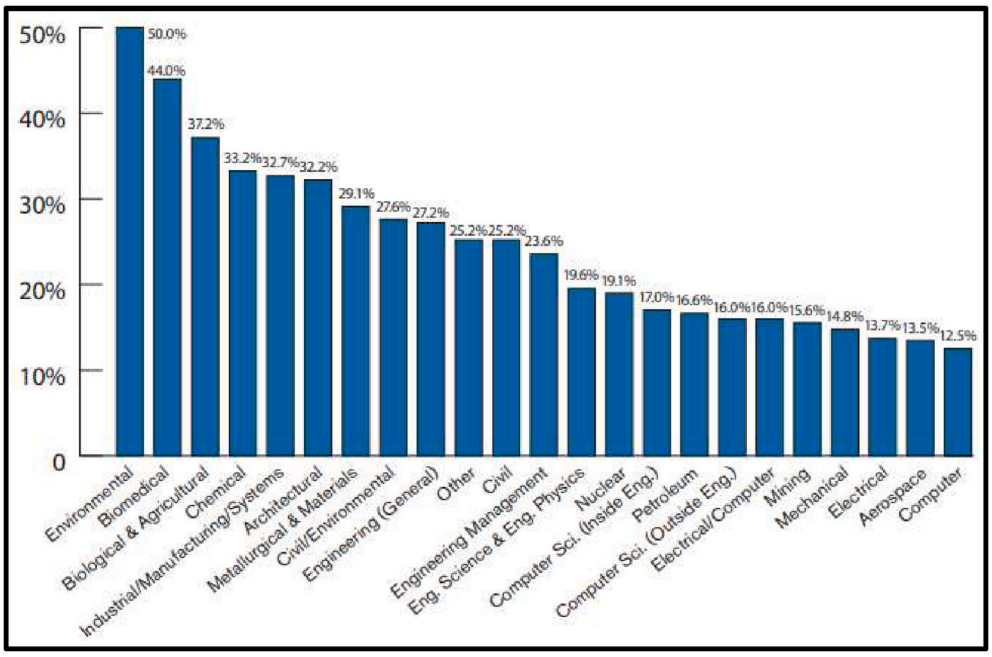


**Fig. 2.** Bachelor's degrees awarded to women by engineering discipline (Yoder, 2018).

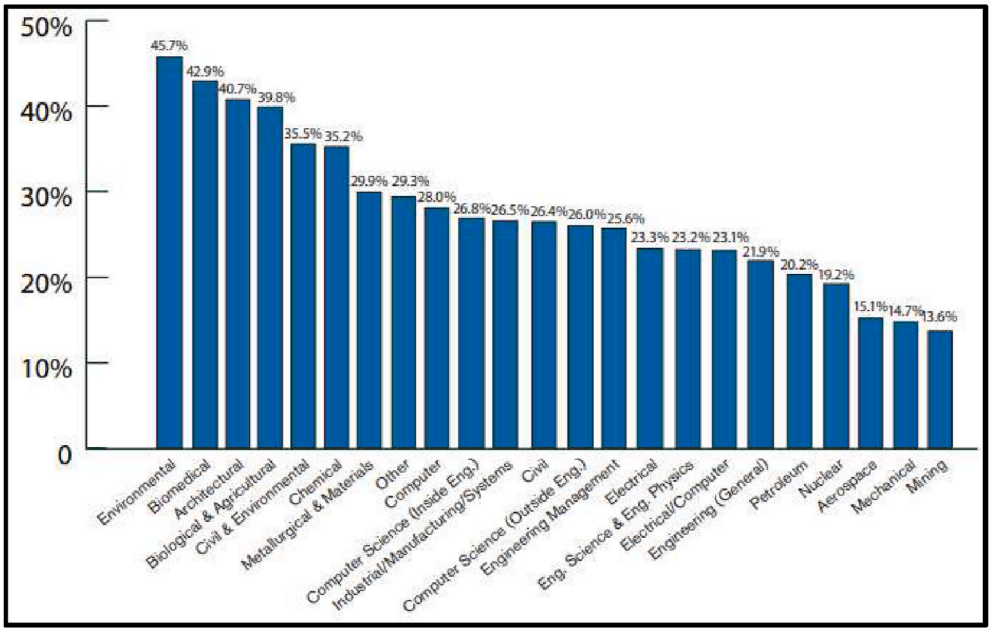


**Fig. 3.** Master's degrees awarded to women by engineering discipline (Yoder, 2018).

Few researches point out peculiar factors that may cause the gender disparity in mining. One key factor is the moral conviction towards the environmental impacts of mining. Compared with men, women are more likely to take a moral stance against the resources sector, which they are more likely to see as posing risks to the environment and society (Measham and Zhang, 2019). They are also less trusting of mining companies and this may contribute to low rates of female participation in mining.

Undeniably, research has shown that female participation in the workforce contributes significantly to social and economic development (Madgavkar et al., 2016; Vogelstein, 2016). Women in the workplace exude enormous positive changes, increased productivity, improved communication, and diversity. Madgavkar et al. (2016) estimates that women could add as much as $28 trillion (26%) to annual global GDP by 2025, if they participate in the economy identically to men. Unfortunately, such tremendous contribution is still being inhibited by legal,

cultural, social, economic, physiological, psychological, and personal barriers. In certain cultures, people still believe that the main responsibility of women is childbirth and housekeeping, therefore they should stay at home and not engage in any economic activity (Lozeva and Marinova, 2010; Subrahmanian, 2007; Marusic, 2016). Similar retrogressive believes are prevalent in many STEM professional environments. For example, many women in engineering professions have expressed being isolated, overlooked, and marginalized due to the prevailing masculine culture of engineering workplaces (Ayre et al., 2013).

In the mining industry, the main barriers identified to hinder female participation are gender discrimination, and unfavorable laws and policies. Men and women are assigned specific roles based on their gender (Pugliese, 2020). In the DR Congo, state-owned companies considered men as employable or income earners while women are considered as homemakers, and as dependents on males (Pugliese, 2020). Kaggwa (2020) also revealed that gender disparity in the mining sector of South Africa is being accentuated by unsupportive supervisors and unfavorable company policies. This leads to career stagnation, and discrimination and remuneration imbalance towards women. Moreover, Lauwo (2018) reported that some mining companies disregard the voice of many marginalized groups, mainly women, in corporate social responsibility (CSR) discourses. Similar gender challenges have been reported in other professions, including politics (Baskaran and Hessami, 2018), education (Wyn and Wilson, 2020), and business (Evans and Maley, 2020). In the construction industry, Nimmesgern (2016) found that the major barriers that hinder career development of women are work and family balance, and lack of professionalism in human resource management.

In trying to increase the stake of women in the mining sector, advocacy groups such as the Women in Mining (WIM), Ladies in Mining and Allied Professions in Ghana (LiMAP-Gh) and Women in Engineering (WINE) have been formed. These groups seek to undertake training, mentorship, networking, and research to attract more women to the industry and retain those already working there (Sakyi-Addo, 2019). Studies such as Lauwo (2018), Pugliese (2020), Perks and Schulz (2020), and Kaggwa (2020), have also suggested gender policies and regulations reforms to encourage diversity and promote gender balance in the mining industry. Further, some mining companies are also committed to integrating gender equality, inclusion, and women's economic empowerment into aspects of their operations (Macdonald, 2017).

Rickard et al. (2017) stated socio-cultural reasons and gender stereotyping as reasons for the low participation of women in large-scale mining. In South Africa, Kaggwa (2020) observed that despite the progressive gender sensitive regulations in the mining sector, women encounter challenges such lack of career progress, and discrimination in decision making and remuneration. Even though progressive efforts are being made to promote gender balance and inclusion in the mining industry, the aforementioned challenges still prevail. The challenges are varied, dynamic and may be location/country specific. That may explain why efforts to improve female participation in mining have had little success.

In this paper, we conduct a comprehensive study backed by empirical data to understand barriers to female participation in the LSM industry. The paper aims to provide an empirical demographic database of female mining stakeholders in the mining sector and unearth the challenges that discourage female participation in the sector using participants from different countries. The empirical data then formed a basis for recommendations to increase female participation in the mining sector. It is also intended to serve as a reliable source of information for advocacy groups, mining companies and government agencies in formulating policies to increase female participation in mining. The study employed open and closed ended questionnaires distributed through online platforms such as Facebook, LinkedIn, WhatsApp and other social media platforms. While participants were drawn from countries in different continents, majority of the participants were from Africa. The survey responses were analyzed quantitatively using the summary statistics and qualitatively using thematic analysis. The views of employees of some mining companies were also sought through semi-structured interviews. A unique addition to the existing literature is that this paper focuses on the views of young, professional African women.

The remaining portions of the paper are presented as follows: Section 2 reviews the current state of female professionals in mining, while Section 3 presents the methodology. Section 4 presents a synthesis of the results. Section 5 discusses the results and Section 6 presents recommendations for improving female participation in mining. The conclusions derived from the study are presented in Section 7.

## 2. State of female professionals in mining

Mining has been a male dominated occupation irrespective of where it occurs. Employment statistics (Fig. 4) show that women constitute less than 20% of mining workforce in the leading mining countries in the world (Fernandez-Stark et al., 2019). Though women have been involved in mining activities for centuries, especially in small-scale mining, they are still significantly underrepresented compared to their male counterparts (Botha and Cronjé, 2015; Kilu, 2017).

The low participation of women in mining is attributed to regulatory restrictions and cultural norms (Fernandez-Stark et al., 2019). Generally, mining is labor intensive, requiring persons with enormous physical strength to perform manual operations (Jenkins, 2014; Wynn, 2001). Thus, men are considered more energetic and suitable for mining jobs than women. Even when women are employed, they are mostly placed in administrative positions (Botha and Cronjé, 2015).

It appears that the historic image of mining as a physically demanding activity still prohibits female participation in mining today. High mechanization and automation do not seem to have played a significant role to encourage female participation. In certain jurisdictions, there are regulations restricting employment of women in mining operations. For example, in South Africa, prior to 1994, women were legislatively prohibited from being employed in underground operations (Botha and Cronjé, 2015; Kilu, 2017). Until recently, it was rare to encounter female miners involved in core mining operations such as drilling, blasting, and materials handling in LSM.

Not only are women poorly represented in core mining operations, but their presence in managerial positions is also not significant. PwC (2013) and Mining.com (2014) show that globally, the mining industry has the lowest number of female board members compared to other industries. The study estimated that women occupied only 8% of all board seats in the top 100 mining companies, with only four female executive directors in this group. While, in the top 101–500 mining companies, the number of women is less than 4%. Estimates by Mining.com (2018) are similar, where only 8% were women. The New South Wales Women in Mining showed that as you go higher in the mining organizational hierarchy, the percentage of women progressively decreases (Informa Insights, 2014) as shown in Fig. 5.

Factors for female underrepresentation in the mining industry include hazardous conditions and security risks, infrastructure complications, physical requirements, remote workplace locations, moral and trust issues, violence, gender bias, harassment, and discrimination (Fernandez-Stark et al., 2019; Rickard et al., 2017; Fernandez-Stark

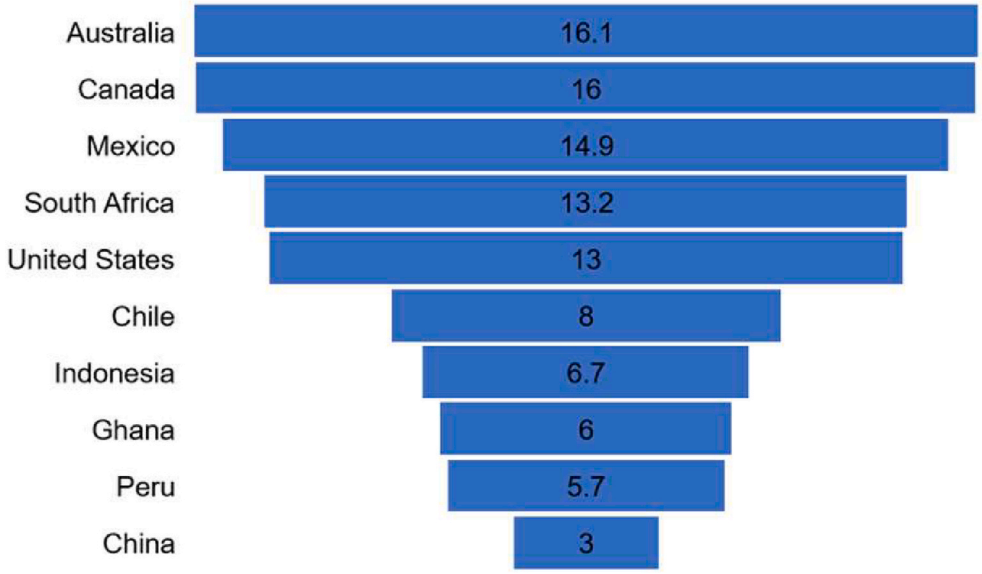


**Fig. 4.** Percentage of mining employees who are female among top gold mining countries (Lahiri-Dutt and Burke, 2011; Connell and Claughton, 2018; MIHRC, 2019; Amor et al., 2020; Calenzani, 2018; Alves, 2019; BSR, 2017). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

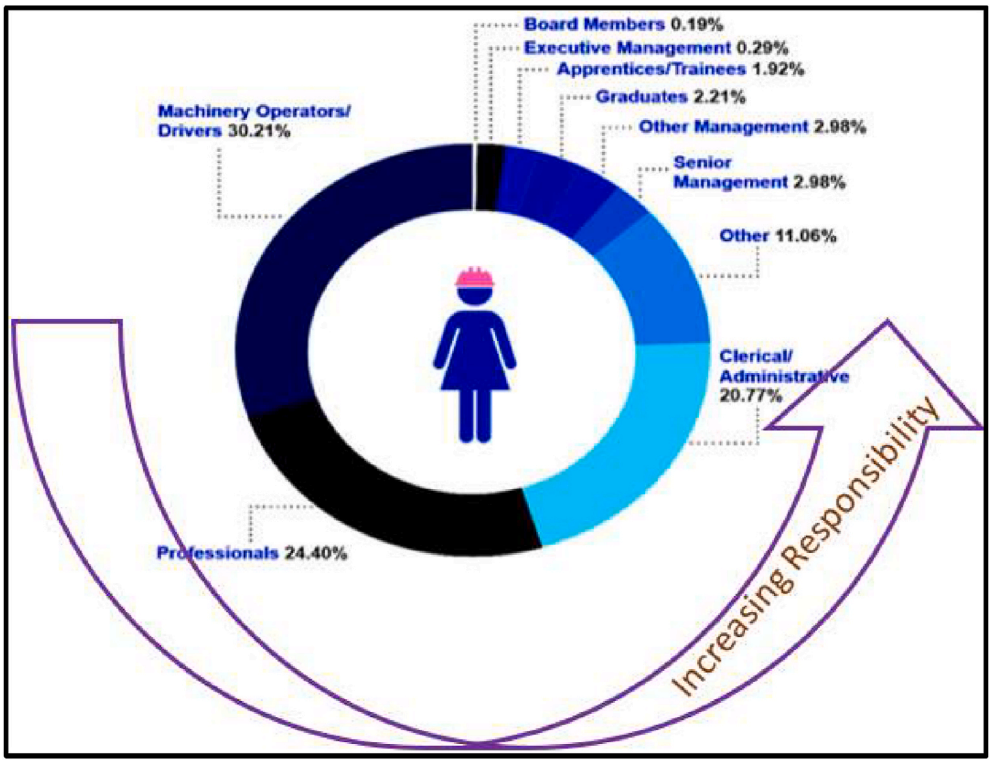


**Fig. 5.** Women Representation in Mining in Increasing Organizational Hierarchy (Modified after: Informa Insights, 2014).

et al., 2019; Ilič, 1996; Ledwaba, 2017; Measham and Zhang, 2019; Pugliese, 2020). These factors have been well explained and expanded in scholarly publications, magazines, and media articles (Lozeva and Marinova, 2010; Macintyre, 2011; Wynn, 2001; Botha, 2016).

With increasing awareness about the benefits of gender diversity at the workplace (Fernandez-Stark et al., 2019; Doku, 2019), individuals, governments, mining companies and civil society organizations are making efforts to eliminate barriers to female participation in the mining industry. Doku (2019) stated that diverse and inclusive teams are more creative, innovative and profitable, and companies with such teams are more productive and perform better than their peers. Thus, the mining industry stands to gain enormously by addressing the gender diversity challenges facing the industry. Some of the initiatives being proposed include establishment of research funds for improving conditions of women in mining (Salinas and Romaní, 2014; Mwakumanya et al., 2016), and programs to encourage more women in STEM education (Milgram, 2011; Sinkele and Mupinga, 2011). Other proposals include occupation, legislative instruments, gender policies, social campaigns, and advocacy for women in mining (Salinas and Romaní, 2014; Sinkele and Mupinga, 2011).

Mining countries such as Canada and Australia are dedicating funds for promoting research activities aimed at increasing the number of women in STEM fields and improving working conditions of female mineworkers (Fernandez-Stark et al., 2019). In South Africa, existing government policies are being reviewed to ensure equal participations of everyone, particularly women in the mining industry (Kandare, 2017). This regulatory effort is in line with UN's Sustainable Development Goal (SDG) 8; to achieve gender equality and empower all women and girls. Again, previously, mine facilities (e.g. restrooms, change rooms, etc.) were constructed without considering the needs of female mineworkers. This situation is changing with the construction of female restrooms, change rooms, and daycare facilities for mothers. More recently, Russia also enacted reforms that would allow women to work in underground mining, an area which they were previously prohibited from working (The Moscow Times, 2019).

Multinational mining companies are also instituting gender diversity and inclusion programs across their divisions. For example, BHP has introduced Global 50:50 Program with the aim that by 2025 women will constituted half of its workforce. So far, since the inception of the program in 2016, the company has increased the number of female staff by 40% (Sanderson, 2018). Similarly, Newmont plans to achieve gender balance in senior management by 2030 (Leotaud, 2019). AngloGold Ashanti and Anglo America have also set similar targets. Though these efforts have resulted in some improvement, the industry is still heavily male dominated with women largely in office and administrative, service, and sales positions.

Presently, civil society organizations such as Women in Mining (WIM) are strongly advocating for female participation in the mining industry worldwide. With presence in most mining countries in the world, WIM is championing the female participation agenda. Through social media campaigns, workshops, conferences, research, and mine site visits, WIM together with other organizations have heightened awareness about gender challenges and what should be done to encourage more women into the mining industry (Macdonald, 2017). Their efforts have resulted in some mining companies actioning projects which will improve the conditions of female mineworkers and make the mining environment more gender inclusive.

A key element hindering significant progress in achieving diversity and inclusion in the mining industry in many countries is lack of accurate and reliable up-to-date data on challenges facing female mining workforce (Botha, 2016). Such data would enable industry stakeholders to allocate resources appropriately and identify areas for improvement. Despite the efforts being made, data on female participation in most mining countries in Africa, including Ghana, are still largely unreliable to support any meaningful planning. Thus, measures should start with rigorous and comprehensive data collection across all mining value chain right from exploration to marketing, as well as all ranks from spotters to senior management. This research contributes in this regard by providing reliable data on female mine stakeholders' demographics and the challenges facing female stakeholders of the mining industry using participants from Ghana, USA, Ireland, Canada and other countries.

## 3. Methodology

We reviewed literature on gender-based issues confronting engineering occupations, especially those in the extractive industry, to understand the dynamics of occupation related gender disparity. The review process also helped the authors to formulate questions which are germane to female mining workforce during questionnaire development. We employed online questionnaire (Lumsden and Morgan, 2005; Wright, 2005) to collect primary data for the study. The questionnaire, consisting of both open-ended and closed-ended questions (Reja et al., 2003), was created using Google forms and distributed on online platforms including LinkedIn, Facebook and WhatsApp. Using excerpts from the questionnaire, a semi-structured interview guide was developed and used to conduct interviews with various female stakeholders in the mining industry. Interviewees were women who had experiences in the mining industry in Ghana and the USA. The interviews sought to verify the responses from the questionnaire and gain in-depth knowledge of pertinent issues identified in questionnaire responses. Mainly, the interviews gave clarity on the levels of female harassment in Ghana and the USA mining industry.

Next, the responses obtained were categorized into quantitative and qualitative data. Exploratory analysis was performed on the quantitative data to extract meaningful statistics. Content analysis was conducted on the qualitative data to identify themes and subthemes.

### 3.1. Population

The target population for this study was all women engaged in the global mining industry. The mining industry was subdivided into five subsectors: surface mining, underground mining, small-scale mining, quarrying and industrial minerals, and oil/gas/energy. An initial attempt to administer the survey saw fear from potential respondents due to the inclusion of the company they work at. To assure respondents that the survey was not being sponsored by any company and no one will be victimized for sharing their experiences, we excluded the company/workplace of the respondents from the survey. Respondents are however believed to be from key mining and service companies, mining colleges/universities and regulatory agencies within the participating countries. Also, the survey covered different stakeholders including students, academics/faculty, employees, and business owners/consultants working on both full-time and part-time basis. There was a wide range of professions covered in this study including engineers, administrative/clerical staff, service providers/consultants, academia, and management. Interviews were conducted to young women who have worked in Ghana and the USA mining industry in entry-level positions. These were chosen so a comparison could be made of experiences of women in both countries. While this is not enough data to be reflective of the two countries, it gives a basis for further exploration.

### 3.2. Data collection and processing

The data collection involved the formulation of mixed questionnaire (open- and close-ended questions) by the authors, transfer of questionnaire into Google forms, and distribution of the questionnaire on social/professional media. Mixed questionnaire was adopted because it makes data analysis easier and focused on the research objectives (Kansake et al., 2019). Also, open-ended questions can lead to discovery of greater information which might not be captured in the research objectives (Gillham, 2008). The online questionnaire method of survey research was used to gather data. Unlike traditional paper-based surveys, online surveys are less costly, flexible, have wide reach, fast delivery, quick response, and can be automated (Lumsden and Morgan, 2005). They are more feasible and effective for collecting data on sensitive issues (Regmi et al., 2016), such as gender-based discrimination and sexual harassment. Online surveys were the only feasible and cost effective method to collect data on a global scale as required in this study.

The questionnaire was administered to respondents via emails, social media, including Facebook, WhatsApp, and Facebook Messenger, and professional network (LinkedIn) over period of two months (i.e. from August 4 to September 30, 2019). We used this relatively short duration to avoid duplicate entries due to the continuous access of the survey to the potential respondents. Also, after this time, there were no further responses received, and so, data collection was ended. Interviews were conducted in October 2020.

The questionnaire had three sections: respondents' demographics, satisfaction level, and channels for addressing dissatisfaction/discrimination/harassment. There was an introductory section that explained the rationale of the survey to potential respondents and assured them that information containing respondents' identifiers will not be disclosed to third parties. The demographic section solicited data about respondents' country of work, education, age, employment status, profession/job description, educational level and type of operation. We added a redundant question about respondent gender so that we could filter out any responses from males. This proved necessary as 4% of the total responses were males. Such responses were deleted from the data before analysis.

The section on satisfaction level pertained job satisfaction/dissatisfaction and reasons for satisfaction/dissatisfaction. It also contained questions about salary/income disparities compared to male counterparts, discrimination and harassment. Section 3 of the questionnaire focused on channels for addressing discrimination and harassment. It contained questions on whether companies had departments that handle discrimination/harassment complaints, whether respondents have ever experienced and reported discrimination/harassment and if their complaints were impartially investigated. It also gathered information on categories of employees that harassed the respondents, if respondents faced retaliation for reporting harassment/discrimination and key challenges discouraging female participation in mining.

Ninety-eight (98) responses were received within the two-month data collection period. Out of this number, 87 (~89%) responses were used for analysis. The remaining 12 responses were discarded because they were completed by males (4%) or unknown gender (7%). The results presented in this paper are based on the 87 responses. While we understand that the number of responses received may represent a very minute percentage of the global mining female workforce, we deem the data sufficient for further analysis due to the wide coverage of professions, geographical locations, age and subsectors of the mining industry. We believe that the sensitive nature of the survey may have deterred a greater percentage of the target population from participating. This assertion is consistent with the concerns expressed by participants during the interviews. Interviewees indicated that many women have been victimized for lodging complaints about harassment. Thus, they feel the responses may be seen by their bosses and be used to victimize them. The natural fear that comes with experiences of intimidation and victimization might have also discouraged many women from participating.

### 3.3. Data analysis

The responses were exported from Google forms to MS Excel® for further processing and analysis. The responses were categorized into quantitative and qualitative data and analyzed quantitatively (summary statistics) and qualitatively (thematic analysis). The responses to closed-ended questions generated the quantitative data while responses to open-ended questions resulted in the qualitative data.

Analysis of the quantitative data was performed using pivot tables and charts in MS Excel® to extract relevant summary statistics. Thematic analysis (Braun and Clarke, 2006; Vaismoradi et al., 2016) was used to analyze the qualitative data. We analyzed the responses thematically and identified seven main themes and twenty-three sub--themes for challenges that female mining stakeholders face. The main themes were derived from a detailed content analysis which identified the modal recurring words. The sub-themes are a summary of respondent opinions, sub-categorized under the main themes based on their similarity to the main themes. Interview responses were used to verify questionnaire responses and provide further details on important issues such as harassment, that were identified from the questionnaire

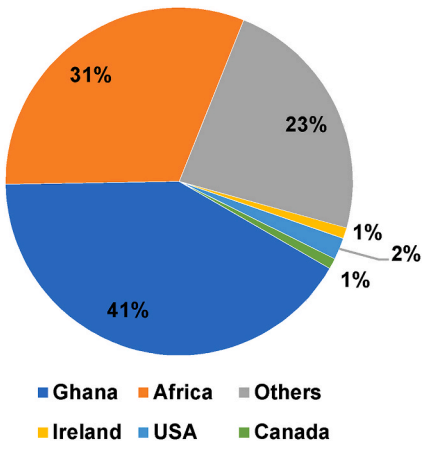


**Fig. 6.** Country of work of respondents.

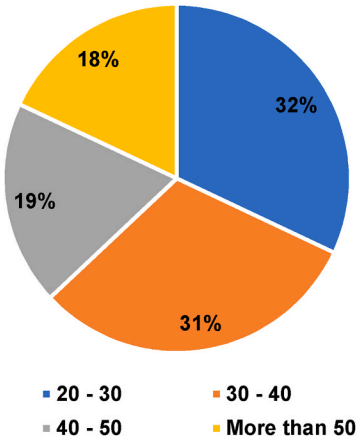


**Fig. 7.** Age distribution of respondents.

responses. For illustration and clarity, some of the interview and questionnaire detailed responses have been captured verbatim in the paper using codes, R1, R2, and R3. Codes are used instead of pseudo names so that no participant (or other women in mining who might not have participated in the survey) gets victimized because their name is the same as a chosen pseudo name.

## 4. Results

### 4.1. Respondent demographics and job satisfaction

Summary of the respondents' demographics is presented in Figs. 6–10. As shown in Figs. 6 and 41% of the respondents work in Ghana, while 31% and 23% of the respondents work in other African countries and other countries outside Africa, respectively. Thus, the results presented in this paper are more reflective of the experiences of African female stakeholders. Participants from outside Africa constituted 27% of the total sample used in this research. "Africa" includes countries such as Nigeria, Zambia, South Africa, Liberia, Mali, Guinea, Ivory Coast, Tanzania, Burkina Faso, Kenya and Cameroun, which had individually under-represented numbers. While the individual representation from countries outside Africa (including "others" in Fig. 6) is low, the aggregate effect of these responses gives good indications of experiences of female stakeholders working in the mining industry outside Africa.

The respondents were fairly young with 32% being 20–30 years and 31% being 30–40 years (Fig. 7). Only 19% and 18% are aged 40–50 years and above 50 years, respectively. As shown in Fig. 8, respondents with bachelor's and graduate/postgraduate degrees constituted 39% and 53%, respectively of the total sample. Thus, the results of this study are much reflective of the experiences of young (under 40 years, constituting 63% of sample) professional (92% of sample) African women. This makes their experiences very important because majority of them will likely remain in the sector for a longer period. Also, the blend of newcomer miners and experienced ones provides a comprehensive view of the experiences of female mining stakeholders. Thus, policies that may result from this research can be directed at having a holistic impact on all female stakeholders, with emphasis on a critical class, the young professional African women. Previous research efforts, especially those conducted in developing countries, have focused on small-scale mining, which is dominated by women with lower levels of education. Thus, much is already known about the challenges and experiences of women within that educational bandwidth (below bachelor's level). This is highlighted more in Fig. 9, which shows that 73% of the respondents work in the large-scale surface and underground mining, and oil/gas/energy sectors, which typically require professionals with at least a bachelor's degree. Small-scale mining and quarrying/industrial mineral sectors, which typically utilize less educated workforce, only constitute 25% of the respondents. It should also be noted that the mode of questionnaire distribution likely dictated the demographics of the respondents. Professionals who have access to resources and require research to execute their duties likely use these online resources daily and thus, are more likely to access and take the survey as compared to the less educated workforce.

Fig. 10 gives the distribution of professions of the respondents. Majority of the respondents are in management (including executive) positions. Other professions captured include engineers/geologists, students/interns, university faculty, administrative/clerical workers and unemployed graduates. Under-represented professions are captured as "others" and include technicians, equipment operators, policy researchers, consultants, supervisors and NGO workers.

### 4.2. Job satisfaction

Fig. 11 shows that 8% of the respondents were very satisfied with their current jobs and 30% are satisfied. This shows that up to 62% of female mining stakeholders cannot claim to have satisfaction with their jobs. Specifically, 17% were dissatisfied, 5% were very dissatisfied and 40% remained neutral (cannot claim satisfaction) in their current jobs. Table 1 summarizes the reasons for job satisfaction as indicated by the respondents. The leading individual reason for job satisfaction is high salary/income (14%), followed closely by supportive work colleagues (13%). Other important reasons cited are clear career paths (8%) and harassment free environment (5%). Majority (31%) of the respondents cited multiple reasons for job satisfaction. These reasons include high income/salary, harassment free workplace, favorable workload, supportive colleagues, clear career path and support for women. This clearly highlights the importance of fair remuneration, supportive and harassment free environments, career growth potential and other factors to attracting women into the mining industry and empowering them to operate productively. Women who have these experiences will be able to serve as mentors and encourage other women to take up careers in the

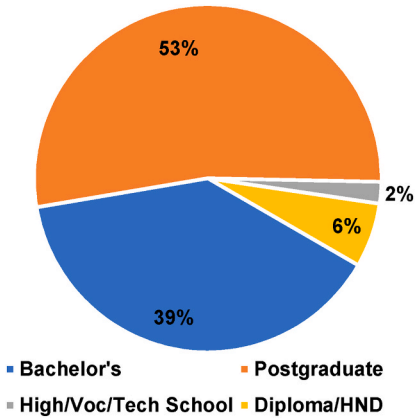


**Fig. 8.** Respondents' educational level.

industry. This has the potential to increase female participation in the industry.

Table 2 summarizes the reasons for job dissatisfaction among female mining stakeholders. The leading reasons for dissatisfaction among female mining stakeholders are no clear career path (25%), low salary/income (10%), unfavorable workload (10%) and unsupportive colleagues (5%). Other reasons, which constitute 10% of the responses, include workplace harassment, lack of motivation from management, poor incentives for women and poor company systems. To demonstrate the income/salary disparity towards women in the mining sector, Fig. 12 shows that 29% of the respondents reported receiving lower salaries than their male counterparts. Only 4% report receiving higher salaries than male counterparts, while 41% report equal salary/income. These results further highlight the importance of providing an equal and gender inclusive career path, salary/income and workload to mining stakeholders. Mining work schedules are inherently demanding, and it is necessary to provide systems that allow women to meet these demands alongside other demands from family. Management also plays a key role in encouraging female participation in the mining industry. As shown, a significant number of the respondents feel dissatisfied with their job due to these multiple reasons. These are preventable with an enlightened workforce, management and support systems that recognize the needs of the female miner beyond work/professional duties.

### 4.3. Discrimination/harassment

The results presented in Fig. 13 indicate that there is pervasive gender-based discrimination in the mining sector, with 53% of the respondents indicating that they have been victims of gender-based discrimination. Fig. 14 further shows that 37% of women in the mining sector have experienced sexual harassment. Fig. 15 shows that 17% of women experienced sexual demands from hiring managers during the hiring process. These results are reflective of the daunting challenges faced by young African professional women engaged in or attempting to venture into mining since this category contributes the greatest percentage of the sample. The results may not reflect experiences of women in the US and other countries that are under-represented in this study.

These results are very telling and require urgent systematic, regulatory, and personal efforts by all mining stakeholders to curtail their prevalence. With more than a one-half of the respondents experiencing gender-biased discrimination and over a one-third experiencing sexual harassment, how can these women, who typically venture into mining against societal and family disapproval, serve as mentors and attract more women into the sector? Most women are fraught with difficult-to-surmount challenges from the hiring process to their daily work experiences. These experiences explain why efforts to increase female participation in mining continue to yield very minimal dividends.

Table 3 shows that 59% of companies where the respondents work have departments for addressing discrimination and harassment complaints. While this is a significant number, it is far from satisfactory. Every company/institution has the potential to experience discrimination or harassment. Therefore, there needs to be departments and policies that make victims feel safe to report these experiences, which usually require a high level of trust and security. When there are specific departments entrusted with this responsibility, and policies/regulations exist and are enforced, it deters perpetrators from such acts and emboldens victims to report their experiences. As explained in section 3.2, many women have faced victimization/retaliation for reporting harassment. This highlights the importance of having trusted people within every company for handling harassment and retaliation issues.

While over 53% of the respondents have experienced gender-based discrimination (Fig. 13), only 24% have reported discrimination/harassment experiences, with 55% indicating that they do not feel safe to report their experiences (Table 3). This is consistent with the views shared by the interviewees that women face victimization for reporting harassment and related challenges. Only 12% of the respondents indicated that reported cases had been investigated with a fair conclusion, while 54% think that cases reported were not fairly investigated (Table 3). Also, 15% of the respondents were satisfied with investigations on reported cases of discrimination and harassment, while 44% were not satisfied with the investigations (Table 3). These results show that companies have minimal commitment to making the workplace safe, comfortable and conducive for women engaged in mining. Even if there are dedicated departments and policies to handle discrimination and harassment, these may not be enforced, and individuals have control over investigations. It shows organizational difficulties that women in mining have to face with little support from their employers. This has the tendency to create a resentful female workforce, resulting in less productive women. It does not create an environment where women can be productive. The ultimate effect is that women in mining will lack the courage to invite more women into the industry. This further highlights the reasons for the continuously low female participation in mining despite the efforts from organizations such as WIM, Society for Mining, Metallurgy and Exploration (SME) and Women

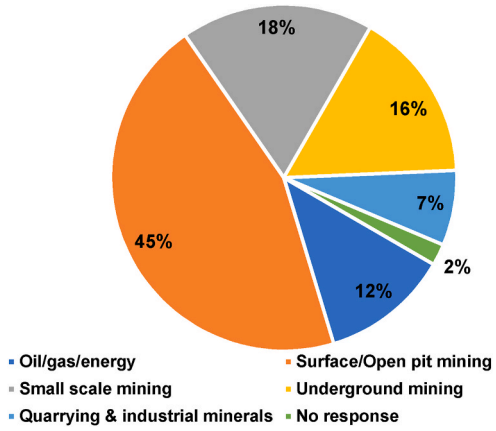


**Fig. 9.** Subsector of work.

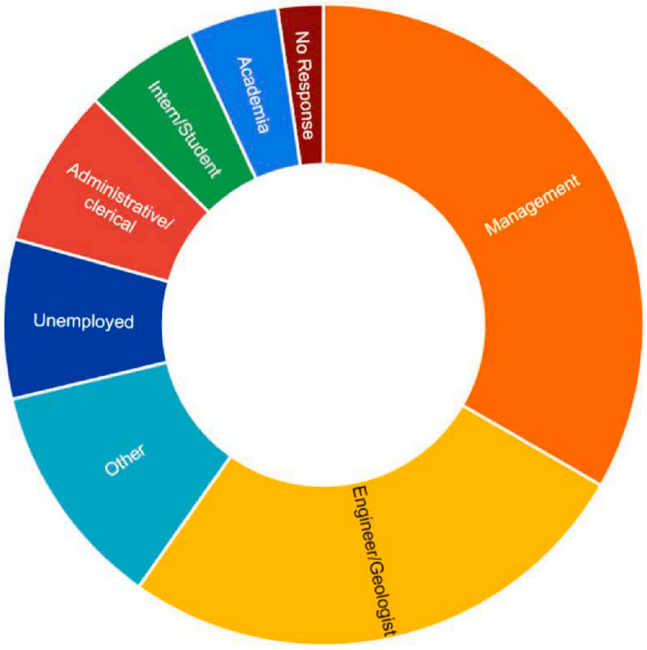


**Fig. 10.** Distribution of respondents' professions.

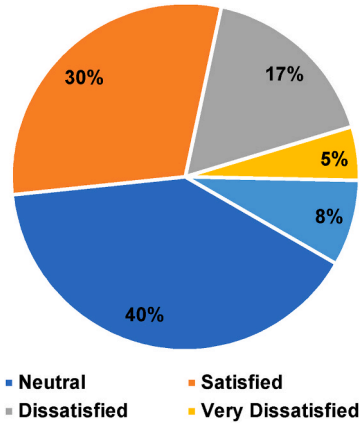


**Fig. 11.** Job satisfaction of respondents.

**Table 1**
Factors that make female mining stakeholders satisfied with their job.

| Factors | No. of Respondents | Percentage |
|---|---|---|
| High salary/income | 12 | 14% |
| Supportive work colleagues | 11 | 13% |
| Clear career path | 7 | 8% |
| Harassment free environment | 4 | 5% |
| Multiple/other reasons: | 31 | 31% |
| • Favorable workload | | |
| • Harassment free environment, Clear career path, Favorable workload | | |
| • High salary/income, Balance between office and outdoor work | | |
| • High salary/income, Clear career path | | |
| • High salary/income, Favorable workload | | |
| • High salary/income, Harassment free environment | | |
| • High salary/income, Supportive work colleagues | | |
| • High salary/income, Supportive work colleagues, Clear career path | | |
| • High salary/income, Supportive work colleagues, Clear career path, Favorable workload | | |
| • High salary/income, Supportive work colleagues, Favorable workload | | |
| • High salary/income, Supportive work colleagues, Harassment free environment, Clear career path | | |
| • High salary/income, Supportive work colleagues, Harassment free environment, Clear career path, Favorable workload | | |
| • High salary/income, Supportive work colleagues, Harassment free environment, Favorable workload | | |
| • High salary/income, Supportive work colleagues, Opportunity to apply best practice and develop independent strategies with team | | |
| • Interesting varied work | | |
| • I've always loved working in remote areas away from City life | | |
| • Lack of machinery/crushing stone pavers equipment | | |
| • Need to support Women in Mining | | |
| • Source of income | | |
| • Supportive work colleagues, Clear career path | | |
| • Supportive work colleagues, Clear career path, Favorable workload | | |
| • Supportive work colleagues, Favorable workload | | |
| • Supportive work colleagues, Harassment free environment, Favorable workload | | |
| • Supportive work colleagues, the fact that I could apply directly what I studied in school | | |

in Engineering (WINE).

From the interviews, it is deduced that the mining workplace in the US is more conducive for women than in Ghana. For example, one interviewee indicated that while working in Ghana's mining industry, she had faced so much sexual demands from bosses to the extent that she had to pretentiously get "too close" to one boss so that other superiors are deterred from harassing her. She also indicated instances where she male friends made comments such as "since you work at company A, you are likely dating a boss because that is well known about company A." On the contrary, the interviewee explained that males in the US mining industry are much more mindful of their utterances and consciously try to avoid harassment and gender-biased statements. These views were consistent among the responses of interviewees who had experiences in Ghana and the US mining industries. One of the interviewees shared that, in the US, "a man can look at you and you know he wants to tell you something outside work but for the fear of that being perceived as harassment, they rather remain silent." Another interviewee stated that "I left my job in Ghana to come to school in the US mainly because I could no longer take the harassment at work." This highlights the vast differences between the two countries. Thus, the results of this study closely reflect the experiences of young professional African women in mining and are corroborated by the interviews. This calls for serious attention to the issues of female harassment in Ghana and by extension, other African and low-income countries where rules on harassment are less-enforced.

Harassment of women in mining is being perpetrated by superiors,

**Table 2**
Factors that make female mining stakeholders dissatisfied with their job.

| Factors | No. of Respondents | Percentage |
|---|---|---|
| No clear career path | 22 | 25% |
| Low salary/income | 9 | 10% |
| Unfavorable workload | 9 | 10% |
| Unsupportive work colleagues | 5 | 6% |
| Multiple/Other reasons: | 10 | 10% |
| • Access to contracts | | |
| • No motivation from management. Management simply didn't see the women working with them. They couldn't wait for us to be done and leave for no good reason | | |
| • Harassment and unfavorable workload | | |
| • Harassment at workplace | | |
| • Lack of facility to conduct research | | |
| • Lack of stone crushing equipment/machinery | | |
| • Poor company systems | | |
| • Poor incentives for women | | |
| • Promoting women in Mining | | |
| • Women inclusiveness are at the barest/lowest. No opportunities for growth | | |

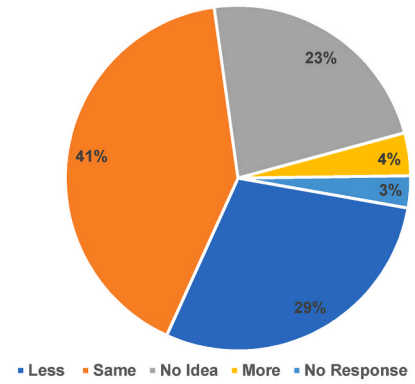


**Fig. 12.** Female salaries compared to male counterparts.

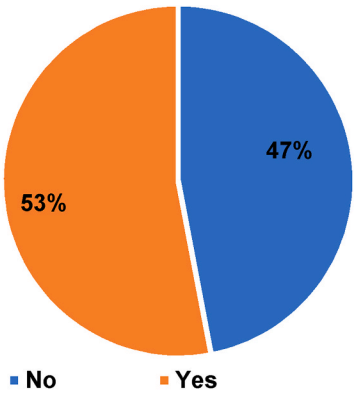


**Fig. 13.** Gender-based discrimination.

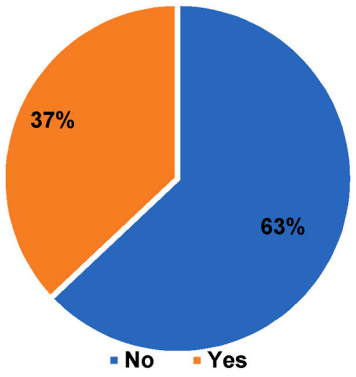


**Fig. 14.** Sexual harassment experiences.

colleagues, subordinates and clients (in the case of consultants/service providers) of the victims. As shown in Table 4, 29% of the respondents reported being harassed by their superiors, while 10% were harassed by their colleagues. Harassment by subordinates and clients was the least at 2% each, while 3% reported being harassed by multiple categories of employees including superiors, colleagues, subordinates and clients. It is evident that the most prevalent source of harassment is the superiors. This makes it more challenging to curb and would require company commitment and executive level action to reverse the trend. Victims may not report their experiences for fear of retaliation. Even if they report, perpetrators can interrupt fair investigations. This might explain why only 12% of reported incidences have been fairly investigated (Table 3).

It appears that most companies encourage victims of harassment to report their experiences as 62% of respondents reported that their companies encourage them to report harassment cases (Table 4). However, 44% of the respondents reported that they faced retaliation for reporting harassment. Only 24% reported not facing any retaliation for reporting harassment. Retaliation has been in the form of verbal and physical assault, transfers/change of department/duties, dismissal/loss of job, non-patronage of services and reduction or denial of salary, bonuses, and other entitlements (Table 4). One of the interviewees stated

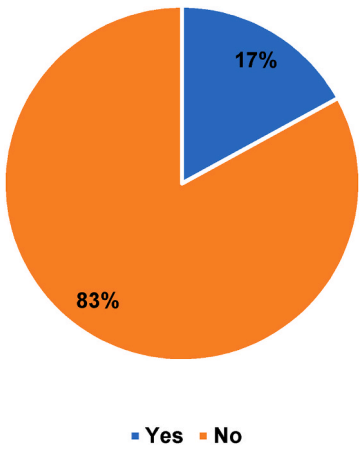


**Fig. 15.** Sexual demands during hiring.

that "my company is not being considered for those contracts because I have been told that I talk too much." This interviewee indicates that she has made several attempts to educate people on harassment and to empower women in mining to report harassment. Thus, even those at the forefront of solving this serious issue are being faced with tougher challenges and this may further discourage female participation in mining.

While majority of the companies may encourage victims to report cases of harassment, it appears there is no security for the victims as majority of them have suffered retaliation for reporting harassment. If superiors are dominantly perpetrating harassment and victims neither receive fair investigation nor have security, it will be very challenging to attract and retain productive female stakeholders. Policies have to be enacted with strict enforcement to provide security for victims and suspects and ensure fair and just investigations and penalties. This will reinstate confidence among victims and potential victims of harassment and encourage more female participation in mining. Until such confidence exists, efforts to increase female participation in mining may continue to yield negligible dividends.

### 4.4. Challenges to female participation in mining

The study employed thematic analysis to summarize respondents' views on challenges facing female stakeholders of the mining industry. Fig. 16 summarizes these challenges based on the responses of the respondents. Seven key categories of challenges have been identified as discrimination, family commitment, gender ideologies, lack of support, lack of confidence, harassment and lack of common goal. These are further classified into sub-themes in Fig. 16.

#### 4.4.1. Discrimination

Discrimination includes gender pay gaps, inequality, unconscious bias (people unconsciously think mining is not for women) and glass ceiling (resistance to women aiming for top positions in mining). These effects serve as demotivators for women engaged in mining. To highlight unconscious bias, a respondent indicated that "*our greatest struggle is a structural one. It is one of mindset … Men know they need to be more inclusive, yet they still have the 'women belong in the kitchen' mentality*."

#### 4.4.2. Family commitment

Family commitment includes poor maternity support systems, unconducive work schedules for childcare and unfavorable work-life balance. Women undoubtedly have higher family commitments than men, especially in developing countries and within African cultural settings. Companies should have policies and resources to support female stakeholders during maternity without resulting in job losses, demotion, loss of income or other impacts. It is also necessary that work schedules consider the need to take care of family or childcare. Once women have a good work-family life balance, they can operate at optimum productivity and attract more women into the sector. In response to the challenges women in mining face, one respondent stated that "*being a woman taking care of children and family as compared to males*." Another also indicated that "*rosters do not* support *gender role of women as home managers*." (R2).

#### 4.4.3. Gender ideologies

Gender ideologies such as cultural beliefs, social prejudices, gender stereotypes and lack of recognition continue to hamper female participation in mining. For example, it is believed in Ghana that women in their menstrual cycle are 'unclean' and coming in contact with gold makes the gold disappear. Addei and Amankwah (2011) explored superstitious beliefs in Ghana's small-scale mining sector and stated that "*women in their menses are prohibited from entering into mining pits and areas where gold is handled for fear that the gods seeing an 'unclean' person will withdraw the gold which is believed to belong to the gods*." This has hindered many women from engaging in mining, especially as mining is mostly done in remote areas that hold deep cultural beliefs. A respondent also stated that "*clients always undermine female mining consultants, wondering if we capable to carry out field work*." Such gender stereotypes hinder female participation in mining.

#### 4.4.4. Lack of support

According to the respondents, women generally lack support to succeed in the mining sector. They give examples as lack of mentorship, equal opportunities, facilities, inclusion and empowerment for women. They also cited unfavorable work policies as a key challenge to women in the sector. As indicated throughout this section, the traumatic

**Table 3**
Summary of harassment/discrimination complaints handling.

| Departments for addressing discrimination and harassment complaints | |
|---|---|
| Yes | 59% |
| No | 41% |
| Ever reported discrimination or harassment? | |
| Yes | 24% |
| No | 76% |
| Complaints investigated with fair conclusions? | |
| Yes | 12% |
| No | 54% |
| N/A | 34% |
| Satisfied with investigation? | |
| Yes | 15% |
| No | 44% |
| N/A | 41% |
| Feel safe to report discrimination? | |
| Yes | 45% |
| No | 55% |

experiences that women have in their mining careers may deter them from serving us mentors for others. This leaves many young female mining professionals with no guidance and direction on how to maneuver these challenges. This has made the mining industry struggle to meet the SDG5, which advocates gender equality. Pactwa (2019) corroborates this claim by stating that the Polish mining industry lags behind in achieving SDG5 (goal of gender equality) mainly because women are discouraged to take-up mining jobs. Reasons cited include unfavorable unemployment structure and pay disparity. This results in continuous under-representation of women in mining.

#### 4.4.5. Harassment

Harassment cannot be overemphasized as an obstacle to female participation in mining. It is very prevalent in the mining industry as shown in Table 3. Sexual harassment, sexism, assaults and male ego issues are stated by the respondents as examples of harassment women in the mining industry face. For example, one respondent stated that "*sexual demands when looking for jobs. Mere sexist reactions and utterances like "you are too beautiful; I don't think you can do this job.*" Another also indicated that "*it's perceived to be a man's world. The harassment for me are the sexist comments and not necessarily the sexual harassment.*" Similar issues have been raised by Kilu (2017) as inhibiting factors to female

**Table 4**
Summary of female mining stakeholders' harassment experiences.

| Response choices | Number of respondents | Percentage |
|---|---|---|
| Which category of employees harass you the most at work? | | |
| Superiors | 25 | 29% |
| Colleagues | 9 | 10% |
| Subordinates | 2 | 2% |
| Clients | 2 | 2% |
| Multiple: | 3 | 3% |
| • Colleagues and Superiors | | |
| • Superiors & Subordinates | | |
| • All categories | | |
| No response | 3 | 3% |
| N/A | 43 | 49% |
| Grand Total | 87 | 100% |
| Does your company encourage you to report your dissatisfaction/discrimination/harassment? | | |
| Yes | 54 | 62% |
| No | 26 | 30% |
| No response | 7 | 8% |
| Grand Total | 87 | 100% |
| Did you face retaliation or victimization because you reported dissatisfaction/discrimination/harassment? | | |
| Yes | 38 | 44% |
| No | 21 | 24% |
| N/A | 28 | 32% |
| Grand Total | 87 | 100% |
| Forms of Harassment Experienced | | |
| Assault (verbal or physical) | 5 | 6% |
| Change of department/duties | 7 | 8% |
| Demotion | 2 | 2% |
| Loss of job | 7 | 8% |
| Multiple | 10 | 11% |
| No Patronage | 1 | 1% |
| Reduced/denial of salary/bonus/entitlements | 6 | 7% |
| N/A | 49 | 56% |
| Grand Total | 87 | 100% |

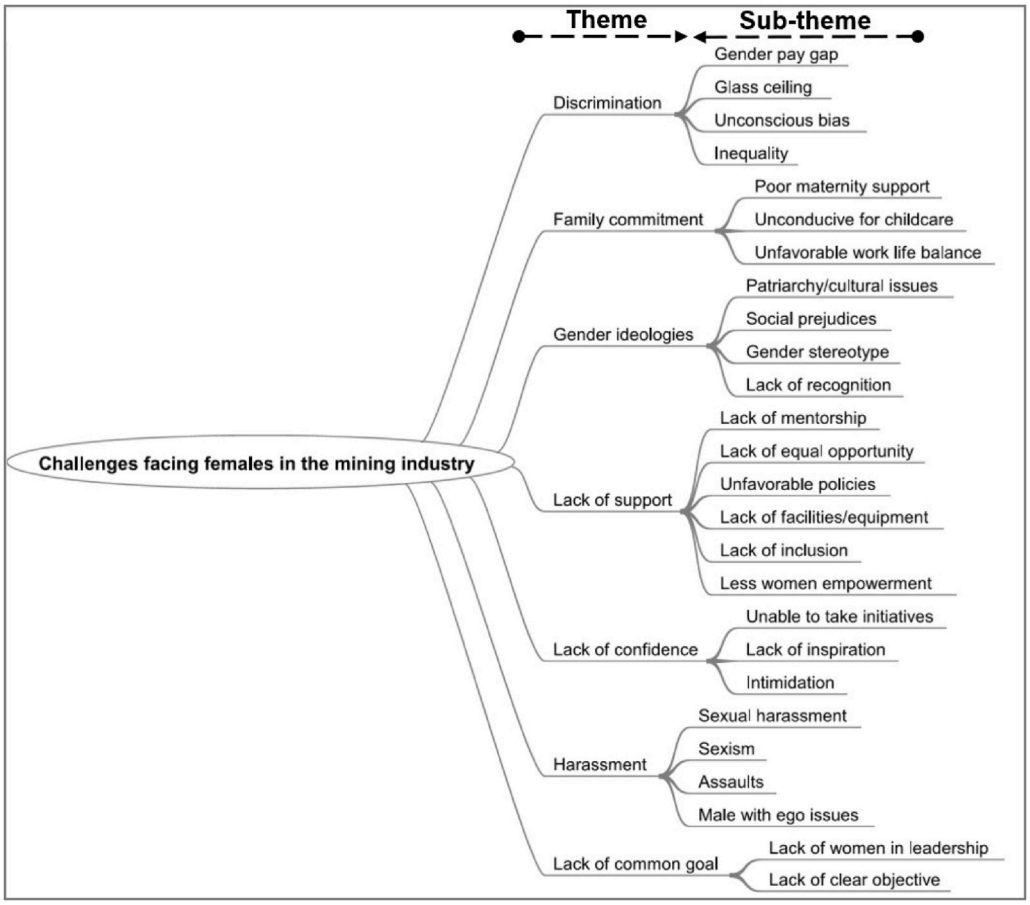


**Fig. 16.** Thematic summary of challenges facing female mining stakeholders.

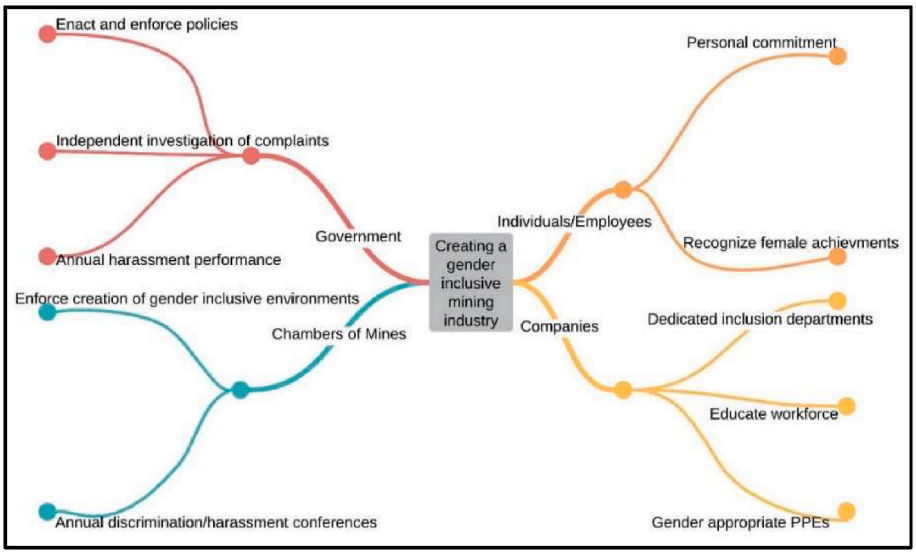


**Fig. 17.** Four-way mind map model for a gender inclusive mining industry.

participation in the Ghanaian mining industry.

Considering the educational qualification of the respondents (more 50% have postgraduate degrees), one would expect that they would be treated equally and respected for their achievements, however, the reality at workplace is far from that. They endure constant sexual harassment from their male counterparts, including supervisors, colleagues, juniors, etc. They are forced to devise interesting schemes in order to navigate and survive at the workplace. To avoid sexual advances from you superiors, you have to align yourself with one of them to create the impression that you are dating him so that the others can stop harassing you (R3).

#### 4.4.6. *Lack of confidence*

The respondents also indicated a lack of confidence exhibited by women in the mining sector. This has been sub-themed into three categories; inability to take initiatives, lack of inspiration and intimidation. A respondent, for example, indicated that "*fear of not thriving in a male dominated environment*" is a key hindrance to female participation in mining. Another also opined that "*fear to take up challenging roles and intimidation by male counterparts*" are limiting factors.

#### 4.4.7. *Lack of common goal*

Finally, respondents indicate that women lack a common goal and are unable to attain higher positions in the mining industry. This is probably causes the lack of mentorship, which is a consequence of not having enough female representation in higher positions.

## 5. Discussion

A unique contribution about this research is that it focuses on the views of young African female mining professionals as over 60% of the respondents are under 40 years old, 92% have at least a bachelor's degree and 72% are from African countries. Thus, the paper highlights their unique perspectives and experiences. Particularly, majority of the respondents work in large-scale mining. Past studies in Ghana and other African countries mainly focused on small-scale mining. Thus, this paper makes a significant contribution to the literature.

As highlighted in Section 4, majority of women in the mining and allied industries do not feel a sense of job satisfaction due to several challenges including harassment, low income/salary, discrimination, unfavorable workloads, unsupportive colleagues and unclear career paths. Conversely, the 38% who feel satisfied with their jobs derive satisfaction from high income/salary, supportive work colleagues, clear career paths and harassment free work environments. As high as 53% of the respondents have experienced gender-based discrimination, 37% have experienced sexual harassment and 17% experienced sexual demands from hiring managers during the hiring process. These results indicate the prevalence of discrimination and sexual harassment of female stakeholders in mining and have been corroborated by the interviews. Similar findings have been reported about the mining industry in sub-Saharan Africa (BSR, 2017), and South Africa (Kaggwa, 2020). This probably contributes to the low participation level of women in the mining sector. With policies such as UMaT's gender mainstreaming and efforts by several organizations not yielding significant results, this paper presents unique perspectives that can help get to the root causes of the problem. The open-ended questions highlight some of the challenges women face, including cultural issues, harassment, retaliation, unequal pay, family-work balance and perception that mining a male's job.

As shown in Figs. 2 and 3, the number of women who received graduate degrees in mining (13.6%) is slightly lower than those who received bachelor's degrees (15.6%). Similarly, while 16% of mining engineering students are women in the US (College Factual, 2019), only 13% of mining engineering professionals are women (Mines Magazine, 2019). A similar trend is observed in Fig. 5, where the number of women drastically reduces up the organizational hierarchy (Informa Insights, 2014). This reduction in the number of female stakeholders up the organizational and professional hierarchy could be due to the daunting challenges confronting women. Such challenges, which are usually

traumatic, make the workplace uncomfortable and can result in a change of careers or educational focus resulting in declining female participants in mining.

Also, this reduces the number of women who can serve as mentors for younger professionals whose views are captured in this study. As discussed in section 4.3, even women who attempt to encourage a gender-inclusive mining workplace are being victimized through the denial of fair contract bidding, loss of contracts, demotions, among other retaliatory consequences.

As shown in Table 3, only 24% of the respondents have reported discrimination or harassment experiences. This can be attributed to the non-existence of dedicated departments that handle such issues in most companies, the insecurity of the victims, unfair investigations (Table 3) or fear of retaliation (Table 4). As shown in Table 4, harassment is dominantly perpetrated by superiors who typically have a great influence on the career progress of the victims and can influence investigations, even if the company has systems for such investigations. This might explain why up to 51% of those who reported discrimination/harassment have experienced retaliation in form of job losses, reduced incomes, assault, demotion, non-patronage of services and change of departments.

Contrary to the experiences in Ghana, the US mining industry is much more conscious of these discrimination and harassment issues as shared by the interviewees. People are making conscious efforts to avoid harassment and to make the workplace comfortable for women. Also, the existence and empowerment of departments dedicated to inclusion in most mining companies in the US, coupled with awareness and strict anti-discrimination policies in government/regulatory institutions in the US, could be contributing to these improvements. For instance, Keplinger et al. (2019) attributed the reduction in sexual harassment in the US mining sector to increased public scrutiny of the topic. Thus, individuals feel better supported and empowered and not ashamed to speak up about sexual harassment.

Discrimination, family commitment and gender ideologies have hindered female participation in mining. Other inhibiting factors are lack of support and confidence, harassment, and lack of common goal among female stakeholders. The experiences women go through in the mining industry make it difficult to have mentors who are willing to help young professionals understand the challenges and maneuver them. Even when they are willing, only few women are able to rise to top positions as observed by Kuykendall and Darden (2020) who indicated that less than one-fifth of leadership roles across global mining companies are occupied by women. Therefore, there is shortage of mentors who can help young female mining professionals navigate the challenges of the industry. These challenges, which have been demonstrated with respondents' testimonies in this paper, require urgent steps to curtail. This will change the narrative of women in mining, allowing many of them to rise to top positions and serve as mentors to younger women who wish to take up career in mining.

## 6. Recommendations for a gender inclusive mining industry

We propose a four-way mind map model (Fig. 17) for resolving the challenges identified in this research. This four-way model calls for government-chamber/union-company-employee commitment to create a gender inclusive mining industry for all genders to safely and comfortably pursue their career goals. It seeks to drive behavioral, policy and systematic changes that we deem necessary for creating a gender inclusive mining industry and a supportive work environment where all stakeholders can pursue their careers without any gender biased disadvantages or hindrances.

### 6.1. Government

Government should enact and enforce policies that encourage female participation in mining, including a quota system for educational institutions, government agencies and private mining companies. The policies should also seek to address the key challenges identified and ensure the security and safety for victims and suspects. Each company, university or agency in the mining sector should also be mandated to have a dedicated department with professionals for receiving, fairly investigating and prosecuting complaints on discrimination and harassment. Government regulatory bodies should also have independent departments to which reports of harassment and discrimination in companies and universities can be filed in real time to ensure independent investigations similar to accident investigations. Harassment and discrimination should be given equal prominence like safety and health in the mining sector. Annual discrimination and harassment reports should be filed with the government mining regulatory bodies to document company performance and compliance with discrimination/harassment policies.

### 6.2. Companies

Companies that do not have dedicated departments for handling discrimination/harassment complaints should establish such departments. All companies in the mining sector should empower such departments so that they can conduct independent investigations on discrimination and harassment complaints. Companies should include discrimination/harassment share in their daily operations meetings/briefings so that employees can share tips for avoiding and overcoming discrimination and harassment. Policies should be enacted and enforced to prevent retaliation. Gender appropriate personal protective equipment (PPEs) should be procured and conducive work environments created to ensure that everyone is comfortable at the workplace. Schedules for women should accommodate their family demands such as pregnancy, maternity, and childcare. Daycare and children play centers should be created where employees can safety leave their children and concentrate on their work. Sustained education and periodical workshops on discrimination and harassment should be administered to employees so that employees are knowledgeable in these issues and conform with policies about them. Contractors, consultants and all third party stakeholders of companies should be given discrimination and harassment orientation before they undertake any job with the companies. Other companies can adopt the initiative by Newmont Corp. (Leotaud, 2019), BHP (Sanderson, 2018), AngloGold Ashanti and Anglo America to increase female employees and female board members within set time limits. All companies should have structures and policies put in place to employ, retain and promote women in the mining industry. The implementation of quota systems to increase the number of female employees and executive members should be pursued by the mining industry. There should also be transparent, fair and non-gender biased remuneration for all employees. Companies also need to have clear career paths for all employees irrespective of gender. These career paths should be openly discussed with employees to encourage them to remain in the industry.

### 6.3. Chambers of mines/mine worker unions

The Chambers of Mines, mine worker unions or similar organizations should enforce that member companies have gender inclusive and harassment free work environments and conditions. Annual discrimination and harassment conferences should be organized for member companies to share best practices and updates to policies so that the industry can continuously learn and implement improved systems that enhance a gender inclusive mining industry.

### 6.4. Employees

Employees should make a personal commitment to ensure a discrimination and harassment free workplace where all genders can equally participate without fear of oppression. Efforts should be made by all employees to avoid sexist comments, intimidation, ego, prejudice and unconscious bias. Instead, women should be made to feel welcome into the mining industry. They should be supported and encouraged to aim high and work to achieve their dreams. They should be recognized for achievements so they can be inspired to work harder.

## 7. Summary and conclusions

This study contributes to efforts that encourage female participation in mining by identifying key challenges confronting women in mining and providing empirical data upon which effective steps can be taken to improve female participation in mining. A unique contribution of the paper is its focus on young professional African women in large-scale mining. Its use of interview perspectives of experiences from Ghana and the US mining industry also adds unique perspectives to the existing literature.

Closed and open ended questionnaires were used to gather empirical data through online sources such as Facebook, WhatsApp, and LinkedIn. These media were used due to the ease of reaching wider audiences at cheaper costs. The responses gathered were analyzed quantitatively and thematically.

The results show that there is a high level of dissatisfaction among female stakeholders in the mining industry due to prevalence of harassment, income disparities, gender based discrimination, unclear career paths and unsupportive work colleagues. About 53% of the respondents have experienced gender-based discrimination, while 37% have experienced sexual harassment and 17% had sexual demands from hiring managers during the recruitment process. Victims are mostly harassed by their superiors and colleagues. These traumatic experiences remain under-reported due to lack of dedicated departments for such issues in most companies, unfair investigations, insecurity of victims and retaliation. Retaliation is typically in the form of job losses, non-patronage of services, demotion, assault or reduction/denial of incomes. Key challenges inhibiting female participation in mining have been grouped into seven categories including harassment, family commitment, discrimination, gender ideologies, and lack of support. It appears the US mining industry has made significant progress in making the workplace more comfortable for women as compared to Ghana.

We have proposed a four-way mind map model requiring commitment from government, mining companies, chambers of mines/mine worker unions and employees to ensure a gender inclusive mining industry. Companies need to establish departments for fair and independent handling of discrimination/harassment and retaliation complaints. Gender appropriate PPEs need to be encouraged among companies. Also, facilities and work schedules should be established to help women combine family duties with career requirements. Companies should also establish systems (e.g. quota systems) to recruit, retain and promote women. Non-gender biased remuneration and career paths should be given to all employees. Individual employees need to consciously work to prevent unconscious bias, sexism, sexual harassment and other behaviors inhibiting the growth of women in the industry. Chambers of mines or mine worker unions should establish platforms such as periodical conferences for sharing information on best practices to encourage female participation in mining. Finally, governments should establish systems for real-time reporting and fair investigation of discrimination/harassment complaints and annual filing of diversity and inclusion performance of the companies.

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## References

Addei, C., Amankwah, R.K., 2011. Myths and superstition in the small scale gold mining industry of Ghana. Res. J. Environ. Earth Sci. 3 (3), 249–253.

Alves, B., 2019. Mexico: mining employment share 2017-2018, by gender. Available at: https://www.statista.com/statistics/1034437/mexico-mining-jobs-distribution-gender/. (Accessed 17 June 2020).

American Academy of Arts and Sciences, 2017. Gender distribution of bachelor's degrees in the humanities. Available at: https://www.amacad.org/humanities-indicators/higher-education/gender-distribution-bachelors-degrees-humanities#:~:text=Women%20received%2061%25%20of%20the. (Accessed 16 June 2020) (Indicator% 20II%2D08a).

Amor, B., Susanti, H., Herlusia, S.I.(, 2020. Gender mainstreaming in Indonesia's mining industry. Available at: https://blogs.worldbank.org/eastasiapacific/gender-mainstreaming-indonesias-mining-industry. (Accessed 17 June 2020).

Ayre, M., Mills, J., Gill, J., 2013. 'Yes, I do belong': the women who stay in engineering. Eng. Stud. 5 (3), 216–232.

Bansah, K.J., Dumakor-Dupey, N.K., Sakyi-Addo, G.B., 2017. Digging for survival: female participation in artisanal and small-scale mining in the Tarkwa mining district of Ghana. *SME Annual Meeting*–Feb, pp. 19–22.

Baskaran, T., Hessami, Z., 2018. Does the election of a female leader clear the way for more women in politics? Am. Econ. J. Econ. Pol. 10 (3), 95–121.

Botha, D., 2016. Women in mining still exploited and sexually harassed. SA J. Hum. Resour. Manag. 14 (1), 1–12.

Botha, D., Cronjé, J.F., 2015. The physical ability of women in mining: can they show muscle? J. S. Afr. Inst. Min. Metall 115 (8), 659–667.

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101.

Brenøe, A.A., Zölitz, U., 2020. Exposure to more female peers widens the gender gap in stem participation. J. Labor Econ. 38 (4), 1009–1054.

BSR, 2017. Women's Economic Empowerment in Sub-saharan Africa: Recommendations for the Mining Sector. The William and Flora Hewlett Foundation, p. 48.

Calenzani, L., 2018. The role of women in Peru's mining industry. Available at: https://www.gbreports.com/article/the-role-of-women-in-perus-mining-industry. (Accessed 17 June 2020).

College Factual, 2019. 2020 most popular mining engineering schools. Available at: https://www.collegefactual.com/majors/engineering/mining-engineering/rankings/most-popular/. (Accessed 4 December 2019).

Connell, C., Claughton, D., 2018. Women in mining: dig the changing face of Australia's mining industry. Available at: https://www.abc.net.au/news/2018-05-22/dig-the-changing-face-of-mining-as-women-make-inroads/9786020. (Accessed 17 June 2020).

Doku, L., 2019. Why the Mining Industry Needs More Women. https://www.forbes.com/sites/woodmackenzie/2019/05/24/why-the-mining-industry-needs-more-women/#23fcc709585c. (Accessed 10 December 2019).

Evans, K.J., Maley, J.F., 2020. Barriers to women in senior leadership: how unconscious bias is holding back Australia's economy. Asia Pac. J. Hum. Resour. https://doi.org/10.1111/1744-7941.12262.
Fernandez-Stark, K., Couto, V., Bamber, P.S., 2019. Background paper for WBG-WTO global report on trade and gender: how can twenty-first century trade help to close the gender gap?-industry 4. 0 in Developing Countries: the Mine of the Future and the Role of Women. The World Bank, p. 22. No. 141574.
Fisher, A.J., Mendoza-Denton, R., Patt, C., Young, I., Eppig, A., Garrell, R.L., et al., 2019. Structure and belonging: pathways to success for underrepresented minority and women PhD students in STEM fields. PloS One 14 (1), e0209279.
Frimpong, D.K., 2016. Men in a Female-Dominated Profession: the Lived Experiences of Ghanaian Male Nurses in the United States.
Gillham, B., 2008. Developing a questionnaire. A&C Black.
Hill, C., Corbett, C., St Rose, A., 2010. Why So Few? Women in Science, Technology, Engineering, and Mathematics. AAUW, Washington, DC, p. 134.
Ilič, M., 1996. Women workers in the Soviet mining industry: a case-study of labour protection. Eur. Asia Stud. 48 (8), 1387–1401.
Insights, Informa, 2014. Infographic: what are women's role in mining? Available at: https://www.informa.com.au/insight/infographic-what-are-womens-role-in-mining/. (Accessed 16 June 2020).
Jenkins, K., 2014. Women, mining and development: an emerging research agenda. The Extractive Industries and Society 1 (2), 329–339.
Kaggwa, M., 2020. Interventions to promote gender equality in the mining sector of South Africa. The Extractive Industries and Society 7 (2), 398–404. https://doi.org/10.1016/j.exis.2019.03.015.
Kandare, M., 2017. Promoting Gender Equality in the Mining Industry. https://genderlinks.org.za/news/promoting-gender-equality-in-the-mining-industry/. (Accessed 10 December 2019).
Kansake, B.A., Kaba, F.A., Dumakor-Dupey, N.K., Arthur, C.K., 2019. The future of mining in Ghana: are stakeholders prepared for the adoption of autonomous mining systems? Resour. Pol. 63, 101411.
Keplinger, K., Johnson, S.K., Kirk, J.F., Barnes, L.Y., 2019. Women at work: changes in sexual harassment between september 2016 and september 2018. PloS One 14 (7), e0218313.
Khan, T., 2013. Mongolia: Raising Female Participation in the Large Scale Mining Sector. https://openknowledge.worldbank.org/handle/10986/16499.
Kilu, R., 2017. Shifting Gender Dynamics in Multinational Ghanaian Mine Jobs: Narratives on Organizational and Sociocultural Barriers. Doctoral Dissertation. Luleå University of Technology.
Kuykendall, T., Darden, K., 2020. Despite Diversification Efforts, Fewer than 1 in 5 Mining Leaders Are Women. S&P Global Market Intelligence. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/despite-diversification-efforts-fewer-than-1-in-5-mining-leaders-are-women-59101897. (Accessed 5 December 2020).
Lahiri-Dutt, K., Burke, G., 2011. Gender mainstreaming in asian mining: a development perspective. In: Lahiri-Dutt, K. (Ed.), Gendering the Field: towards Sustainable Livelihoods for Mining Communities. ANU E Press, Canberra, pp. 213–230.
Lauwo, S., 2018. Challenging masculinity in CSR disclosures: silencing of women's voices in Tanzania's mining industry. J. Bus. Ethics 149 (3), 689–706.
Ledwaba, S.K., 2017. Breaking Down Gender Barriers: Exploring Experiences of Underground Female Mine Workers in a Mining Company (Doctoral Dissertation).
Leotaud, V.R., 2019. Still a Way to Go to Achieve Gender Balance in the Mining Industry. https://www.mining.com/still-way-go-achieve-gender-balance-mining-industry/. (Accessed 10 December 2019).
Lozeva, S., Marinova, D., 2010. Negotiating gender: experience from Western Australian mining industry. J. Econ. Soc. Pol. 13 (2), 7.
Lumsden, J., Morgan, W., 2005. Online-questionnaire design: establishing guidelines and evaluating existing support. Proceedings of *International Conference of the Information Resources Management Association*. IRMA'2005, pp. 407–410.
Macdonald, C., 2017. The role of gender in the extractive industries, 442. Extractive Industries.
Macintyre, M., 2011. 2. Modernity, gender and mining: experiences from Papua New Guinea. Gendering the field: Sustain. Times 21.
Madgavkar, Anu, Elingrud, Kweilin, Krishna, Mekala, 2016. The Economic Benefits of Gender Parity.
Magazine, Mines, 2019. Are women the mining industry's most underdeveloped resource. Available at: http://minesmagazine.com/8749/. (Accessed 4 December 2019).
Marusic, K., 2016. People Still Believe Women Belong in the Kitchen and Men Belong at the Office Good grief. It turns out gender stereotypes are just as bad today as they were 30 years ago. https://www.womenshealthmag.com/life/a19934409/gender-stereotypes-study/. (Accessed 22 October 2020).
Measham, T.G., Zhang, A., 2019. Social licence, gender and mining: moral conviction and perceived economic importance. Resour. Pol. 61, 363–368. https://doi.org/10.1016/j.resourpol.2018.11.001.
MIHRC, 2019. Tackling the gender gap in mining: gender equity in mining works saskatchewan. Available at: https://mihr.ca/news/tackling-the-gender-gap-in-mining-gender-equity-in-mining-works-saskatchewan/. (Accessed 17 June 2020).
Milgram, D., 2011. How to recruit women and girls to the science, technology, engineering, and math (STEM) classroom. Technology and engineering teacher 71 (3), 4.
Miningcom, 2014. Let's Talk about: Women in the Mining Industry. https://www.mining.com/lets-talk-about-women-in-the-mining-industry-31775/. (Accessed 10 December 2019).
Miningcom, 2018. Only 13% of board members in the mining industry are women: Bedford. Available at: https://www.mining.com/13-board-members-mining-industry-women-bedford/. (Accessed 10 December 2019).
Mwakumanya, M.A., Maghenda, M., Juma, H., 2016. Socio-economic and environmental impact of mining on women in Kasigau mining zone in Taita Taveta County. Journal of Sustainable Mining 15 (4), 197–204.
Nimmesgern, H., 2016. Why are women underrepresented in STEM fields? Chemistry–A European Journal 22 (11), 3529–3530.
Ofori, D.F., 2007. Gender-based discrimination in the workplace: a Ghanaian perspective. Acta Commer. 7 (1), 14–28.
Pactwa, K., 2019. Is there a place for women in the polish mines?—selected issues in the context of sustainable development. Sustainability 11 (9), 2511.
Perks, R., Schulz, K., 2020. Gender in Oil, Gas and Mining: an Overview of the Global State-Of-Play. https://doi.org/10.1016/j.exis.2020.04.010.
Pugliese, F., 2020. Mining companies and gender. Policies: the Women of the Congolese Copperbelt, Past and Present. The Extractive Industries and Society.
PwC, 2013. Mining for talent: *a study of women on boards in the mining industry by WIM (UK) and PwC*. Available at: https://www.pwc.com/gr/en/publications/assets/mining-for-talent.pdf. (Accessed 10 December 2019).
Regmi, P.R., Waithaka, E., Paudyal, A., Simkhada, P., Van Teijlingen, E., 2016. Guide to the design and application of online questionnaire surveys. Nepal J. Epidemiol. 6 (4), 640.
Reja, U., Manfreda, K.L., Hlebec, V., Vehovar, V., 2003. Open-ended vs. close-ended questions in web questionnaires. Developments in applied statistics 19 (1), 159–177.
Richman, L.S., Vandellen, M., Wood, W., 2011. How women cope: being a numerical minority in a male-dominated profession. J. Soc. Issues 67 (3), 492–509.
Rickard, S., Treasure, W., McQuilken, J., Mihaylova, A., Baxter, J., (ASI, 2017. Women in Mining, Can a Mining Law Unlock the Potential of Women? Adam Smith International and International Women in Mining, London.
Robnett, R.D., 2016. Gender bias in STEM fields: variation in prevalence and links to STEM self-concept. Psychol. Women Q. 40 (1), 65–79.
Royal Academy of Engineering, 2016. Engineering and economic growth: a global view. Available at: https://www.raeng.org.uk/publications/reports/engineering-and-economic-growth-a-global-view. (Accessed 21 June 2020).
Sakyi-Addo, G.B., 2019. INTERVIEW: georgette barnes, president, women in mining Ghana. Available at: https://www.mining.com/web/interview-georgette-barnes-president-women-in-mining/. (Accessed 4 December 2019).
Salinas, P., Romaní, G., 2014. Gender Barriers in Chilean Mining: a Strategic Management. Academia Revista Latinoamericana de Administración.
Sanderson, H., 2018. BHP on Track to Achieve 50% Female Workforce by 2025. Available at: https://www.ft.com/content/063eb6bc-d10f-11e8-a9f2-7574db66bcd5. (Accessed 20 June 2020).
Sharma, S., 2010. The impact of mining on women: lessons from the coal mining Bowen Basin of Queensland, Australia. Impact Assess. Proj. Apprais. 28 (3), 201–215.
Silbey, S.S., 2016. Why do so many women who study engineering leave the field? Available at: https://hbr.org/2016/08/why-do-so-many-women-who-study-engineering-leave-the-field. (Accessed 4 December 2019).
Sinkele, C.N., Mupinga, D.M., 2011. The effectiveness of engineering workshops in attracting females into engineering fields: a review of the literature. Clear. House A J. Educ. Strategies, Issues Ideas 84 (1), 37–42.
Starobin, S.S., 2004. Gender Differences in College Choice, Aspirations, and Self-ConceptAmong Community College Students in Science, Mathematics, and Engineering. "Unpublished doctoral dissertation, University of North Texas.
Starobin, S.S., Laanan, F.S., 2008. Broadening female participation in science, technology, engineering, and mathematics: experiences at community colleges. N. Dir. Community Colleges 2008 (142), 37–46.
Subrahmanian, R., 2007. Gender in Primary and Secondary Education: A Handbook for Policy-Makers and Other Stakeholders. Commonwealth Secretariat.
Sumbas, A., 2020. Gendered local politics: the barriers to women's representation in Turkey. Democratization 27 (4), 570–587.
The Moscow Times, 2019. Russia opens 350 banned professions to women, stripping soviet-era restrictions. Available at: https://www.themoscowtimes.com/2019/08/16/russia-opens-350-banned-professions-to-women-stripping-soviet-era-restrictions-a66903. (Accessed 4 December 2019).
Vaismoradi, M., Jones, J., Turunen, H., Snelgrove, S., 2016. Theme Development in Qualitative Content Analysis and Thematic Analysis.
Vogelstein, R.B., 2016. Tackling Barriers to Women's Economic Participation. https://www.cfr.org/blog/tackling-barriers-womens-economic-participation. (Accessed 22 October 2020).
Wright, K.B., 2005. Researching Internet-based populations: advantages and disadvantages of online survey research, online questionnaire authoring software

packages, and web survey services. J. Computer-Mediated Commun. 10 (3), JCMC1034.
Wyn, J., Wilson, B., 2020. Improving girls' educational outcomes. Feminist Critical Policy Analysis I. Routledge, pp. 239–249.
Wynn, E.J., 2001. Women in the mining industry. In: Paper Delivered at the AusIMM Youth Congress. Brisbane: Australia (vol. 24, No. 07, p. 2017).
Yakovleva, N., 2007. Perspectives on female participation in artisanal and small-scale mining: a case study of Birim North District of Ghana. Resour. Pol. 32, 29–41.
Yoder, B.L., 2018. Engineering by the numbers, 2016. American Society for Engineering Education.