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Women in science: Leveraging ICT tools for sustainable economic empowerment

Felix Chukwuma Aguboshim ^{1,*}, Joy Ebere Ezeife ¹ and Ifeyinwa Nkemdilim Obiokafor ²

¹ Department of Computer Science, Federal Polytechnic, Oko Nigeria.

² Department of Computer Science Technology, Anambra State Polytechnic, Mgbakwu, Nigeria.

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Abstract

Introduction: Significant empirical evidence from literature revealed that women constitute half of the world's human capital. Evidence also shows that women have the potentials to redress gender gaps in all facets of all scientific endeavors if empowered through Information and Communication Technology (ICT), favorable ICT laws, policies, cultures, ethics, and values. Despite these important women virtues, there are numerous pieces of evidence in the literature that support significant gender gaps in internet use (23%), literacy rate (48.6%), pay gap (22%), scientific innovations, etc., resulting majorly from restrictions placed by cultural laws, ethics and values that impose gender sensitive ICT policies, especially in Africa. This study highlights strategies to leverage the economic empowerment of women in Science through ICT adoption, favorable ICT policies, culture, ethics, and values.

Methodology: The authors adopted the Unified Theory of Acceptance and Use of Technology (UTAUT) as the conceptual framework for this study. The authors also explored a narrative review methodology where related research findings from peer-reviewed articles are used to draw holistic findings that revealed significant information on strategies for leveraging economic empowerment of women in science through ICT adoption, favorable ICT policies, culture, ethics, and values.

Results: Results show that leveraging their literacy abilities for ICT adoption may increase their sociability capital resources thereby advancing sustainable goals for significant national economic development.

Discussion: Gender gaps may result among women in science diverting time for circular works, due to unfavorable customary laws, ethics, and values, to meet family responsibilities or having less control over finances, which negatively impact their affordability of ICT facilities.

Conclusion: There cannot be effective science education, especially among women without effective leveraging of ICT innovations, literacy, adoption, and usage required to leverage economic empowerment of women in Science.

Keywords: ICT Tools; Economic Empowerment; Gender Gap; Ethics; ICT Adoption; UTAUT

1. Introduction

Significant empirical evidence from literature revealed that a significant gender gap exists not only in terms of digital access but also in the ability of women in science to leverage new technological applications for sustainable economic development. As basic services delivered by digital technologies are becoming ubiquitous, sustainable ICTs coupled with the use of mobile and internet-dependent interfaces have become important scientific innovation enablers and essential pathways to gender equality and sustainable economic empowerment [29]. Women constitute half of the

* Corresponding author: Felix Chukwuma Aguboshim
Department of Computer Science, Federal Polytechnic, Oko state, Nigeria.

world's population and human capital [24], [36], and [44], and have the potential to redress gender gaps in all facets of all scientific endeavors if empowered through favorable ICT laws, policies, cultures, ethics, and values, and employment privileges. Despite these important women virtues and the substantial increase in ICT adoption globally, only a few women in science are able to harness ICT opportunities in engaging in communicating and establishing social networks as well as having access to improve public and private services for their economic empowerment.

There are still significant challenges to overcome in ensuring women are included in the transformation to a technologically enabled scientific society [7] and [23]. ICT is widely unavoidably integrated into ambient or ubiquitous environments that can only be handled with better connections between humans, their memories, and physical space through an intuitive interface or “smart” interaction [19] and [45]. In spite of these ambient or ubiquitous technological connections globally, there are numerous pieces of evidence in the literature that support significant gender gaps in internet use (23%), literacy rate (48.6%), pay gap (22%), scientific innovations [8], etc., resulting majorly from restrictions placed by cultural laws, ethics, and values that impose gender sensitive ICT policies, especially in Africa. Every discovery, when put to use, adds something new to the culture and becomes a factor of social change [37]. However, if one does not guide the culture, the culture will guide one [20]. There is a technology culture comprising of organization ICT standards, protocols, values, and ethics, and there is an inherent individual background culture such as restrictions placed by cultural laws, ethics, and values that impose gender-sensitive ICT policies. Many of the challenges of women are culture-based because culture plays a significant role in how people perceive women's role in society which affects the pace at which women societies achieve these goals. If women in science are not guided by technology culture, they will be guided by inherent individual background culture that imposes unfriendly gender-sensitive ICT policies.

Ample evidence exists that suggests that ICT access and usage are structured along gender lines where social, economic, inherent individual background cultural barriers, as well as attitudes, impact negatively on female adoption and usage [17]. Inherent individual cultural backgrounds and practices have often favored males and systematically perpetuated their dominance over females which further transgressed to impact the adoption and usage of ICTs. This is further heightened by the disposable income and affordability of women in science to own ICT gadgets for better ICT communication [17]. Globally, males dominated ICT adoption and usage [1], because ICT-related jobs are often disproportionately given to men rather than women by employer organizations [4]. The digital gender divide becomes even more pronounced when it involves women in science as creators of technology. In the USA, while 88% of all ICT patents are invented by male scientist teams of inventors, only 2% of patents are invented by female teams of inventors [4]. When it comes to the commercialization of knowledge, only a few women, compared to men, decide to set up a new business venture in the ICT sector probably due to the country's level of economic development and cultural background [38].

Many barriers to women's digital inclusion are traditional gender restrictions, which manifest themselves through laws or socio-cultural norms, poverty, lower educational opportunities for girls and restricted access to labor markets, as well as persistent gender stereotypes [38]. According to the Women's Technology Empowerment Centre (W.TEC), women make up less than 22% of the total number of engineering and technology university graduates in Nigeria [47], with less than 25% professional engineers and technology practitioners [21] and [40]. This gender gap does not enrich or complement the nation's workforce with the diverse qualities and perspectives of women, without which better and more useful tools for economic empowerment will be lacking because the developers of such tools do not fully represent the diversity of the societies, especially in Nigeria. This means that to get fully functional and universally acceptable inventions, the opinion of women, especially women in science has to be taken into consideration.

This study highlights strategies to leverage the economic empowerment of women in Science through ICT adoption, favorable ICT policies, culture, ethics, and values aimed at empowering women in science by eliminating these traditional restrictions to promote their digital inclusion for economic empowerment.

2. Literature Review

Gender equality and the empowerment of women are among the top development goals of the United Nations [48]. Culture and social norms couple with ICT management play a significant role in sustainable information society [49], and how people perceive women's role in society that affects the pace at which women contribute their quota in achieving these goals. Many of the challenges of women in science are culture-based [22] that culminate in poor ICT adoption and increase income inequality [32]. The Poor ICT usability gaps among Nigerian women in science are claimed to be related to the existing gender gaps in internet use (23%), pay gap (22%), tech-related positions (26.7%), tech workforce (19%), tech leadership positions (22%), developer workforce (5%) [8], internet penetration rate (41%), mobile ownership (31%), support mobile internet use (20%) [16], resulting majorly from technology culture and the

inherent individual background culture restrictions placed by cultural laws, ethics, and values that impose gender-sensitive ICT policies. Culture, whether technology culture or inherent individual background culture determines how scientific methodology is built and executed.

2.1. Conceptual Framework

The analytic tool adopted to illustrate the theories that this study intends to present is the Unified Theory of Acceptance and Use of Technology (UTAUT), proposed by [46] which was adopted as the conceptual framework. UTAUT model claims that the benefits of using technology and the factors that drive users' decision to use it are what determine users' acceptance behavior. The theory considers factors: user adoption behavior toward intention to use ICT, and users' usage behavior of ICT. These factors are collectively affected by four constructs: performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC), and four moderators: gender, age, experience, and voluntariness of use. UTAUT model in recent times has been widely adopted [31]. The theoretical foundation to study ICT sustainability as the driver or enabler of sustainable economic empowerment through closing the existing gender gaps: internet use, pay gap, tech-related positions, tech workforce, tech leadership positions, developer workforce, internet penetration rate, mobile ownership, etc among women in science, is built on UTAUT.

2.2. How Technology Culture Affects Women in Science

Many of the challenges of women are culture-based [27], because culture plays a significant role in how people perceive women's role in society which affects the pace at which women societies achieve these goals, particularly in Nigeria and other developing countries. Moreover, culture affects everything including the adoption and the progress of science and technology: time, energy, financial resources dedicated to research and development. Technological innovations are built or founded on the culture of the people [9] and [35]. Globally, the human race is influenced by the cultures in which they grew up and the societies in which we live. Our inherent individual background cultures shape or motivate our expectations, values, beliefs, goals, and adaptations [28].

The scientists are also shaped by their technology cultures and societies, which in turn, influence their work. Technology has a culture of its own which is often at odds with the inherent individual background or broader culture [35]. Technology influences society through its products and processes, while social needs, attitudes, and values influence the direction of technological development. There is a technology culture comprising of organization ICT standards, protocols, values, and ethics, and there is an inherent individual background culture such as restrictions placed by harmful cultural practices, laws, ethics, and values that impose gender-sensitive ICT policies. Technology Culture and Inherent Individual Background Culture seem to be mutually exclusive or viewed from one of two opposite directions in the sense that if women in science and the society are not guided by technology culture for women empowerment and reduction of gender inequality, they will be guided by inherent individual background culture which impacts negatively on women ICT adoption and usage [17], and their affordability of ICT facilities. Digital usability is linked with digital literacy, adoption or access to digital innovations, and online safety [43]. Inherent individual background culture breeds unfavorable customary laws, ethics, and values which negatively impact women in science. Gender inequality is underpinned by system usability factors that have some bearing with a complex mixture of cultural and structural factors that must be addressed if gender inequality is to be reduced or closed.

2.3. How Inherent Individual Background Culture Affects Women in Science

The Inherent Individual Background Culture in a society can have far-reaching effects on ICT adoption and the nature of production technologies in that society [12]. Most ICT adoption, especially in developing countries, are incomplete, [12]. Nigeria is a typical country where ICT adoption is grossly incomplete resulting in different groups of firms, organizations, and government organs having different production technologies. ICT innovations in Nigeria are not adequately implemented or used. This is because most technological innovations in Nigeria lack solid and proper implementations because they often end with IT leaving off the "information and communication" aspect of ICT [2]. As a result, ICT innovations that should leverage women's economic sustainability are visited with non-international standard protocols embedded with corrupt policies and practices, ignorance, illiteracy, that rendered decision rights, ethics, and values for sustainable economic empowerment and information-related processes attitudinal and impotent for driving the sustainable economy. Policy measures, laws, and infrastructures required to handle ICT sustainability in Nigeria have become attitudinal, and so implementation and adherence to policy control over policy enforcement, and enterprise definitions are no longer reliable or efficient in sustaining ICT innovations [2], [29], and [30].

Nigeria is most likely the only country with cameras mounted on their traffic lights without corresponding ICT machinery to checkmate culprits. This is because the ICT required to drive the traffic light machinery is not complete resulting from poor ICT adoption that manifested in non-integration of databases, corrupt or inconsistent data capture

protocols, weak data migration and integration, and decayed or no updated data. No nation runs an automated traffic system without proper data governance and documentation of vehicles and their owners. In the alternative, policemen and other touts are being used to check traffic light offenders, when the traffic lights are embedded or supposed to be embedded with monitoring cameras. Opportunities for women in science to thrive like their counterparts in developed countries are lost because technological innovations in Nigeria have been made to be dispositional or feeling-motivated, thereby rendering its sustainability unsuccessful, useless, and worthless [2]. It takes a sustainable ICT innovation to drive women in science for economic empowerment. Globally, significant relationships exist between human adherence to ICT protocols and policies required for the adoption of ICTs and SICT [6], [29], [30], and [41].

Violations of established ICT policies and safeguards are the major challenges to a poor sustainable economy in Nigeria. When ICT innovations are driven by Inherent Individual Background Culture in a society, they become attitudinal and driven by corrupt practices, human emotions, behaviors, and thoughts, useless, un-impactful, and their outputs nonsensical. This resulted in loss of revenue, inaccurate analyses, damaged reputation, economy, and loss of access to professional and income opportunities, especially for women in science. Additionally, women in science are going to be missing out on the large potential that women represent because they are not participating in the know-how of the design of science and technology sectors, and are unaware of its effects on them in the country. Any nation that refuses to guide the culture or refuses to adhere to rules and regulations of the global ICT culture for women's technological empowerment will be guided by her local culture of discretionary behavior (i.e. their culture guides them). There, the global objectives leave off. This is the case in Nigeria where cultural ideas, ethics, and values were structured to favor men and maintain their dominance over women that excluded women from decision making roles in the society, thereby reducing women to be seen as homemakers, baby-makers, and home keepers without a place for paid work, their technological advancement notwithstanding. As a result, substantial gender gaps exist in governance practices, internet access, and use, pay gap, political ambition, technology-related positions, workforce, leadership, and developer outcomes, ICT adoption and usage, and the ability to own ICT devices which are heavily dependent on income and affordability [3].

Women have less access to resources: property, financing, technology, and education, which are needed to support active engagement in science, technology, and innovation. As a result, their presence in employment, entrepreneurship, and research are lower than men's [8]. Women in science have poor technology leadership positions (22%) [8], underrepresented in decision-making positions in science, and in the corporate sectors [33]. Nigerian women in science have an exceptionally low rate of technology leadership (2%) [8]. Despite the overwhelming global awareness of the need for scientific innovation adoption, Nigeria and other developing countries spend much less of their gross national product to promote scientific innovations especially when requests for sponsorship are coming from women. As a result of economic and other problems, women in science are not in an exceedingly position to extend their commitment to science and technology or extend their spending on research and development (R&D). This challenge is heightened by poor planning and adherence to international ICT protocol standards. Science and ICT innovations are complex and need support from a complicated infrastructure, an honest educational system, and also the society. Women in Science should be given more financial resources to encourage them in R&D. However, in this era of limited resources, women in science should decide fundamentally on a limited number of areas essential to economic and social development that must be developed, so as not to overstretch the limited resources. There is a need to unite women scientists from developing countries.

3. Methodology

Data do not speak for themselves, and so must be narrated [13]. In this study, the researchers adopted a narrative review approach. The narrative review approach involved the review, analysis, and integration of different and related and interactional approaches and research findings [10], with the aim of exercising a holistic-content reading and drawing holistic interpretations or conclusions [5] and [26], based on the reviewers' own experience, existing theories, and models that may answer the research question. A narrative review is adopted where the purpose is to draw holistic interpretations or conclusions, and significant interpretations based on the existing theories, conceptual framework and models [18] and [26]. A narrative study approach is most appropriate for a descriptive or explanatory study that allows for a narrative-constructivist and integration approach [10], uses mainly narrative methods of data collection and analysis, and produces a final narrative report [13].

There are significant strengths in a narrative review methodology in the sense that it has the ability to provide platforms for the comprehension of diverse and numerous understanding of multiple data sources and research findings. It also provides the opportunity to make reflective practice and acknowledgment of researchers' views and knowledge [19]. Researchers with diverse backgrounds and views have incorporated the use of narrative reviews or adopted narrative methodology as best suitable for comprehensive studies [18], [25], and [26]. Methodological triangulation, a platform

for engaging multiple sources of data to gain multiple perspectives, and maximize the reliability and validity of data, in order to build a coherent justification of data interpretation was also adopted [11] and [15]. The explanation for adopting methodological triangulation was to confirm the reliability and validity of information collected, and justification of interpretations from the reviews.

4. Data Collection

Researchers are considered the primary data collection instrument in a narrative review qualitative study [14], [39], and [42]. This is because these data are mediated through the human instrument (researcher), instead of through questionnaires, or machines or inventories [34] and [39]. Data collection came from reviewed research findings that are related to our study. The ProQuest databases, ScienceDirect, Google scholar, Walden University international library databases, and other related peer-reviewed texts were our major sources of data collection. The researchers used a combination of phrases and terms as key search words to search for related literature on the study objectives. Such phrases and terms included “leveraging ICT tools for sustainable economic empowerment”, “influence of culture on ICT adoption among women in science”, “how technology adoption impact gender equality”, etc. Our reviews incorporated 49 references. Forty-four (90%) of the entire references within the study are peer-reviewed.

5. Analysis, Synthesis, and Discussions

In Nigeria, women in science are disproportionately represented in the existing ICT-driven positions in areas of internet use, pay gap, tech-related positions, tech workforce, tech leadership positions, developer workforce, internet penetration rate, and mobile ownership. These ICT-driven positions do not adequately reflect women in science who are expected to contribute majorly to profitable economic and social development possibly because they are restricted by cultural laws, ethics, and values that impose gender-sensitive policies, standards, culture, protocols, values, and ethics. This desire to Leverage ICT tools, technology, and inherent individual background culture, organization ICT standards, protocols, values, and ethics, to favor women in science for effective and sustainable economic empowerment is increasingly important and represents new challenges that must be addressed by all stakeholders, especially at this time when technological innovations are becoming increasingly ubiquitous, with interconnected and interdependent facilities.

Strategies that have been shown to be effective from this study’s findings include: promoting the culture of equivalency and participating responsibility between men and women in paid and overdue care work, promoting women’s leadership in public and corporate economic decision-making and in employer’s and worker’s organizations, investing in gender equality and women’s economic empowerment, creating more jobs and decent work for women to promote gender equality for sustainable growth and development, promoting a culture of equality and shared responsibility between men and women in paid and unpaid care work. Strategies that establish development programs that induce further jobs and ensure decent work for women in science, particularly within the informal sector, and promote women’s leadership in the public and commercial profitable decisions. These findings were consistent with the study’s conceptual framework and supported current literature on leveraging ICT tools for sustainable economic empowerment. Findings from this study are important to women in science and the nation for sustainable growth and development.

6. Conclusion

Women in science contribute substantially to economic and social development, especially in science education. There cannot be effective science education, especially among women without effective leveraging of ICT innovations, literacy, culture, adoption, and usage required to leverage economic empowerment of women in science.

Compliance with ethical standards

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Disclosure of conflict of interest

There are no conflicts of interest.




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Biography of Authors

	<p>Dr. Felix Chukwuma Aguboshim holds a doctoral degree in Information Technology from Walden University, Minneapolis MN 55401, USA. He is currently a chief lecturer in the department of computer science, Federal Polytechnic Oko, Nigeria, where he worked as the Head of Department of Computer Science, and Director of Campus. He is also an adjoining lecturer at the University of America Study Centre in Nigeria.</p>
	<p>Dr. Joy Ebere Ezeife holds a doctoral degree in Information Technology from Federal University of Technology Owerri, Nigeria. She is currently a Senior lecturer in the department of Computer Science, Federal Polytechnic Oko, Nigeria.</p>
	<p>C. ipt. Obiakafor Ifeyinwa Nkemdilim is a Certified Information Technology Practitioner, and a Certified Microsoft Innovator. A graduate of Computer Science from Federal Polytechnic Oko, She also has a Post-Graduate Diploma in Computer Science from Nnamdi Azikiwe University Awka. Presently, she is a Higher Instructor at the Anambra State Polytechnic Mgbakwu, in Anambra State, Nigeria in the department of Computer Science Technology.</p>