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# African Women Entrepreneurship In The STEM & Technology Field:


**Investigating the experiences of female African entrepreneurs in STEM & technology industries, including challenges related to access to STEM education, socio-cultural gender biases, and work-life balances, and exploring the impact of these experiences on Africa's overall economy.**

AUTHOR

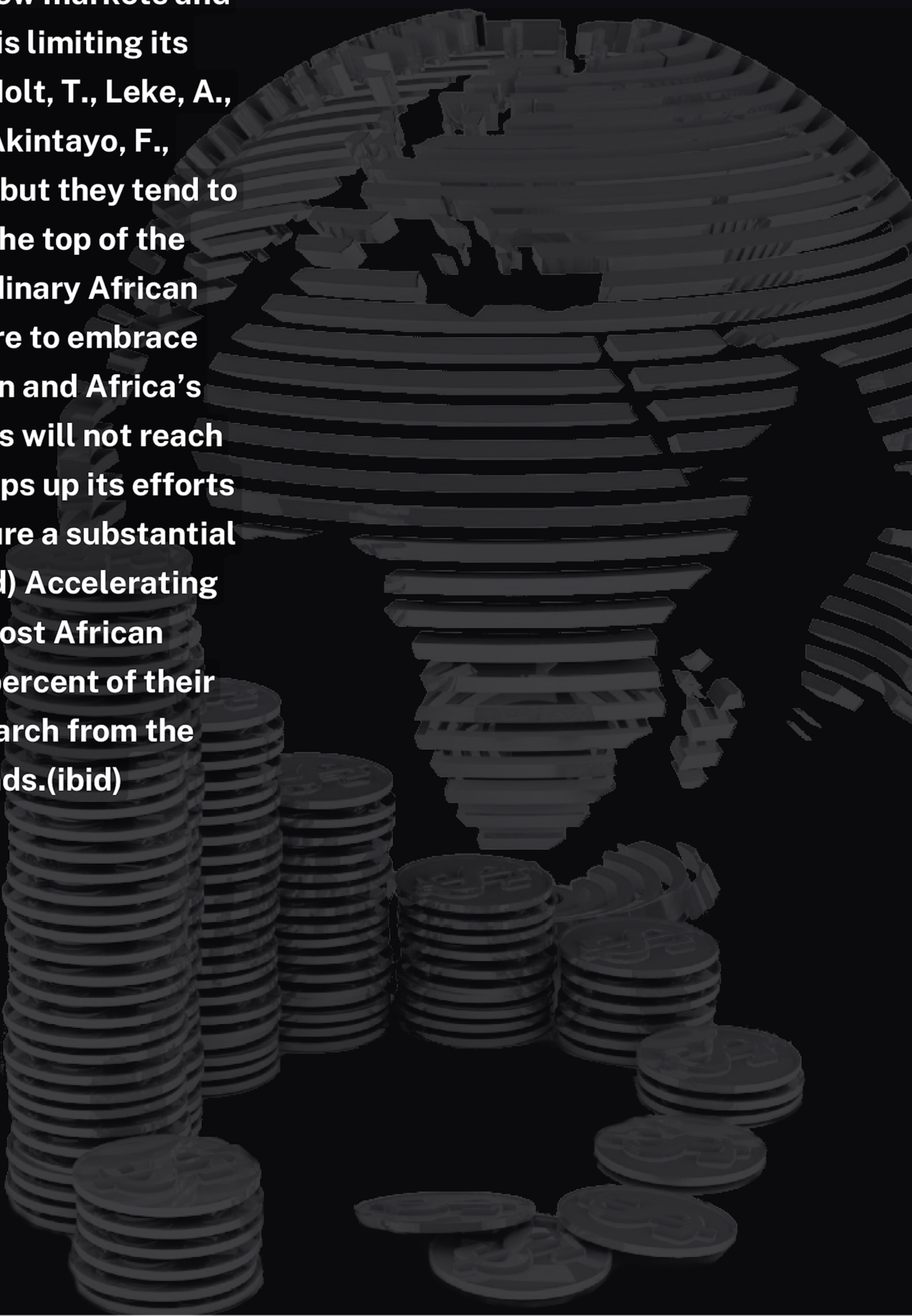
**Ndeye Aminata Thiome**
**Gender Tech Initiative**
**Intern 2023**

# ABSTRACT

The continent of Africa has a bright economic future ahead, but this fact can be hindered by the lack of opportunity and support for women in entrepreneurship. Half of Africa's potential is held by African women. African women not only have the social skills to place Africa forward, but they also have the intelligence and work ethic to boost Africa's overall economy. This paper will focus on the newly booming STEM & technology industry that is on the rise in Africa and it will analyze why African women are not able to fully participate in these fields due to socio-cultural factors and issues with education access.

# INTRODUCTION

There is a large missed opportunity for the African continent to reach its true potential due to the issue of gender inequality that is present in the majority of African societies. Gender inequality in Africa remains high, and progress toward gender parity has stagnated. Africa has so much promise; the continent is home to some of the world's fastest growing economies and offers an exciting frontier for businesses looking for growth and new markets and yet, persistent gender inequality is limiting its potential. (Moodley, L., Kuyoro, M., Holt, T., Leke, A., Madgavkar, A., Krishnan, M., & Akintayo, F., 2019)Pockets of good news do exist, but they tend to be success stories for women at the top of the pyramid, but not for millions of ordinary African women. (ibid) Because of the failure to embrace gender diversity, millions of women and Africa's overall social and economic progress will not reach their full potential. (ibid) If Africa steps up its efforts now to close gender gaps, it can secure a substantial growth dividend in the process. (ibid) Accelerating progress toward parity could boost African economies by the equivalent of 10 percent of their collective GDP by 2025, new research from the McKinsey Global Institute finds.(ibid)



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# PARITY & AFRICA'S ECONOMY

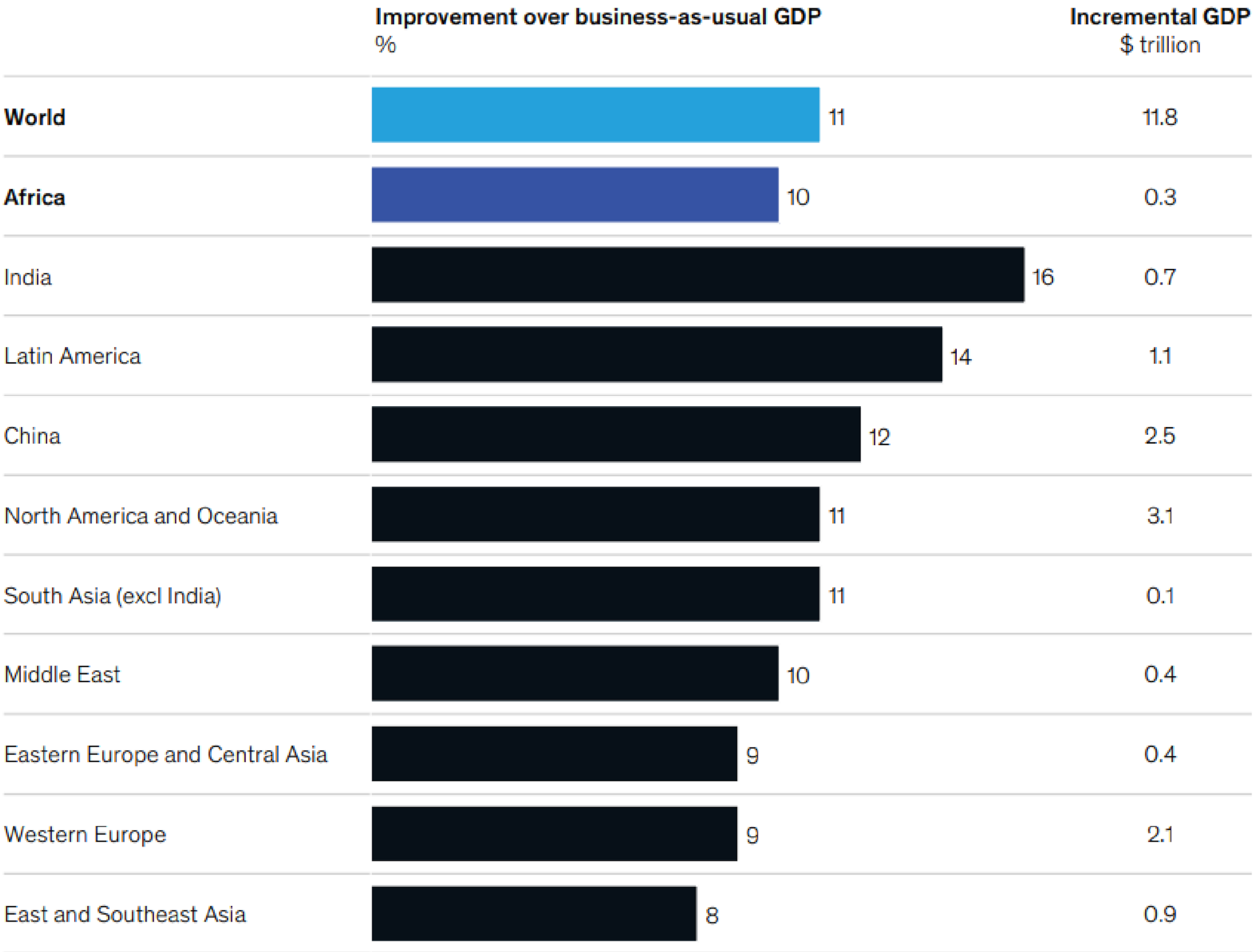
Although some African countries have made tremendous progress driving toward gender parity in some areas, gender inequality remains high across the continent. (Moodley, L., Kuyoro, M., Holt, T., Leke, A., Madgavkar, A., Krishnan, M., & Akintayo, F., 2019) Overall, progress toward gender equality has stalled over the past four years. (ibid) At the current rate of progress, it would take Africa more than 140 years to reach gender parity. (ibid) On McKinsey's Global Institute Gender Parity Score or GPS — a measure of progress toward equality — Africa scores 0.58 in 2019, indicating high gender inequality across the 15 GPS indicators of gender equality in work and society. (ibid) Women account for more than 50 percent of Africa's combined population, but in 2018 generated only 33 percent of the continent's collective GDP. (ibid) This reinforces and fuels inequality and compromises Africa's long-term economic health. (ibid)

Africa's GPS for 2019 is the same as four years previously. (ibid) Across Africa, the only indicators on which there has been progress — in aggregate — are legal protection and political representation. (ibid) All other indicators have stayed the same or even regressed in some countries. (ibid) The GPS weights each indicator equally and calculates an aggregate measure at the country level of how close women are to gender parity where a GPS of 1.00 indicates parity; a GPS of 0.95, as illustration, indicates that a country has 5 percent to go before attaining parity. (ibid) For most indicators, low inequality is defined as being within 5 percent of parity, medium between 5 and 25 percent, high between 25 and 50 percent, and extremely high as greater than 50 percent from parity. (ibid) Most indicators of gender inequality are measured as female-to-male ratios ranging from zero to 1. Data for 2015 are taken from end-2014 and data for 2019 are taken from end-2018. (ibid) The journey toward parity differs substantially among African countries. (ibid) South Africa has the highest GPS at 0.76, indicating medium gender inequality. Mauritania, Mali, and Niger have the lowest scores at 0.46, 0.46, and 0.45, respectively (extremely high inequality). (ibid)

# Exhibit 1

**In a best-in-region scenario, Africa could add $316 billion to annual GDP by 2025, or 10 percent above business as usual.**

Incremental 2025 GDP from improving gender equality at the best-in-region rate




Source: International Labour Organization; Oxford Economics; IHS; national statistical agencies; McKinsey Global Growth Model ; McKinsey Global Institute analysis

# Exhibit 2

**Africa largely mirrors world performance for gender equality at work, with the least progress toward parity in unpaid care work.**

**Gender inequality at work,** female-to-male ratio

Extremely high | High | Medium | Low | Area of focus

| Indicator | World average | Africa | India | Latin America | China | North America and Oceania | South Asia (excl India) | Middle East | Central Asia and Eastern Europe | Western Europe | East and South-east Asia |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Female population, 2017, million | 3,551[1] | 580 | 645 | 318 | 672 | 198 | 204 | 128 | 182 | 214 | 411 |
| Labor-force-participation rate | 0.64 | 0.76 | 0.30 | 0.67 | 0.81 | 0.83 | 0.37 | 0.34 | 0.78 | 0.82 | 0.70 |
| Formal employment | 0.86 | 0.68 | 0.81 | 0.94 | 1 | 1 | 0.46 | 0.74 | 1 | 1 | 0.88 |
| Professional and technical jobs | 0.73 | 0.68 | 0.34 | 0.95 | 0.84 | 1 | 0.36 | 0.54 | 1 | 0.96 | 0.94 |
| Unpaid care work | 0.33 | 0.39 | 0.10 | 0.30 | 0.39 | 0.63 | 0.19 | 0.27 | 0.50 | 0.55 | 0.35 |
| Leadership positions | 0.37 | 0.33 | 0.17 | 0.64 | 0.37 | 0.67 | 0.11 | 0.17 | 0.63 | 0.47 | 0.43 |

[1]Total. Figures may not sum, because of rounding.
Source: McKinsey Global Institute analysis

McKinsey & Company

Although the overall picture is one of stagnation or even reversals in the journey toward parity, some countries have shown remarkable improvement on some indicators.(ibid)
For instance, Rwanda and South Africa have increased women's representation in middle-management roles by 27 percent and 15 percent, respectively. Algeria has cut maternal mortality rates by around 9 percent. (ibid) Egypt has tripled its score, and Guinea and Liberia doubled their scores on legal protection of women.(ibid) These examples of rapid progress should inspire others to forge ahead with actions to advance gender equality.(ibid)

Africa's overall progress toward gender equality at work is similar to that of other regions (Exhibit 2).(ibid) This is largely because women's labor-market participation is high in Africa. (ibid) The GPS for women's labor-force participation is 0.76 — denoting medium gender inequality — whereas the global average is 0.64 or high gender inequality. (ibid) Africa's female participation is roughly on a par with that of China, Eastern Europe and Central Asia, North America and Oceania, and Western Europe.(ibid) However, most African women work in low-paid, often subsistence, jobs in the informal economy.(ibid)

Advancing women's equality can deliver a significant growth dividend. (ibid) In a realistic "best-in-region" scenario in which the progress of each country in Africa matches the country in the region that has shown most progress toward gender parity, the continent could add $316 billion or 10 percent to GDP in the period to 2025 (Exhibit 1).(ibid)

In the formal economy, Africa has made notable advances on getting more women into executive committees and board positions. (ibid) Africa has the highest female representation at the board level of any region at 25 percent against a global average of 17 percent and marginally higher than average representation on executive committees at 22 percent. (ibid) Nevertheless, Africa's GPS on women in leadership positions — which includes top and middle-management positions — is still only 0.33, a little below the global average of 0.37. (ibid) Since 2015, progress on increasing women's presence in middle-management roles has gone backward — on average across Africa by around 1 percent a year. (ibid) In North Africa, only 9 percent of women attain middle-management roles despite the fact that they account for 53 percent of the population completing tertiary education. (ibid) Too few African women make it into high-quality professional and technical jobs. (ibid)

Successful programs have a number of common elements.(ibid) First, they address deep-rooted attitudes about and behavior toward women. Second, programs are designed to achieve sustained impact. (ibid) Third, they work with women as partners to identify issues and engage the most appropriate stakeholders who can be male or female but need to be effective agents of change.(ibid) Finally, successful programs incorporate monitoring and evaluation to track progress and provide information that can drive accountability and commitment to goals.(ibid) Interventions in five priority areas could be the core of an effective agenda for change (Exhibit 4). (ibid)

# Rise In STEM & Technology Entrepreneurship


# & Its Promising Role In Africa's Economy

The entrepreneur is an important engine for the growth of the economy. Entrepreneurship is a burgeoning global phenomenon  and its importance is recognized in modern business practices, as the entrepreneur is the single most important player in a modern economy. (Bubou, G. M., Siyanbola, W. O., Ekperiware, M. C., & Gumus , S., 2014) The Global Entrepreneurship Monitor (GEM) hypothesized that the entrepreneurship conditions in a region will stimulate every entrepreneurial activity which in turn stimulates regional economic growth (ibid)  This, according to the Organization for Economic Cooperation and Development(OECD), is because entrepreneurship has great potential for creating jobs and reducing unemployment, not just in the population in general, but also among people who are vulnerable to social exclusion. (ibid)

**Equally, science, technology, innovation and entrepreneurship have been proven, not only to be the impetus for growth and economic prosperity, but also serve as the foundation for the transformation of the new economy (ibid). Unfortunately, there is an apparent dearth of science and technology entrepreneurship capital in Africa, a situation that has led to the near non-existent productive capacity of the continent, with very minimal potentials for value addition, with the resultant effects of low capacity for wealth creation and increasing levels of unemployment. (ibid) Accordingly, capacity is insufficient  even to stay meaningfully connected to global advances in science and technology; and opportunities to transfer and adapt knowledge- the same knowledge that is producing concrete benefits elsewhere- remain mostly unknown and vastly underexploited in Africa (ibid).**

**Africa had shared most of the characteristics of Latin America and the Caribbean in nearly all ages.(ibid) Some of those shared features are: lack of technology and innovation management expertise; poorly funded higher education sector resulting in low rankings in the world's best universities ranking table; low levels of research, development and innovation (RDI) funding; poor intellectual property rights regimes; and weak regional and national systems of innovation.(ibid) Affirming the above, Juma (25) maintained that creating links between knowledge generation and business development is the most important challenge facing Africa.(ibid)**

# How Women Can Be Successful In The Cybersecurity Field

# Elaine Muir

## Manager, Cyber Security Education and Awareness

**Success as a female cyber security professional requires at least three things, Elaine Muir of Australia-based insurance company IAG says – perseverance, networks and support. (Withers, S., 2021)The message, she emphasizes, is: “If you want to do this, you can succeed!” (ibid)**

**Perseverance: Muir cites the slogan, “You don’t have to be amazing to start, but you have to start to be amazing”. Or perhaps more prosaically, “A journey of a thousand miles begins with a single step” – and then it’s a matter of taking the next step, and the next.(ibid)**

**Networks: For women looking to enter the cyber security industry, Muir says that... networking events are important ways of finding out what these jobs involve and what skills and characteristics are needed, and for developing the contacts and relationships that might help nurture your career.(ibid) Employees need to see a range of people in the various roles they might aspire to hold in 10 years or so.(ibid) It’s not only new entrants that need such role models – women who have established their careers benefit from seeing others who have successfully returned from a family break.(ibid) So, Muir and other women are trying to encourage their peers – just as men do –and making sure opportunities similar to those they have had are available to others.(ibid)**

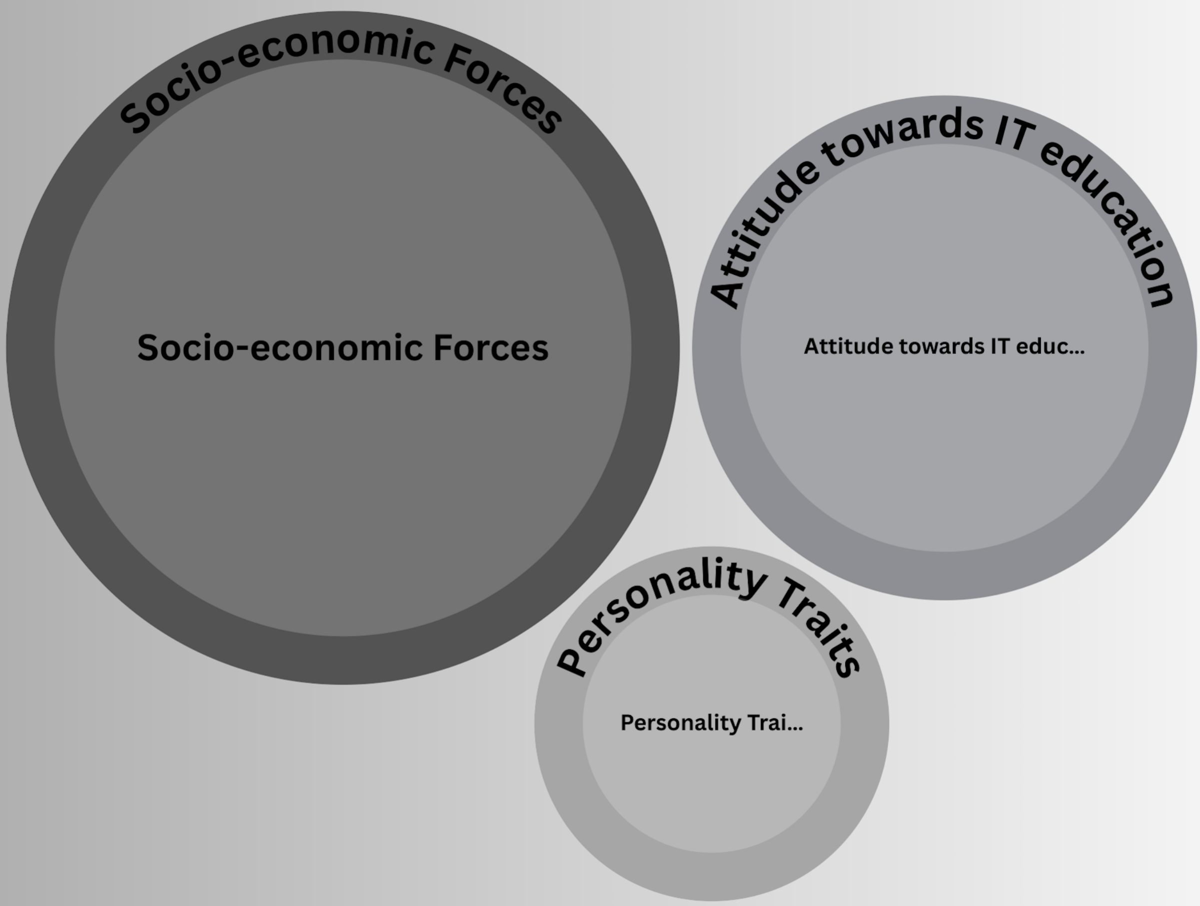
**Support: This includes finding someone who will let you vent, encourage you to keep going (perseverance again), and help you to understand that you don’t have to put up with poor behavior, says Muir.(ibid)**

# CHALLENGES AFRICAN WOMEN FACE IN PURSUING CAREERS IN STEM & TECHNOLOGY FIELDS

Socio-cultural biases prevent women from successfully competing against men for senior roles in digital companies (Seetharaman, 2017).(Adeola, O., 2020) According to the 2014 GSMA Connected Women Survey, the percentage of African women holding senior positions in the mobile communications industry is 9 per cent (GSMA & ATKearny, 2015). (ibid) Market-related factors such as the paucity of investment and installation infrastructures affect women disproportionately (UN Statistics, 2016). (ibid) The implication of the slow pace of achieving gender equality in Africa, for instance, will elongate Africa's expected time for economic prosperity, growth and development across all sectors.(ibid) The uneven representation in key decision-making processes and discrimination against African women will further make Africa less relevant in the global world.(ibid) It puts in jeopardy the African Union's Agenda 2063 that seeks to transform Africa into the global powerhouse of the future, which plan could end up as a mirage (see African Union, 2015).(ibid) Dominic et al. (2017) asserted that the failure to include women in all spheres of life is responsible for the continued underdevelopment of African nations associated with weaker governance, poor quality of life, slower economic growth and poverty.(ibid) A more recent article by Ighobor (2019) argued that sub-Saharan Africa was losing the sum of US$95 billion yearly because of the gender gap in the labor market.(ibid) The argument is reinforced by the statement of the Interim President of the World Bank Group, President Kristalina Georgieva, said that "if women have equal opportunities to reach their full potential, the world would not only be fairer, it would be more prosperous as well".(ibid) The United Nations (2020) also makes the same argument that granting womenfolk equal access to decent work, education, health care and their inclusion in the key socio-political and economic decision making process will benefit societies and humanity as a whole.(ibid)

Male-dominated activities and gender-sensitive fields, such as ICT, present key limitations for sustainable opportunities and career development for women in Sub Saharan Africa. (Adeola, O., 2020) On the African continent, research regarding women in STEM is lacking, but women's participation in STEM careers and education is also quite low compared to elsewhere. (Siwale, K., & Mwalemba, G., 2023) From 2015 to 2018, women numbered approximately 13% of South Africa's STEM graduates,roughly 12% in Congo D.R. and Kenya, 13% in Rwanda and 6% in Mozambique (World Bank, 2020). (ibid) Additionally, a mere 30% of scientific researchers in Sub-Saharan Africa are women, and less than 30% of these are engineering graduates (Amutabi, 2020; Marie-Nelly, 2021). (ibid) These significantly low figures mean that scientific work and technology innovation is missing their invaluable, diverse and critical perspectives and contributions. (ibid) Chichester, Pluess, Lee, and Taylor (2017) argued that gender gaps in the fields of science, technology, engineering and math restrict women from securing technical and high-level positions. (Adeola, O., 2020) This position is supported by the unspoken bias against educating the African woman since the culture expects her to leave school or work in order to get married and raise children.(Adeola, O., 2020) In some African countries, there are certain socio-cultural beliefs and practices that are largely connected to the creation of feminine identities, ideas of domesticity, and gender stereotypes that may exclude girls from pursuing science subjects. (Siwale, K., & Mwalemba, G., 2023) Sociocultural norms and gendered expectations significantly affect girls' educational opportunities, learning outcomes and decisions about study and work (Kitetu, 2008;O'Brien & Crandall, 2003).(ibid) Aside from cultural inclinations, the educational attainment of African women is affected by early marriage, adolescent pregnancy and school costs (Chichester et al., 2017).(Adeola, O., 2020)

A conceptual framework devised by Mahatanankoon et al. (2012) shows a list of factors that impact student decisions to enroll in IT majors. (Siwale, K., & Mwalemba, G., 2023) These factors were grouped into three areas, namely: socio-economical forces, attitude towards IT education, and personality traits. (ibid) A few subcategories of these groups were used in forming the study's framework. (ibid) These include family influence, self-efficacy, self-confidence, and attitude towards IT education.(ibid) The framework is based on a study done in Thailand, which is a developing nation, suitable to assist in shaping this study. (ibid) Additionally, various studies both globally and in Africa that assessed factors that contribute to or inhibit women's careers in STEM were reviewed. (ibid) Findings from these studies that focused on choosing whether or not to pursue STEM careers were then grouped. (ibid)



**Women play a vital role in scientific leadership and contribute to Africa's development, but they remain significantly underrepresented in higher education and STEM sectors.(ibid) Statistics show that women made up 28% of scientific researchers, while men accounted for up to 72% of those in STEM careers (AAS, 2020). (ibid) The underrepresentation of women in STEM is usually described as a manner of "leaky pipeline." (ibid) This metaphor evokes a system something like a "pipeline" carrying students through different levels of education, such as primary and high school, university, master's and so on, to high positions in STEM in academia or industry. (ibid) Additionally, the metaphor helps to characterize the problem as a flow of girls/women diminishing as these stages progress (Soe & Yakura, 2008).(ibid) Most research regarding female participation in STEM majors or careers is focused on why girls or women do not enter the IT educational pipeline, and why they do not persist, advance, or remain in the field ( Bartol & Aspray, 2006a, 2006b; Cohoon & Aspray, 2006).(ibid)**

**In this "pipeline", at each transition point or entrance into the next stage, the "pipeline" shrinks or "loses" people. (ibid) Research shows the key moment of "dissatisfaction" or "exclusion" to be in middle/primary school, where, by high school, gender differences in computing interests are well established (Vitores & Gil-Juarez, 2016). (ibid) As the number of girls and women decreases through the pipeline, it is important to understand the possible reasons for the "leak" or for the continuation at certain transitions. (ibid) This may provide greater insight into the underrepresentation of women in STEM fields and sectors.(ibid)**

**There seems to be a set of common topics that explain why girls avoid studying computing subjects in high school, and/or choose not to enroll or major in computing at the university level. (ibid) These topics include, but are not limited to, a lack of role models and support from both family and teachers; peer pressure to conform to stereotypical gender roles; and the general misperception of what STEM careers look like (Babin et al., 2010; Sele, 2012).(ibid) Additionally, there appears to be a common psychological explanation as to why girls avoid computer- related subjects, where the research agrees on four aspects: (1) the image and stereotypes of computer scientists as awkward, nerdy males, who lack interpersonal skills and are obsessed with technology; (2) the image of computer science as a male- dominated area; (3) a poor knowledge and/or awareness of computer science as a discipline and a career; and (4) the perception of computer-related subjects as unattractive and/or boring (Anderson et al., 2008; Banerjee & Santa Maria, 2013).(ibid)**

Due to the fact that STEM industries are male-dominated, not many women are found in these sectors, and they continue to be underrepresented. (ibid) The technology industry also shows that women have a greater probability of working part time, taking a break from their careers, or even resigning. (ibid)  In this sector, women currently hold 21% of high executive positions, 13% of which are in the engineering field (Lamolla & Gonzalez Ramos, 2020; Wisniewski, 2017). (ibid) These low figures are also reflected in academia and research, where, in the EU, only 33% of researchers are women, compared to the 30% in Sub-Saharan Africa (Amutabi, 2020; European Commision, 2016).(ibid)  This gender gap reinforces the bias that technology is not an appropriate space for women, and poses a threat to achieving gender equality globally. (ibid)

At the professional level, Cortes and Pan (2016) found that women are less likely to choose occupations with long work hours, which colonize their time and attention. (ibid) According to Xie and Shauman (2004), married women with children are less likely to complete their STEM degrees, pursue STEM careers and be promoted to STEM jobs. (ibid) The time commitments demanded by working in STEM and raising a family deters women from pursuing STEM careers and persisting in those careers.(ibid

# The Study

**Kaluwa Siwale & Gwamaka Mwalemba conducted a study in 2022 to contribute to studies regarding the low participation rates of women in STEM fields and careers. They state that, “there remains very limited understanding of this phenomenon from an African women’s perspective”. The study seeks to elevate the experiences of African women pursuing STEM professions and studies.**

**( Following pages will be facts and figures from the study)**

**The study was qualitive, with data collected through semi-structured interviews (See Appendix). The target population included African women who were: (1) enrolled in university and pursuing technology-related studies; and (2) women working in the technology industry or academia. Initial participants were women at university pursuing studies in the computer science, engineering, science and information systems disciplines. Additionally, academics in the stated disciplines were also approached. Women in industry were mostly identified through snowballing amongst interview participants. Participants varied in terms of classification, such as occupation, country of birth, year of study, type of study and country of tertiary study.**

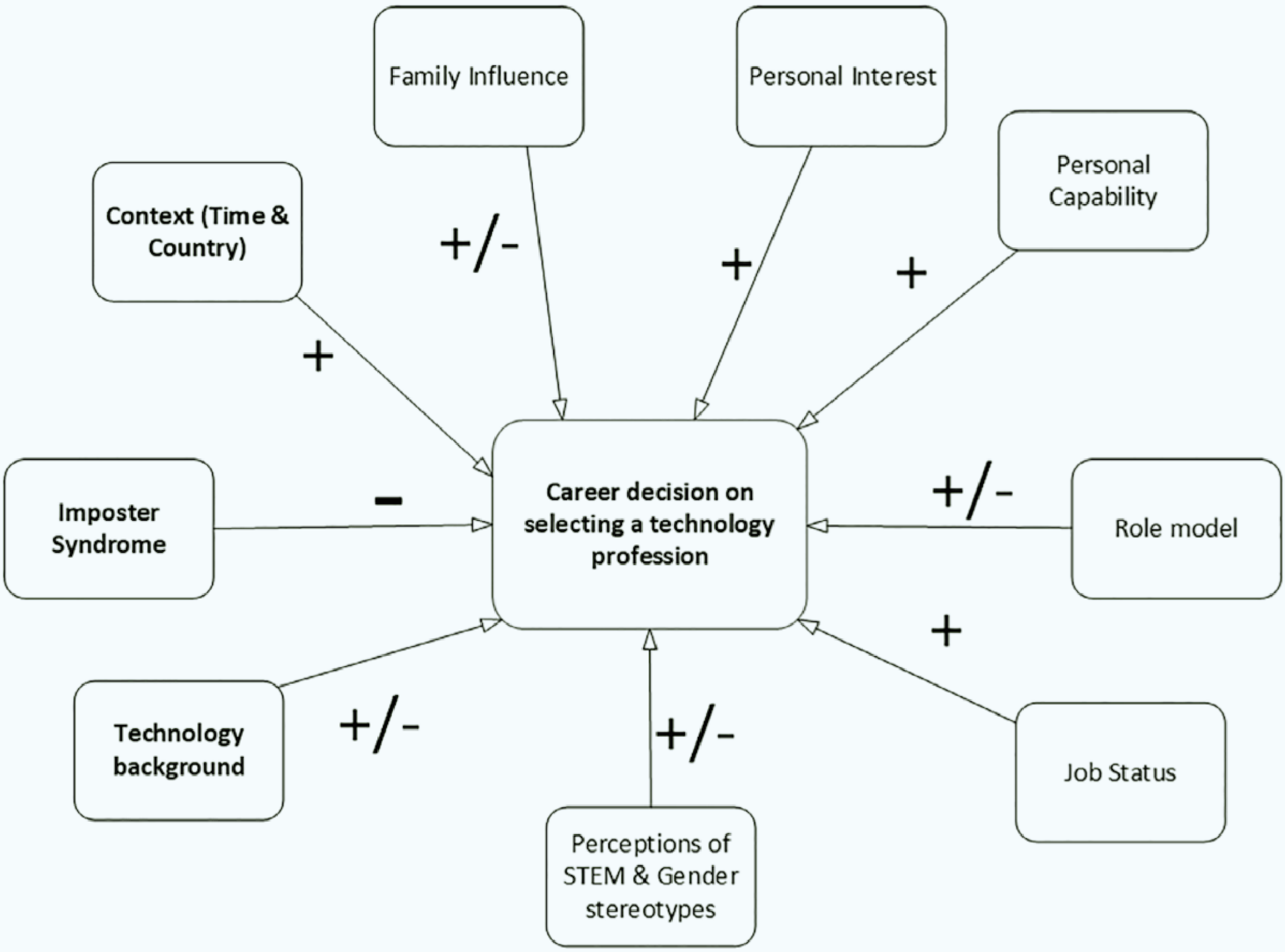



**FIGURE 1** A conceptual framework summarizing influences for a career decision on selecting a technology profession for African women

**A total of 18 African females agreed to participate and were therefore interviewed. These included 8 university students, 5 academics and 5 working professionals. Table 2 below shows the demographics of each participant, which include the participants occupation, country of birth, country of tertiary studies, and year of studies or completion. To keep any personal identifiable details private, participants were assigned numbers and randomized names. For this study the first step involved relistening to audio recordings and annotating transcripts in order to highlight potential descriptions of interests. This was followed by generating initial codes through labeling annotations that were relevant to the research questions. For this study, 14 initial codes were identified (see Figure 2). The next steps involved grouping these codes into themes, and then refining these themes into what we termed "abstract categories."**

**TABLE 2** Participants' demographics

| Participant (random) name | Occupation | Field of studies | Year of study/ completion | Native country | Country of university studies |
|---|---|---|---|---|---|
| Maria | Student | Civil Engineering | 2nd year | Zambia | Canada |
| Esther | Academic | Mathematics and Science | 1972 | South Africa | South Africa |
| Salima | Academic | Information Systems | 2003–2004 | Tanzania | South Africa |
| Lombe | Academic | Electrical Engineering | 2006 | South Africa | South Africa |
| Monde | Academic | Mathematics and Statistics | 2018 | South Africa | South Africa |
| Casangi | Student | Information Systems | Honors | South Africa | South Africa |
| Khalid | Student | Information Systems | Honors | Zimbabwe | South Africa |
| Ayana | Student | Mathematics and Computer Science | 4th Year | South Africa | South Africa |
| Nadine | Student | Information Systems | Honors | South Africa | South Africa |
| Ruth | Student | Analytics | Honors | Zimbabwe | South Africa |
| Rethabile | Student | Information Systems | Honors | South Africa | South Africa |
| Tariro | Academic | Computer Science | 2016 | Zambia | Zambia |
| Seline | Student | Information Systems | Honors | South Africa | South Africa |
| Luthendo | Product Manager | English Literature and classics | 2011 | South Africa | South Africa |
| Sedi | IT Technician | Civil Engineering | 2007 | South Africa | South Africa |
| Anati | Consultant | Computer Science | 2010 | Tanzania | South Africa |
| Mahali | Web Developer | Computer Science | 2018 | Zimbabwe | South Africa |
| Zelie | Facilities Manager | Electrical Engineering | 2007 | South Africa | South Africa |

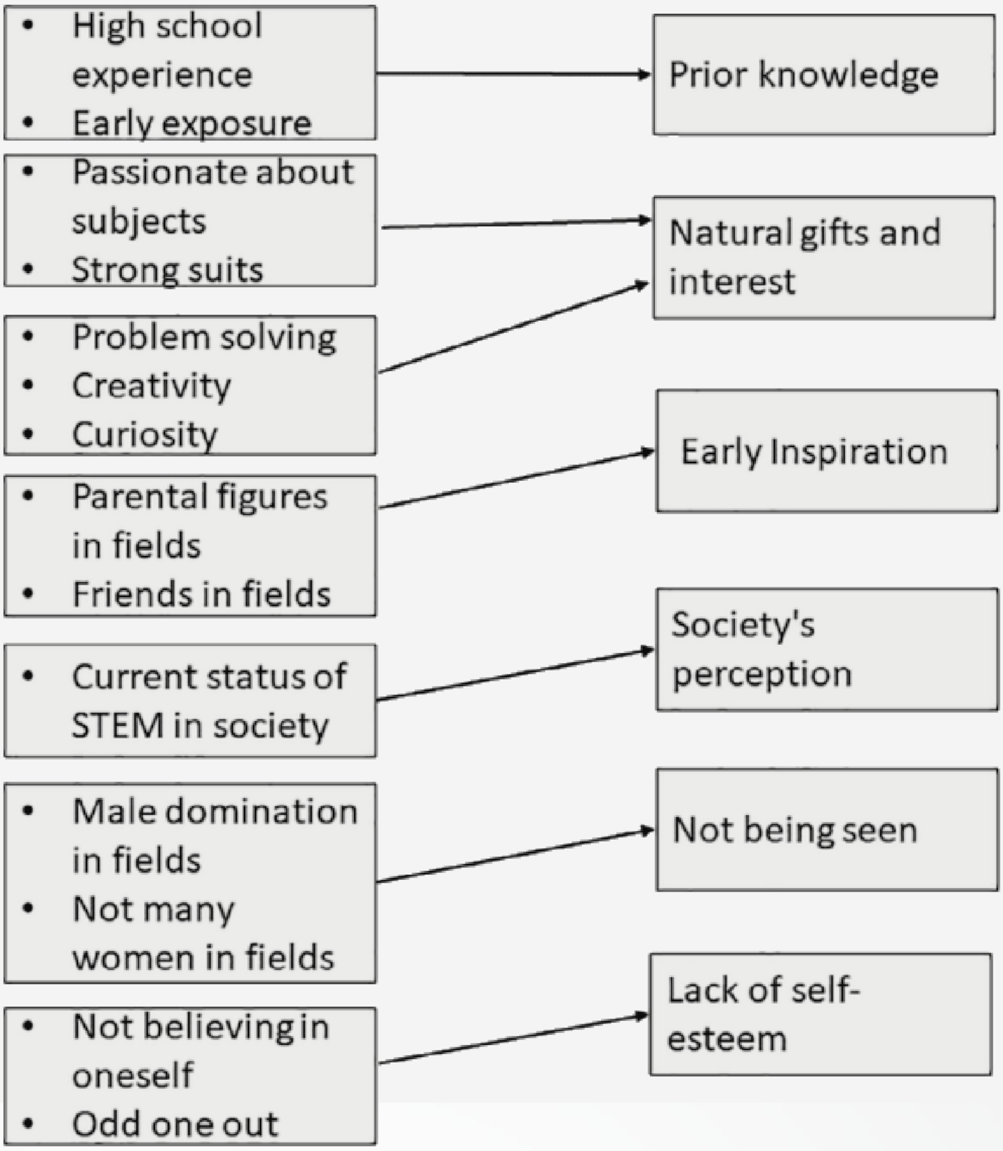
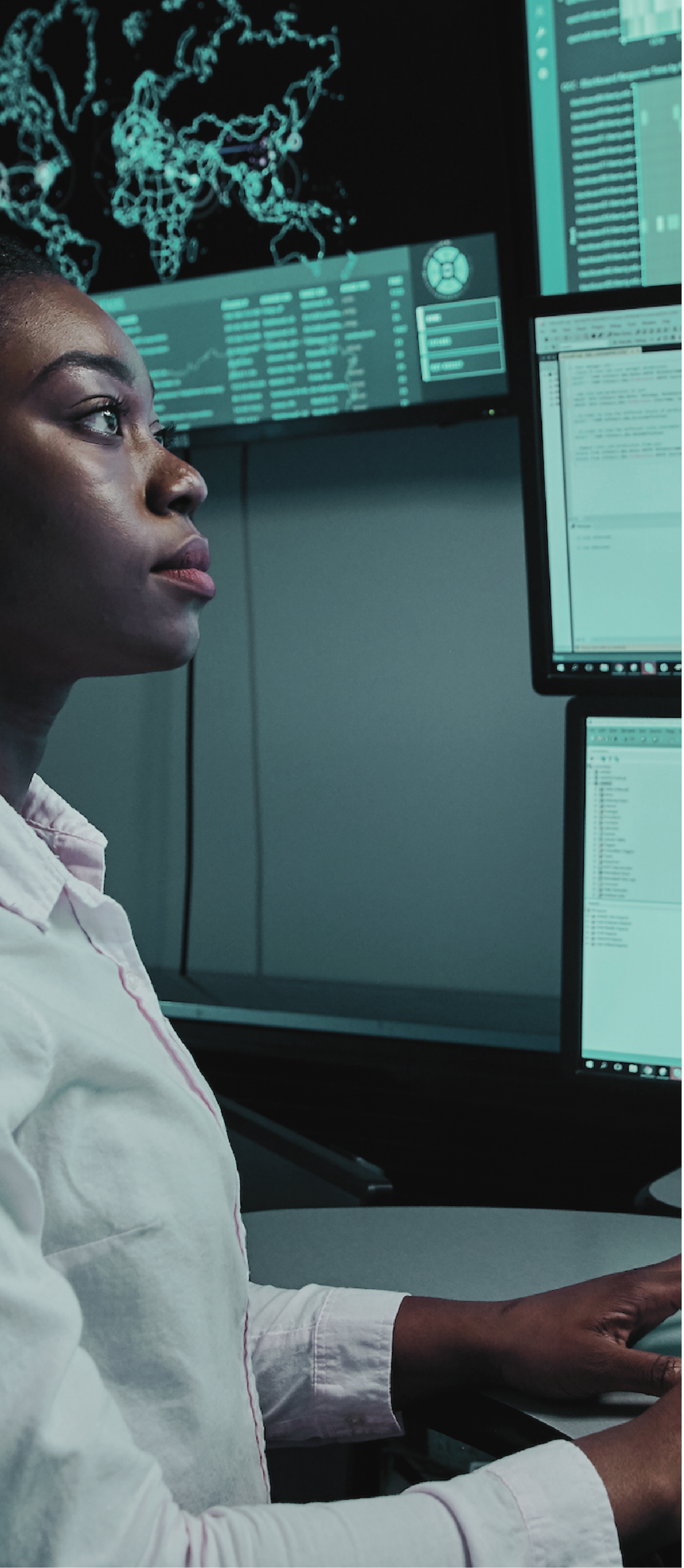



**FIGURE 2** First-order codes and abstract themes. First-order codes; Abstract categories

**Figure 2 shows the first-order codes and abstract categories generated from the analysis. After identifying the categories, the proposed conceptual framework (Figure 1) was used to further refine the data in terms of grouping and naming similar patterns. In this process, researchers were careful not to be blinded by the conceptual framework to the point of overlooking new themes emerging from the data.**



# Challenges

**The first objective of the study was to understand the challenges African women faced when deciding to pursue technology-related studies. For further clarification, the researcher described challenges as barriers, hinderances, or other experiences. Participants are all cited verbatim.**

# Imposter Syndrome

Imposter syndrome was described by participants as a doubt in one's abilities and “feeling like a fraud.” In a typical case of imposter syndrome, an individual doubts their abilities and in a particular setting, feels a sense that they do not belong. Imposter syndrome constitutes a perception of not belonging in a given environment or a role, which is an important construct highlighting society’s expectations of how women ought to view themselves in their careers.

“ ...because I am a person that tends to overthink, so I always told myself am I really going in the right degree? So, I had a lot of challenges thinking maybe I should switch to something easier.” (Rethabile)

# Perceptions Of The Field & Gender Stereotypes

**STEM sectors or majors are mostly male-dominated, creating a narrative that they are unwelcoming of women. This dynamic was discussed by a participant who viewed the STEM majors as a manner of "boys club" and did not see herself in these fields.**

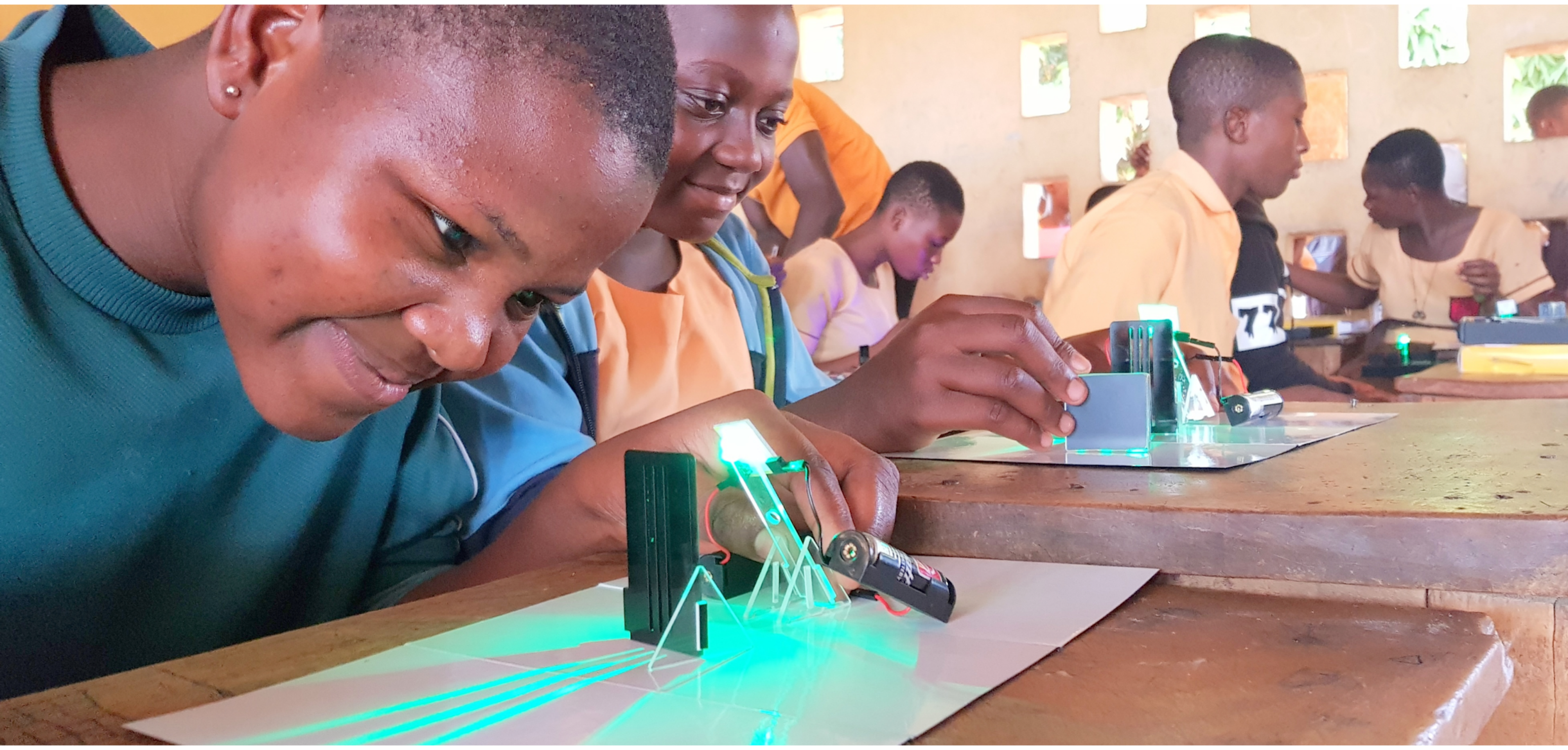
**Most African countries still hold socio cultural beliefs in which the female identity and the gendered expectations of girls tend not to be associated with the study of STEM subjects, or entry into science or technology fields. As discussed by a participant regarding gendered cultural standards:**

**"That's influenced by one's cultural standards, in that boys are the ones who are encouraged to be the problem solvers, to play with the toys and gears and stuff." (Khalid)**

**However, gendered stereotypical views were understood to be more affirming for some participants:**

**"He wouldn't let his daughter study science and I took it more as a motivation than a challenge." (Esther)**

# Technology background




**Technology or technical background was attributed to participants either attending technical high schools or having some form of familiarity (or the lack thereof) with technology or science subjects before university. For some participants, the lack of a given technology background was an inhibiting factor.**

**"The fact that I don't have a technical background, like in terms of coding; I came into this degree with no knowledge of coding or anything like that." (Khalid)**
**Other participants had some level of familiarity with technical subjects or areas before tertiary education:**

**" I went to a technical school, so I already had, sort of like some background from high school in terms of the technical courses or sort of like the engineering-related courses already." (Lombe)**

**Having a technology background from exposure through schools or apprenticeship gives respondents a sense of familiarity, confidence and interest in pursuing STEM subjects. By way of contrast, those who had no technology exposure or background before joining university lacked the confidence, and in some cases the interest to pursue STEM subjects.**

# Motivations

**The second objective of the study was to understand the motivational dynamics African women experienced when deciding to pursue technology related studies.**

# Context (Time &Country)

**For the study, context classified a participants upbringing, such as the country of birth or the type of society. Additionally it refers here to how a relevant African society perceives STEM fields at that moment in time.**

**“...the momentum for doing computer science had just come in South Africa. Everyone was almost trying to do computer science.”  (Salima)**

**“... The Zambian Market at the time in 2010, 2011... I thought I would have a better chance of finding a job quicker if it isn't so saturated.” (Tariro)**

**The quotes above point to a time period and location (Zambia, South Africa) when the various factors in the surrounding environment (context) encouraged even women to pursue either studies or a career in STEM.**

# Personal Interest In STEM Subject

Being intrigued or having enjoyed STEM subjects during early education was a common discussion amongst participants. Some participants who majored in STEM fields at the tertiary level made the choice in high school, based on a growing interest in mathematics and science.

“So growing up, I liked the science courses, I liked math and I knew I was interested in science... but then the course that appealed to me then when I was just completing my A-levels was computer science.” (Anati)

For some participants interest in science or technology areas occurred once they were already at the tertiary education level:

“I accompanied a friend of mine in their course. They were majoring in information systems, but they were taking a course from the computer science department, so I joined. I accompanied them in one analysis course and I fell in love and that's how I changed my major.” (Salima)

An observation of this theme was that the interest in science or technology would usually be expected to begin at an early age, or in early education but for some participants particularly amongst the student cohort, that interest developed after they were already attending university.

# Personal capability

**Personal capability involve participants' ability or self-efficacy regarding science or technology areas, as well as in a more general sense. This can include how they performed in these subjects in high school and how they were able to handle more difficult subjects:**

**"But languages isn't that natural to me as science and math... I like a challenge." (Esther)**

**Some participants demonstrated a personality-based sense of self-efficacy compared to other participants who were good at science or math in their early education:**

**"I discovered information systems and it felt like it aligned more with me and my personality, like the levels of creativity that it needed. I wanted to be creative." (Nadine)**

**Self-efficacy can influence the development of career interests which in turn affects career choices.**

# Family setting

A nurturing environment necessarily influences an individual's choice of career. Participants described the aspect of family support or influence, where family members were already involved in STEM careers, or supported the participant's choice of career. The definition of "family" for this study included friends as well. Family in the African context often refers to what in Western terms would be understood as the "extended family". In addition, the notion of family often expands, depending on place and context, non-blood relations, and other kinds of relationships which may assume familial significance or meaning. Having family in STEM fields acted as a form of mentoring or premature understanding of these fields. Additionally it sparked a sense of curiosity and excitement about STEM subjects:

"... I think it might have been influenced by my parents' degrees on their line of interest or line of work...they are both engineers." (Casangi)

Some participants had a different experience when it came to family influence or social support:

"...no one in my family knew what computer science was so my mom was very reluctant to agree to let me study computer science." (Tariro)

# Job Status In The Field

**The financial security and stability of working in STEM careers was another theme discussed by participants:**

**“ And also like it would offer me proper financial stability and that like there's high employability as well... so just seeing that it offers that security.” (Seline)**

**“...Whereas in the sort of tech space there is a lot of opportunity to go into different roles and you know it's a bit more headroom to grow and make more money, which is nice, so that was also a factor in working that out.” (Luthendo)**

# Role Model

**Seeing other women or even men in STEM fields plays an important role in making a career decision. It creates a feeling of being seen or seeing one's future self in a role or place. Additionally, it also triggers the attractiveness of these fields:**

**“We had a fantastic headmaster, and I think he even nurtured my love of science more with the way he taught science and chemistry and I think my love for chemistry came from that.” (Esther)**

**However, for some participants, the lack of role models, or the gender disparity in STEM fields, in itself created a sense of purpose or discouragement:**

**...there isn't a lot of representation in the field and I would like to be that voice for other women or maybe set an example. (Casangi)**

The findings in this study point to some overlaps, as well as several differences between the experiences and perspectives of African women, to those identified in existing literature and are summarized in the conceptual framework presented in Figure 1. The overlaps are seen when it comes to the impact of family influence, personal interest, personal capability, role model, and job status. However, the study has also highlighted additional dimensions that were not initially identified in literature. These include "impostor syndrome," which was seen to have a negative influence, "context" which had a positive influence, and lastly "technology background," seen to have either positive or negative influence (see Figure 3). The issue of context was seen as particularly interesting, as it was linked to dimensions such as family influence, as well as perceptions of STEM. Context (time and location) can be seen to influence traditions, perspectives, expectations, and stereotypes regarding the role of women in society. Africa is not monolithic, both in terms of the dimension of space (location), as well as time. That is, what can be observed in one part of Africa is not necessarily what is also happening in another part. Similarly, what is experienced today is not necessarily what would have been experienced five or ten years ago. There is a diversity of perspectives at the family and societal level, depending on where the participants were raised, but also on the era or generation in which they were raised. In some contexts or societies within Africa, mainstream gendered and cultural perceptions and expectations of girls and women do not associate them with careers in STEM fields, and to some extent, education in general (Ekine, 2013). Women are primarily seen as nurturers and caretakers, where their primary roles include looking after the household, and performing typical household chores that are stereotypical for mothers and/or wives, such as cooking, cleaning, and looking after the children (Boahene, 2013). It is through this prism that an education in STEM in certain African societies is seen as "less valuable" to girls (Ekine, 2013; Simpkins et al., 2006). Such expectations are often ingrained early on in life and are deeply embedded in other societal norms and practices, and as such, are quite difficult to overcome. These beliefs and biases also hold that science is a challenging domain, where, as a consequence, it is more suitable for males, since girls are regarded not to be as capable or as intelligent as boys (Boahene, 2013). This then later translates to a lack of interest in STEM fields, or creates a negative perception that women do not belong in these fields, and thus affects the decision-making process regarding whether or not women choose or aspire towards a STEM career. However, some respondents from the study showed that the

## 6 | CONCLUSION

The study set out to explore the challenges and motivations experienced by African women pursuing technology-related professions. This was done so as to further understand the low participation of African women in STEM fields. The findings highlight some similarities between the experiences of African women and what is reported in literature as experiences of other women pursuing technology-related studies and professions. However, the study also points to a few additional dimensions. A reflection on the results highlights some differences in experiences as a result of the positionality of African women. Moreover, the study acknowledged that the issue of women's experiences is complex, as it is often intertwined with several other systemic cultural, institutional, and in some cases legal systems embedded within different societies. While this study has managed to highlight several dimensions implicated in African women's decisions to pursue technology-related professions, there is still both the potential and the need for further studies that take a deeper look into these dimensions and their interrelationship. This could be in the form of longitudinal studies, ethnographic studies within specific contexts, as well as studies that will include those who have been discouraged or prevented from pursuing STEM professions. This is necessary if we are to better understand and address the low degree of participation of women in STEM fields.

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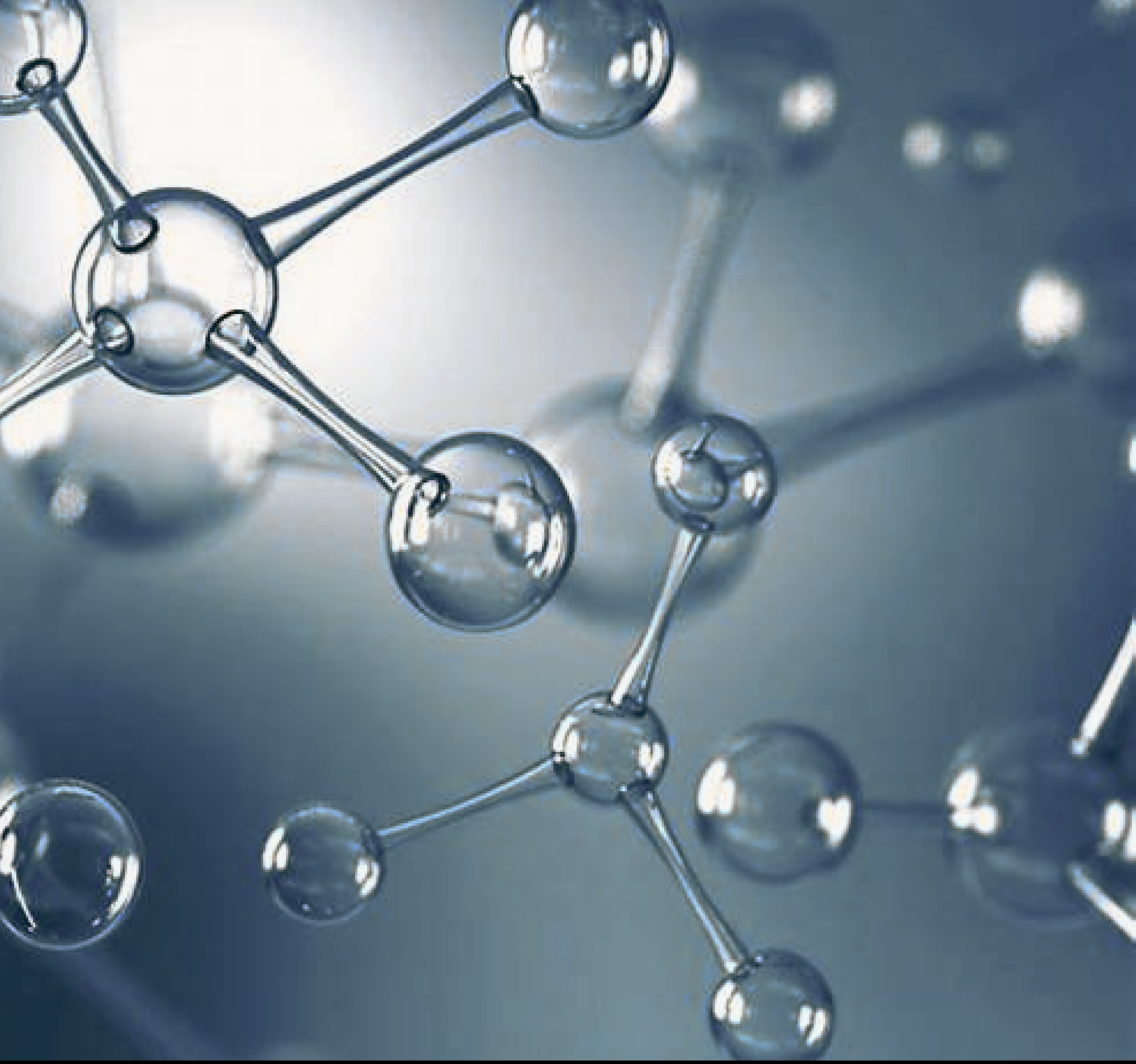

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