Blockchain and gender digital inequalities in Africa: A critical afrofemtric analysis

by

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Abstract

Advances in the technological sphere are synergistic with society's progression. Technological innovations result in social realities, and these correspondingly remodel technologies to reconcile their functions and values with society's needs. The birth of blockchain ushered in euphoric pronouncements about its disruptive potentialities for low-resourced societies. While dominant discourses frame it as a tool for enabling grassroots participation in socioeconomic activities, they ignore the societal embeddedness of innovations. A central premise of this study is that the modalities of blockchain's adoption reflect, and to an extent cement, the inequitable gender power dynamics of its context. Drawing on principles of gender justice from my original critical theory afrofemtrism, technofeminism, and the social construction of technology, I examined the adoption of blockchain technologies in Ghana and its engagement with gender digital inequalities.

My empirical data is from 33 qualitative interviews with participants in the blockchain economy. I found that investing and trading in cryptocurrency are the principal blockchain activities in Ghana. This evinces the perception of low entry barriers without needing specialized education. Additionally, participants are overwhelmingly male, and the women in the space navigate a complex existence of relegation and comity. Their presence in this male-dominated space opens them to ridicule, and yet they benefit from better transactional opportunities as people perceive them to be more trustworthy than the average man. Blockchain could engender financial emancipation for women and other marginalized social groups. However, conditions like the compound effect of inhibiting familial, societal, and cultural socialization on gendered interests and progression undercut these affordances. Blockchain in itself is, therefore, not a panacea. Interventions for social change must include gender justice-conscious policymaking, as well as nationwide conscientization of the underpinnings of gender digital disparities. This study's findings are integral to advancing studies in gender disparities in a sociotechnical arena. It also contributes to knowledge emanating from the Global South, particularly regarding emerging technology.

Keywords: Blockchain; Gender digital disparities; Afrofemtrism; Global South; ICTs for social change; Technology adoption

Dedication

This is for my mother, Betty Blay Ackah, whose inspiring legacy bolsters and guides me through every step of life's journey. I miss you every day. I also dedicate this to my father George Alfred Ackah, thank you for staying true and dedicated.

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List of Acronyms

ARPANET	Advanced Research Projects Agency Network
ATM	Automated Teller Machine
BoG	Bank of Ghana
BRICS	Brazil, Russia, India, China, South Africa
BTC	Bitcoin
CBDC	Central Bank Digital Currencies
CEO	Chief Executive Officer
CID	Criminal Investigation Department
CPU	Central Processing Unit
DeFi	Decentralized Finance
DFS	Digital Financial Services
ECCB	Eastern Caribbean Central Bank
EOCO	Economic and Organised Crime Office
ETH	Ether. Cryptocurrency from Ethereum
Fintech	Financial Technology
GBC	Ghana Broadcasting Corporation
GCCH	Global Coin Community Help
GDP	Gross Domestic Product
GHC	Ghana Cedis
GSMA	The Global System for Mobile Communications Association
GSS	Ghana Statistical Service
GWH	Department of Gender, Women, and Health
IBM	International Business Machines Corporation
ICO	Initial Coin Offering
ICT	Information Communication Technology
ICT4AD	Ghana ICT for Accelerated Development
ICT4D	Information Communication Technology for Development
ICT4SC	Information Communication Technology for Social Change
ILO	International Labour Organization
IMF	International Monetary Fund
IT	Information Technology
ITU	International Telecommunications Union

LAC	Library and Archives Canada
MFI	Microfinance Institutions
MIS	Management Information Systems
MNO	Mobile Network Operators
MoF	Ministry of Finance
Momo	Mobile Money
MOU	Memorandum of Understanding
MTN	Mobile Telephone Network
MTO	Money Transfer Operators
NBFI	Non-Bank Financial Institutions
NCA	National Communications Authority
OECD	Organisation for Economic Co-operation and Development
OMG	OmiseGo
PHE	Department of Public Health and Environment
PMMC	The Precious Minerals Marketing Company
PoS	Proof of Stake
PoW	Proof of Work
REB	Research Ethics Board
SAP	Structural Adjustment Programs
SCOT	Social Construction of Technology
SEC	Securities and Exchange Commission
STEM	Science, Technology, and Mathematics
STIWA	Social Transformation Including Women in Africa
TPS	Transactions Per Second
UNHCR	United Nations High Commissioner for Refugees
UPSA	University of Professional Studies, Accra
USA	United States of America
USAID	U.S. Agency for International Development
WB	World Bank
WEC	World Economic Forum
WFP	World Food Program
WHO	World Health Organization
XRP	Cryptocurrency from Ripple Labs

Chapter 1. Constructive disruption

The study in context

> It's you, you decide what you want to do when it comes to technology … I don't see how technology is a gender thing … I don't see the gender gap. Yes, in as much as the group we have and the people who I engage with, I meet more males than females, I don't see that as a gender gap. All I see is interest. (Yoofi[1], Male entrepreneur)

Society and technological innovations are consistently embroiled in a reciprocally influential evolution with contextual conditions informing the multifaceted permutations (Kline & Pinch, 1996; Wajcman, 2004). These myriad conditions include the economic, sociocultural, and infrastructural environment. A principal effect that introducing a technology into society engenders is inequalities among members. These inequalities, in turn, seep into the technology's ecosystem in determining the voices and ideas which shape the modalities of innovation and adoption (Wajcman, 2004). Digital inequalities manifest in discrepancies in access, meaningful use, and types of digital devices among individuals, social groups, and nations. Specifically, gender digital inequality refers to these disparities as they occur between genders, regardless of the social group to which they belong. The determinants are as diverse as the contexts in which they occur. They include social and cultural conditioning, inequalities in education, lack of and underestimation of skills, and economic disparities (Fuchs & Horak, 2006; Herbert, 2017; van Dijk & Hacker, 2003). Further, the gendering of digital technologies through the values that we ascribe to them in their design, production, and usage contributes to gender digital inequalities (Kline & Pinch, 1996). A principal difficulty in addressing these inequalities is their surreptitious but pervasive existence.

Dismissal of the average Ghanaian woman's experience of digital inequalities was widespread in my conversations with this study's participants. Added to this, some participants maintained that blockchain's diffusion in Ghana is devoid of sociocultural influences, such as one's gender and socialization. The opening quotation above evinces these perspectives. Interestingly, Yoofi is not ignorant of the overwhelming underrepresentation of women in Ghana's blockchain space. What he is missing is an

[1] Pseudonym. All names assigned to research participants are pseudonyms.

awareness of the conditions of the sociotechnical ecosystem that determine gender bias. Another male entrepreneur pointed out to me that if gender inequality existed in digital spaces, I, as a woman, could not investigate blockchain. A male participant who owns an IT company that develops blockchain applications opined it was merely trendy to occupy oneself with gender biases. It was not an actual reality. He added that if studies produced statistics that showed fewer women with access to digital devices (National Communications Authority [NCA], 2020), it was only because the average woman does not want to participate in these studies. This unwillingness thus results in lower female representation among respondents. Also, he supports the women in his family financially. Considering that his career is in information technology, these women are vicariously using digital technologies although investigations would not count them. These assertions underscore the necessity of the study's purpose, which is to investigate blockchain's propensity to interact positively or negatively with Ghana's gender digital inequality. To successfully carry out this examination, it is necessary to unearth the sociocultural underpinnings of the disparities to understand how they relate to the adoption of blockchain. An important aspect of this phenomenon is the reality that actors who participate in a particular innovation's sociotechnical ambit influence the social change in which the innovation engages (Wajcman, 2004). The sociocultural context does not operate in a vacuum, however. They align with the technological characteristics of the innovation to drive contextual affordances and enable the modes of diffusion.

Blockchain is a distributed digital ledger that is accessible across a network of participating users or nodes (via digital devices like computers). These nodes collectively verify information on interactions that transpire in the ledger. The system's inherent stipulation that all transactions be performed with public key encryption preserves a blockchain platform's integrity. As well, the history of every transaction is indelible and verifiable. Transactions are linked in a chain and simultaneously recorded on each participant's device, making it almost impossible to delete or modify the records. These features, combined with the pseudo-anonymity of the data on many blockchain platforms, ensure that participants do not need intermediaries and do not need to trust each other to exchange digital assets. The technology largely guarantees security (Morabito, 2017; Mueller-Eberstein, 2017; Swan, 2015; Yli-Huumo et al., 2016). Blockchain is an innovation whose popularity keeps expanding, especially due to the

fame of cryptocurrencies like Bitcoin. It is the underlying technology on which cryptocurrencies are built. Other applications of blockchain include smart contracts[2], aid distribution databases, and platforms for voting and other political processes (Pilkington, 2016; Swan, 2015; Yli-Huumo et al., 2016). Pundits also champion blockchain for enabling social change processes that improve socioeconomic circumstances. These applications of blockchain converge with principles of Information Communication Technologies for Development (ICT4D), or, more appropriately, Information Communication Technologies for Social Change[3] (ICT4SC). Such social change initiatives work through digital platforms to ensure marginalized groups' equal and meaningful participation in all aspects of society. Applicable areas where blockchain can occasion social change include the health, educational, and economic sectors (Heeks, 2017; Melkote & Steeves, 2001). To illustrate with a specific use case, the World Food Program (WFP) has implemented blockchain-based applications which validate aid recipients' identities to ensure unauthorized persons do not intercept their food and cash assistance (2017). Blockchain-based identity systems of this nature denote a revolutionary development for underprivileged people who do not possess nationally issued identification documents. They can thereby sidestep restrictions on accessing services like banking and land registration (Pilkington, 2016; Underwood, 2016; Woyke, 2017). As a result, Syrian refugees in Jordan can now receive direct and secure funds from WFP through blockchain applications. Thus, they avoid contending with regulatory restrictions from financial institutions due to their precarious status. Blockchain's decentralized, immutable, and trustless quality can ultimately create empowering environments of equitable participation of all social groups (Kshetri, 2017; Mueller-Eberstein, 2017; Thomason, 2017; WFP, 2017).

Nonetheless, ICT4SC is limited in its approach towards addressing inhibiting social, institutional, and economic structures. These are the very foundations of the

[2] Pioneered by the Ethereum blockchain platform, a smart contract is an auto-executing agreement which has the agreed upon terms written into the code of the digital contract. Thus, transactions can be trusted even when participating parties are anonymous because no one can renege on or change any aspect of the terms. For instance, donations to health facilities would automatically be transferred when specific medical services are discharged.

[3] To eliminate the ethnocentric connotations of 'development' which projects an impression of a certain standard of advancement that all countries must attain, this study opts to use the concept of social change to express ideals of continual progress towards dynamic qualities of societal wellbeing based on realities of unique contexts.

social issues that the initiatives purportedly target. For instance, health intervention campaigns through mobile phones that encourage health-seeking behavior sometimes ignore the infrastructural impediment to these recommendations, such as severely under-resourced health facilities. Criticisms against the focus on the phenomenal possibilities of digital innovations include the idea that they are an exercise in conjecturing rather than evidence of reality (Graham et al., 2014; Schech, 2002). Flor (2015) for example, emphasizes the inherent difficulty in examining macro-level economic data to establish a direct link between the objectives of information communication technology (ICT) interventions and positive outcomes.

Similarly, the development of blockchain for social change aligns with the prevailing era of the networked society. In this context, the digitization of economic, professional, and other practices frames technological facilitation of socioeconomic progress. Digitization procedures highlight the immense value that information and knowledge have in the global system of informational capitalism (Castells, 2010). Accordingly, as ICT4SC initiatives operate with universalistic perspectives of the value and effectiveness of new digital technologies, they propagate dominant value systems. Without addressing impediments like the lack of political will to implement enabling gender-aware policies, ICT4SC projects could contribute to creating and concretizing digital divides (Dutta, 2011; Schech, 2002). In this respect, although adulations about blockchain's potentiality to enable grassroots' agency are increasingly commonplace (Kewell et al., 2017; Kshetri, 2017; Swan, 2015), the power dynamics of the society could generate a contrasting account. With the yawning digital inequality in Ghana among various socioeconomic groups, it is important to ascertain people's engagement with the affordances and constraints of the technology based on their differing realities.

Unpacking the research focus

Digital technologies occupy a central position in contemporary discourses on the relationship between society and technology and its outcomes. Castells (2010) famously expounds the extent to which breakthroughs in innovations like the internet have reconstructed the space and times of social organization. Swan (2015) emphasizes that the disruption that blockchain technology is stimulating has the potential to recompose all characteristics of society. This pervasiveness makes an investigation that emphasizes justice for marginalized populations even more imperative. Globally, and

especially in Ghana, the contextual setting of this research, blockchain is at the early stages of the diffusion curve. Thus, the timing is apt for employing applicable values in its innovation in a manner that levels the playing field for everyone. To this end, the dissertation enacts an in-depth contextual analysis into the social dynamics of the innovation to explore their interaction with digital disparities. Such steps are important because ICTs can engender opportunities in areas such as education, income generation, and democratic processes. They may consequently exacerbate existent inequalities between people based on their participation.

More concretely, the NCA in Ghana (2020) reports that at the end of the second quarter of 2020 the mobile voice subscription penetration rate was 132.47%, while subscribers of mobile data represented a penetration rate of 82.49%. These figures usually give a perception of high digital access rates. Considering factors such as the large swathes of rural regions with meager connectivity, the reality, however, is that access is not ubiquitous. The statistics also mask instances of gendered social stratification, where men control phone use in some homes (Awoonor-Williams, 2013; Grameen Foundation, 2012). Thus, the emphasis on the potential of ICTs does not engage with the existing power structures in the public and private sphere, which dictate access and usage of information technologies (Scott, 2014). A 2019 NCA and Ghana Statistical Service (GSS) report evinces that the gender gap in internet use is approximately 17.8%. Likewise, the World Wide Web Foundation's Women's Rights Online Report (2020) demonstrates that an overwhelming majority of Ghanaians are disadvantaged when we compute meaningful connectivity beyond mere access to the internet. The Alliance for Affordable Internet's measuring tool used in this report assesses four dimensions; regular internet access with a minimum threshold of daily use, an appropriate internet-enabled device, enough data, and a fast connection. Using this metric, only 12.5% of Ghanaians self-report as having a meaningful connection. This figure compares with internet users constituting 30% and who are primarily urban dwellers. Further, the gender gap in meaningful connectivity is 14.9%. With these factors in mind, it is important to investigate how an internet-based digital technology could therefore overturn the established knowledge monopolies of the information society to include hitherto marginalized persons.

Kwami contends that gender digital inequalities result from the extant power dynamics of society (2020). This perspective thus warrants emphasis in research on the

adoption of ICTs. For instance, Kelkar and Nathan (2002) argue ICTs facilitate a new composition of gender roles through the new skills, educational, and economic opportunities that they grant women. Hilbert additionally asserts when women gain access to ICTs, the vicious circle of inequalities they are stuck in can turn into a virtuous circle. The potentialities of ICTs will facilitate positive outcomes which will equip them in the fight against inequalities (2011). As a disruptive technology (Christensen, 2015; Christensen et al., 2018; Mueller-Eberstein, 2017; Pilkington, 2015) that promises an egalitarian field of possibility to include marginalized groups in the digital space, proponents deem blockchain a pertinent tool to occasion this virtuous circle (Woyke, 2017). However, these viewpoints must concurrently highlight how the growth of the information society in a capitalist world increases and cements digital inequalities in many cases (Marwick, 2013). One needs to approach digitization efforts with a view of digital devices as only a facet of a social system. Technology thus should not be the sole tool for the transformation being sought. It would work in tandem with other relevant dimensions of society (Walsham et al., 1988).

The primary data on which I base this study reveals that participants in the blockchain space are predominantly male. This reality makes possible a certain power structure that would likely reinforce imbalances in the meaningful participation of the Ghanaian blockchain community. Added to this, a key consideration is that early adopters, especially those who are first to profit significantly from the technology, have a marked influence on the way it spreads. This is because they help determine who joins in the space based on whom they communicate with about the technology, whom they invest in and support, and what aspects of the innovation they promote (Bowles, 2018; Rogers, 2003; Shevinksy, 2015). The central premise of this research is that innovations are socially embedded. Digital technologies develop in the context of the social structure of gender relations while consequently impacting these relations. My research, therefore, investigates these mutually constitutive factors between blockchain technologies and gender realities in Ghana.

Significance of study

This study is foundational in more ways than one. Blockchain's status as a relatively novel digital technology, especially in Ghana, means that its innovation, adoption, and diffusion have not experienced rigorous critical investigation. This is even

more integral in terms of the present investigation being an emic production of knowledge on digital systems emanating from the Global South. The study is thus a crucial representation and addition to scholarly conversations on local knowledge production systems. To the point, this is a concerted step towards addressing the hegemony of voices from the Global North that dominate channels for producing and spreading knowledge even on issues relating to contexts outside of the region.

Secondly, unearthing the social dynamics of a technology's adoption processes, precisely in the initial period of its diffusion, is also key to understanding the eventual place that the technology comes to have in society. The dissertation is thus well-positioned as a ground-breaking text in addressing contemporary and eventual marginalization in Ghana's digital sphere. In addition, even though the principal aim is to elucidate the impact that blockchain could have or is having on the gender digital divide, this is the first study to present a detailed view of the prevailing sociocultural context in which blockchain is being adopted and diffused.

The final value that this research contributes is the original conceptualization of afrofemtrism, a theory for analyzing the sociotechnical ecosystem of an afrocentric context in furthering gender justice. This advances theory development in society and technology studies. Hence, the study fills an important gap in scholarly literature as existing theories which deal with gender justice with a focus on Africanists and people of African descent are not directly applicable to research on technology and society.

Aims and objectives

As a disruptive innovation, blockchain's purported ability to partake in social change requires a critical analysis of the baseline conditions. This involves establishing Ghana's context as well as outlining which voices are taking part in the early trajectory. This dissertation aims to ascertain and critically examine blockchain's interaction with gender digital inequalities. To accomplish this, my first objective is to explore the economic, social, cultural, political, and other circumstances which contributed to the introduction and diffusion of blockchain innovations in Ghana. Secondly, I examine the actors and social groups participating in various aspects of the design, production, and use of blockchain innovations. The third objective is to determine the social, cultural, political, and economic structures that facilitate or inhibit their participation. Additionally, I

establish the gendered perceptions, narratives, and performances that members of Ghana's blockchain society embody and perpetuate. The final objective is to demonstrate how gender realities impact blockchain's adoption patterns, and how blockchain innovations similarly impact gender realities.

Synopsis of chapters

The dissertation starts with an exploration of scholarly perspectives on digital technological innovations and society. This is a theoretical chapter that lays the intellectual context out by charting the pertinent areas which serve as the lens to appreciate the substance of the research. Specifically, I interrogate the relationship between changes in society and simultaneous transformations in the technological ambit. The rise of digital technology has paved the way for a pervasive reality of interconnectedness among people. Rainie and Wellman (2012) extol a digitally networked configuration of social relationships in societies with widespread digital connectivity. Consequently, the idea of who makes up one's village or community has evolved. For many people, social networks have switched from only referring to people in our immediate physical environs to those who might be in the farthest point relative to one's geographical location but are still within immediate reach via the internet. Castells correspondingly adduces that not only do societies conform to their characteristics, but information created and operated through communication technologies propel the contemporary global economy (2010). Scholars like Harding (2008), Hassan (2008), and Zuboff, (1988) also emphasize the new social, cultural, and political realities precipitated by digital innovations, whether for good or bad.

In the second section of the chapter, I introduce the theoretical framework that facilitates the analysis and discussion of the study's data. The first theory is afrofemtrism, the study's original conceptualization whose central preoccupation is to deepen activism for gender justice in the technological arena. Afrofemtrism provides a systematic framework to engage with the meso, macro, and micro conditions that interact with the creation, evolution, and use of technologies. This concept is especially pertinent to critical feminist movements.

The next theory of analysis is Wajcman's technofeminism (2004). It focuses on the embedded nature of technologies in dynamic patterns of social relationships and

societal structures. A key aspect of this theory is the extent to which technologies may enable or inhibit aspects of those relationships. Through the analytical lens of technofeminism, I elucidate the sociotechnical network of blockchain in Ghana and explore its role in the gendered perspectives and roles of the participants. I also employ principles of the Social Construction of Technology (SCOT) to decipher the characteristics and pull-forces of the various participants in Ghana's blockchain society. SCOT provides an applicable guiding concept for analyzing the relevant social groups and the agency that they espouse based on their gendered positioning in their various sociocultural contexts.

In chapter three, I describe the methodological trajectory of the investigation's data collection activities, as well as the epistemological and other framings that guide the qualitative data analysis. I used semi-structured interviews as the research's principal data collection technique, with a snowball method for recruiting participants. Even though we widely credit blockchain innovations with disruptive capabilities that would establish new socioeconomic and other material realities, it is an 'unseen' platform. Particularly where users remain anonymous, as with Bitcoin, one cannot very well download metadata from the platform to explore their background information. Thus, interview data is crucial insofar as it provides relevant insight into invisible realities based on self-disclosed data.

In chapter four, I provide a detailed overview of blockchain technologies. Here, I describe its general attributes and explain what it does, how it works in multiple contexts, and what it means. Next, a key exercise I initiate here is an iterative process of theory development, data analysis, and interpretation. I present blockchain's orientation in time and space in the Global South through the lens of the first afrofemtric analytical component, transnational connections. In many countries in this region, blockchain's predominant application is for mitigating gaps in the financial sector. These contextual expressions, therefore, attest to specific definitions of identified needs and the remedial effect of digital systems. Thus, I establish a broad perspective to facilitate an understanding of blockchain's genealogy in similar ecosystems by drawing connections between innovations in other Global South countries and Ghana. A key aspect of this analysis is the significant role blockchain is playing in disrupting the national and international remittance system.

In chapter five, I analyze and discuss the economic, sociocultural, and political settings of blockchain in Ghana. The chapter expounds on the conditions that engendered the innovation's adoption and diffusion, as well as those factors that contributed to determining the usage patterns that exist presently. An integral aspect of this development is to establish who the relevant social groups are, and what background characteristics determine individuals' affiliation. I also discuss how these propel their participation in the blockchain space. Indeed, in examining blockchain's adoption, a vital consideration is to highlight the affordances and constraints, and not merely to describe the pathways. Hence, the chapter outlines areas like the sociotechnical context of the unbanked populations in Ghana, and how members of the blockchain community are aspiring to address this.

In chapter six, I delineate the interplay between gender digital disparities and the diffusion and adoption patterns of blockchain in Ghana. Afrofemtrism is the principal prism through which I engage with the empirical material. This is a recursive relationship between data analysis and theory construction. The chapter presents a critical analysis of the gendered meanings of blockchain adoption. I emphasize the relationship that participants have with the innovation as well as their lived experiences based on their participation in its sociotechnical system. In interrogating these dynamics, I underscore the analysis with a conscious appreciation of the positioning that different actors have in the network. An additional facet of the chapter's discussion is the material conditions of the social structures and social networks that perpetuate the identification and performance of gender by the constituents of blockchain's ecosystem. In this case, the dependent variable is blockchain technology, and the independent variables are gender, social relations, and the sociocultural conditions that frame them.

Chapter seven reiterates the study's main arguments and how they connect with the findings and analysis. The dissertation's results provide an insight into an understudied area, blockchain's adoption and diffusion in a Global South context. Hence, the conclusion locates blockchain's adoption in Ghana in the micro-context of the relevant stakeholders, its macro-level interplay with the social, cultural, political, and economic setting, as well as the pertinent transnational connections. Importantly, chapter seven affirms that this is only a first step in the critical and systematic exploration of Ghana's and the wider Global South's relationship with blockchain. Finally, I suggest further research and policy pathways which would strengthen interventions

and facilitate blockchain’s contribution to the advancement of meaningful social change in Ghana.

Chapter 2.

Digital technology's evolutionary relationship with society: A review

In acknowledging that technological innovations are socially embedded entities, this research posits that sociotechnical environments replicate and impact aspects of the adoption setting's social structure (Leonardi, 2010; Williams & Williams, 2003). A key component of social contexts is gender power relations and how they relate to unequal participation in the technology's ecosystem (MacKenzie & Wajcman, 1999). Considering blockchain's projected participation in social change, this study critically examines how its adoption relates to gender digital inequalities in Ghana. In furtherance of this goal, this chapter critically outlines the foundational literature serving as the frame of analysis for society's evolving relationship with technology. These are representative ideas, theories, and debates that have shaped technology and society studies. Focusing on the evolution of digital technology and the impact they have on society, I analyze central arguments from scholars like Castells (2010), Harding (2008), Hassan (2008), and Rainie & Wellman (2012). They variously characterize and analyze social systems according to the prevailing technological innovation. I also present counterarguments to these positions from critics such as Garnham (2004) who challenges Castells' distinction of the global network society as a novel phenomenon. Following these, I explore a related school of thought centered on the contributions that technologies make to society's progress, information communication technology for social change (ICT4SC). This encompasses theorization about the potentialities of digital innovations to produce socioeconomic transformations for the marginalized. The underlying rationale for presenting these arguments is to establish the debates on the proclivity for blockchain to address gaps including digital access among communities of people facing diverse deprivations. Thus, the central area of interest for this analysis is blockchain's interaction with the gender digital divide in Ghana. The next section discusses the theoretical framework for analyzing this interaction.

I outline the investigation's theoretical positioning by explicating the principal points of departure for analyzing data on technology and society. The principal authorities here are the technologically deterministic viewpoints like what Ellul (1967;

Ellul & Wilkinson, 2011) asserts, in contrast with social constructionism championed by Pinch and Bijker (1984, 2012). Next, I introduce critical theories which foreground a gender analytical component towards attaining gender justice. In this discussion, I highlight a gap I identified in gender justice theories. These do not appropriately operate at the junction of critical analysis of a digital technology which focuses on gender dynamics and the unique realities of an African context. I remedy this gap by constructing afrofemtrism. I end this chapter by developing the theoretical framework that frames the study's analysis and interpretation of the primary data. This involves establishing connections between afrofemtrism, technofeminism, and social construction of technology (SCOT).

2.1. Digital technology in our present reality

Technological innovations are both markers and consequences of social evolution illustrated by factors such as socioeconomic groupings, social relationships, and cultural outputs. Technologies are key to the definitive catalysts that effect societal transitions from one era to the next. In a dynamic and cyclical dance, the resulting social realities caused by these transitions produce a remodeling of existing technologies to reconcile their functions and values to those of society's needs (Feenberg, 2002; Harding, 2008). To illustrate, the industrial age espoused manufacturing processes structured within the factory system and large-scale standardized structures of production. Industrial societies then evolved into increasingly urban spaces with less reliance on traditional and artisanal skills. Steeped in the capitalist economic system, this social transformation redefined every aspect of society. Manifestations of the transformation include the production of class stratifications and their attendant conflicts, the modernization of value and belief systems, the definitions of popular culture and cultural spaces, and the evolution of transport and communication systems (Chirot, 2011; O'Brien & Szeman, 2004; Schwab, 2016). Feenberg (2005) posits that the technical codes of a given innovation reflect, and to a certain extent cement, the inequitable configuration of power dynamics of the social context of its distribution. The remodeling of technologies, therefore, could result from opposition by disadvantaged groups.

Schwab (2016) opines that we are living in a digital revolution “characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres”. Rainie and Wellman (2014) in turn describe the present social order as a networked social operating system, where the rise of social networking and astounding connectivity facilitated by advances in internet technology, mobile, and other digital innovations intertwine with society’s progression. The innovations and capabilities that digital systems have made possible expand economic, health, and communication opportunities. These changes have their consequent effects on the evolution of technology, and their mutual actions engage in the rapidly advancing phenomenon of the present digital-minded society. Developments in digital technologies thus constitute and construct sociocultural, political, industrial, and other realities (Castells, 2010; Thomason, 2017; Zuboff, 1998). Castells also comprehensively develops the impact of information technologies in transforming the space and times of social organization (2010). He suggests that contemporary society is a knowledge economy where information is currency and holds undisputable prominence in all aspects of life. ICTs are the agents of information generation, processing, and transmission. They have consequently engendered our present social system, the information age (Castells, 2010).

Central to the information age is the concept of the network society; a social structure of interconnectedness among nodes of people, societies, and political and industrial entities, which are organized and shaped by information and communication technologies (Castells, 2010). The concept of networks in themselves is not a new phenomenon (Castells, 2010; Hassan, 2008; Rainie & Wellman, 2012), but the novelty of the network society lies in the influence of new information technologies, whose logic of networking and speed mediate the functioning and experiences of society. The new artifacts of the network society comprise networkable digital gadgets and applications such as the Internet, mobile phones, and computer systems.

The so-called information age has generated various new social realities. A good example is the concept of virtuality, which has become an intrinsic aspect of our consciousness. In Castells’ thesis on real virtuality, communication processes are the foundations of cultures, and these processes synthesize ‘reality’ with symbolic representation. Thus, there is no objective reality but its symbolic representation via the

symbols of communication. What pertains to the network society is real virtuality based on the omnipresence of the virtual life of cyberspace.

> …a system in which reality itself (that is, people's material/symbolic existence) is entirely captured, fully immersed in a virtual image setting, in the world of make believe, in which appearances are not just on the screen through which experience is communicated, but they become the experience. (Castells, 2010, p. 404)

The surge in social networking via platforms like Facebook depicts real virtuality. These connections are the new 'social operating system' of the network society. This is a sociotechnical system where the boundaries of physical social networking and online social networking collapse into each other to form a new layer of reality (Rainie & Wellman, 2014). Contrary to the discourse on the anti-social effects of the internet (Ma, 2011; McPherson et al., 2006), Castells (2010) and Rainie and Wellman (2012) posit regular use of the internet leads to more physical ties. Castells distinguishes between weak and strong human ties. He explains the internet presents unique opportunities for making several weak connections. These provide avenues for sharing information and experiencing superficial social interactions in the virtual world. Rainie and Wellman, on the other hand, extol the benefits of not-so-weak online social networks. As they put it, people are not online because they are hooked to information technologies, but because they are hooked to other people online. The basic unit of human networks is no longer the family but the individual in a system of networked individualism. With the extensive reach of the internet and the ubiquity of the mobile phone, the networked individual has vast networks, unlike previous small physical networks. People also have more avenues for problem-solving, like efficiently raising funds on online crowdfunding platforms for medical emergencies.

Contrastingly, Hassan considers real virtuality a negative consequence of the network society's logic of speed. Life has become a whirlwind of images, signs, and symbols because information technologies mediate our experiences. Society, afflicted with numbness of the senses, cannot process and experience life in the fullness of reality. Our numbed capacities can only appreciate the simulation of reality. This forces society to accept lived experience only on a plane where the amalgamation of concrete reality and virtual reality exists (2008).

To develop a well-rounded discussion on the interconnection between information technology and contemporary society is Harding's (2008) social constructivist theorization of technological change. Her critical analysis emphasizes four aspects of technological change: the introduction of new artifacts; new knowledge, skills, and techniques; changes in the social division of labor; and new ethical, political, and social meanings. This categorization provides an optimal avenue to develop a discussion on the key characteristics of the network society.

New Knowledge, Skills, and Techniques

The early years of corporate computerization exemplify Harding's first point. Employees like office clerks felt de-skilled by computers. They no longer had an intimate and tactile relationship with their jobs through "paper-and-pencil" processing as their tasks in the new digitized workspace converted to automated data entry. Despite this, the managers ignored their objections because the increased work output elated them. Easier access to the data stored on online databases also meant greater control (Zuboff, 1988). In this post-Fordist era where social-interventionist policies were declining and market liberalism was high, 'efficiency' was the new mantra, and computerization ensured that (Hassan, 2008). Desired characteristics of how society organized labor (increased profit margins, automation and speed, concretization of management's authority, and efficiency in data input from the elimination of the human factor) were ingrained in digital software. Thus, the rules of the corporate structure disseminated in an objectified state. Society came to perceive them as intrinsic and unalterable traits of digitization and influenced widespread digitization (Flichy, 2008; Zuboff, 1988).

Regarding new knowledge and skills, immaterial assets like ideas, more than physical space and capital, are the most sought-after tools for more efficient production processes (Cardozo et al., 2013; Castells, 2010; Hassan, 2008). People who gain the appropriate capital in knowledge-based skills in areas like computing command valued positions in the new stratification of labor. Bell asserts that we have become a post-industrial society in which information and knowledge are the basis of economic activities (1976). Further, firms strategically eliminate unionized cultures by restructuring labor. They introduce widespread automation and subcontracted positions that are more flexible and individualized. There is a resultant increase in precarious labor with more ad hoc positions that do not offer benefits or job security. The valorization of specific skills

that the global network deems relevant heightens social exclusion, inequalities, and social polarization (Amichai-Hamburger, 2011; Castells, 2010; McChesney & Schiller, 2003).

On a wider scale, the localities with substantial human and organizational resources in the design and production of digital technologies have also become essential nodes in the network society (Castells, 2010). To illustrate, the city of Bangalore, the information technology capital of India, is home to major digital technology firms, educational and research institutes, and is one of the most prosperous cities in the world based on its Gross Domestic Product (GDP). The measure of the importance of such locales is not just their income or innovations, but their value recognition by world leaders. For example, on their state visits to the United States (US), Indonesian President Joko Widodo and Chinese President Xi Jinping both scheduled visits to Silicon Valley and held high-level meetings with industry leaders like the CEOs of Google and Facebook (Schiller, 1999; Tegos, 2016; Wattles & Riley, 2015).

Changes in the Social Division of Labor

Information systems are not limited to specific sectors, which underscores the emergent culture of the social division of labor (Atkinson, 1998; Hassan, 2008; Zuboff, 1988). Specialized commodity production between industries has adapted to the demands of the network society. Thus, knowledge production and technological innovation have become mainstays of most industries. Financial organizations in the US have invested more in information systems and skilled personnel than the information industry itself (CRASSH Cambridge, 2015; McChesney & Schiller, 2003; Schiller, 1999). Global military investments in software systems are exponential, just as medical science (research, education, treatment) depends heavily on data and knowledge processing. For instance, information processing and digitally mediated collaboration among researchers all over the world facilitated breakthroughs in research on the human genome (Castells, 2010). Added to these, industries in digital technologies have very diverse portfolios. Beyond these types of varied investments, the dynamics of the neoliberal globalized economy operate on the imperatives of digital technologies. Hence, world economies are reorganized into a network of industry relationships (Cardozo et al., 2013; Castells, 2010).

Furthermore, with the free-market ideology of neoliberal globalization, nation-states have lost the ability to control and regulate global flows of wealth and information. This comprehensive extent of the network society transcends traditional national boundaries, the global industrial world is intimately intertwined. Castells describes this phenomenon as a ‘global automaton’. This is an expanding and dynamic entity of a financial network made up of nation-states and multinational companies. It has a life of its own and operates by its own rules. To exemplify this interconnectivity, the financial crisis which started in 2008 was globally devastating because of the number of international markets plugged into the network society. All the control measures by central banks and governments could not stem the tide of the financial meltdown (Castells, 2010; Hassan, 2008).

New media technologies, like the Internet and the social media platforms running on it, have blurred the lines between the traditional concept of consumers and producers (Denegri-Knott & Zwick, 2011; Ritzer et al., 2012; Toffler, 2008). This is enabling a generation of digital natives known as prosumers, at once producers and consumers of digital content. New media have developed into mass self-communication technologies because they allow prosumers to create content and self-distribute it. Thus, there is a proliferation of user-generated content which has increasingly occupied a central position in digital cultures. A defining feature is interactivity, where prosumers transmit and receive media products in real-time as they participate in a networked hypersociality (Castells, 2010; Hassan, 2008; Serazio, 2015). With the ecumenical range of the internet, content can reach global masses of people.

As a principal exigence of these ubiquitous new media technologies, individuals in the network society are constantly connected in the virtual life of social relations and professional affiliations. There is a widespread conflation of workspaces with home settings, with the erasure of boundaries between the two. The perpetual connectedness that the internet permits has become a professional necessity (Cardozo et al., 2013; Castells, 2010; Serazio, 2015). The Covid-19 pandemic has taken this fusion of the professional and domestic spaces to a heightened level. With many countries limiting human movements in public places to help reduce transmissions, many people have had to work from home. Digital platforms like Zoom have catapulted into the limelight as people rely on them for their professional, educational, and social activities. The pandemic has accelerated the digitalization of many societies, and aspects of this

enhanced virtual reality might remain when countries ease physical and social restrictions. Foreshadowing this emerging phenomenon, organizations like the Canadian e-commerce company Shopify have taken giant steps to institute a permanent remote-work policy for most of their employees (Lutke, 2020; Pringle, 2020). In the words of Shopify CEO Tobi Lutke, “Office centricity is over” (Lutke, 2020).

Another aspect of the changes in the social division of labor is that traditional purveyors of knowledge progressively have to share or sometimes cede their authority to people and entities without their professional credentials. For example, doctors contend with patients challenging them with medical information from the internet. Journalists and bloggers are also now jockeying for recognition as credible sources of information (Rainie & Wellman, 2012). New media has introduced the novelty of the horizontal nature of communication. People’s voices can circumvent the hierarchical old media systems like newspapers, television, and radio to express themselves and expect a form of response (Bachan & Raftree, 2011; Graham et al., 2014). As an example, YouTube has helped create many celebrities. Without the benefits of the television or movie-making machinery with substantial budgets, they have propelled themselves to stardom with their YouTube-based content. Social media enjoy such profound societal acceptance that more traditional media like television and radio have adapted to their peculiarities by customizing outputs. They transmit information via social media platforms directly to audiences. News stories and entertainment programs now suit the interests of the wide range of audiences plugged into the media network through the multiple points of access of digital media technologies.

New ethical, political, and social meanings

In the new ethical environment made possible by the network society, issues of surveillance and privacy have gained ascendency. The scandals surrounding government agencies’ invasions of privacy illustrate this. An example is Edward Snowden’s exposure of the US National Security Agency’s access to data on US citizens and other governments’ communication (MacAskill et al., 2013). These scandals have raised concerns about democracy in the digital age. Digital technologies undergo rapid innovations that give rise to a variety of privacy issues (Pecora, 2002). Meanwhile, laws on cybersecurity and privacy do not seem to catch up to this pace. The intrusions and the leaks were possible because of the pervasive reach of new technologies in our

lives. The social connectedness that new media makes possible means that various platforms have access to vast amounts of users' personal data including contacts, hobbies, location, and addresses (Aguirre et al., 2016; Cohen, 1999-2000; Fuchs, 2012).

Politically, digital technologies are not the only determining factor for the network society's interconnectedness. Organizations and governments' search for capital and power also sustains it (Amichai-Hamburger, 2011; Graham et al., 2014; Schech, 2002). These ambitions contribute to geopolitical frictions, as national governments and regional collaborations wrangle for control and access to markets. An example is the US' double standards in their treatment of China's protectionist stance towards Google. The United States disputes China's claim of national security, when "in 1992 the US, as a pioneer in Internet technologies, denied China's initial request to be connected to the global Internet on national security grounds" (Zhao, 2010, p. 266). Moreover, various countries particularly from the Global South, like Brazil and South Africa, have agitated for the mostly US-based multinational organizations to relinquish proprietary control over Internet governance (CRASSH Cambridge, 2015; Zhao, 2010). Another political factor is that politicians use ICTs to disseminate information to several sections of the population. The politicians who are adept at employing language and images that suit the tempo and regulations of social media are the ones whose messages appear more widely circulated, irrespective of their veracity (Fuchs, 2018; Ott, 2017; Vitak, 2011). Castells considers politics in the network society a system of scandals. Character assassinations through instant and always-on information technologies lead to victory (2010).

Regarding the construction of social meaning, identity is enmeshed in a world straddling perceived reality, symbolic representation of reality, and virtuality (Atkinson, 1998; Castells, 2010). Notions of belonging to a collectivity of shared identity reflect in the virtual world of the internet. It becomes a space for society to crystalize the ideal self by adopting particular identities and conferring identities on other social groups to establish distinction (Nakamura, 2002). The logic of speed, efficiency, and accuracy also underscores social consciousness and is an inherent aspect of the network effect. Even traditional educational establishments place an increasing emphasis on efficiency by offering fast education in pertinent skills to suit the market (Hassan, 2008). Corporations churn out technological innovations in a speedy and timely precision to gain market advantage (Castells, 2010).

Literature on the network society has criticized this logic of speed as cultivated, while presented as a 'natural essence' of the network economy. The reliance on speed is nothing new, it goes as far back as 1736 with Benjamin Franklin's famous dictum 'time is money' (Hassan, 2008). Speed in productions as a necessary characteristic for effective competition drove capitalism before the emergence of the network society. These values, which are embedded in digital technologies to satisfy market needs, have become accepted as automatic characteristics of the system based on the 'automaton' of the network society (Flichy, 2007; Hassan, 2008). Also, the multiplicity of communication systems and patterns, coupled with the rapid changes in information technologies, induce a sense of social disorientation in interpersonal relations (Castells, 2010). Another counterpoint is that speed clouds perception, limits the accuracy of judgment, and increases the probabilities of errors (Hassan, 2008).

To conclude, an analysis of the emergence of digital technologies in the network society highlights the social exigencies that contributed to their creation and production. Information technologies provide an arena for instituting and reconceptualizing social belonging, social stratification, and identity formulation. Conversely, these technological developments stem from needs, possibilities, and objectives of the sociocultural, political, and economic structures (boyd, 2011; boyd & Heer, 2006; Nakamura, 2002).

New age?

I would be remiss to end this section without discussing opposition to the characterization of the network/information society as a new 'age'. Kumar (2005) acknowledges that societies around the world have experienced the information revolution. The importance of information technologies in various aspects of organizational and social life evinces this. However, this does not necessarily signal a new society or a new age. In his view, the myth of the information society is nothing more than a capitalist ideology based on the commodification of knowledge and information, which were hitherto freely available. Webster advances an ideological critique to the framing of a new social system as if present societies which interact with ICTs are completely different from those that came before them. He emphasizes that information and information systems are indeed central to all aspects of contemporary social systems. Nonetheless, the rise and pervasiveness of ICTs do not connote a revolutionary new age, but a continuous informatization process whose 'newness' is in

its rapid and massive spread (2014). Analyzing and theorizing about social change from the perspective of the technologies and their affordances “oversimplifies change and misconstrues the character of technology itself since it drains it of social content and context” (Webster, 2014, p. 341).

Garnham similarly (1998) raises questions about the novelty of Castells’ justification for a network society. For instance, extensive and fast communication networks have always underscored the capitalist mode of production. He rejects Castells’ position that the global network society has caused an end to the class struggle between capital and labor. This argument neglects human agency, wherein “the logic of capital only works its invisible magic so long as individual capitalists, or the institutional agents of capital, are driven to accumulate” (p. 110). Garnham ultimately dismisses Castells’ network society theory as a technologically determined postmodern exercise. It does not provide adequate answers to vital issues like the relation between the mode of production, the consciousness of labor and social stratification, and the sphere of politics and culture. Finally, Garnham outlines Castells’ failure to clearly articulate the ideological enterprise of dominant forces to subsume social learning and democratization processes of ICTs by favoring entertainment functions (1998). These critiques are valid in demonstrating the error in imbuing technologies with the sole power of effecting societal revolutions. As Webster argues, insofar as information is a major aspect of contemporary social advancement, ICTs in themselves are not machinating social processes as if by a neutral automatic logic. Investigating the roles that digital technologies play is a crucial endeavor whose complexity is diminished by taking a deterministic stance. These types of analysis temper the immensity of political, economic, and other interests which purposefully create, augment, and diminish various innovations towards specific goals.

Similar to the preceding discussion about digital innovations and their role in creating social systems, pundits interrogate technology’s contribution to social transformation in the context of socioeconomic progress. In the next section, I present a critical development of this school of thought as a transition to discussing the relationship between blockchain, gender inequalities, and the Ghanaian society.

2.1.2. ICT for social change

An area of interest for this study that corresponds with the preceding conversation on technologies contributing to multifaceted realities of social systems is socioeconomic transformations through digital innovations. Specifically, the concept of technologies as tools for occasioning social change usually frames perspectives on the development and evolution of digital technology in the Global South (Hafkin, 2002; Melkote & Steeves, 2001). This field of study is information technology for development, or less paternalistically, social change (ICT4SC). Arewa refers to these as “technology uplift narratives” because of the widespread assumption that sharing in the digital economy presents unique opportunities for economic wellbeing (Law as Culture, 2019). Early conceptualizations of socioeconomic development came through experiences from Western Europe, North America, and parts of Asia. These include industrialization, technology innovation, and urbanization (Lerner, 1958; Rogers, 2006; Sparks, 2007). The bedrock of development as an agenda is the modernization theory. It championed the dissemination of Eurocentric economic policies with an attendant mental reconfiguration of the recipient nations which were largely in the Global South. Thus, modern lifestyles had to replace ‘futile’ superstitious and non-scientific traditional outlooks, thereby leading to accelerated development (Lerner, 1958). To exemplify, the initial rendition of the diffusion of innovations theory follows this frame of thought (Rogers, 2003, 2006). The central logic was that technological systems could be transferred from the ‘developed world’ into ‘underdeveloped/developing’ economies to modernize their systems and engender development.

Critical scholars roundly criticize these dominant paradigms as intellectually ethnocentric and self-seeking, with hegemonic ideals that mostly favor the interests of the Global North (Dutta, 2011; Melkote & Steeves, 2001; Rogers, 2006). The criticisms are especially pertinent in the shift from colonization to globalization, as the World Bank (WB) and International Monetary Fund (IMF) champion neoliberal sentiments. Thus, they posit a kind of globalization which reflects continuing power inequalities between the Global South and North, as not everyone experiences globalization in the same way (Dutta, 2011; Sparks, 2007; Unwin, 2009). Therefore, the present market reality of neoliberalist globalization is repackaged neo-colonialism, which provides the North the ability to meddle in the affairs of the world’s majority through multilateral organizations like the IMF. It also represents ideas and practices from the Global North as better. In

the final analysis, this study uses the term ‘social change’ in place of ‘development’ to emphasize that different societies conceptualize social progress differently. Accordingly, social change should not be about adhering to hegemonic standards which consequently concretize global power disparities between nations (Dutta, 2011; Servaes & Arnst, 1999; Sparks, 2007).

In championing the potentialities of a given ICT4SC intervention, it is important to decipher the underlying principles of progress that guide them. Unfortunately, contemporary social change initiatives appear to reflect the initial ideologies of modernization theories (Chakravartty & Zhao, 2008; Melkote & Steeves, 2001; Scott, 2014). Examples of goals espoused by most ICT4SC projects include changing individual and societal behaviors through mass messaging and employing digital mechanisms to attain specific ends. These goals are usually measured by the standards of external multilateral and bilateral agents (Scott, 2014; Waisbord, 2008). Even more importantly, an overwhelming oversight in early ICT4SC discourse was gender-specific concerns as a key factor in social change. This omission was particularly detrimental firstly because it eliminated female voices from the determination of a community’s progress. It also set the stage for deeper marginalization of women on the global scale (Gillard et al., 2008). As Hafkin points out, gender only became an important aspect in research and analysis on ICT policies in the Global South in the late 1990s. Its exclusion from national-level ICT policymaking is the root of the present gender digital inequalities in many parts of the world (2002).

To illustrate, the Ghana ICT for Accelerated Development (ICT4AD) Policy (2003) guides the government’s activities in the ICT sphere. The policy rightly outlines the reduction of gender inequities by building the ICTs capacities of women and girls as one of its main objectives. However, gender concerns do not make it into the 14 priority focus areas which the policy categorizes as “The 14 ICT4AD Pillars” (p. 9). Moreover, the language of the document touts positive projections of ICT4SC without due analysis of the multifaceted conditions of the political, economic, and social realities of different communities. There is no mention of how their ICT4SC programs would adapt to the vastly multifaceted sociocultural realities of the different parts of the country. Further, the policy does not even distinguish which artifacts come under the term information technologies. There is an apparent blanket approach at transforming Ghana “into an information-rich, knowledge-based and technology-driven high-income economy and

society" (p. 25). Finally, the document makes no distinctions between approaches for people with distinct socioeconomic income levels, people from different regions of the country, and between rural versus urban areas.

Due to its favorable qualities like decentralization and trustlessness, blockchain has come to gain a distinctive foothold in the worldwide ICT4SC space. Advocates herald it as an innovation positioned to enable an inclusive environment where the average person gets to join in peer-to-peer value exchange. This arguably spells disruption for the present hierarchical economic and social systems (Adriano & Monroe, 2016; Nica & Taylor, 2017). Various social change applications of blockchain involve targeting disadvantaged social groups and individuals. Nevertheless, even though blockchain is experiencing a boom in diffusion, Ghana's media culture is an interesting one because of the conflation of the boundaries between new and old media. Radio is still a hugely prevalent media, arguably some of the most influential media personalities work in radio. In rural communities as well as economically disadvantaged urban areas, we could very well consider television and radio as new media for many homes. Indeed, large segments of more affluent urban communities use traditional and new media concurrently. Hence, the distinction of old and new would more likely align with their invention dates rather than the recency in uptake and popularity (Fosu & Akpojivi, 2015; Gadzekpo et al., 2020). A consideration of the socioeconomic differences among the various social groups which interact with these intersecting media realities, therefore, helps to hone the contextualization of any advocacy for digital technologies. I develop the discussion of blockchain as a participant in social change more broadly in chapters four and six.

2.2. Theoretical positioning: Gender's relationship with science, technology, and society

As the above discussion shows, scholars with diverse theoretical underpinnings variously deliberate the interrelation of the consciousness and functioning of technology and society. The perspectives presented are helpful for this study in so far as they provide a macro-outlook for analyzing the developments that technologies contribute to in societies. They, however, leave certain deficits in areas that are especially pertinent to the focus of my study, such as gender. Although gender is not the only distinctive marker

of social grouping, it is a fundamental aspect of human societies. Its foundational absence in Castells' treatment of network society, as well as in Harding's systematic examination of technological change, is a profound deficiency. These scholars are also overwhelmingly deterministic in the capabilities they ascribe to technologies. For instance, though Harding presents a social constructivist view, her categorization of the various features of the network society predestine society to certain realities based on the prevailing technology of the time. Thus, rather than being cast as interlinked constituents of a sociotechnical network, she presents society and technology as separate entities. To expand this conversation on society's entanglement with technology, this research takes a critical perspective of digital technologies' accompanying values which particularly present inequitable experiences for women in the Global South. Feenberg asserts that "no fundamental progress can occur in a society that sacrifices millions of individuals to production and disempowers its members in every aspect of social life, from leisure to education to medical care to urban planning" (2002, p. 3). This study proceeds on a similar conceptual tangent of centralizing the female perspective in blockchain's sociotechnical space by confronting the conditions that breed disparities. In so doing, power structures are reconfigured to institute a truly decentralized and equal environment for all participants.

Kwami (2020, para. 2) succinctly delineates the problem with gender digital inequalities as a problem of power, the prevailing power dynamics "determine who benefits from and shapes the content, development, and use of ICTs". To examine these power dynamics, critical feminist theories give the most proficient frameworks to investigate the gendered participation patterns of the people involved in the blockchain space in Ghana. With an ultimate focus on the gender digital divide in Ghana, these theories would be the best framing tools to explore its causes and facilitators. Mama (2011, p. 8) considers feminism as "a degree of organizational and intellectual autonomy, which means the space to articulate analyses and political agendas rooted in clear analysis of the material and cultural conditions of women's lives". A feminist standpoint centralizes the critique of power relations and politics of knowledge and expertise. Scholars advocate for the dismantling of all forms of oppression inhibiting women's liberation, including philosophical, socio-economic, and political oppressions (Salo & Mama, 2001). As a method of inquiry, this field's analysis uses the position of the marginalized as the point of departure. Hence, the lived experiences of respondents

are the prism through which this research develops. Knowledge is therefore co-produced and not extracted. Another vital aspect of critical feminist theory is the larger but deeper perspective it provides for a more nuanced understanding of the forces at work that produce divides (Gadzekpo et al., 2019). Chair (2019, para. 2) notes the importance of probing deeper when she says,

> While the numbers measure the male/female sex gap in Internet use, gender is more complex than the numbers. We therefore can't just talk about sex and numbers here. Power dynamics, sex and sexuality, cultural and social norms, race, ethnicity, location, income and level of education are all factors which make gendered digital inequality a complex issue.

Admittedly, as a Ghanaian student with graduate education from North American institutions, approaches from these settings have greatly influenced me. I was more readily able to carry out an analysis using hegemonic feminist thoughts like technofeminism. Throughout this dissertation phase, my Ghanaian roots and identity have made me feel a weight of expectation to foreground feminist thoughts emanating from the Global South. I am eager to rise to the challenge of joining in the discourse on achieving gender parity through the intricacies of the African experience (Bosch, 2011; Opoku-Mensah, 2001). I consider this work a fertile ground to interrogate concerns about the universalist approaches that dominant feminist theories portray in analyzing women's experiences (Bosch, 2011; Manuh, 1991). I challenge this perception through an examination of the blockchain ecosystem in Ghana, using theoretical frameworks that are cognizant of the sociocultural and other conditions at play. Thus, I endeavor to examine respondents' opinions from the perspective of the multifaceted sociocultural sensitivity of a critical African feminist theory.

2.2.1. African Feminisms

African feminist writers take a critical position on the broader body of feminist studies which have traditionally privileged ways of knowing and expressing based on the experiences of the Global North. Bosch (2011) refers to this as the seeming "whiteness" of the field. I have had quite a challenging experience in seeking to ensure that the treatment of African feminisms in this research does not portray a single perspective. As it were, no one framework could be generalizable enough to be called an 'African feminism' considering the diversity of cultures, languages, and philosophies that pertain to the continent with several thousand ethnic groups spread over 54 countries (Dickson

et al., 2020). My denotation of African feminist thought, therefore, does not infer universality to the entire continent. It rather suggests a focus on issues pertaining to an African context. This point merges with Mohanty's emphasis on an 'imagined community'. She explains this as an alliance that cuts across physical and other borders, in recognition of the multivariate realities of different communities even when they experience the same phenomena, like digital technologies. She posits that this unison elevates feminist scholarship from alliances based on only categorizations like biological and racial affinities, but into the political realm. "[I]t is the *way* we think about race, class and gender-the political links we choose to make among and between struggles… However, clearly our relation to and centrality in particular struggles depend on our different, often conflictual, locations and histories" (Mohanty, 1991, p. 4). An important aspect of African feminisms that this study considers is the focus on power dimensions among communities within a country and across national borders. This interconnectivity recognizes the context of the multiple and unique sociocultural realities.

The core subject of feminist ideologies, as I apply in this work, is the "'Woman' -a cultural and ideological composite Other constructed through diverse representational discourses (scientific, literary, juridical, linguistic, cinematic, etc.)-and 'women'-real, material subjects of their collective histories" (Mohanty, 1984, p. 334). At the same time, my application of the feminist lens does not focus on just women, but the gender relations involving men and women, and the attendant realities that are created and performed in the sociotechnical ecosystem of blockchain in Ghana. This principle acknowledges the importance of men's participation in overturning the suppression that women face. Women's weakened positioning is distinct from "the generalized oppression of all African people" (Mekgwe, 2006, p. 17). Thus, to ensure success, feminist activity and scholarship are not the sole purview of women but a collective endeavor. This opinion influenced my decision to have both male and female participants to foster an environment of a shared purpose. No one should have to demand that their gender, race, or social positioning must not automatically predispose them to marginalization and oppression. Steady buttresses this point by first positing that African feminism centralizes a more inclusive ideology in recognizing the multivariate dimensions of oppression. In the final analysis, the essence of these diverse elements is the simple appreciation of the humanity of women (1987).

Feminism as both a form of activism and an assemblage of concepts and philosophies is a uniquely complex term to define (Mohanty, 1991). In its ideal form, it multifariously applies to the environments and reality of the community utilizing it. Accordingly, African American feminist thoughts surround issues such as racial and social justice in the United States and how these interrelate with economic, health, political and other inequalities (Collins, 2008; hooks, 2000; Steady, 1987). Towards a need for self-definition, the conceptualization of feminism and its application to the African context is even more contested among African activists. One of the main points of departure is in the very coinage of the term. Scholars point to its origin in Europe and North America where it is mostly applied to the conditions experienced by the Caucasian middle-class woman. Using the term in the sociopolitical activism for gender equality by African scholars thus gives the impression that the very activism being enacted is also a borrowed undertaking. This would mean an elision of the authentic endeavors of various actors whose activisms predate any trade and colonial contacts and, therefore, any engagements with the Global North (Dosekun, 2007; Salo & Mama, 2001). Through an analysis of the Nnobi society in Nigeria, Amadiume & Caplan (2015) highlight the forced patriarchal government systems instituted by colonialism and its attendant western format religion and education. These consequently erased forms of socioeconomic and ritual power that women traditionally had. She details multiple acts of asserting the agency of women in response to oppression, including “genital cursing” and boycotting certain roles which were essential to the smooth operation of their communities such as trading in the marketplaces. Even in the mid-19th century and early 1900s, and predating feminism in Europe and North America, women like Constance Cummings-John in Sierra Leone and Huda Sha’arawi of Egypt displayed various acts of resistance against oppressive systems. These historical facts run contrary to some assertions that activism towards achieving and/or safeguarding women’s socioeconomic and political rights are alien to the values and cultural ecosystem of many communities on the African continent (Dosekun, 2007; Mama, 1995; Mohammed & Madunagu, 1986; Salo & Mama, 2001). Aidoo emphatically opposes this assumption at the Stockholm Writers’ Conference when she insists that

> African women struggling both on behalf of themselves and on behalf of the wider community is very much a part of our heritage. *It is not new and I really refuse to be told I am learning feminism from abroad*… Africa has produced a much more concrete tradition of strong women fighters than most other societies (Nfah-Abbenyi, 1997, p. 121, emphasis in original).

Added to this, women on the African continent must contend with the manifold realities of not only their gender but also their being African and from the so-called third world (Ogundipe-Leslie, 1987). When scholars theorize feminism in the African context, they usually do so in juxtaposition with their unique postcolonial realities. These ideas relate to the contradictions inherent in the multifaceted female statuses in precolonial matriarchal and patriarchal cultures, their erosion during the colonial period and consequent resistance against this oppression, and the complex variants of these conditions that exist in the postcolonial period (Dosekun, 2019; Ogundipe-Leslie, 1987). Thus, a central objective is to subvert the consequences of the colonial history, the resultant marginalization of postcolonial countries in the global system, and the forced reconfiguration of religious, cultural, and socioeconomic structures (Mekgwe, 2006).

To underscore the integrity of the experiences of African women and foreground them in discourses and scholarship on gender, proponents proffer homegrown alternatives which address two major gaps. Firstly, the conceptualizations are African-inspired and not imported. Also, the ideals they espouse are based on the environment and circumstances from which they emanate (Dosekun, 2019; Mekgwe, 2006). I will discuss three examples of these, the first of which is Womanism.

Womanism

Two scholars from different backgrounds concurrently formulated womanism in response to perceptions that the term feminism did not adequately address the realities of the Black woman. They are Chikwenye Okonjo Ogunyemi, a Nigerian novelist, and Alice Walker, an African American writer (Ogunyemi, 1985). Ogunyemi posits that the distinctness of the Black woman's struggle is in the historical and ongoing racial injustice that she endures. The undergirding philosophy of womanism is the Black woman's recognition of the sexual, racial, cultural, national, economic, and political issues that she must contend with, irrespective of her geographical location. Ogunyemi modified this encompassing unity in later works by elucidating the variances in context, thoughts, and actions of Black people. She postulates that African American womanism ignored the specific lived experiences of the African woman (1996).

STIWANISM

STIWANISM, on the other hand, is a movement that concerns itself specifically with the Black woman on the African continent. Coined by Ogundipe-Leslie, it stems from the acronym STIWA, which denotes “social transformation including women in Africa” (1994, p.230). She delineates a divide even among women, asserting that “[M]arried women are afraid to shake the status quo; they are afraid and want security through men; they are harsher on other women than men are; they cling to the vanishing respectability of being married” (1994, p. 211). Moreover, Ogundipe-Leslie is firmly optimistic in the belief that the eradication of gender inequalities is central to the critical transformation of African countries. STIWANISM considers the fight for female empowerment the collective purview of both men and women. It challenges the hegemonic patriarchal structures inherited from the colonial pasts, which have contributed towards the establishment of a false dichotomy between the genders.

Nego-feminism

This last example operates on a heightened level of inclusivity across elements such as issues, community settings, and sociocultural values. Propelled by heterogenous ideals, Nego-feminism by Nnaemaka (2004) posits the importance of the collective whole of a community in addressing injustice. In this sense, feminism should necessarily be a flexible process of negotiation between the various agents of a society, a negotiation devoid of ego, violence, and divisive individualistic interests. This give-and-take modus operandi ensures everyone involved applies sensitivity in their renegotiations of sociocultural hierarchies and imbalances of power. Considering that challenging the power and traditions of the patriarchal status quo in many African countries is a continual process, reaching a compromise in the interest of all members of the community is key to ensuring the success and sustainability of the projected change.

2.2.2. Afrofemtrism

Beyond the politics in the conceptualization of female-focused activism for Africans, I realized in the course of my research that there was a missing link between the existing African feminist and similarly oriented theories, and the empirical material I had gathered from my research participants. Overall, the extant theories fall short in comprehensively addressing the changing tides of societies in terms of the political,

economic, and sociocultural climate, and how technological advancements intersect with these. My interest in employing African theorizations in a study on the gender dynamics of blockchain is towards challenging hegemonic structures that oppress women and other social groups. A key goal is to unravel the complex subjectivities of the gender realities of the contemporary Ghanaian operating in the ICT ecosystem. This must pave the way to dismantle gender injustice. Furthermore, it involves an understanding of the modalities involved in navigating the various aspects of their traditions and cultures vis-à-vis their contemporary lived realities. Many of the investigation's respondents discuss the conflicts and congruity between their career pursuits in ICTs and the Ghanaian setting that is both deeply traditional and cosmopolitan. These intersecting conditions of consanguinity and professional affiliations make for unique experiences that are not easily appreciated in other societies (Ogundipe-Leslie, 1994).

Additionally, my interactions with the participants generated an interesting dimension to the discourse on the (in)existence of female agency in a contemporary Ghanaian context, like what the ICT space provides. For example, one participant was emphatic in his submission that the focus of my investigation was unnecessary because the present Ghanaian society did not have any issues with gender inequalities, especially for people who interact with ICTs. He opined that technological advancement erodes the sociocultural tenets which undermine women's agency. This view pushes for an in-depth look into the reconfiguration of gender power dynamics within and among social groups, and across professional and other spaces (Dosekun, 2007; Osha, 2006).

My answer to this gap was to develop an applicable critical theory, Afrofemtrism. 'Afro' represents the focus, which is people and issues in any geographical setting which originate from or affiliate with the African continent. 'Femtrism' is a play on the words 'female' and 'centrism', referring to activisms in the interest of gender justice for women and other marginalized groups. Adopting a proactive stance, this theory addresses gender injustice in its multivariate form by challenging the very social and other structures that perpetuate it. It does not merely clamor to include disadvantaged social groups in the existing structures, it is a concerted effort at disassembling said structures in a truly substantive way. Hence, an afrofemtric investigation opens to scrutiny power relations and the many discourses, traditions, and practices that maintain them, to enable their disruption towards gender justice. However, all these angles must develop on the fundamental understanding of the manifold realities that different people live like

their gender, age, ethnic grouping, socioeconomic status, and educational level. Thus, afrofemtrism directly considers the features of the temporal setting of any research in addressing the issue at hand.

Mekgwe highlights the importance of a critical theory using this diversity of perspectives and backgrounds as points of departure. We need to emphasize "the recognition of various and varied 'femininities' where women do not easily fall into neat categories such as 'the oppressed' as against 'empowered men'; 'marginalized third world women as against imperialist western women'" (2006, p. 21). Afrofemtrism circumvents the trap of essentializing the idea of who an African woman is and the gender roles they perform. It does this by elucidating their self-declared identity markers, as well as the relevant aspects of their professional and personal realms. There is no intrinsic representation of a female or male identity, nor should we entertain a single concept of the parameters that delimit perceived African cultures. At the same time, this model is cognizant of shared conditions and histories that combine to enhance the analysis. Irrespective of the similarities in areas like socialization and culture that many people of African descent have, buying into the single story of a core standard for the African identity flies in the face of the rich diversity that the African ecosystem enjoys. In other words,

> This anti-essentialist argument does not imply that there is no such thing as Africa. It does not deny the many shared historical, material and cultural conditions across Africa, which are in many ways unique to the continent and which in many ways shape our identities as African. It denies rather that these conditions are inherent, natural or fixed. (Dosekun, 2007, p. 42)

Afrofemtrism applies to various sociocultural and professional situations bearing in mind the wider politico-economic and other backgrounds which frame the setting in question. 'Bread and butter' issues (Mikell, 1997) which encapsulate material necessities like economic opportunities and empowerment, political freedoms, and sexual reproductive health and liberties, are as valuable as knowledge production activities. Thus, for instance, the framework could be applied to an analysis of the gender relations and gender identity performed by individuals in a rural environment, and how this impacts maternal health. It could also serve as a pertinent tool for analyzing the impact of the Ghana Learning Radio: Reading Program launched by the Government of Ghana in partnership with the US Agency for International Development (USAID). An initiative borne of the closure of schools and other educational institutions due to the Covid-19

pandemic, the program delivers distance learning instruction in 11 Ghanaian languages and English through Ghana Broadcasting Corporation (GBC) radio stations (US Embassy in Ghana, 2020). An afrofemtric analysis would examine the effect of this enterprise on various social groups in rural, urban, and peri-urban settings, with a focus on the differences and similarities in male and female experiences. How does the participation of an international entity like USAID impact these experiences, as well as the larger processes of implementation and participation of the audience? The specific focus of this model is to investigate the channels that occasion and cement the marginalization of certain social groups, especially women.

Afrofemtrism borrows from Eisenhardt's work on maintaining testability and relevance in building theories from research data (1989; Eisenhardt & Graebner, 2007). Although she focuses on case study research, the emphasis on iteratively engaging primary data and theory development towards generalizability across research settings applies to this investigation. She stipulates that traditions in theory generation emphasize the importance of contributions from previous literature, as well as the researcher's insight borne of their common sense and experience. However, to achieve validity of the theory and enhance its testability and relevance across different research settings, another salient feature to explore is inductive reasoning from the empirical data. The beginning of this section shows the importance of contributions from previous works on relevant subject areas. This includes literature on gender justices especially those emanating from Africa and its diaspora. Literature on the relationship of ICTs to social change processes is also key to this conversation. These establish and provide opportunities to present new insights for addressing identified gaps. They also facilitate the interrogation of conflicting findings to enhance generalizability by establishing underlying conditions which are similar but produce dissimilar outputs (Christensen, 2006; Eisenhardt,1989).

Secondly, my common sense and lived experiences contributed to the simultaneous data analysis and theory-building processes. Common sense here relates to popular judgments and deductions based on experience (Rosenfeld, 2011). These involve the subjective perspective that the researcher contributes to deciphering the meanings and gendered interactions that research respondents relay. Thus, I drew on my firsthand knowledge of the cultural background of the research setting. Acknowledging the researcher's positioning throughout the analysis and interpretation

process is vital. This is because, as a critical frame aiming to deconstruct established hierarchical positioning, afrofemtrism recognizes a researcher does not operate in a vacuum bereft of political and ideological values (Christensen, 2006; Eisenhardt,1989). The final step is the involvement of empirical data using inductive logic. This ensures that the evidence that the data provides supports the theory. Grounding the theory in empirical material also establishes its validity as it reflects the reality of the research context. This study, therefore, develops afrofemtrism through constructive interaction with the primary data. To this end, I ground the theory in and reflect material realities. Empirical data of this nature is an integral element for establishing multiple perspectives and experiences directly from the community under study. The data does not constitute specific truths, but is a means for critical reflections on the contemporary sociotechnical system of blockchain adoption in a Global South context (Alvesson & Kärreman, 2011). Although the present operationalization is in the Ghanaian context, the testability that the data provides expands its scope of application. The underlying principles of afrofemtrism thus lend themselves to applicability in other contexts because it emphasizes descriptive and inductive processes (Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Gehman et al., 2018). I employ these features in each category of afrofemtrism's framework of analysis.

Regarding the methodological framework that afrofemtrism suggests for analyzing and interpreting empirical material, the main components are categorized under the micro, macro, and meso contexts of society. These analytical components are 1) individual, community, and social group dynamics, 2) culture, tradition, and the contemporary setting, 3) overarching national parameters, and finally 4) transnational conditions. These components are reciprocative in that they do not occur on a hierarchical scheme. Different sociocultural contexts and digital innovations interact with social, national, and global dynamics in unique ways. Hence, the subject matter and units of analysis determine how an investigation approaches the micro, macro, or meso terrain. This involves centering the unique meanings that apply to specific variables, as the fundamental causal components themselves differ from one context to the next. Chapter six develops afrofemtrism through an analysis of the gendered sociotechnical environment of blockchain in Ghana.

In the interest of achieving social change where gender injustice is concerned, I engage participants in a self-reflexive process (Bosch, 2011). I explicate and challenge

the culture of exclusion in the ICT arena, which reflects the imbalance of gender power relations to the detriment of women. An ultimate aim is to engender an inclusive digital media environment that encourages emancipatory sociocultural, political, and economic progress (Opoku-Mensah, 2001). This is fundamentally an exercise in confronting established gender hierarchies in their interplay with people's experiences with digital technologies like blockchain. Further, afrofemtrism amplifies the cross-cultural and cross-boundary sites of affiliation in cognizance of the intersecting objectives of activists like the African American feminists. Respecting collaborations and affinities among individuals and communities in different parts of the world, afrofemtrism emphasizes the changing realities of what it means to belong to an African fraternity whether by lineage, location, or by affiliation. The contestations with feminists from the Global North do not take away from the importance of global African, pan-African and Africanist collaborations which acknowledge multiple but shared interests and experiences. Although focusing on marginalized groups from or affiliated with Africa, it is nevertheless important to avoid entrenching the idea of a chasm between women of African descent and women of other ethnicities. Undoubtedly, we cannot adequately generalize experiences without the risk of essentializing certain contexts or ignoring the specificities of some social groups. Notwithstanding, we must take advantage of the "many grounds and opportunities for dialogue, alliance, and solidarity-building with other women elsewhere, self-named feminists especially" (Dosekun, 2019, p. 5). In employing afrofemtrism in this dissertation, I seek to balance the unique realities of the various social groups in Ghana and the recognition of the similarities in their gender makeup based on the Ghanaian context. I advance the ideals of the collaboration of ideas on gender activism with the support of technofeminism's analytical framework.

2.2.3. Theoretical perspectives from the Global North

In science, technology, and society studies, scholarly work on technology proffer perspectives on the relationship between technology and society, with different treatments of the (in)existence of humans' agency. Theoretical undertakings explain the trajectory of technologies from the point of design, through to its production process and eventual consumption experiences. These interrogations focus on scientific, technological, and social interactions. They also consider the level of autonomy that the artifacts and/or humans have in these interactions and in subsequent changes in the

social sphere (Bijker, 2012; Latour 1992; Pinch & Bijker, 1984). Two principal but opposing traditions in the theorization of technology is Social and Cultural Constructivism and Technological Determinism. Their opposition lies in the direction from which they examine technology's effect and impact in conjecturing its relationship with society.

Determinism exists in multiple forms, with its supporters propounding varying degrees of technology's agency in determining the social, cultural, economic, and other evolution of societies. This viewpoint highlights the degree to which technologies drive human thought and action in time and space. Thus, even though humans create technology with certain purposes in mind, they attain life-altering powers in their development and spread to become forces of social change. Ellul (1967) is a key voice in the deterministic camp. He describes the extent to which technology impels civilization and, through inherent logic like efficiency, positions itself as a fundamental impetus of social consciousness (Ellul & Wilkinson, 2011). Postman advocates appreciating the multivariate effects of technological innovations by pointing out that "Every technology is both a burden and a blessing; not either-or, but this-and-that" (1992, p. 4-5). While acknowledging that technological change creates both winners and losers, he asserts these effects occur below the level of social consciousness. Technology develops unpredictably, which overturns social structures, causes ideological transformations, and even destabilizes socially accepted ideas by reconceptualizing phenomena. A contemporary analytical stream in technological determinism is Castells' work on the Network Society which I discussed earlier in the chapter. From his perspective, digital technology incites society's domestic, communal, professional, and other events so much so that the evolution of technology categorizes our chronological progress. Not only does technology determine our pastimes and interest, but it also frames the networks we belong to and the subtleties that determine our position within these networks. Technology's far-reaching tentacles maintain a firm grip on local and global strings of political mechanisms and determine the course of global economies.

At the other end of the spectrum lies constructivist theories, exemplified by Social Construction of Technology (SCOT). SCOT goes beyond the technical considerations of technological artifacts. In this perspective, the evolution of artifacts is not a spontaneous process borne of the scientific and the technical, but a result of negotiating societal factors and social groups. Social, economic, political, and other mechanisms play very

decisive roles in the trajectory of technological design and development. Over time and through adoption and use, these competing interests result in an artifact's evolution to where they might be distinct from designers' initial ideas (Bijker, 2012; Bijker, 1995). MacKenzie and Wajcman (1999) also question the idea of technologies as innovations arising from scientific discoveries independent of social exigencies, and, based on their intrinsic logic, progress to impact our lives. As an illustration, the authors relate how the arrangement of keys on the QWERTY keyboard rose to prominence in the days of the mechanical typewriter as a solution to certain adjacent keys getting stuck due to frequent use. Even though the development of the electric keyboard erased this problem, and irrespective of increased awareness of their lower efficiency, society's conventional preference for the QWERTY keyboard was unshakeable. The versatility of the character of technological artifacts proves that outside of the political, social, and other characteristics of a given context, we must not singularly imbue them with the sweeping causative power in social change processes that determinists give them. Technological determinism is essentially an oversimplification.

Critical theories, on the other hand, unearth the reasons behind the nature of technology's relationship with society. Examining the technological and social contexts from which they emanate, they highlight the biases in technological and social systems. They also show how these biases engage with the design, production, and use processes. They posit questions such as why did the technology evolve the way it did? Which hegemonic ideals do these technologies serve? Feminist analyses of the relationship between science, technology, and society operate with a critical lens towards gender justice. Critical perspectives go beyond the traditional ascription of overarching power of technology to influence society, to analyze the extent to which they become tools in people's endeavors in democratic processes and the achievement of social justice (Feenberg, 2002; Harding, 2008). These explorations run the gamut of dismal projections of negative impacts of technologies on women's world, to descriptions of nirvana where the advancement of feminine ideals in professional knowledge and skills, for example, demonstrate that the future is female. Wajcman considers this a future envisioned with a "fusion of technology with ideals, hopes, and nightmares" (2004, p. 101). In this respect, technofeminism's contribution to this research is to advance the position that society and technology undergo a mutual evolution along a reciprocally impactful course. Technofeminism merges efficiently with the investigation's focus on

deciphering how the Ghanaian society and blockchain are developing. Also relevant is the study's focus on how this evolution engages with the gender digital divide in Ghana. A tangent of science, technology, and society studies, technofeminism emphasizes that society and technology exist in a jointly constructive sociotechnical network. Analyses involving these entities, therefore, need to develop with this interconnectedness in mind.

2.2.4. Technofeminism

This research is a critical outlook on blockchain's adoption and spread in Ghana. I assess the subjective interactions that people have in their practices with blockchain, with an emphasis on gender as a key variable. This analysis is in consideration of the parallel influence of the sociocultural, economic, and political context of the society. Another central dimension is the dynamics at play in the social relations of the participants in the blockchain space in Ghana. Researching on a burgeoning technology like blockchain is relevant because it illustrates the importance of centralizing the realities of various social groups in relation to eminent innovations. I interrogate the ideals and motivations at play among my participants based on the perspective that these are fluid entities that are formed, reformed, and adapted to their changing realities (Wajcman, 2004).

Technofeminism (Wajcman, 2004; 2010) is not rooted in deterministic tendencies of overestimating the impact of technology on society. Rather, it recognizes that technology and society have a symbiotic effect on each other, a relationship impelled by a complex environment of sociocultural, political, economic, and other factors. Therefore, I study gender and blockchain as mutually embedded aspects of society, "in which technology is both a source and a consequence of gender relations" (Wajcman, 2004, p. 7). Technofeminism aligns with my research interest because of my core mandate to mainstream a gendered analysis. This is unreserved advocacy for overturning the prevailing convention where gender is a principal consideration of a research context only when the study subjects are women (Wajcman, 2004).

Another integral aspect of this research will be to go beyond the overemphasis on consumption and representation, to include design and other production processes. I do this by unpacking the conditions surrounding the creation and use of applications built on blockchain platforms in Ghana, with "a technofeminist awareness of men's and

women's often different positions as designers, manufacturing operatives, salespersons, purchasers, profiteers, and embodied users" (McCaughey, 2006, para. 7). Technological determinism is not erroneous in its assertion that technology affects society in more ways than one (MacKenzie & Wajcman, 1999). This study, however, takes the position that technology's impact stems from an intricate combination of the social and other values inherent in the design, production, and adoption processes of the technology, as well as the scientific attributes of the innovation itself.

Furthermore, it is important to explore the conditions that perpetuate gender digital disparities by examining the gendered meanings of blockchain adoption and diffusion in Ghana. To this end, I am faithful to the tradition of technofeminism in highlighting the multiplicity of perspectives in this investigation. This is essentially a reflexive conversation among stakeholders involved in blockchain technologies, who assess their various positions within the socio-technical network (Wajcman, 2010). I examine ideas about the dynamism of the shaping and construction of gender identities, roles, and performativity, as a consequence of and through the digital innovative space. Social interactions nurture these complex constructions, and their repeated enactment concretize them (Wajcman, 2004). Indeed, as the present research demonstrates, the social processes of gender formulation and realization show up even in professional interactions in the blockchain space.

In the wider discussion of digital inequalities, technofeminism is particularly relevant as a framework of analysis because it facilitates an investigation into how the digital culture interacts with gender realities. A key argument Wajcman advances is that technology is not gender-neutral, its design, production, and adoption are socially influenced. The co-construction of gender and technology, therefore, merits rigorous theorization. This must not involve the tendency to give fantastical projections of society's future with technology or bemoan the dystopic social changes facilitated by technology. "Engagement with the process of technical change must be part of the renegotiation of gender power relations. I take this as my central concern, while fully recognizing that gender is not the only axis of social hierarchy and identity" (Wajcman, 2004, p. 8). More pointedly, this theory focuses on how the diffusion and adoption of digital technology link with its impact on gender power relations. Thus, I am interested in the extent to which different social groups benefit from the promises of engaging with ICTs like wealth generation, empowerment, and accumulation of social capital.

Fetishizing blockchain's potential as a panacea for gender digital disparities would cause a deterministic oversimplification of a phenomenon that requires a comprehensive analytical treatment. In blockchain's Ghanaian ecosystem, this analysis integrates "the material, discursive and social elements of technoscientific practice" (Wajcman, 2004, p. 107) to delineate the intricacies of the gender realities presented by the research participants. The multivariate social and cultural elements that facilitate issues like digital disparities and educational deficiencies demonstrate that we cannot generalize effects like the reconfiguration of identities through ICTs. Also, considering how the cultural realities of the Ghanaian society are so deeply embedded in almost all sectors, it would be worthwhile to investigate if ICTs afford the same fluid space for a multiplicity of subjectivities. What is important is to appreciate the extent to which culture influences women's or men's priorities and interests, and how this reflects in the blockchain space.

Inasmuch as the ICT field is male dominated, which underlines the yawning digital gap between men and women in Ghana, blockchain could also present opportunities for subversive enterprises to help overturn inequalities. Endeavoring for change necessitates widening the conversation beyond the penchant for ICTs to establish gender hierarchies. The connectivity between certain technological characteristics and features of the sociotechnical network with which they interact could facilitate positive changes. Digital technologies, therefore, are not unchangeable entities. Their technical content, use, and evolution "are amenable to sociological analysis and explanation, and to intervention" (Wajcman, 2004, p. 33). Situating the sociocultural and economic possibilities with which blockchain interacts in Ghana also means that one must carry out a corresponding delineation of the constraints of the environment. "New technologies are malleable, but they also reveal continuities of power and exclusion, albeit in new forms" (ibid, p. 54). Even with the proliferation of mobile phones, many Ghanaians do not regularly access the internet. Digital illiteracy is high, and the radio and non-smart televisions are still new media for many. Among those who do access the internet, most do so through the mobile phone rather than computers or other such devices. As comparative research has shown, there is a relationship between internet access and use primarily through the mobile phone and lower digital usage, skills, and knowledge (Correa et al., 2018). Therefore, the wider context is integral to understanding the digital environment.

Finally, the criticism leveled at the social constructivist and technological deterministic paradigms gives me a springboard for probing theoretical and empirical explorations of information and communication technologies. Wajcman (2012) asserts that the foundational scholars of technology and society overly focus on the materiality of artifacts, while communication technologies do not lend themselves to this kind of analysis because they are not so material as they are symbolic. Their production and use are for their symbolic purpose, not a material instrumentality. I will analyze this assertion in light of both material and symbolic treatments of communications systems and their linkages to social, economic, and political conditions. For instance, I explore the modes of cultural domestication that the participants might have employed in the adoption of blockchain, as well as what they have observed with other members of the blockchain community.

2.2.5. Social construction of technology (SCOT)

> Studies show that the generation and implementation of new technologies involve many choices between technical options. A range of social factors affect which of the technical options are selected. These choices shape technologies and, thereby, their social implications. In this way, technology is a sociotechnical product, patterned by the conditions of its creation and use. (Wajcman, 2004, p. 34)

This quote underscores the socio-technological processes in the lifespan of innovations. To enrich the in-depth deliberation of the present study's findings, SCOT provides a systematic methodological framework of analysis for engaging my data. SCOT's mission is to open the 'black box' of technological artifacts to unearth the seeming mystery of technological design. In this perspective, social values and interests play very decisive roles in the trajectory of technological design and development. The designer is not the sole determiner of the final shape. They also denote the metamorphosis through which technologies undergo in the process of adoption and use over time, which may undermine a designer's intentions (Bijker, 2012; Bijker, 1995).

In response to technological determinism, this approach theorizes that technological innovations are not valueless and do not determine social change. Social, cultural, political, and economic processes rather shape their design, production, and adaptation (Humphreys, 2005; Pinch & Bijker, 1984; Trevor & Pinch, 1995). Thus, we can analyze the reasons why innovations come to be, and the forms they take, by

considering certain key aspects of society. SCOT, therefore, highlights the contributions and influences of various social stakeholders through the design aspect of the innovation to its widespread social acceptance. A later conceptualization of the framework by its principal proponents (Trevor & Pinch, 1995), engages wider social phenomena that take part in the innovation process beyond the technical and scientific aspects that are more readily recognized. They also take it a step further to investigate the reciprocal effects of innovations on society as well, recognizing that technology and society are not separate entities. In applying SCOT to my research, I will not only focus on the social actors involved in the design and production of blockchain applications within the Ghanaian context, but will also throw light on diffusion, adoption, and adaptation procedures. A fundamental objective will be to clarify how the mutually transformative relationship between blockchain technology, and the wider context of Ghanaian society facilitates or impedes gender digital divides.

The following are the methodological steps to carrying out an analysis of the social construction of technological innovations.

Interpretative flexibility

This component conjectures that technologies come to be through intergroup negotiations over the various interpretations that there could be. The final product is not the only possibility nor necessarily the best or most efficient, but the most widely accepted. Analyzing the emergence and adoption of digital technologies should highlight the social exigencies that contributed to their creation and production. A vital aspect of this analysis is interpretative flexibility. This explains that the progression of an innovation is not linear, but a social activity of scientific, market, and political forces (Bijker, 1995; Cardozo et al., 2013; Flichy, 2007). In agreement with SCOT, Wajcman (2004) also highlights the importance of a sociotechnical system or network. This involves influences on the creation and implementation of an innovation, such as from the technical, cultural, and economic environment. Thus, an artifact's evolution could rely on the existence of another kind of technology or technical system to facilitate its operation. An example is blockchain's dependence on the internet and digital devices such as computers. In line with the contextual influences, its practical functioning emerged from the economic and political principles of having a value exchange system that is free from the barriers imposed by governmental regulations and thereby not

susceptible to economic impacts like the global economic crisis of 2007-2008 (Mueller-Eberstein, 2017; Nakamoto, 2009; Werbach, 2018).

Another illustration of interpretative flexibility is the development of the internet which resulted from an amalgamation of military strategy, big science cooperation, technological entrepreneurship, and countercultural innovation (Castell, 2010; Hassan, 2008). The distinctness of its original purpose from present-day usage illustrates how sociopolitical realities reflect in technologies. The first form of the internet was the Advanced Research Projects Agency Network (ARPANET), a military commissioned project for national security use against nuclear attacks (Castells, 2010). Later, the global diffusion of the Internet was a venture to spread capitalism and establish Anglo-American cultural hegemony (Cardozo et al., 2013; CRASSH Cambridge, 2015; Schiller, 1999). Capitalism's need to exploit social relations promoted widespread connectedness to ensure society's entrapment in the cycle of commodified sport, entertainment, and health services (Hassan, 2008). The evolution of the internet thereby reveals how innovations can adapt to the interpretation of the setting of its diffusion. Principal actors that facilitate this interpretative flexibility are the participating social agents which SCOT designate the relevant social groups.

Relevant social groups.

This refers to the agents involved in the various stages of innovation; design, production, adoption, and use. "The term is used to denote institutions and organizations (such as the military or some specific industrial company), as well as organized or unorganized groups of individuals" (Pinch & Bijker, 1984, p. 414). To fit SCOT's framework, a distinguishing feature about a social group is that they share a system of significance for a particular innovation. After adopting the artifact, the relevant social groups express their concerns with it which could cause modifications to the design. The feedback loop repeats over a period until there is a final product that addresses the problem of the most influential group (Bijker, 1995; Klein & Kleinman, 2002; Pinch & Bijker, 1984).

I am cognizant of the fact that the social groups involved in the technological and social processes of innovations do not operate on an equal footing. There are inherent power asymmetries that privilege particular forms of knowledge per group interests. Additionally, some groups are inadvertently and/or systematically excluded. Also, principal actors may be individuals and may not belong to any identifiable groups at all,

thus important to this investigation is the probable existence of intra-group and intergroup conflicts. Ultimately, these considerations will be analyzed within the parameters of the construction and performance of gender identities (Klein & Kleinman, 2002; MacKenzie & Wajcman, 1999; Williams & Edge, 1996).

It is important not to merely analyze how men and women relate with a technology, but to go beyond that and examine how the power relations between them both shape and is shaped by the innovation (Kline & Pinch, 1996). To engage meaningfully with the context of gender, I will toe the line of Kline and Pinch to study the reciprocal relationship between gender and blockchain through the participants' embodiment and performance of gender identity. Analyzing a gender digital gap necessitates an understanding of any groups who could be negatively affected, beyond their mere exclusion.

Closure and stabilization

After the process of relevant social groups interpreting the modalities of the innovation, the next and final stage is closure. Closure occurs when the social actors progress beyond the negotiation and conflict stage to reach a consensus about the technology. At this stage, there is a cessation of further design modifications and the technology stabilizes into its concluding form. Kline and Pinch in later works (1996) acknowledged that denoting a final stage where an innovation is closed and stabilized enforces too narrow a frame of analysis. This is because with the involvement of new social groups/actors, there is further diffusion and adaptation. Social construction is, after all, a dynamic process as different actors periodically enable interpretative analysis and further modifications.

This research does not engage with closure and stabilization as blockchain is a relatively novel innovation that is still undergoing rapid evolution. Its diffusion in Ghana is a recent phenomenon and is nowhere near stabilized.

2.3. Research questions

As a new media technology that is enjoying exuberant acclamation as the future technology to reconfigure all aspects of human societies, blockchain's fame is global. Its use in Ghana mirrors the worldwide emphasis on cryptocurrencies, although there are

several blockchain-based projects in such sectors as agriculture and land registration. The fact of it being at the beginning stages of the diffusion curve makes this study opportune for establishing a baseline of relevant participating social groups, and how they influence the adoption and development processes of blockchain in Ghana.

The research questions that guide the study are;

RQ 1. In what ways and under what conditions does the diffusion of blockchain innovations interact with socioeconomic conditions in Ghana?

RQ 2. Who are the relevant social groups/actors involved in the design, production, and use of blockchain innovations?

2b. What are the social, cultural, political, and economic structures that facilitate or inhibit their participation?

RQ 3. In what ways do gender realities impact the diffusion of blockchain? And how do blockchain innovations impact gender realities?

3b. How is gender constructed, perceived, and performed by people who engage with blockchain technologies?

These research questions define the purpose of the study and guide the investigative process. In the next chapter, I operationalize the questions using a semi-structured interview method to collect the study's empirical material. Semi-structured interviews are particularly appropriate for investigating the sociotechnical ecosystem of an unseen digital technology like blockchain. To carry this out, I rely on the ideals of afrofemtrism and technofeminism to establish and analyze the complex constitution of the ecosystem. SCOT as well provides an analytical framework to guide the exploration of the stakeholders. The next chapter details the study's methodological approach by describing the underlying epistemological principles, qualitative data collection process, and critical interpretation of the data.

Chapter 3.

Methodology

In this chapter I describe the methodological course of the fieldwork and analysis elements of the study. I begin with an explanation of the epistemological and other framings that guide the steps of the investigation. My empirical methodological approach is informed by a fusion of characteristics from afrofemtrism, technofeminism, and the social construction of technology (SCOT). These theories facilitate a methodology that highlights the applicable sectors of the Ghanaian society that come into play in the blockchain community. Afrofemtrism and SCOT especially lend themselves to an analysis of the social groups which are driving the diffusion of blockchain and the forms that their engagements are taking. Technofeminism ensures I supplement their methodological steps by paying attention to gender relations in the sociocultural and professional spheres. This will provide a better understanding of the pathways that blockchain has taken so far and could traverse in relation to the gender disparity in digital cultures in Ghana. I then discuss my primary data collection technique, which was semi-structured interviews with a snowball method for recruiting participants. Next, I explain the analytical steps I took with the empirical material. I end the chapter by discussing the advantages of my methods, as well as the challenges that I encountered in the field and how I addressed them.

My social ontological process in this research is to understand the nature of the relationship between the constituents of Ghana's blockchain sociotechnical system (blockchain and the people interacting with it), and how the underlying structure of the wider Ghanaian society influences this relationship. In this regard, aspects of the context that I focus on include how participants' lived realities as gendered beings interact with their participation in the blockchain space. As well, how blockchain simultaneously relates with these realities is a vital consideration. Based on this, I discuss the dynamics of the sociotechnical system's impact on the adoption patterns of blockchain in Ghana and the manner of diffusion. Research establishes that the gender digital divide is modeled on already existing social inequalities (Hilbert, 2011; van Dijk, 2020). Therefore, social groupings like gender, education, and ethnic groups encounter barriers in areas such as health and political engagement as well as with digital technologies. I critically

delved into these issues to highlight how the dimensions of the disparities in the blockchain space could address the gender digital divide. In this sense, my goal was to identify pathways to mitigating the gender digital disparity in general, with the specific instance of the blockchain society in Ghana as an example. I employed an interpretive strategy to draw meaning from the blockchain community in answering my research questions. Technofeminism is a valuable theoretical framework in this regard because it gives me space to carry out a critical analysis of the hierarchies inherent in the gender relationships in and out of the sociotechnical system.

My lived experiences as a female Ghanaian researcher guide the way I applied technofeminism and the social construction of technology as theoretical frameworks for both data collection and analysis. The epistemological starting point of my research, which I expand on in the next section, also shaped my subjective positioning during this investigation. Epistemology here refers to the architecture and parameters of knowledge and the avenues for its justification (Audi, 2010). The specific focus for this study is a concept of knowledge from an African perspective, embedded in normative structures and ideologies and based on conventions. A central tenet of what constitutes knowledge in an African context is that realities are borne of tradition and remembering (Appiah, 2005; Museveni, 2005). Added to this is a feminist epistemic view that knowledge is framed by the concrete embodiments of our material existence. This involves components such as race, gender, and class identities, and their manifestation according to settings of period and location (Campbell & Wasco, 2000; Narayan, 2004). To interrogate my subjective positioning, I engage with Ratner's (2002) counterargument to the position that subjectivity is opposed to objectivity in research. Indeed, cognitive activity, the perception of any reality, and how we communicate these in an investigation reveal a certain criterion which is itself culturally constructed in time and space. The values that undergird a truth are, therefore, nonexistent outside of the researcher and features of their context, like their academic culture and religion. This notwithstanding, subjective or objective views with which one approaches the analysis of a phenomenon do not formulate the inherent facts espoused by the research subject. The approach I took was to recognize the importance of constantly questioning if my subjectivity hinders objective comprehension, or rather enables it. In this way, I maintained an exercise of objective conceptualization while appreciating how my values and knowledge systems interacted with the data (Ratner, 2002).

3.1. Epistemological framing

I situate the data within the sociotechnical context of blockchain enthusiasts in Ghana while engaging with the larger economic and political structures of the country. This is based on my epistemic framing which foregrounds a consciousness of the centrality of culture and tradition in African knowledge systems, as well as ways of knowing borne out of the interplay between our material realities. Employing a qualitative data collection method was essential to a comprehensive investigation on sociocultural positionings in a digital technology space with both material and symbolic dynamics. Afrofemtrism and SCOT provided the methodological tools in terms of the aspects of the sociotechnical system to be analyzed. A key component of that, in the interest of this research, was the agency of the relevant social groups, and the meanings they make and share of the technology. These considerations were integral guiding principles to the methodology I employed for my data collection and data analysis.

Later iterations of SCOT have sought to address shortfalls in the original work of Pinch and Bijker, such as the reciprocal relationship between society and technology (Kline & Pinch, 1996). They have also highlighted how gender is an important characteristic especially during the interpretative flexibility phase where social groups create and employ meanings of a technology. However, technofeminism supplies a more in-depth perspective for the power relations among social groups and its influence on the evolution of technologies. It directly unearths the link between digital technologies and gender relations, making gender considerations a principal aspect of any research and not just an addition. Afrofemtrism takes these perspectives to the heart of an African context through its emphasis on the relationship between the individual and community, the culture, and national and transnational components. These epistemic foundations, therefore, grounded the methodology of my investigation in a well-rounded manner.

3.2. Data collection methods

I employed semi-structured interviews framed by ethnographical principles as my data collection technique. Although I am a Ghanaian woman with an emic understanding of the Ghanaian context, I recognize that the perceptions of the members of the blockchain community in Ghana are unique to their own experiences. Hence, I explained

to the participants that they could say as much as they wanted or withhold what they were not comfortable divulging. This is because the study privileged their stories, thus legitimizing their lived experiences and opinions (Harding, 1986). Inasmuch as the principal aim is to gain a holistic view of the components of the sociotechnical environment, the research objectives necessitate an in-depth understanding of the participants' sociocultural context through the prism of their beliefs and in their own words (Hay, 2010; Lindlof & Taylor, 2011).

3.2.1. Interviews

As a social inquiry, this study took an interpretive approach consisting of semi-structured one-hour interviews with 33 participants. Interviews as a qualitative method were crucial for probing the contextual intricacies of respondents' motives, behaviors, and actions. It was also a decisive tool to examine the reasons for their execution of the gender frames in the social and professional relations in which they partake. Hence, I chose semi-structured interviews to achieve an adequate exploration of the perspectives and meanings that undergird the processes and structures involved in the sociotechnical environment (Wong, 2008).

The in-depth semi-structured interview format was valuable in widening the breadth of information that respondents gave. It also revealed diverse aspects of cultural barriers and perceptions regarding gender and digital technologies. Additionally, they facilitated an environment of natural interaction between researcher and participants. A final value that semi-structured interviews gave was the elimination of any perceptions of hierarchy that could unduly influence the research participants' responses (Babbie & Benaquisto, 2014). I adapted the research to the sociocultural climate, which furthered a better comprehension of the reasons for certain decisions, and why social actors perpetuate certain practices. For instance, some of the questions covered their socialization and if or how they perceived these backgrounds to influence their engagement with blockchain. They also discussed the unique circumstances under which they were first introduced to using ICTs in general, and blockchain specifically. Situating data collection methods in the sociocultural climate efficiently highlighted the interdependence between blockchain technology and the social context (Walsham, 1993).

I also employed a semi-structured interview guide. This was useful because I knew that I was interested in unearthing the intricacies of the interaction between society and blockchain, but I did not have the answers. The format, therefore, gave me room to develop a conversation where the questions served as prompts but did not constrain responses and allowed for follow-up inquiries. The interviews were open to adaptation depending on the illustrations and connections that interview participants wanted to bring into the conversation. At the beginning of each interview, I explained to the participants that even though I had an interview guide, our conversation did not have to be specific to the questions. The process privileged any descriptions and information that they wanted to provide to establish the underlying patterns of the environment (Morse & Field, 1995). In some cases, this flexibility led to a logistical challenge during the transcription process, because some conversations extended well beyond the one-hour timeframe. Overall, the study benefited greatly from this interpretative process, as it resulted in research participants collaborating in the construction of meaning within the ambit of the social shaping of blockchain technology, and how it, in turn, shapes gender realities.

I conducted 20 interviews while I was in the field and the remaining 13 from Vancouver. Interestingly, only two of the conversations occurred in-person. The rest were virtual, even while I was in Ghana. In my recruitment emails to the participants, I established that our meeting would be in the setting of their choosing. This could be in person, via phone call, or virtual means like WhatsApp or Skype, which are two very popular social media platforms in Ghana. Most of the participants preferred either phone calls or WhatsApp. One participant who had consented to the interview had scheduling challenges and had to change our appointment dates several times. I was particularly interested in talking to him because he is one of the founders of the Ghana Blockchain Society. This is the most organized and consolidated group of blockchain enthusiasts in Ghana. He has also established the first blockchain-based educational institute in the country. I was certain that the information I would get from interviewing him would be a valuable addition to my data. I, therefore, offered to send him WhatsApp voice notes of the interview guide, and he would send me voice notes of his responses at a time convenient to him. This technique was particularly useful as the extra flexibility encouraged him to elaborate extensively and provide numerous illustrations.

3.2.2. Recruitment of interview participants

The research's units of analysis were blockchain enthusiasts who work as independent traders, or with various blockchain-based projects. I did not have any exclusions in relation to age except for minors. I also did not establish an inclusion or exclusion criteria relevant to physical and psychological condition or demographic group. I was open to interviewing people regardless of nationality, educational background, or any other social grouping, so far as they engaged actively with blockchain in Ghana. The only structure I sought to maintain was in the gender parity of participants. I aimed at speaking with 15 men and 15 women. This was important because the investigation is best served with a balance in the perspectives and experiences of both genders (Campbell & Wasco, 2000). The sociocultural processes that come together to frame gender identities permeate all aspects of society, including the professional realm. In this sense, the views presented by the different genders proffer a broad panorama of the complex social forces and practices that create blockchain's ecosystem in Ghana (Haslanger, 2017). Because of the underrepresentation of women in this field, however, I was only able to speak with 12 women. I detail my recruitment difficulties below.

I consider this an illustrative sample, meaning 33 people of such diverse backgrounds, interests, and experiences gave a splendid vista of the blockchain community without claiming representativeness. However, this number of participants also established adequacy in describing the space based on the commonalities in the information that they gave (Boddy, 2016; Morse & Field, 1995). To wit, by the 20th interview, I had reached information saturation. Conversations with respondents did not provide fresh insights beyond the data given by the previous informants (Creswell, 1998; Taylor et al., 2015). This, therefore, bolsters the generalizability of this study's outcomes particularly in line with the transferability of the parameters of the data collection, analysis, and contextual interpretation of the findings (Carminati, 2018; Delmar, 2010). The potential relevance of a broader application of the analytical framework used in this study lies in its contribution to critical analyses of experiences and adoption patterns in ICT spaces and their interaction with the wider social structures (Barbour, 2014). A valuable feature of qualitative research is the richness of descriptions that respondents give. The multiplicity of meanings and interpretations that I obtained about their experiences lends credence to a system of validity that does not privilege single perspectives (Boddy, 2016; Eisenhardt, 1989). The empirical material from the

interviews reveals that there are so many levels to the stakeholders in the blockchain space. This research is thus foundational in the knowledge gap it fills with the intricacies of the Ghanaian blockchain society.

I began identifying and communicating with potential participants through social media platforms (Twitter and LinkedIn) as soon as Simon Fraser University's Research Ethics Board approved the study's ethics application (REB# 20180590). I searched for people who identified themselves as blockchain enthusiasts/professionals or any such similar term. I also scoured news articles on blockchain in Ghana, identified persons mentioned in these articles who worked in some capacity with the technology and then searched for them on social media. This aligns with the concept of the digital domain as a research instrument (Quinton & Reynolds, 2018). Digital platforms thus served as facilitators for identifying and connecting with participants. I sent them messages identifying myself, introducing the study, and inviting their participation. I then sent formal recruitment letters as well as informed consent forms. The consent form clearly outlined that should they choose to participate in the interview, they were free to withdraw from the research at any point if they so wished with no consequences whatsoever.

I was in Canada when I first started recruitment efforts and hoped to arrange some interviews before I arrived in Ghana for fieldwork. My eagerness, however, quickly waned when I repeatedly faced roadblocks. I received very few responses, and those who did respond and were open to virtual conversations kept rescheduling our appointments. It became increasingly apparent that this method of communication would prove problematic if it were my primary technique for recruitment. I needed to find avenues to interact face-to-face with some prospective interviewees to enlist their participation. When I first got into the field, I went to a blockchain meetup and fraternized with several attendees. This was largely successful as some of them became interview participants. Because of the problems I faced in enlisting new participants without a prior introduction or personal encounter, I switched to a heavy reliance on a snowball technique to recruit more participants. After each interview, I would ask the participant if there was someone else they could recommend for the study. The interviewees could either ask the potential participant for consent to give me their contact information or they could forward my contact information and an information letter to them. This way they could get in touch with me if they were interested in participating. The participants mostly opted to communicate with their recommendations first and then pass on their

contacts to me if they agreed to the interview. I always emphasized my interest in speaking to more women because I was having a hard time getting female participants. This difficulty resulted in my engagement with more male than female respondents, 21 men versus 12 women. An interesting trend I noticed among blockchain enthusiasts was that they mostly connected via social media platforms. WhatsApp was their primary communication channel. Many participants informed me they did not personally know the people they recommended to me beyond WhatsApp chats on cryptocurrencies. A final participant recruitment avenue I used was direct messaging to members of the Blockchain Society of Ghana WhatsApp group. One organizer of the meetup I attended who is also an administrator of the WhatsApp platform invited me to join the group after our interview. However, I only recruited two participants from here. The most likely reason for this difficulty is the same for the other people I interacted with on other social media platforms. They could not trust someone with whom they did not have a prior connection.

3.3. Analysis

Babbie and Benaquisto (2014) define qualitative analysis as “the nonnumerical examination and interpretation of observations, for the purpose of discovering underlying meanings and patterns of relationships” (p. 373). Arriving at the underlying meanings and fashioning out thematic patterns involved a rigorous process of information comprehension, analytical, and critical thinking. Of the 33 participants, 32 consented to my audio recording our interviews. I made notes during my conversation with the one participant who preferred that I did not use a recorder. I then undertook a preliminary analysis while transcribing the recordings by rereading and correcting the information to ensure that the data was accurate. Additionally, I used an inductive data analysis process for this study through the qualitative analysis software NVivo. My coding approach was data-driven. This means that I did not have predetermined themes under which I intended to classify the information derived from the interviews. To eliminate the limitations that predetermined categorization can give, I used open coding to elicit emerging themes, interconnections, and categories (Dudovskiy, 2018; Eisenhardt, 1986; Thomas, 2006). By so doing, the coding frame provided a valid description of and matched seamlessly with the material (Eisenhardt, 1986; Schreier, 2012).

I started coding by reading through all the interview transcripts to identify patterns that run through the experiences and opinions of multiple participants. Based on this, I highlighted emerging themes to develop a preliminary thematic coding scheme. I then reread the transcripts in a more detailed manner to edit and refine the multilevel codes. The patterns I outlined facilitated my process of synthesizing the data, drawing meanings from, and interpreting it. This included making connections between the various themes culled from the data and highlighting similarities and contrasts (Dudovskiy, 2018; Wong, 2008). I also created memos to note other details that arose which would be helpful during the analysis (Babbie & Benaquisto, 2014). In order not to influence my coding process with predetermined labels, at this stage I did not involve any ideas from the theories on which I based this study. However, when I was through with this initial analytical phase, I consulted the literature as a basis to easily identify unique occurrences in this research context (Morse & Field, 1995; Thomas, 2006). The appropriate representation of the multiple realities presented by the participants establishes the credibility of this investigation. To guarantee this, I employed strategies like consistently keeping an open mind, being conscious of my subjective positioning, prolonged and sustained collaboration with participants, and documenting deviant cases even if they do not fit with the major categories. I also undertook peer debriefing with participants and colleagues who are knowledgeable about the field and communicated with participants to verify data (Eisenhardt, 1986; Morse & Field, 1995).

I recognize that dominant discourses in my academic and sociocultural upbringing shape my viewpoint and theoretical background. This could influence the study's representation of reality. As a scientific process, however, my investigation takes a critical view of this tendency, and I openly presented my values and their role in the research process. I also integrated multiple participants' viewpoints into the analysis and interpretation process. I delineated the multivariate perspectives of the research setting in a way that clarifies my stance and that of the participants. This helped ensure consistency and evict possible personal biases (Barbour, 2014; Dudovskiy, 2018). To remain faithful to the context of events and experiences, I use descriptions extensively, especially through the illustrations that the interviewees themselves provided (Babbie & Benaquisto, 2014; Eisenhardt & Graebner, 2007). The thick descriptions and inclusion of verbatim participants' accounts further ground the study's analysis in the research context. Therefore, the voices of the research subjects are invaluable to ensuring

transparency in the analytical process and bolster my interpretations (Corden & Sainsbury, 2006). The next section outlines the trials and benefits that I experienced, especially in the data collection phase of the study.

3.4. Challenges and advantages

My principal advantage in this investigation was my familiarity with the sociocultural nuances of gender relations in Ghana. Added to this was my general familiarity with people's interactions with digital technologies in terms of access, use, design, and production, and how they fall along gender lines. This insider advantage (LaSala, 2003) was instrumental in many ways, including in the development of my interview guide, as it helped me to construct culturally appropriate questions. It also facilitated my rapport with participants during the interviews because I could appreciate references they made to certain phenomena, and appropriately ask follow-up questions to tease out further information. Nonetheless, to ensure that I was not being overly presumptuous in my familiarity with the sociocultural context, I was self-aware of possible biases throughout the study. Also, I consistently asked for descriptions and further explanations if an answer that an interviewee gave was contextual and an outsider could not readily relate to it. I endeavored to remain objective throughout the interview process by not overtly demonstrating to the participants that we shared common knowledge. I did this to avoid assumptions about familiarity that could be wrong. This also involved refraining from proffering my personal views (Hellawell, 2007; Morse & Field, 1995).

Added to this, I frequently straddled the fence between my position as an outsider-researcher and insider-Ghanaian. I joined the Blockchain Society of Ghana WhatsApp group, which has a membership of 204[4] participants. I am not an active participant in the many vibrant conversations that the members have about blockchain, hence, I would not consider myself a member of the community per se. Not only do I not regularly converse with them, but I also do not have the business and other connections that most of them share. Additionally, outside of the few ones that agreed to participate in my study, the majority of the society members do not know me at all, and neither do I

[4] Number of participants in April 2021

know them. However, being privy to these conversations provides me insight into members' interests and innovations. In many instances during the interviews, I found myself moving around on an insider-outsider continuum (Hellawell, 2007), based on the substance of the conversation and how much I could identify with their experiences. This contrast between my knowledge of the general Ghanaian sociocultural reality, but an alien position in the specific blockchain society, is advantageous because it facilitates what Lewis (1973) calls a 'perpectivistic knowledge'. This is the idea that reality is multidimensional, thus accepting a single so-called objective stance based on the positioning of the researcher presents just a partial reality. "[T]he varied perspectives should be complementary, although differing in focus and problem" (ibid., p. 586). Thus, it was important for me to reconcile the different viewpoints concerning individual and group interests with my own understanding.

My attendance at the Ghana Blockchain Society's networking event was very useful. It was integral for me to ground myself in the sociotechnical environment through my interactions with blockchain enthusiasts (Morse & Field, 1995). Because I did not consider this as a data collection site, my focus was to network with community members and establish connections. I was especially interested in building a rapport to invite their participation in the interviews. During the networking breaks, I found out that most of the attendees with whom I spoke also came for networking purposes. Their main agenda for attending was to socialize with other enthusiasts because the social dynamics of blockchain society in Ghana presently propagates primarily virtual connections. This was therefore a good opportunity to make in-person connections with like-minded individuals and share information on trade and investment opportunities. This event, however, was a precursor to my challenges in diversifying my interview sample space.

Being there made me aware of the difficulty I could encounter in trying to access female participants. I was one of the only two female attendees in a population of about 40 participants. I spoke with one of the facilitators and I asked if he knew female blockchain enthusiasts in Ghana. He said the only woman he knew that had a close connection to blockchain was the wife of his associate. Her participation in the space was through her marriage to an enthusiast, not necessarily based on her own actions in the space. Several of the connections I made also drew blanks when I asked the same

question. There was one female speaker, who agreed to an interview for this study. She did not know any other women to connect me with after our conversation.

Another challenge I had with the interview process was the state of internet access in Ghana. Not only is it relatively expensive for the average person, but infrastructural challenges also sometimes make the connection tenuous even in urban areas. As I have already discussed in earlier sections, most of my participants opted to connect via phone call, WhatsApp, or Skype rather than have an in-person conversation. The bad internet connection made our conversations quite challenging at times. For approximately 50% of the interactions, I had to ask interviewees to repeat responses they had given because I was unsure if my recording device had adequately captured their submission due to the breaks in the call. While I was in Ghana, I was able to work around this because I could offer to call them on the phone as a solution and that always worked. However, certain conditions necessitated scheduling some interviews in the period when I had returned from the field. The first one was the difficulties I had in finding female participants, thus lengthening the interview process. Secondly, since I had to operate on their availability, I had to accommodate the few participants that said that waiting till the period after my time in the field would be most convenient for them. A phone call was no longer a viable option in these cases because of the expensive international call rates for conversations of this length. The best resolution was to use two different recorders with the hope that these would help to capture as much information as possible.

Blockchain has come to have a negative reputation among many Ghanaians because some of the earliest adopters scammed many people when cryptocurrencies first boomed as viable investment options in Ghana. With little understanding of the inner workings of purchasing coins and keeping a wallet, many people use middle persons who act as brokers. This increasingly commonplace situation is what is driving the instances of crypto scams because in several cases, the brokers abscond with people's monies. The perception of possibly being defrauded presented a challenge in my recruitment process. In a few instances, people did not respond to my communication via platforms like LinkedIn. Later, third parties connected us and based on the introduction they were willing to be interviewed. Even though my recruitment message did not mention anything about investment or crypto trading, they still preferred not to communicate about blockchain at all with a stranger unless they were sure they could be

trusted. My employment of the snowball recruitment method was, therefore, the best resolution to this issue. Having a mutual contact establish my connection with prospective respondents eliminated the distrust barrier. These recruitment complications resulted in three extra participants beyond the initial goal of 30 as respondents who had initially been hesitant later contacted me and consented to the interview. Even though I had attained the set number of participants, I opted not to refuse their participation because they were women, and I was eager to augment my meager female sample.

My next chapters delve into the details of this unique environment in which blockchain is enmeshed and how this is building Ghana's blockchain sociotechnical network. In chapter four, I start with a broader discussion about blockchain instantiations in the Global South and its distinctive evolution along the lines of meeting social needs. This is an initiation of the afrofemtric analysis by introducing transnational conditions as an analytical component. This involves an investigation of global conditions that relate to Ghana's local setting. Although this study is set in Ghana, the next chapter is an opportunity to establish connections between the various blockchain settings in the Global South and the intersections between the realities that come to play in this space. In chapters five and six I present a more detailed panorama of the sociocultural context of blockchain's adoption in Ghana. I end with an analysis of the emerging relationship between gender realities and a digital technology with such a promisingly impactful future.

Chapter 4.

Blockchain in the Global South

Although approximately 49% of the world's population do not have access to the internet, over 4 billion people exist in a veritable network society (Castells, 2010; International Telecommunications Union [ITU], 2020; United Nations, Department of Economic and Social Affairs, Population Division, 2019). Digital technologies have such a profound presence as their application in diverse aspects of society's life processes appears to be second nature. Widespread use of the internet ushered in a revolutionary social consciousness about connectedness across and within borders, a phenomenon that continues to permeate all spheres of contemporary life including the professional, economic, and political worlds. Numerous societies live a deeply digital reality from which innovations are constantly being churned out, spurred on by the internet as a bedrock (Castells, 2010; Rainie & Wellman, 2012). One such innovation emerged on the heels of the global financial crises which devastated economies worldwide. The pseudonymous Satoshi Nakamoto birthed blockchain technology with the introduction of Bitcoin (2008). The technology is premised on the power of the internet to link users participating on a shared platform, whose digital connectivity enables a certain simultaneous storage and maintenance of a distributed ledger from which people can exchange anything of value.

In this chapter, I discuss the permutations of blockchain's adoption in the Global South to establish a wider context for the later conversation on blockchain in Ghana. These linkages are especially pertinent because of the parallels between the gaps that blockchain applications aim to fill, and how the discursive components impact the focus of adoption mechanisms. Afrofemtrism argues that an adequate critical analysis of local adoption processes requires a comprehensive picture of the global ecosystem of digital technologies, as well as the specific transnational instantiations of blockchain technologies. Indeed, shifting global centers of power in the dynamic sphere of digital innovations helps to situate the framework of possibilities of blockchain's potentialities (Csikszentmihalyi et al., 2018). Before delving into the Global South's sociotechnical involvement with blockchain, however, in the first section of this chapter I define and describe blockchain technology and explain what it is, what it does, and what it means.

4.1. Introducing blockchain

The birth of blockchain occurred against the backdrop of the network society with its intriguing mesh of virtuality, symbolic realism, and privacy mechanisms. Considering its intrinsic quality of interconnectedness among users, blockchain technologies remain true to the values of the information age through the elements of speedy transactions, sharing, and horizontal information processing. Much like digital trends like big data and artificial intelligence, blockchain has become a buzzword in the chain of technological paradigm shifts marking the digital face of the network society. In sum, blockchain is a decentralized digital database powered by the Internet and run by a network of users who operate on an automated consensus (Swan, 2015; Werbach, 2018). Users on the database can effectuate varying kinds of transactions by exchanging digital goods in a largely secure manner. They record the entire history of all transactions in the order in which they occurred. This helps to detect any manipulation and counterfeiting of data. The name of the technology explains the process that ensures this security. “Block” stands for the batched and codified transactions which are time-stamped and locked in a block of data. The word “chain” refers to the cryptographical connection that is made between all the blocks on a platform. Blockchain is thus an immutable, shared ledger of interlinked blocks of codified information. Transactions can be anonymous with the persons involved being primarily identified with individualized identity markers as codified addresses. Each of the participants or nodes which form the network maintains a copy of the database, thus making records immutable, as it is virtually impossible to modify records on each node (Maslova, 2018; Tappscott & Tappscott, 2016).

Due to its characteristics of trustlessness, ensuring accountability in the exchange of value, and ability to circumvent traditional systems of identification, blockchain is a system of the future with solutions for gaps in various spheres of life (Cao et al., 2020; Kewell et al., 2017; Swan, 2015). A blockchain platform can be private and, therefore, limited to users from agencies involved in a specific project, publicly accessible like Bitcoin’s platform, or a hybrid of the two. To further my discussion of blockchain in this section, I will start with an explanation of key components before expounding on the workings of the data structure. I would like to note that these explanations refer to the most fundamental aspects. With cryptocurrency applications being the foundational implementation of blockchain, the following explanations are most

applicable to the system in that field. There are several modifications in its execution depending on the industry or context in which blockchain is being applied.

Automated consensus on a decentralized ledger

The idea of the automated consensus lies in the disintermediation that blockchain occasions. Users collaboratively manage the documentation and transfer of ownership of items of value on the distributed ledger. More broadly, this refers to the process where participating users on the blockchain system collectively agree on information about ownerships and transactions. There is, however, more than one kind of consensus mechanism, it depends on the blockchain platform. I will discuss the two most popular ones, Proof of Work (PoW) and Proof of Stake (PoS). The pioneering Bitcoin blockchain is based on PoW, while the second most popular blockchain Ethereum employs PoS. With Bitcoin, for example, the users achieve this consensus process by working out computationally generated algorithms to verify and agree on transactions (explained in detail below). After a miner solves the computational puzzle, the other nodes verify and agree to the resolution before they lock it into a block. Users who verify transactions on a PoS system work in randomly constituted committees which the system disbands after a set number of transactions. In this case, consensus does not have to be among the entire network of users (Cao et al., 2020; Ogino et al., 2021). The users on a blockchain platform are commonly called nodes or peers. They are essentially witnesses to transactions and the storehouse of all transactions that have ever taken place on the ledger. Nodes communicate with each other and access the blockchain platform through the internet, which facilitates instantaneous and consistent interaction. The blockchain ledger is decentralized because all nodes maintain versions of it. New information on transactions is regularly forwarded among them, and even those who disconnect from the network and reconnect later can update their storage accordingly (Drescher, 2017; Werbach, 2018).

Protection of data

To understand how users keep information private and protected on the blockchain, we must first understand hashing. Here, mathematical algorithms encrypt data by generating unique codes which identify said data. These codes, called hash value, functions, or references, are significantly smaller and therefore take up less space than the original information. In essence, information like deeds to real estate property stored

on the blockchain is encrypted and uniquely identified through cryptographic hash functions which do not resemble the original information at all. Another important point to note about protecting data is that hash functions are effective in authenticating anonymous data because they have a one-way function. This means that one cannot retrieve the original data that is converted into creating the resulting cryptographic hash value. The process also ensures that different data cannot have matching hash values, thereby preserving their unique markers (Drescher, 2017).

Furthermore, hash references are the digital fingerprints that nodes use to authorize and authenticate transactions. Thus, even though a blockchain system can be open to everyone, the system uses digital fingerprints as measures to ensure that only the owner of an account has the authorization to transfer ownership and goods of that account. In the cryptocurrency sphere, account holders could also have unique cryptographically generated private keys that grant them access to their data. Using the private keys, they can create digital signatures for each transaction to authorize them as well as to verify them. Accordingly, the cryptographic data of the digital signature as well as the cryptographic text of a transaction need to match, therefore authenticating the account as the originator of the transaction. All nodes on the platform would have public keys which they can use to decipher information about transactions and verify the account which authorized them (Drescher, 2017; Tapscott & Tapscott, 2016). The next section explains how users operationalize transactions.

Exchange of digital goods

To transfer ownership of goods between accounts, blockchain platforms use asymmetric cryptography. This is where an account holder encrypts the information of a transaction they want to undertake, by creating a cryptographic hash value of the transaction's data. This data could be the accounts involved in the transaction, the value of the property to be exchanged, and the conditions that must be fulfilled for the transaction to be implemented, for example. Each transaction, therefore, has a unique transaction ID. This hashing process generates both a private key, which only the account holder accesses and a public key to which any member of the platform has access. Nodes use the public key to decipher the hash value of the transaction. The process is asymmetric because only the originator of the transaction has the exact details of the transaction data, while

everyone else can access the hash reference, not the exact details. Hence, public keys do not grant participants access to the originating account (Drescher, 2017).

Verification of transactions

When a transaction occurs, that is someone transfers their digital good to another person in exchange for another item of value, the details of the transaction are recorded through algorithmic procedures. The peers then operate on a consensus to verify the transaction and accept its storage onto the ledger. The validation procedure for the PoW consensus mechanism is known as mining. The validating nodes are miners, they expend time and computational resources to solve mathematical hash puzzles that each transaction generates to arrive at the hash reference. This is an energy and time-intensive procedure which requires high-powered computer processors, and in some cases, specialized devices used in professional mining operations called mining farms (Drescher, 2017; Kewell et al., 2017; Tapscott & Tapscott, 2016). The amount of time and energy that it costs miners to verify transactions is the principal impetus for Ethereum's transition from PoW to PoS. With PoS, validators stake their cryptocurrencies as collateral for their validator status. In this context, the platform algorithmically apportions transaction processing to validators based on factors like how long their currencies have been staked, or how many coins they stake (Cao et al., 2020; Kim et al., 2021; Won, 2020). This means they do not need to employ the cutting-edge computers that miners need as there is no race to solve the hash puzzle. Ethereum now runs the beacon chain, a network that operates a PoS consensus parallel to the existing PoW platform. Developers are working towards eventually fully transitioning into a single platform which only runs on the PoS consensus layer (Kim et al., 2021; Ogino et al., 2021; Rossi & Rouge, n.d.; The Beacon Chain, 2021).

A transaction is considered duly verified when a miner's or validator's solution matches the hash reference of the transaction. After their verification, and once the nodes reach consensus, transaction data is locked into a block on the ledger. In the specific instance of cryptocurrencies, miners and validators who work to verify the transactions get rewards for their efforts. The reward system differs per platform, but they are primarily in the form of cryptocurrencies. The rewards system is based on speed (PoW) and quality of work (PoW and PoS), as I will explain in the next section which deals with locking blocks onto the ledger (Cao et al., 2020; Drescher, 2017).

Storage of transaction data in linked blocks

Storing and securing transaction details in blocks is an intrinsic aspect of clarifying ownership. A blockchain ledger preserves the entire history of all transactions that transpire in the order in which they occur, as well as identifiers of the accounts that take part in the transactions. This provides further attestation to state of ownership of digital goods. As I have mentioned previously, the blockchain system relies on cryptography to ensure data privacy, authentication of ownership, and authorization of transactions. Miners and validators process transactions in consensus. They build the blockchain structure by undergoing these transactional processes to add validated blocks to the platform. To achieve this, for PoW every miner can compute the hash puzzles to process transactions and add blocks to the system. They agree among themselves that whoever submits their solution first gets the reward. Solving the puzzle for the hash value is difficult and complex work, but verifying it is easy. Thus, to ensure the quality of work, all nodes can act as supervisors by reviewing the submitted solution to establish that there are no errors. This peer control maintains the integrity of the system in that only authorized and valid blocks are locked in. Under these circumstances, when a review of a block finds instances of errors, the node that validated that block can be punished in various ways including by having their reward withdrawn. Validators who work with the PoS on Ethereum also work in consensus to uphold data integrity. Validators are randomly grouped into committees to attest to the integrity of a transaction. These committees are disbanded and validators are reassigned regularly. PoS, therefore, ensures greater speed in transaction verifications and storage as consensus is not among the entire network of users. In their case, if they commit errors or jeopardize the integrity of the system in any way, they lose their collateral (Cao et al., 2020; Drescher, 2017; Ogino, 2021; Won, 2020).

To guarantee that all data is stored in a change-sensitive manner, blocks of information are stored progressively and linked to the previously stored block because they contain their hash reference. In other words, each block has a reference to the preceding block, thus securing the chronological order. This chain of linked data is consequently secure because any modifications to one of them would alter all the others in the chain. These connections between blocks are vital because they render the ledger sensitive to change. Although blockchain systems prevent manipulation of stored transaction data with the inability of locked blocks to be modified, further information can

be added to the platform through the same process of an automated consensus and locking in another block, which is also connected to the entire system (Drescher, 2017). To illustrate, the blockchain ledger is akin to a digital filing system in which each file contains encrypted text to the identification details of members of a society and all the files are chronologically numbered and linked. Assuming that this is an anonymous society, the only way for someone to prove they are a member is to have their file in the storage system. The system is then set to trigger an alert if a file were to be modified. If someone were to attempt to deny a person's membership by deleting their file, it would trigger an alarm to the entire system because the omission of one file number would cause the number system to become askew. By the same token, if they were to try to modify the identification details of one file, they would also be caught because the subsequent file has a reference to the exact details that this file contains, which would mean the infiltrator would need to attempt to modify all the linked files just to manipulate their target.

Thus, if any details of a block were to be changed, whether it be transaction details like participating accounts or the transaction's hash reference in the locked block, it invalidates the links within the blocks and taints the entire data network because of their interconnection. To avoid this, one would have to not only change the specific reference but all the subsequent ones in the connected blocks as well as all the hash references that form the links between the blocks. Further, the stored database on all nodes would have to be updated to reflect this modification. This is only possible in the event of a 51% attack, which is when a sole entity controls the majority of the hash rate which would empower them to override all nodes on the platform and control transaction records. This "radical all-or-nothing approach" (Drescher, 2017, p. 132) is the system's effective way of deterring manipulation of data. We say that data on a blockchain is immutable, because firstly the adjustment in stored data will alert the other participants to the inconsistencies in linked hash references. It would also cost considerable time, energy, and money to invest computing power in attaining the 51% control to manipulate the entire database to match the modification. Finally, the most recent block is called the head of the chain. It is the most adequate reference point to gain information about the previous blocks. Thus, nodes can access the history of all stored transaction data by going in reverse order from the head of the chain (Drescher, 2017).

Systematizing integrity, engendering trust

To summarize, the issues in the digital environment that blockchain addresses have hitherto been fundamental boundaries to cost-effective, protected, and trustworthy transactional relationships (Kewell et al., 2017). In the first place, blockchain leverages the power of peer-to-peer systems where people can exchange value without the need for intermediaries. One of the most applicable illustrations is the case of the financial industry. For example, to transfer money from one country to the other through the banking system, there are intermediary agencies that process the transaction, with fees. Accordingly, agents like banks and credit/debit card companies act as intermediaries between consumers and goods and service providers. Beyond the fees that are paid to each intermediary, they have their processing schedules which also prolong the duration of the transaction. In the context of decentralized peer-to-peer systems like blockchain, however, the nodes would be both the entities seeking to exchange money for a service (landscaping) or property (material goods like cellphones and immaterial goods like music) and those that provide these goods and services. In principle, since financial transactions do not need to be validated by third-party institutions, blockchain facilitates a higher level of speed in value exchange irrespective of distance and national boundaries or obstructions. The elimination of third-party entities also removes the costs that are associated with their input, making blockchain transactions largely cheaper. It also impedes the intrusion of data mining entities that profit off of users' information (Tapscott & Tapscott, 2016, 2018; Werbach, 2018).

Blockchain also steps in as a solution for key concerns that people have with digital media systems, such as protection of privacy against data breaches, protection of identity, and prevention of user commodification (Kewell et al., 2017). Swan considers this innovation a disruptive one in a class like the Internet. As it grows into a universal reality, blockchain will change human activity on a scope akin to the Internet (2015). The promise of blockchain's decentralization contributes to its hype, especially in the present digital system rife with asymmetrical pathways of exploitation and profit-making principally accrued by select sectors of the global digital society. Its ingenuity lies in the fact that it truncates certain negative attributes of the network society while guaranteeing services that address myriad social, economic, and political gaps.

Likewise, “blockchain can be considered a tool for achieving and maintaining integrity in distributed systems” (Drescher, 2017, p. 24). Integrity is a vital component of any digital system, a component that is not always at the forefront of users’ minds because it is non-functional and works in the background of the system’s processes. Integrity operates in three ambits, the first is the maintenance of data integrity. Here the system’s data needs to be accurate, complete, and invariable according to accepted standards. Secondly, behavioral integrity is vital, the system must faithfully carry out its mandate without logical errors. Furthermore, the system needs to be secure to have integrity. This means that appropriate restrictions are in place to prevent unauthorized access to data and services (Drescher, 2017). This quality of integrity, however, surges to the forefront when its function is compromised, like when one realizes that a hacker has accessed their data on their computer or phone.

The ability of nodes to collectively verify and clarify ownership on blockchain ledgers secures items of value by ensuring that only authorized persons can transact with the digital good. This ensures the integrity of the system. Trust works hand in hand with integrity, in that nodes do so because they trust that the integrity of the system is firmly established. The ability of a blockchain system to ensure that transaction data is immutable and verified by consensus safeguards integrity among participants. Trust in the specific case of blockchain systems is so entrenched that people consider it a trustless system. Thus, the incorruptible nature of the system’s integrity means that users do not even need to trust in the processes, because trust is an intrinsic aspect of how the framework itself is built and operates (Drescher, 2017; Werbach, 2018). This new architecture of trust (Werbach, 2018) therefore proves its versatility in fields that seek to achieve progressive social change by mobilizing digital technology in ways that impede shortcomings like corruption and exclusion. The next section engages with blockchain’s potentialities in social change endeavors.

4.2. Connecting dots: Blockchain across the Global South

Next, I examine the study’s empirical material by connecting the affordances of blockchain discussed above with the potentialities of settings in the Global South. Forasmuch as blockchain is a global technology, it is important to make transnational connections between its application in Ghana and other geographical locations in the

Global South with similar realities. To better situate this discussion, I will first enumerate the various analytical components of afrofemtrism. The theory is at its core a critical intellectual undertaking that proactively engages with ICT ecosystems by challenging the structures and other tenets that perpetuate gender inequalities. As an activist positioning in the interest of gender justice, it emphasizes the importance of the empirical situatedness of the research context by unraveling the complex subjectivities of the research participants. The study's construction of afrofemtrism is thus a project of bridging the substance of lived realities with generalizable theoretical concepts. Therefore, this is a recursive relationship between theorizing and interpretation of the empirical material.

Notwithstanding, the framework of analysis benefited from insights from the works of critical gender justice scholars. This is in concert with Christensen's assertion that "all observations are shaped, consciously or unconsciously, by cognitive structures, previous experience, or some theory in use" (2006, p. 41; Timmermans & Tavory, 2012). For instance, Steady's (1996) postulation of the importance of recognizing the multiplicity of the oppressed existence of women in African feminism is a principle I inculcate. I am also strongly aligned with technofeminism's postulation of the mutual influence the society and technology exert on each other (2004).

The development of afrofemtrism starts with a descriptive phase to establish a clear picture of the facets and ideations that constitute the research setting (Christensen, 2006; Eisenhardt, 1989). These include the transnational conditions that interact with Ghana's local blockchain reality, socioeconomic features that facilitated its introduction and spread, the characteristics of the participants in the space, and the technological innovations that combine with blockchain to form a technological cluster[5]. Systematic descriptions of this nature are integral to institute a theoretical foundation that delineates the parameters of the theory to facilitate future applications (Christensen, 2006).

Next, based on an analysis and interpretation of the data, I predicate the causative linkages between the underlying conditions in the space and the existence and progression of gender disparities. For the most part, the data actuates an inductive analytical process (Glaser & Strauss, 1967) by informing the components under which I

[5] See chapter five for detailed descriptions.

organize the research information for analysis. In turn, I employed a deductive procedure of analyzing and interpreting the material based on the categorization that the data engendered. To this end, the analytical components for examining the characteristics of the innovation's environment are 1) individual, community, and social group analysis, 2) culture and traditions, 3) overarching national parameters, and 4) transnational conditions. These components are the theory's micro, macro, and meso frames of analysis. As I mentioned above, I consolidated these elements from the themes that emerged from the data. The predictive power that the process underscores for afrofemtrism characterizes it as a normative theory (Christensen, 2006).

In the present section, I advance an afrofemtric analysis of Ghana's positioning in the global system and the interactions that this status could precipitate in her blockchain ecosystem. Building on this global outlook, I initiate the theory's descriptive foundation by presenting a transnational Global South context to the advancement of blockchain. I frame these illustrations in afrofemtrism's perspective of the extent to which various international blockchain environments share similarities with the research context or influence it to an extent.

4.2.1. Transnational conditions

This analytical component of afrofemtrism focuses on structures, events, and circumstances outside of national borders which have direct or indirect linkages with sociotechnical systems within nation-states. These influences could be in terms of the international connections that participants maintain in their professional pursuits or transferring knowledge on use cases. I begin with a broad overview of various global conditions which have local implications.

Borrowing principles from the world systems theory (Wallerstein, 2011), afrofemtrism acknowledges the unequal stratification of national economies through the ramifications of the imperialist nature of colonialism and globalized capitalism. For many Sub-Saharan countries, their post-independence positioning developed a distinctly dependent quality in the capitalist-oriented global system (Arewa, 2019; Mikell, 1997). The configuration of the international market facilitates a system in which the hegemonic economic entities maintain an exploitative relationship with semi-peripheral and peripheral economies, primarily made up of countries from Africa, Asia, and Latin

America (Arewa, 2019; Wallerstein, 2011). In the contemporary context, the global market comprises not only national economies but multinational conglomerates and other private interests. The political and economic relations with the centers of power are structured in a way that maintains the subordination of poorer economies like Ghana. Her multilateral agreements with entities like the IMF and the World Bank are good illustrations of this inequality. These institutions ignore the contributions of global forces and only focus on national factors as causes of economic stagnation and fiscal inefficiencies. One of the IMF and the World Bank's key interventions in addressing poverty is the widely critiqued Structural Adjustment Programs (SAPs) which form the backbone of their lending relationships with many countries in the Global South. Independent studies of these programs show major negative consequences, especially on vulnerable populations. This is because of reasons like their stipulation that nation-states stop investing in social services. Research shows that the SAPs produce repercussions ranging from the concretizing of gender inequalities to environmental degradation (Hammond et al., 1993; Konadu-Agyemang, 2018; Mackenzie, 1993).

The world system is not a single monolithic arrangement, however, but a dynamic structure of multivariate systems. Even among countries, the passing of time bears witness to an evolution of traditional roles in the world economy. Many are evolving from largely agrarian economies which primarily produced raw materials to feed the production systems of industrialized countries. India is a great example of this. The rapid development of its service sector and industrial sector made up of pharmaceuticals, telecommunications, software, etc., has helped thrust her into a global position of power. In 2010, India was one of the major emerging economies that founded what we currently know as the BRICS nations (Brazil, Russia, India, China, South Africa). Furthermore, within the Global South there exists unique configurations, like the emerging relationship between China and several African countries. Since the Cold War era, China has aggressively pursued a South-South trade and economic plan to establish its strong presence in the face of the United States' global hegemony. In positing itself as an alternative to other bilateral and multilateral partners, China's financed investments are largely with non-conditional loans and grants. She also champions the development of infrastructure across the continent, focusing on oil-rich countries like Sudan and Nigeria and countries with vast mineral resources like Zambia. These investment activities have contributed to guaranteeing markets for Chinese

products and human labor, as well as vast sources of cheap raw materials (Alden & Jiang, 2019; Kragelund & van Dijk, 2009).

An examination of the transnational conditions that stifle socioeconomic advancement for societies, therefore, needs to be sensitive to the global historical realities and how they intersect with local manifestations of inequalities. This signifies concerted attention to the events that bred and are maintaining the status quo. These include prevailing ideologies, relationships, and policies that govern them, as well as the alternative paths to socioeconomic progress which ensure equal opportunities and wellbeing for all. A key consideration in the critique of the global structure of economic exploitation and inequalities is the understanding that socioeconomic progress does not occur along a specific trajectory as espoused by the biases of modernization concepts. On the whole, material conditions framed by global and local markets, as well as international sociocultural, religious, and other nexus between cultures, are fundamental to the power relations in societies. Focusing on gender justice as an illustration, global dynamics have many direct impacts. For instance, the effect of climate change on health outcomes for men and women usually varies. This results from situations like gender-based discrimination and the variances in socioeconomic and political conditions. Research shows that women are more prone to morbidity from extreme heat and related climate change-induced events. Since they occupy lower ranks in the domestic hierarchy of satisfying dietary needs, women are also more likely to be malnourished during droughts or famines. Additionally, of the billions of people living in poverty globally, 70% of them are women. This means that women are overwhelmingly affected economically by climate change. Climate change is a global problem with global consequences. Hence, it is integral to have consistent collaboration among activists both locally and internationally in challenging the structures and actions that facilitate it, with an emphasis on gender power relations (Department of Gender, Women, and Health (GWH), Department of Public Health and Environment (PHE), World Health Organization (WHO), 2014; Sorensen et al., 2018).

Another key consideration for analysis in afrofemtrism is the relevance of the aforementioned global interconnectivity based on the conditions of the network society as espoused by Castells. The logic of globalization correlates directly with the diffusion of innovations, and for our present purposes, diffusion, and adoption of digital technologies. The virtual ambit of blockchain and other features like ease of international

transactions, decidedly actualize a pattern of both local and international connections. The empirical material reveals that the professional ambit is primarily driven by people embroiled in the contemporality of the combination of neoliberal ideals of profit-making and globalized networking. These situations merge with and diverge from domestic realities in ways that reflect the diverse digital cultures of the people engaging with ICTs in Ghana. As an illustration, Nyameke built his blockchain-based South-South remittance system because he wanted people to have options outside the expensive monopoly of the multinational money transfer companies.

In another sphere, global oligopolies of media and telecommunication industries are in themselves imperialist units and therefore part of the core entities which serve as the vehicles for advancing hegemonic ideals of democratization and neoliberalism. The presence of a multinational commercial media system is instrumental in instituting consumer values that grease the wheels of the rapid technological advancement that we are experiencing presently (CRASSH Cambridge, 2015; McChesney, 2001; Schiller, 1999). In the current global village, social and cultural structures are interconnected through various forms of media, causing dominant realities to influence and in some cases overshadow local settings around the planet. The reconfiguration of this space and the world systems structure, in general, can be seen in the breakthrough of Netflix. Its digital streaming service has propelled it to an industry giant closing out 2020 with a market capitalization figure of about $255 billion. This means Netflix has superseded Walt Disney's hitherto lead position in the media arena (Ponciano, 2021; United States Securities and Exchange Commission, 2020). Specifically, the role of international social media platforms like Twitter and WhatsApp in the communication, socializing, and business practices of Ghana's blockchain society is immense. As discussed in earlier sections, WhatsApp is the predominant platform for cryptocurrency trading. It is proving to be the engine ensuring the existence and operation of the principal instantiation of blockchain in Ghana. Study participants Afiba, Manza, and Jojo, for instance, confirm that this is the primary channel for their trading activities. Yao and Dewa advertise their services and trade interests using the WhatsApp status update feature. Lamptey, Sedem, and Kodzo use the application as a platform for organizing groups to share information and enhance connections among enthusiasts. Nyameke uses Twitter extensively to popularize his remittance application. Finally, owing to the power and clout

of Twitter CEO Jack Dorsey, Nyameke's meeting with him was instrumental in boosting the commercial success of his product.

In the same spirit of standardized values of a networked world, Kwami points out that the homogenizing quality of globalization encourages a certain idea of neutrality in discursive spaces. For example, people take it for granted that participation in the blockchain space is open and any social group that is not represented is staying out by choice. This is also existent in ICT social change initiatives which are driven by prescriptive and uniform conjecture. Such occurrences undercut the sustainable development and success of digital equities (2020). Conversely, one can argue that globalization's entrenched position in the world has translated to an increase in the global flow of goods, information, ideologies between countries, etc. Consequently, there are arguably more economic opportunities for women in the ICT and service sector due to the increased demand for professionals with cognitive and other soft skills, rather than physical ability (Castells, 2002; World Bank, 2011). Expanded ICT diffusion also contributes to widening channels for knowledge sharing. To illustrate, all of this study's participants whom I classified as innovators[6] assert that they got to know about blockchain from global news on the internet focused on emerging innovations.

> For me… I continuously try to read about developments in technology… emerging technologies and all that. Because one of the things that we do at Kumasi Hive is to accelerate the adaptation of technology in our local context… if we get access to some of these things a bit early, then it could bring better changes in our lives. (Adom)

As Adom recounts here, a principal focus for his company is to remain abreast with new technological innovations on the international scene and adapt them to the local Ghanaian setting. With blockchain, he educated himself extensively on the core technology by watching YouTube videos. He then created educational materials and set up technical teams to train them on blockchain application design. One of the areas in which they have been most successful is building applications to address gaps in health records systems. Another example is Kobe, whose mentor is a Japanese blockchain expert he connected with on Facebook. They shared information on their projects and his mentor helped him fine-tune his concept on an agricultural supply chain network. These instances demonstrate that greater access to varied information streams through

[6] Chapter 5 gives a systematic categorisation of the respondents

the internet and other media channels leads to wider participation in narrative spaces, increased education on relevant issues, and participation in the knowledge economy (Castells, 2002; Gazdekpo et al., 2020; World Bank, 2011). Finally, digital platforms advance the internationalization of use cases and experiences, which spread knowledge about different perspectives on norms and practices. This could also help effectuate positive social change. Thus, for example, disseminating information on the repercussions of women missing out on education could result in the elimination of barriers such as domestic gender roles which burden young girls unnecessarily (World Bank, 2011). These perspectives, however, contain generalized assumptions which manifest in various societies differently. Ultimately, individual and group efforts can only achieve so much without the collaboration of structural and systemic adaptation, like conscious policymaking.

More concretely, I now contextualize blockchain's evolution in international environments which mirror realities in Ghana to portray the transnational connections. The affordances of blockchain in these settings reveal the cross-border relationships that the innovation could engender. Establishments in the Global South have progressively worked to expand the DeFi ecosystem. Short for decentralized finance, DeFi are decentralized digital applications which operate primarily in the finance sector (Hertig, 2020). Its central premise is to remove the control over monies and financial transactions out of the hands of centralized entities like banks, into those of users. DeFi is an amalgamation of financial technology (fintech) built on blockchain systems with inherent qualities of decentralized and open-source networks, improved security, and reduced costs of transactions. DeFi distinguishes itself from cryptocurrencies in that they enable more complex transactions and are not just avenues for the transfer of value from one party to the other (Hertig, 2020). The illustrations below, however, demonstrate how certain national environments do not lend themselves easily to all the above-mentioned features. The organizations, therefore, implement compromises to establish varying versions of blockchain-enabled DeFi platforms. A common denominator among the motivations that guide blockchain's uptake in these Global South contexts is addressing gaps in local and international remittance systems. The following are two pacesetting blockchain projects which have gained widespread attention.

OMG Network

The first example is OMG Network, a blockchain network that aims to solve the unbanked problem in South-East Asia. Built on the Ethereum platform, OMG Network collaborated with the Ethereum founder Vitalik Buterin and Ethereum developer Joseph Poon to design the underlying protocol (Krupka, 2020). Ethereum is a universal digital infrastructure capable of running blockchains and other distributed network applications. They revolutionized smart contracts as well as the ability to provide a platform on which various blockchain applications and programs can be run (Bratspies, 2018; Swan, 2015; Werbach, 2018). The OMG Network CEO Vansa Chatikavanij[7] emphasizes that "basic financial services like online payments, making a transfer, is a 21st-century fundamental human need" and should therefore be accessible to everyone (Russo, 2020, 16:21). She stipulates that it is important that people can transfer money globally without restrictions because this ensures participation in the global economy. She aims to magnify the reach of the platform to make financial services available to people in even the remotest corners of the globe.

OMG Network's Initial Coin Offering (ICO)[8] in 2017 rode in on a wave of great publicity. Chatikavanij confesses that the team focused heavily on marketing early on before the product was launched, without appreciating the complexities of the DeFi space. Although they have received some critiques for disappearing after the well-publicized ICO and only launching the product three years later, she emphasizes the importance of taking time to ensure a network that delivers on its promises. "[W]e hunkered down for two years, and then we just said okay let's build and then … in 2020 … let's get a really good launch partner and then let's just let the product speak for itself" (Russo, 2020, 25.22).

Essentially, the OMG Network aims to be a financial system on which users transact assets with unprecedented speed, at impressively low prices, and across both digital and national borders. Her interest in developing OMG started when she worked with the World Bank and oversaw the disbursement of loans to entities in Myanmar. She

[7] The company was acquired by a Hong Kong-based OTC trading firm Genesis Block in 2020. No new administrative changes have been announced as of April 22, 2021.

[8] A method that blockchain and cryptocurrency establishments use to raise capital from the public in order to launch new products, investors therefore buy their crypto assets.

experienced the very low distribution of banks, especially in rural areas, which hampered the smooth running of financial transactions. People without access to financial services resort to such insecure means as saving their money under their mattresses. As a result of the meager banking infrastructure, the disbursement of loans to local government offices, which she facilitated in her position with the World Bank, had to be in cash and transported by hand. She reports that this was a process that was both dangerous and tedious. Transactions of this nature were also expensive because people had a general mistrust of the local currency and preferred the United States dollar, further increasing transaction costs due to increased exchange rates (Russo, 2020).

A third factor that spurred her interest in cryptocurrencies as a viable solution to the bottlenecks in fund transfers was the penetration rate of smartphones. In her own words, she was floored by the Bitcoin alternative because one could open an account without ever having to talk to anyone and do it from anywhere so far as they had a capable digital device. Her journey to implementing accessible solutions resulted in a collaboration with Thailand-based Southeast Asian online payment gateway company Omise, and their eventual development of the OMG Network on Ethereum. OMG Network's slogan is "Unbank the Banked", a twist on their focus on including unbanked populations into the global financial ecosystem while paying homage to DeFi enthusiasts' interest in circumventing the domination of centralized institutions like banks (Russo, 2020).

OMG Network has global goals, aiming to be a worldwide decentralized exchange which would encompass transactions across borders. It also aims to be interoperable with all major payment portals like PayPal and cryptocurrency platforms like Tether (Hicks, 2020; Krupka, 2020; Russo, 2020). Thus, from the very foundation of the OMG Network, the team endeavored to ensure that the underlying system would be capable of facilitating large-scale transactions between multilateral participants which would side-step established centralized networks (Poon & OmiseGO Team, 2017). Built on the Ethereum platform, OMG's blockchain ensures cross-compatibility in that users can trade across other chains and with other platform tokens like ETH and Bitcoin. The OMG chain remains the manager for all these activities (Omgpool, n.d.; Shevchenko, 2020).

The OMG team recognizes the danger of spreading themselves too thin by trying to address every concern that comes with operating a decentralized financial network. The co-founder of the Ethereum platform, Vitalik Buterin, encapsulates these issues well with his term 'the scalability trilemma'. This highlights the difficulty in achieving a perfect balance between scalability, security, and decentralization, the three most desirable features of a blockchain platform. Buterin opines it is usually only possible to optimize two out of the three components at once (Krupka, 2020; Ometoruwa, 2018; Russo, 2020). Blockchain's decentralization means that there is no central authority with total control over a platform's records. It is a highly democratic environment where all the nodes have access to the transaction history[9]. Scalability refers to a platform's ability to go mainstream by expanding to have multitudes of users, while nodes are capable of processing thousands of transactions per second. With the decentralized characteristic of blockchain, scaling up a platform to include more users could slow down transaction speed. This is because a vast number of nodes would take longer to verify transactions, reach consensus on verifications, and update their records, compared to a smaller network of nodes. Added to the issue of speed, reaching consensus among a massive population of nodes is also expensive in terms of the computing power and effort that they collectively expend, an ultimately inefficient feature. The third desirable component, security, is ensured through the collective verification of ownership and transaction details of the automated consensus. The decentralized access to and storage of records adds to the system's integrity, as it renders data immutable (Altarawneh et al., 2020; Drescher, 2017; Low, 2020).

To address the trilemma, the various solutions that people proffer for scalability either jeopardize security or decentralization, which consequently destabilizes the consensus protocol of the nodes on the system. The OMG team concluded that their main objective was to build an infrastructure that perfects the solution to scaling while maintaining the security of the network. For this reason, they do not optimize for decentralization. Chatikavanij asserts that "It's a trustless centralized transaction processing service, with decentralized security" (Russo, 2020, 34:20). After the system runs for a period, users' needs and use patterns would determine the other concerns that have to be dealt with and the kinds of solutions that would be most applicable. OMG

[9] See more descriptive discussion under Introducing blockchain.

takes decisions surrounding protocols and solutions to scaling up with the needs of the users in mind, considering their varying socioeconomic levels and the remittance needs that the network intends to meet (Hicks, 2020; Krupka, 2020; Russo, 2020).

One of the barriers that blockchain platforms have had to circumvent is the cost and speed of transactions. This is primarily because of scalability issues as discussed above. To become a full-fledged alternative to centralized digital payment systems like Visa, they must be able to compete at either the same level or at even faster rates. Visa has an average capacity of 65000 transactions per second (TPS) (Visa Inc., n.d.), although their 2020 annual report reveals a considerably more conservative 4500[10] TPS by September (Visa Inc., 2020). Comparatively, on April 22, 2021, the Bitcoin blockchain guarantees an average of 3.6 TPS, while Ethereum improves on that rate at 16 TPS (Blockchain.com, 2021; Blockchair.com, 2021). Ethereum reports that the eventual merge into its new platform, Ethereum 2.0 or ETH2, will solve scalability impediments. They project a processing speed of between 2 and 3000 TPS and progressively reach 100,000 TPS (Buterin, 2020; Ryan, 2020). As things stand now, however, these slow rates greatly hinder blockchains and their objectives of global mass uptakes. Conversely, OMG completes 2000 transactions per second (Russo, 2020). Chatikavanij reiterated the need for transactions to be completed in record time, considering the expanse of the market that they intend to cover and the amount of trading that they anticipate will transpire on the network.

To work around congestion problems that result from increased participation on blockchain networks, especially how it relates to scalability, the team collaborated with Buterin and Poon of Ethereum to engineer a protocol to enhance scalability known as More Viable Plasma. This protocol operates with the OMG Network as a child chain of the main Ethereum platform. A child chain is a secondary blockchain platform that runs its own network of transactions but is still integrated into the parent platform. For instance, the nodes from the parent platform process transactions and validate them. Depending on the system, parent platform nodes either validate all transactions or a set fraction of the most recent ones (Zhou et al., 2020). Validation regulations from Ethereum, therefore, are the standard for OMG validators on Plasma. This child chain works on transactions in batches, blocks will not be added to the main Ethereum

[10] Computed from a reported 140.8 billion transactions for the year

platform individually but in groups. Compressing data in this manner has helped the team succeed in guaranteeing that the network works approximately at a third of the cost on Ethereum (Krupka, 2020; Poon & OmiseGO Team, 2017; Russo, 2020).

To maintain security, the network has watchers, they are users or OMG token holders. They form the decentralized security branch which validates the transactions on the child chain. The cryptocurrency exchanges that integrate with the network would also run their watchers (Russo, 2020). Chatikavanij acknowledges it would take time to fully realize OMG Network's vision of engendering an inclusive, open financial ecosystem for all levels of the global society. In the first place, the possibilities of use cases that blockchain can provide are still not wholly apparent. This will come with time as the innovation matures. Mass adoption is another aspect of the space that could take time as people learn and understand the opportunities and advantages that blockchain facilitates. In the meantime, the team is taking pains to trumpet their assertion that blockchain creates economic opportunities with the inclusive access to financial services it makes possible, "financial access improves lives" (OMG Network, 2020; Russo, 2020).

Another blockchain platform originating from the Global South and exerting its worldwide influence in the blockchain space is the Caribbean-based Bitt.com. It differs from the OMG Network in that its point of departure is to enable a payment system powered through central banks. However, its impact on social change in financial inclusion is just as profound.

Bitt

Founded in Barbados, Bitt is distinguishing itself as a pacesetter in the charge for Central Bank Digital Currencies (CBDC). Spearheaded by Gabriel Abed, it emanated from the founders' concerns about building a fair financial ecosystem in the Caribbean that meets everyone's needs. In an interview with a crypto/blockchain journalist Laura Shin on her podcast Unchained, Abed opined that blockchain is a technology that could enhance the empowerment of all social groups and widen participation in the financial sector. A primary focus of Bitt's blockchain-based currency digitization platform is therefore to address the issues faced by the populations who have been too long oppressed by the global financial market. These include the members of the society who are underbanked and unbanked because they ordinarily do not have access to modern banking facilities (Acheson, 2017; Shin, 2019).

Another impetus for establishing Bitt is the strong trade ties between Caribbean countries. In this regard, the basic relational framework already exists and would benefit from a shared digital financial payment network that reinforces the economies. A CBDC also makes multilateral relationships more efficient. At the onset, Bitt's principal strategy was to highlight the inefficiencies in the financial systems of the individual Caribbean countries, as well as in the economic relationships between them, and devise ways they could address them by employing blockchain. The system would make it possible for hitherto marginalized communities to attain financial services because it would be accessible via all forms of digital devices, even mobile phones. Some Caribbean islands have about a 100% mobile phone penetration rate. The ITU estimates that there are about 108 mobile cellular subscriptions per 100 people in Barbados (Acheson, 2017; ITU, 2019; Shin, 2019). These high penetration rates make a digital system of this kind easily diffused. This is especially significant compared to the low penetration bank rates, Barbados has an estimated 15.5 commercial bank branches and 28.98 Automated Teller Machines per 100,000[11] adults (International Monetary Fund, 2019).

The first issue they sought to tackle was international remittances. Abed points out that available services to transfer money into the Caribbean are costly. Prices on the average money transfer range from eight to 18% per transfer. They saw the promise that Bitcoin could have in this arena, where people could transfer remittances at a marginal fraction of the cost. After drawing up a blockchain-based remittance service, Abed describes how Bitt's progress was hindered by its biggest roadblock, "the last mile problem" (Shin, 2019, 8:02). The dilemma involved how to get the funds from the point of transfer into the hands of the consumer. The commercial banks refused to integrate with their system, therefore funds could not be directly transmitted into recipients' accounts in a seamless transaction process. This impediment turned into an inspiration because it compelled them to study blockchain technology in a more in-depth fashion. The information from this investigation helped birth the idea of collaborating with the Central Bank of Barbados to create an inclusive digitized payment network for financial transactions based on a digital equivalent of the Barbadian dollar. Bitt could, therefore, circumvent the process of negotiating relationships with individual commercial banks (Shin, 2019).

[11] Overall population is presently 287,025 per information from data.worldbank.org

The journey towards creating a national dollar on the blockchain and representing it digitally on a national platform was rocky at best. The executives of the Central Bank of Barbados rejected the idea at the first meeting. They proceeded to build a team of experts, including compliance professionals, financial experts, and developers, to work out the modalities of what such a digital system would entail. They had several meetings with central bank governors from various Caribbean countries, as well as with relevant government officials. The Bitt team realized that the novelty of what they were suggesting was causing the authorities' hesitation to implement the project. The fact that blockchain would effectuate this solution, a new technology that did not have a large-scale distribution and reputation in the Caribbean, was a major hindrance. Abed explains that in all his encounters with governors of the various central banks and other relevant leaders like finance ministers, they would get excited by the explanation on how the system would resolve extant inefficiencies. As soon as he mentioned that the solution was to come about through blockchain though, the excitement would give way to trepidation in some cases, and outright rejection in many others. The turning point for them was a meeting with Mr. Byrne, CEO of Overstock.com, who was interested in the innovation of a central bank-backed digital currency and the difference it could make for marginalized populations. Mr. Byrne's financial support of the project, as well as his presence at meetings with finance ministers and governors of the central banks in Jamaica and Barbados, galvanized the support that Bitt needed to establish a version of the project that everyone agreed to (Shin, 2019).

Led by the Barbadian chief economist, Marla Dukharan, and the Caribbean Development Bank, the Caribbean Settlement Network is the operational blockchain-based payment digital system between Caribbean countries, with interoperable services between the currencies of the participants. As opposed to the operational strategy set forth by mobile money systems in several Global South countries, a private organization would not control this open payment system. All constituent financial organizations and government agencies have the same level of access with a standard set by the Central Bank. To maintain the autonomy of the participating organizations and government bodies, each entity opted to set up a blockchain platform of their choice. Services between them are, however, smooth because each platform follows a set reference framework under a digital dollar standard. Hence, there is interoperability between all participating entities. This system is not fully decentralized, as it is only the government

and financial sector representatives that have access. Abed considers this a starting point for an untested territory that is now gaining acceptance. He perceives this platform as the channel for governing bodies, and particularly central banks, to operationalize and appreciate the superiority of blockchain in terms of its efficiency, the elimination of corruption, and costs. Once blockchain is widely accepted with all its unique capabilities, even the average person on the street who might not be technologically savvy would have confidence in it because the governing apparatus of the financial sector backs it (Acheson, 2017; Shin, 2019).

Further, Bitt's collaboration with the Eastern Caribbean Central Bank (ECCB) has produced DCash, the first-ever central bank digital currency in the world which serves the Eastern Caribbean Currency Union. Launched on March 31, 2021, consumers can use the digital version of the currency union's EC dollar with financial institutions and merchants, as well as remit money between Antigua and Barbuda, Grenada, Saint Christopher (St Kitts) and Nevis, and Saint Lucia. This can be both for local and cross-border transactions (Burnett, 2021; ECCB Connects, 2021). DCash transactions are free for users (DCash.com, n.d.). Added to this, Bitt operates a separate digital payment initiative in Barbados, mMoney. It is built on a blockchain platform, but only partly decentralized. Consumers download the application onto their mobile devices and can use it to pay for goods and services with participating merchants. People can also pay for utilities with mMoney. Like DCash, consumers do not have to pay for using mMoney. Bearing in mind that mMoney aims at providing an inclusive environment for the economically excluded, the central bank primarily finances initiative. Abed points out that it makes sense for the central banks to pay for it because the savings that they stand to make with a digitized currency would be outstanding. They become more financially efficient in blocking leaks, as well as gain a cheaper, simplified, and better accounting process facilitated by blockchain's immutable recording. They additionally save by not having to spend on printing paper money or even debit and other kinds of cards. The signatory commercial banks and merchants also pay fees (mmoneybb.com, n.d.; Shin, 2019).

Bitt's strategy of employing the support of central banks and developing centralized platforms is an interesting departure from the ideals that many cryptocurrency enthusiasts champion (Brunton, 2019; Nakamoto, 2008; Shin, 2019). This channel could be a major influence on the form that blockchain and digital

currencies based on blockchain platforms progress into, especially in the Caribbean context. In the fast-changing environment of blockchain, the dynamism of innovation illustrated by Abed and his team gives a great picture of the vast possibilities in the blockchain space.

To present a balanced discussion on blockchain technologies and their promise for social change, the final segment of this chapter analyzes a few of their possible fallouts. As a burgeoning digital technology, it is safe to say that we still do not have a fair grasp of the magnitude of use and development possibilities. This is even more so for societies that are now discovering it. Nonetheless, the ardor surrounding blockchain's potentialities must be tempered with a consciousness of attendant drawbacks. Especially in the sphere of social change, these drawbacks could further disempower already marginalized people.

4.2.2. Risks in a trustless technology

Even though we can consider blockchain to be a magnificent pathway to plugging holes in different aspects of national economies, its inherent capacity to birth novel digital realities and disrupt the status quo necessitates cautious implementation (Law as Culture, 2019). Tapscott and Tapscott refer to this as its ability to make both positive and negative contributions to the world (2016). I will wind up this chapter with a discussion on some of the probable pitfalls of blockchain adoption, which are accentuated by the key characteristics. These could cause negative repercussions if blockchain is not operationalized judiciously.

The perils of immutability

A good example of how blockchain's immutability could have serious repercussions is in land registration in Ghana, where formalization of land titles is low. In peri-urban areas, about 80% of land transactions are informal (Aitken, 2016; Picarelli, 2017). The country also has a dual-track administration of land tenure, where the state regulates approximately 20%, with the remaining 80% of lands regulated by customary law (Ehwi & Asante, 2016). These include lands owned by families and administered by designated family heads or held by clans. Many of the customarily held lands are stool

or skin[12] lands, with traditional authorities maintaining allodial title on behalf of their subjects. For ownership of these lands to be legally recognized, both the customary and state agencies need to validate the transaction process. Research shows that majority of land transactions involving customary law are informal and therefore not legally registered. This presents various issues of ownership contestations considering the number of lands regulated by customary law (Aryeetey & Udry, 2016; Obeng-Odoom, 2016; Picarelli, 2017).

Simultaneously, the registered portions are sometimes plagued with inconsistencies in demarcation and location coordinates on the registration documents. Additionally, either mistakenly or because of corruption, officials sometimes commit blatant misallocations of ownership. Overall, land insecurity is rife, as frequent conflicts ensue over issues like sales without the consent of clan members, and double selling of plots with consequent conflicts involving the different owners (Aryeetey & Udry, 2016; Obeng-Odoom, 2016). There are news reports of land registry personnel being bribed to change ownership details on record to favor the highest paying party involved in disputes. Another case for the digitization of land ownership is the example of Haiti. The nature of the land title records system which was paper-based hampers the reconstruction efforts following the devastating earthquake in 2010. This has caused several disputes over property ownership, and many of these remain unresolved because the quake destroyed records (Akmeemana & Oprunenco, 2018). Proponents consequently point to the value that blockchain offers for land registration to help stamp out such concerns.

In 2018, the Government of Ghana signed an agreement with IBM to develop a land registry database on a blockchain platform. Bitland Ghana is a start-up that has also leveraged the capabilities of blockchain as a decentralized ledger for land registration (Amlanu, 2018; Bates, 2016; Myjoyonline.com, 2018). These initiatives highlight the advantages of blockchain as the technology's decentralized nature and immutability means that corrupt interests cannot change records. Legitimizing land ownership with the improved registration system that these projects proffer will create

[12] Stools and skins are the traditional symbols of authority. Chiefs and kings in southern Ghana are symbolised by the stools they sit on, and those in the northern parts by the animal skins which serve as their thrones.

value addition to properties, thereby generating capital. Owners could use them as loan guarantees, for instance. However, as one of this study's informant puts it,

> You cannot just come in and migrate old records that have issues into a blockchain that will be immutable and transparent forever. No. So everything needs to be … reset. So if we are talking about lands, education, finance and all that, look, the authorities, the regulators, they don't even have the will to reset everything. So it doesn't work here. (Yoofi)

Yoofi is doubtful that blockchain would work in this sector because digitizing the already existing records would need an extensive overhaul. The many errors in demarcations and inconsistent ownerships taint the records considerably. Corrupt data does not become accurate just by putting it on a blockchain network. If officials do not make concerted efforts to sanitize and clean up the records, the problem that these instances present for blockchain is the inclusion of errors at the point of digitization. Blockchain's immutability quality will further compound this and make contestations a difficult arena to navigate (Kriticos, 2019; Reese, 2017).

Secondly, in the case of the Ghanaian government's plans, the present proposed structure of blockchain for land registry systems is somewhat akin to centralized systems. Thus, the permissioned parties which are traditionally mandated to oversee the processes involved in regulating and administering ownership records would be the nodes of the digitized platforms (Kriticos, 2019). This takes away from blockchain's value of decentralization. A workaround to this could be that anyone with a property stored on the blockchain should have access to the ledger, thus participating in the maintenance of credibility.

Scaling up the quandary

Another problem to consider is the predicament blockchain platforms have with scalability. As is expected with a new technology that pundits proclaim to undergird the impending world order (Swan, 2015; Tapscott & Tapscott, 2016; Werbach, 2018), the interest that people have in blockchain intensifies with each publicization of a novel application, or whenever Bitcoin leaps in value. Early adopters are riding the wave of their privileged status and positioning themselves as sources and imparters of knowledge. One only has to perform a cursory search on websites like Meetup.com or Eventbrite.com to discover the immense number of blockchain-based meetings and conferences advertising varying levels of education on the application. This amount of

activity, however, disguises the fact that blockchain is not yet a mass innovation. As it stands now, Bitcoin's platform cannot accommodate widespread uptake yet, because it does not have the security infrastructure to handle very high levels of usage. For one thing, an overwhelming increase in participation could beset the platform with unanticipated bugs (Tapscott & Tapscott, 2016).

Decentralization, which further buttresses the immutability of information, ensures the security of the platform (Ometoruwa, 2018; Werbach, 2018). The scalability trilemma is a key consideration here, as scalability on a mass level would also affect transactional capacity. It would cause the already slow network processing rate of transactions per second to slow down further. Another issue at work in this scenario is the cost implication of scalability. Ethereum gas is the unit of measurement that quantifies the processes involved in executing smart contracts or other transactions on the network. The denomination of gas prices is gwei, which is distinct from the platform's cryptocurrency ether. When miners complete the processing of a transaction, they are paid in an equivalent amount of gwei in ether, as gwei is essentially a subunit of ether. Miners determine gas prices. The amount of processing time, the effort that each transaction requires, and the number of transactions that are in the queue to be processed, influences the determination. Ethereum currently has high gas fees, which results from high demand from increased transactions because of the network's limited space. From April to June 2020, fees climbed an exponential 500%, sparking investigations into technical solutions to arrest the climb (Foxley, 2020). Thus, scalability negatively affects the technology as it drives up gas prices. This further inhibits widespread participation since the high costs repel people with financial constraints.

Socioeconomic power dynamics

Another demerit of the blockchain system is the emerging power stratification among participating users. This is especially jarring for a decentralized system with egalitarian sentiments which accords an equal voice to each node. Satoshi Nakamoto is an enigma because of their ingenuity in creating the status-quo-disrupting novelty that is blockchain. Even more enigmatic is how they did not revel in the limelight by exposing their identity and basking in all the accolades that this achievement has garnered them. Neither did they intend to capitalize on the technology, they left the code open source and did not patent it. This has contributed to Bitcoin's improvement as coders have the access

necessary to work out hitches and to innovate further. Satoshi's anonymity partly ensures that the ownership of the network remains the users' and thereby truly decentralized (Humayun & Belk, 2018). These foundational ideals of universal participation and decentralization, however, do not appear to hold up in all respects. Powerful players in the digital world could still maintain hegemonic positions in the blockchain ecosystems.

The first illustration of this phenomenon is creators of platforms, as exemplified by the case of Ethereum creator Vitalik Buterin. They usually have an advantage through their technological educational backgrounds and attendant skill sets. These make them strategically positioned to make huge financial gains from their innovations. Comparatively, blockchain is generally inaccessible to the average person because the technical aspect is difficult to comprehend. Being an internet-based technology also establishes a boundary for the approximately 3.7 billion people worldwide who cannot participate meaningfully in the digital system because they do not have internet access. This number increases when we consider people who face issues like inaccessibility to digital devices, inability to use the system adequately, and infrastructural impediments to their engagement with the digital economy introduced by blockchain (ITU, 2020).

Added to this is the culture of exclusivity in some elite circles which has developed in the ironically 'universal' space of blockchain. A great example is the Satoshi Roundtable, in the words of Gabriel Abed "this very exclusive private event of the who's who alphas of the crypto industry" (Shin, 12.50, 2019). After he and his partners had launched the beta version of a national digital dollar on a blockchain system for Barbados and other Caribbean countries, he was eager to make financial and other connections among other blockchain enthusiasts. Since he did not have the relevant connections yet, he had to repeatedly lobby Bruce Fenton, the organizer of the Satoshi Roundtable, to be able to attend one of their events. Thus, the decentralized and egalitarian spirit of blockchain only lies in certain aspects of the technology, the participants are still as stratified as society is.

Mining trends also illustrate power dynamics in the cryptocurrency arena. Bitcoin mining is an essential aspect of the platform as it ensures a secure and credible system for transactions. The low probability rate in successfully computing the problem and earning a Bitcoin helps maintain the distribution of power among the various nodes.

Nonetheless, the reality is that to a significant extent mining is a self-interested endeavor for economic incentives, with Bitcoin's network reportedly valued at about $150 billion (Elmandjra & Hsue, 2020). Mining has advanced from a domain of hobbyists operating with desktop central processing units (CPU) into a competitive, multibillion-dollar industry employing specialized computer equipment. The rise of large-scale mining operations in places like China and many other countries proves this. Another consideration is the growing complexity of computing requirements in the mining process as the platform expands in users. These factors cement the positions of these powerhouses to the detriment of smaller facilities that cannot compete on the same scale. Those entities with the right equipment and energy resources can maintain their participation in the full ledger, while less adequately equipped nodes end up storing smaller sections of the ledgers if they do not have the storage capabilities. This could consequently affect consensus as participation remains the purview of a few and therefore relatively centralized (Bendiksen & Gibbons, 2019; Elmandjra & Hsue, 2020).

In addition, the allocation of tokens also enhances the growing hegemony of large mining entities. The system is programmed in such a way that it halves the number of new Bitcoins released approximately every four years (a period in which 210,000 blocks are added to the chain). Thus in 2012 miners received 25 bitcoins per block (with a total of 10,500,000 new coins), 12.5 bitcoins per block in 2016, and on May 11th, 2020 the network halved rewards to 6.25 bitcoins per block. At this rate, by the year 2140, the system would not be producing any more Bitcoins with a maximum number capped at 21,000,000, and mining would be rewarded in transaction fees. This process guarantees a sustainable value for the currency because the supply of coins in circulation will be controlled, and the lower amount of it would increase demand. The larger mining operations are therefore well placed to own substantial quantities of a finite and valuable resource (Beccuti & Jaag, 2017; Houy, 2014). On another tangent but still concerning mining oligarchies, a powerful and wealthy entity could hypothetically gain 51% control of the network and control the consensus-making dynamics. The hypothetical figure would need to purchase an immense number of mining operations and have astronomical financial and energy resources to run them, gaining them the majority quantity of hash rate production. This would mean that they could determine things like which blocks get added and taken off the chain, and which types of transactions are prohibited (Tapscott & Tapscott, 2016).

Blockchain versus governments and regulations

Furthermore, characteristics that proponents attribute to blockchain platforms like the rejection of overboard regulation, disintermediation, and cryptocurrencies threatening the strength of national currencies, have in some cases clashed with governments (Werbach, 2018). Since governments could determine how people deploy the technology based on legal impositions and regulations, their actions could negatively affect innovation and the development of blockchain in some jurisdictions. Governments are additionally instrumental in determining the organizations that can take part in mediating blockchain transactions. In Ghana, for instance, respondents to this research opined that the lack of regulation has created a viable environment for myriad scams and fraudulent schemes. Some also expressed their hesitation to scale up their blockchain-based initiatives because of the lack of governmental support for them. One of them even considered pulling out completely to avoid making losses in the event that the Ghanaian government were to clamp down on blockchain activities.

The Diem[13] digital currency is a fitting illustration of blockchain initiatives negotiating conflicts with governments. In 2019, Facebook appeared in the blockchain-backed money transfer space intending to "enable a simple global payment system and financial infrastructure that empowers billions of people" (The Libra Association, 2020). Following political pressure in the United States (US), the company was compelled to switch courses from making its digital token the only currency of the digital payments system. This addresses the concerns that policymakers expressed about Diem possibly threatening the authority and strength of national currencies if the payment system were to gain a large-scale userbase. Based on Facebook's wide reach, the US government was especially concerned about Diem positioning itself as a world currency and destabilizing the status of the US dollar as a global reserve currency (Browne, 2021). The French Economy and Finance Minister Bruno Le Maire shared a similar concern, insisting in an op-ed in the Financial Times that it would threaten the national sovereignty of countries. He opined that even implementing a regulatory framework for this instance would not be an appropriate answer. Cautioning against allowing Diem's global ambition to have free rein, Le Maire pointed out that "The project would mean a

[13] It was called Libra when it was first introduced.

private company controlling a common good and taking over tasks normally discharged by states. This is unacceptable for both economic and political reasons" (2019, para. 2).

The international backlash was so intense that some major partner organizations like Visa and Mastercard backed out as members of the Diem implementing association. In 2021, as Diem is primed for an imminent pilot launch, the project is revamping its image to disassociate itself from being seen as a Facebook project which comes with the negative connotations that petrified national regulators. The Libra Association underwent a makeover and is now the Diem Association headquartered in Geneva. The Association has also been intentional about publicizing that it is a network of several organizations with equal stakes and not just a Facebook entity. Diem will now be pegged to other currencies starting with the US dollar, there will different tokens backed by each of the supported currencies. Their corresponding digital wallet, Novi, will also maintain this multi-currency system (Browne, 2021; Morse, 2020). The governmental resistance has consequently diluted the authority that Diem could have had significantly (Brett, 2020; Murphy & Stacey, 2020; The Diem Association, 2020). With the growing popularity of cryptocurrencies, people's mistrust in the financial system following the 2008-2009 financial crisis as well as the economic fallout of Covid-19, and Diem appearing to challenge the hitherto global power of the US dollar, the US government is intensifying its attention on regulatory frameworks related to cryptocurrencies and blockchain as a whole. Congress has set up the Congressional Blockchain Caucus to serve as an intermediary between the government and the digital industry. The Caucus purports to operate with a hands-off approach to reduce regulation in a space where innovation thrives on freedom (The Congressional Blockchain Caucus, 2016).

To sum up, although being in relative infancy means we can hardly estimate the lengths to which blockchain innovations will go, it is not hard to appreciate how the field already has attributes that contribute negative effects in its sociotechnical ecosystem. The path of innovation and adoption that the internet traversed presents probable comparative scenarios. For one thing, the current state of the internet buttresses this argument on the dynamics of hegemonic positions, especially as regards content creation and control over accessibility and use. Powerful establishments have managed to privatize large aspects and services of the technology. With the present dominance of social media, our digital experiences are even more mediated by private profit-making interests. For example, some applications maintain a hegemonic position, control the

proprietary stores we can access them from, and maintain invasive data mining. To an extent, these occurrences negate the celebration of the internet as an egalitarian platform with a horizontal distribution of freedoms like self-expression and self-identification (Tapscott & Tapscott, 2016). “The biggest mistake that one can make is not to dismiss blockchain technology as a fantasy or a fraud; rather, it is to embrace it too credulously” (Werbach, 2018, p. 69). Even with all the positive attributes for which we hail blockchain so ardently, it is crucial to address probable fallouts purposefully and continuously to reveal its equal world-changing potential.

Chapter 5.

The socioeconomic tapestry into which blockchain weaved itself in Ghana

In this chapter, I explore the adoption of blockchain in Ghana. I situate this in the social, economic, and other conditions that influence this process. Afrofemtrism posits that the wider politico-economic and other realities of a setting should frame the examination of a technology's evolution. This chapter presents a description of the national context before developing a more systematic analysis of gender dynamics with afrofemtrism's framework in the next chapter. As a critical analysis, delving into and laying out relevant aspects of the sociotechnical environment is imperative to providing a holistic perspective of the relationship between society and blockchain. In the interest of the present chapter's discussion, the macro setting of the sociocultural, economic, and political dynamics of Ghana significantly influences the mode of blockchain's adoption.

As Wajcman propounds through technofeminism, the affordances of a specific society, like gendered educational pursuits and equity in professional spaces, combine to influence the underlying forces and modes of adoption processes. We should therefore not divorce technological innovations from their contexts of creation and operation (Law as Culture, 2019; Gadzekpo, 2009; Wajcman, 2004). This additionally relates to the realities that people face and their ability to address concerns in this reality. Lived experiences influence the needs that people seek to address, and the tools they employ to attain their objectives. In this chapter, I establish the identified circumstances that are contributing to blockchain's spread. These circumstances also connect with qualities of the technology to emphasize its applicability to corresponding areas of interest (Wajcman, 2004). Illustrating society's enabling background buttresses afrofemtrism and technofeminism's shared position that society and technology engage in a respectively influential journey in the technology's adoption.

Presently, blockchain operates primarily in the fintech arena in Ghana. Enabling circumstances in the nation's financial sector plays the most prominent role, as this is the area in which blockchain is most applied. These conditions have been the dominant factors for blockchain. They facilitate adoption and also shape the specific instantiations

of the innovation in Ghana. Thus, the conditions of the country's financial services set the stage for the discursive and practical permutations that shape blockchain's adoption. To provide a comprehensive contextual discussion of the blockchain arena in Ghana, I first introduce this study's respondents as key components of the sociotechnical framework.

5.1. Blockchain adoption in Ghana

5.1.1. Makeup of participants

According to SCOT, outlining the relevant social groups in a sociotechnical ecosystem is an important first step to understanding the disparities in the space. Thus, in this section, I establish the stakeholders in Ghana's blockchain environment. I characterize individuals as members of a given social group because they share common characteristics, a set of meanings, and interests in their connection with ICTs (Pinch & Bijker 1984). The overriding feature of each classification is their principal occupation with blockchain. The technology came into the Ghanaian digital space in uncoordinated spurts of adulations and enthusiasm. One can therefore not point to a cohesive entity or event as the main initiator of its introduction and spread. Mostly, participants from this study either got to know about blockchain from reading online articles and blogs to keep abreast of emerging digital technology (40%), or through conversations with friends or family (53%). Rogers posits that the perceived advantage that an innovation has in addressing certain needs compels would-be adopters to pursue knowledge of said innovation (2003). Adoption occurs when the knowledge gained confirms the value of the innovation's probable impact. Over 90% of participants declared that irrespective of how they found out about the innovation, they primarily educated themselves by researching the characteristics of blockchain and the possibilities that it presents. This process lends credence to Rogers' assertion, as their investigation assured them of opportunities that their continued engagement with blockchain would grant them. The data also shows that most people's communion with it is on an individual or small-scale level. Few major organizations are representing themselves as ardent players. Two participants, for example, got involved in blockchain through their employment. The company they work with trained them and assigned them

roles which involve building and managing blockchain applications, as well as educating clients on the applications.

Generally, the informants who are skilled in digital technologies have some educational background in fields such as computer science, programming, and information technology. They are building blockchain-based applications as well as organizing and facilitating training programs, conferences, and meetups. They intend to develop the blockchain society and establish themselves as authoritative voices in the field. The others are entrepreneurs with diverse professional and educational backgrounds. Their major attraction is the pecuniary value of trading in cryptocurrencies. These actors, unlike the public, who are reportedly operating through middle persons[14], have conducted their own research on the modalities of investment and trade with cryptocurrencies. In furthering their trading activities, these entrepreneurs are on a constant lookout for ICOs[15]. They buy the cryptocurrencies they deem to be most promising hoping to sell them when their values rise. They also invest in already reputable assets like Ether and Bitcoin. Most of their trading activities happen through international and local WhatsApp chat groups formed for cryptocurrency trading and investment. As many of the interviewees intimated, these cryptocurrency communities are mostly virtual. The only information they usually have of the other members is whichever identity markers they choose to use as their profile names. However, some of them develop wider relationships among themselves outside of their interactions on the group platforms. These relationships remain almost entirely online or via phone calls and not in-person.

I present a broader illustration of the categorization of blockchain's relevant social groups in Ghana using the schema of adopter groupings created by Everett Rogers (2003). The five adopter groups are innovators, early adopters, early majority, later majority, and laggards. Rogers presents his characterization of adopters based on their level of innovativeness, "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system" (p. 280). Innovativeness is contingent on the setting. The rate of adoption exhibited by other

[14] I expand on the middleperson phenomenon throughout the chapter

[15] The funding mechanism that blockchain and cryptocurrency establishments employ to launch new products.

members of the social system determines its value. He clarifies that this categorization exists on a relative spectrum. It is admittedly a simplification that proffers a level of generalized understanding. He goes further to explain that these are 'ideal' categories culled from various empirical studies but not necessarily the most perfect for all situations. Their use does not connote the inexistence of deviants, for instance. The categorization is summarily valuable in describing observable trends that are manifest in various parts of the world. Innovativeness is highest in the first category and decreases with each subsequent group. Considering that blockchain is still in its infancy in Ghana, we cannot widely apply this classification yet, a case of incomplete adoption (Rogers, 2003). Thus, the participants in this study are either innovators or early adopters. Considering the primary focus of the study's early adopters, I refer to them as traders to make their occupation clear.

This study privileges an analysis of the individuals within the categories as units of adoption rather than groups of people. Although more recent renditions of diffusion of innovations encourage less reliance on individual adopters (Rogers et al., 2019), the lack of cohesion among participants in blockchain's social system in Ghana complicates group analysis. Focusing on individuals is also relevant for this type of pioneering study as it affords us the benefit of a more in-depth perspective of the constituent subjects in a novel sociotechnical environment. It is important to note that the members of Ghana's blockchain community discussed here do not fall neatly into the categories. We could also consider some innovators as traders since they own cryptocurrencies and will sell them when the value rises appreciably. Their varying relationships with blockchain highlight the fluidity that the technology affords the community. The wide applicability of the base technology, the tokenization of assets that it has enabled, the multiple access points for participation, the ease and speed of exchanging tokens, etc., have ushered in a space where participants are at liberty to traverse hitherto bounded categories. They can, therefore, create and embody different socioeconomic identities and engage in multiple activities according to their interests and capabilities. However, I would not categorize those innovators as traders because they do not actively trade in cryptocurrencies as a principal occupation with blockchain.

Innovators

Innovators are a venturesome group with an interest in new innovations irrespective of how risky and uncertain they might be. Rogers stipulates they are fairly urban, and their social connections are primarily outside of their local networks because of their avant-garde nature. This disconnection sometimes results in a lack of respect from people in their immediate social environment (2003). Innovators make up 36% of this research's respondents. The inclusion criterion that this study employs is those participants who first encountered and started exploring blockchain through their own initiatives. They did not directly receive information about the innovation from anyone, especially in their Ghanaian social networks. They came upon it in their research on new technologies, or by reading about technological advancements on news portals or blogs. Innovators describe themselves as inquisitive minds, with a zeal for learning about new ideas. Their introduction to blockchain was in the early period of its evolution. In the Ghanaian setting, however, Rogers' description of the common attributes of these agents does not adequately encapsulate those who belong in this category (2003). To begin with, 42% of the innovators do not have recourse to substantial capital resources.

For instance, Egya invested in cryptocurrencies out of a need to generate extra income to pay for his education and his livelihood. For Nyameke, at the time he began to build programs on a blockchain platform, he had dropped out of college and was searching for a professional lifeline. Within a year, he had succeeded in identifying and addressing a glaring practical need for affordable remittance service between African countries. With his cryptocurrency-based mobile phone app, his goal is to lay a path towards mass adoption of the technology even for people who have no IT knowledge. Senders have the option to transfer funds in their local currency or Bitcoin and the recipient could also withdraw their funds in fiat or Bitcoin. Bitcoin is, however, the medium of value transfer in the background which helps keep costs low. He asserted that getting the average person to use blockchain innovations does not have to be through direct engagement. "What if the market woman can benefit from Bitcoin indirectly?" So far as they have access to a mobile phone, anyone could employ blockchain innovations in their transactions and not be left out of the disruption. To further expand on the innovators' socioeconomic standings, four of them stated that they have working-class incomes, while one described himself as someone with an average economic status. Only three of the innovators asserted they are upper-middle-class

people and therefore could have adequate financial cushioning if their foray into the blockchain environment were to fail.

Furthermore, the innovators are a group with diverse professional and technical capabilities. They are not all equipped with advanced relevant technological knowledge per Rogers' original conceptualization (2003). While six out of the 12 are IT professionals, Ayebia, for instance, is an assistant program officer with the Environmental Protection Agency and Ebo is a chartered financial analyst. In the case of the university professor Lamptey, although he is not necessarily an IT professional, he teaches courses in design and entrepreneurship and heads his university's design lab. Hence, he regularly engages with technological innovations with his students to foster the development of innovative entrepreneurial ventures. In this capacity, Lamptey is an opinion leader in his social networks and not seen as an outsider according to the original characterization of innovators. Indeed, compared to experiences that a number of the early adopters outlined in our conversations, most innovators are well-respected even in their affiliation to blockchain. This is most likely because they do not primarily focus on trading cryptocurrencies. They hold varying degrees of power in their local environments because of their positions as IT professionals or similar status. Thus, they sometimes find themselves in the role of gatekeepers of knowledge on information technologies, especially with inventions that have not reached Ghana yet. Adom is the executive director of a company that, among other services, runs a business incubator. They train and support people to create technological innovations to address the immediate needs of their communities. Egya owns an IT company that develops blockchain-based applications and has an online exchange platform for cryptocurrencies. For this subset of innovators, their influential standing legitimizes their voices in their interactions with people about blockchain, which has helped to widen diffusion patterns. For instance, through his university's design lab Lamptey has helped to organize blockchain hackathons. Adom and Egya also coordinate blockchain training programs and speak at national and international events on digital innovations and blockchain.

On the other hand, Ebo detailed his frustrations in trying to get people in leadership positions in government agencies to implement blockchain in areas like public procurement and national identification processes. He has also approached various universities and other tertiary institutions in his quest to legitimize blockchain through the

creation of educational courses. To enhance the viability and marketability of his proposal, he has engineered a potential student exchange relationship with George Brown College in Toronto. Regrettably, the leaders in both the governmental and educational sectors appear resolute in their refusal to see the value that he is proposing through the blockchain initiatives. He noted,

> I organized a one-day seminar at UPSA, University of Professional Studies… with the Accounting and Finance students on blockchain, and the whole auditorium was full, over fifty people, with some of their lecturers there… after that lecture I had a lot of students calling, sending emails. (Ebo)

His description above of the enthusiastic response that these students gave sharply contrasts with the interactions he has had with university authorities. This is an interesting microcosm of the state of affairs at the national level. With the rapidly rising attention that blockchain has, especially in investing in cryptocurrencies, it is quite jarring how little productive interest the regulatory bodies have shown. Ebo thinks it might be because some authority figures benefit from the deficiencies that exist in the system. Thus, if governmental procurement procedures are not transparent and entirely verifiable, people could get away with preferential sourcing. Overall, as the earnest reception from the students portrays, Ebo has distinguished himself as an authority on blockchain's applicability to Ghana. He speaks at conferences and corporate seminars to emphasize the technology's suitability to address conditions in the country.

Beyond the more individualized participation in the innovators' category, a few companies are striving to propagate blockchain's adoption. Notable among them is Kumasi Hive, an organization that emphasizes fast-tracking the adaptation and contextualization of digital technologies to the Ghanaian context. A respondent who works there explained how they have made strides in propounding blockchain through training programs.

> I just saw the possibility of it after reading it, in our local context, what it can do. So I just pushed for it. So, I got some of our team members to specialize in it. We got content and all that, so then we built the content and then, we run some of the first blockchain training programs. And then built further content, and then built applications from it. (Adom)

Adom is an innovator who runs an established IT firm and therefore had ready resources to initiate projects after he educated himself on blockchain. After researching

extensively, he recognized the myriad ways that his company could adapt the technology to the local context. He designed training programs for members of his team and then expanded these programs to the wider public. He did this when no individual or institution had instituted local and publicly available blockchain educational modules. Kumasi Hive's pioneering status in the field is further heightened by their concerted efforts in encouraging female participation. Adom has trained an all-female team on blockchain program development, and they built an application for managing health records for local hospitals.

To add to the conversation on their technical capabilities and professional affiliations, although not all the innovators specialize in IT, 11 out of the 12 have educational backgrounds in STEM fields. This validates how educational pursuits determine interests and positioning in certain fields. Their foundation and the training it has given them towards their present activities with blockchain underscores the importance of mitigating the sociocultural aspects of societies that limit one's academic aims based on gender. Adom surmised it was easy for him to decide on studying electrical engineering because he is male. Men are generally not constrained by sociocultural pressures and inhibitions in making career choices. In contrast, society discourages women from studying in what he calls "high tech" fields. The female to male ratio among the innovators directly reflects his submission, only two out of 12. This ratio is congruent with the gender constitution for blockchain (and by extension STEM fields) as a whole. In fact, among the entire sample of this study's participants, only two women have technological expertise and experience. One of them, however, does not design or develop blockchain applications. Even though her original job assignments involved software development, her role with the company's addition of blockchain services is educating people on how to use their blockchain applications and organizing various disseminations events. I will explore these points further in the next chapter, which analyzes the gendered Ghanaian social system in which blockchain is developing.

A final and interesting finding for this group is that they operate in isolated bubbles. Participants do not know of others' blockchain endeavors even if they are acquainted. The quotations below illustrate this observation and show how their surreptitious activities are amplifying the impression that there is very minimal application design and building going on. Apart from their personal endeavors, each

participant only seems to know the few standout applications that have had some publicity in the media, such as Bitland for the land registration system.

> I've not seen anyone in the country with as detailed technical knowledge as he has, but if there are, maybe they are quiet. A lot of tech people are quiet, they sit down, and they don't say anything. (Mantse)

> I don't know if you know so much about Ghana, people don't brag and walk around and do publications about things they do like you do in Canada, no. Everybody keeps their thing until it's ready. Right, so currently there is no blockchain solution that's working in Ghana. Ecampus is the closest. Even that you don't want to claim we are working, we want to keep it on the cool. Because there's no legislation and all of that. So if you make too much noise they'll kill it before you even start. So we are all being careful. (Yoofi)

> I do meet up with some people, but you see one thing is… most of these organizations they have their own hidden agenda. Sometimes you go, it seems you are there with them, the next time… they have taken your idea and they are doing it on their own, so that is why sometimes we become careful in terms of sharing or meeting. (Atoapem)

Participants acknowledge here that it is common practice for people involved in designing and building blockchain applications to not share information on their projects. Yoofi's biggest concern is being shut down by the government due to the lack of legislation. In the instance where the government declares blockchain illegal in Ghana, he would not face any repercussions because he is carrying out his activities clandestinely, "on the cool". In terms of their connection to each other, about 64% of them belong to the Ghana Blockchain Society and participate on their WhatsApp group platform. This is a highly interactive platform with regular conversations on current national and international affairs on cryptocurrency and blockchain. From their own assertions, they know (of) each other in some capacity and also connect at hackathons, workshops, and other blockchain events. These interactions appear not to have generated enough trust for open conversations about their projects, however. My first encounter with this mistrust was at the blockchain meetup I attended to connect with the community and enlist participants. An attendee mentioned he was working on a blockchain application and I eagerly asked him for more details. He was resolute in his refusal to discuss it. He explained he did not want his ideas to be copied, he would only talk about the product after its launch.

The general mistrust is likely a direct repercussion of the overwhelming incidents of fraud that have racked the space. Both the Bank of Ghana and the Ministry of

Communication have cautioned the populace against patronizing cryptocurrency products, and by extension blockchain since many people consider them to be synonymous (Acquaye, 2019; Class FM, 2018). Additionally, with people clamoring to be pacesetters in the game, safeguarding their intellectual property might guarantee their lead. This is an interesting contrast to interactions that some participants reported having with international contacts. Kobe for example refined his concept for an agribusiness platform by sharing ideas with an international contact he met through a blockchain group on Facebook. This indicates that they do not perceive stakeholders from outside Ghana as threats to their advancement. Very recently, the Bank of Ghana has launched a pilot regulatory sandbox targeting financial service innovations like blockchain. This is a forum that would allow the testing of selected innovative products under regulatory supervision (Bank of Ghana, 2021). It would be interesting to see how this new development impacts the interactivity and innovation sharing in the blockchain community. The next section expounds on the constituents of the early adopters as a relevant social group.

Early adopters

Rogers posits that early adopters are more ingrained in their local communities and are therefore more respected. This leads to their ability to better position themselves as opinion leaders. An opinion leader is an agent in a social system who can influence other members' behavior and actions. The belief system and norms of the society opinion leaders find themselves in influence their activities. Further, their legitimacy stems from their perceived technological competence. An early adopter is essential to critical mass adoption of an innovation due to the influence they wield as role models. They are less prone to risky ventures. People, therefore, take them seriously when they convey their approval of a technology to their peers (2003). In the Ghanaian context, their opinion leadership manifests in a more nuanced manner, in part because of the mistrust people have in blockchain. Hence, their ability to influence other members of the community is not automatic, it is based on their success with the innovation. Kabenla for example reported that his family only became receptive to his interest in and advocacy for blockchain after he made his first million[16] from investing in cryptocurrencies.

[16] He did not clarify the fiat money in which he valued this amount.

Sixty-four percent of respondents are early adopters. In the context of blockchain in Ghana, they fall under the category of opinion leaders because they represent those who learned about blockchain through personal and professional networks early on and have also advanced a dissemination of information. These early adopters have a very varied professional portfolio, including a veterinarian who used to be a forex trader and saw the opportunity to transfer his trading skills into the crypto sphere. There is also an accountant who described himself as a blockchain enthusiast and advocate, as well as students and several entrepreneurs. One of the most interesting cases of professional crossovers is a nurse who opted not to practice in his field after he graduated from nursing school so that he could dedicate himself fully to trading in cryptocurrencies. He is additionally working with a team to develop a cross-platform payment system based on a blockchain. Although one person confirmed they had a working knowledge of IT concepts and programs, early adopters generally do not describe themselves as experts in informational and digital technologies, or even experts in investments and trading.

Overall, the activities and interactions of early adopters with their professional and personal networks have been integral to the spread of knowledge and adoption of blockchain. To exemplify, one of Nhyira's principal responsibilities with Ghana.com is to train clients on how to use the blockchain applications that they develop. Ghana.com is a key player in blockchain in Ghana with an already established reputation as a pacesetter in the digital sphere. The founder, Prof. Quaynor, is a well-known innovator recognized for such exploits as establishing the first Internet Service Provider in the country. In 2013 he was inducted into the global Internet Hall of Fame in the pioneer category for ground-breaking work on internet development in Africa (Ghana.com, n.d., para 4; internethalloffame.org, n.d., Pioneers section). Two of their platforms for which Nhyira provides client support authenticate industrial and academic certifications to counteract forgeries. Their clients include universities and professional educational institutes. In addition to this, Ghana.com operates an agro-industry supply chain. This is a platform that connects agents like communities of farmers, transportation providers, creditors, and donors in an open and trustworthy supply chain system (Ghana.com, n.d). Nhyira also facilitates blockchain training at Ghana.com's pioneering Blockchain Academy. This is a well-structured program in a short course format where they introduce registrants to the infrastructural setup of blockchains and cryptocurrencies as well as the development

of applications. Added to this, she speaks on the innovation at conferences and similar events.

Other participants influence people's opinions in different capacities. For instance, Lariba is a newspaper journalist whose principal engagement with blockchain is to publish accurate information on it so that the negative publicity the innovation has would not dissuade people who might be interested in getting involved in the space. Sedem is a teaching assistant at a public university and has formed cryptocurrency meetup groups with regular sessions throughout the school term. He described the membership as very dynamic, some people come for just a few sessions, while others attend over a longer period. A few only come once or twice to dispel or confirm their suspicions about the fraudulent nature of cryptocurrencies.

> [S]ometimes we create WhatsApp groups and we… share the links… we encourage the ladies there to join and all that. And then back on campus we have different (student society) groups that are mainly for females and we try to get those groups to also inform the people… whenever they have a program, for them to get on board. (Sedem)

Sedem is adept at targeting women as an underrepresented social group in the space and most probably do not have enough resources that speak to their specific interests. One of his techniques is to give women discounts for his paid events. Adams et al.'s research on blockchain-focused meetups for women shows that they can be congenial sites for acquiring knowledge and sharing ideas around an emerging technology (2020). Sedem has managed to tap into the interests and uncertainties that women express to encourage productive conversations while positioning himself as the expert capable of dispelling these uncertainties. His meetups and virtual groups, therefore, function to create an inclusive environment for women seeking knowledge on blockchain. A common interest that I observed among the various participants who are active agents of blockchain information dissemination is their aim to further their reputation as experts.

In terms of early adopters' principal occupation, most of them call themselves cryptocurrency traders, investors, or merchants. They mainly trade in cryptocurrency, particularly in Bitcoin, which is the most popular currency in Ghana. The overrepresentation of traders in this category is distinct, as only two innovators do some trading.

> In terms of the different sectors within the blockchain space itself, there are people who are involved with the day-to-day trading of cryptocurrency. And that is actually very huge in here Ghana. I would say that it's probably the bigger sector in the space. (Azindoo)
>
> [S]ome do investments in the blockchains, some also are merchants because basically, here in Ghana… what we do is we patronize blockchain mostly in cryptocurrency. (Sisi)
>
> So far the people I've met, especially in Ghana, are people who (are in) the cryptocurrency bubble, they were interested in 'I want to buy Bitcoin, so what's blockchain?" Then they started getting into it. (Nhyira)

Per participants' observations, cryptocurrency merchants are the actual majority of the members of the blockchain community in Ghana. This predominance evinces the perception of low barriers to entry. Some participants stated one does not need specialized education to buy and sell cryptocurrencies. As Manste puts it, "[A]nyone can take it up. You don't have to be an IT person, so even a nurse and a janitor and all these people, and a lot of students, go out taking up trading now." Yao expresses the same sentiment and intimates that he is probably more skilled than the average cryptocurrency trader because he used to be involved in forex trading. Both fields have lower barriers to entry than the major financial markets because one needs a nominal amount of money to participate, and the knowledge base also appears to be lower. However, this is not entirely accurate because any kind of trading requires a minimum level of financial knowledge to be successful. Finally, some traders offer small-scale remittance services to people who primarily want to send money to and receive from other African countries. A respondent noted that the biggest remittance market is with the Nigerian international students in Ghanaian universities. As they receive money regularly from their parents, using cryptocurrency merchants helps them save substantially because of the low fees. They can also circumvent the caps that traditional money transfer organizations like MoneyGram place on transfer amounts.

Being that early adopters focus their attention overwhelmingly on trading, they do not take part in the activities of the wider Ghanaian blockchain community, unlike the innovators. Many have never attended any of the meetups, seminars, or other events. The bulk of their interaction is with contacts in online communities specific to investing and trading in cryptocurrencies. This singular preoccupation has resulted in an appearance of insufficiency in general knowledge on the rudiments of blockchain. About four respondents used blockchain and cryptocurrency interchangeably without seeming

to differentiate them. One said she only knows blockchain to be for personal transactions. Another, who had been trading for about three years at the time of our conversation was not familiar with any other applications of blockchain beyond cryptocurrencies.

Moreover, an intriguing facet of their trading activities is that they primarily connect among themselves on virtual platforms, the most popular being WhatsApp. Manza credits these online communities as integral to her success because they facilitate ease of value exchange among members.

> [I]f we didn't have these kinds of platforms, the WhatsApp ones, to actually trade in with the coins that we buy or acquire… (it would) have been extremely difficult to actually get Bitcoins or any other coins in Ghana… So they are like, they make things so much easier. So this is a very positive thing. And there are good people there that are willing to do a few things. But the same time there is the negative aspect which is, it's easy to get scammed or deal with fraud out there because… you don't know anybody there… but it's also very important. (Manza)

Manza's assertion presents an opportunity to analyze WhatsApp as an integral aspect of the blockchain space in Ghana. That is the location for her entire interaction with clients and colleagues for trading activities. Thus, it not only facilitates communication in furtherance of her business, but it also serves as a cryptocurrency exchange platform. This circumstance is not unique to just trading, it is similarly a force in streamlining the activities of the wider Ghana Blockchain Society. As I mentioned in the methodology chapter, joining their WhatsApp group eased my entry into the community during my fieldwork. This is where they share information on events and current affairs, broker deals, and establish business alliances. The messaging service is the most used social media platform in Ghana. A survey on internet users' self-reported social media usage showed that 83.9% of them used WhatsApp regularly, compared to 70.8% and 69.7% of usage for Facebook and YouTube respectively (Kemp et al., 2020). What makes WhatsApp particularly endearing is the low internet data usage that it requires. This is especially significant considering high internet fees and sometimes unreliable network access. So far as one's digital device has an internet connection, calls and messaging services are free. It is also the commonest interpersonal source of news and entertainment through the texts, images, and videos that people share. WhatsApp has a voice messages function, hence it is a communication tool of choice for people who lack literacy skills as they can send messages without needing to type. Further, group chats

are popular for connecting large numbers of people around common interests. Added to this, end-to-end encryption protects users' calls and messages (WhatsApp.com, n.d.).

Indeed, WhatsApp has transformed the media and social interaction ecosystem in Ghana, given the extent to which it has contributed to interconnectivity among individuals and communities (Boyd, 2019; Koomson, 2020; Pindayi, 2017). It provides a public sphere for interactions that are unencumbered by the structures and regulations of society. These values further enhance its usability in the decentralized peer-to-peer exchanges devoid of restrictions that are intrinsic to blockchain. WhatsApp's widespread use makes it a platform for traders to integrate their communication and social media needs with trading activities. Considering that the number of social media users in Ghana increased by about 37% between 2020 and 2021 (Kemp et al., 2021), WhatsApp is a fertile environment for accessing a ready market. Even more appealing is the fact that it is a platform that is not bound by national borders, users can interact with people from any part of the world. Manza explained this,

> [E]ven though there isn't so much information out there yet because the whole industry is still young, people that are already in it, like your predecessors… are very eager to share knowledge… It doesn't really matter whether the person is a Ghanaian, is in UK, Canada… so long as you challenge the person, they want to tell you everything, their experience, they are happy to, you know, let you know what is there, what you should look out for… so that has… I guess contributed positively to my interaction. (Manza)

This is a positive consequence that traders point to from their experiences on virtual platforms like WhatsApp. As Manza details here, the atmosphere of support and knowledge sharing has enhanced her experience as a trader. Other participants discussed instances where they alert each other to possible frauds and share information about price drops on popular coins and ICOs that seem like good deals. The pervasive extent to which the cryptocurrency traders use WhatsApp is likely a chief reason for Ghana's less than impressive showing among the countries at the helm of user traffic on popular DeFI webpages. Fernau's analysis shows that in the top users of the biggest DeFI sites, nations from the Global South usually rank third or fourth (Fernau, 2021). The lower activity that the members of Ghana's blockchain community show in these rankings could have more to with the affordances that WhatsApp presents them rather than lower usage levels compared to other nations.

In contrast to the above commendable features of the blockchain ecosystem in Ghana, there is also a disparaging aspect. This is the deluge of duplicitous schemes which accompanied the sudden popularity of cryptocurrencies in Ghana. It is a situation that has been particularly impactful on traders. The schemes are as varied as people's imaginations. In some cases, they entice people into investing in cryptocurrency trading companies (mostly online) with the promise of shockingly high returns. The frauds flourished because many did not know exactly how to purchase crypto assets or understand the principles of owning and maintaining wallets. Hence, they would be deceived into paying monies to some entities to have them purchase coins on their behalf and manage their digital wallets without them having any access to them. After a period, they would find out that the company was fake, and the website had vanished along with their funds.

> There are times that I have lost money to fraudsters and scammers. (Afiba)

> About Ponzi schemes… it has dented some of my relationship with people… introducing somebody to invest his money, somebody invests like $200, $500… But then in the end whatever they put in they didn't get all back. So the relationship with those people became somewhat, you can't tell them anything, they'll be like you made them lose their money and stuff like that. (Kodzo)

Just as Afiba and Kodzo's experiences, many traders shared stories about how they have convinced friends to invest in schemes that turned out to be hoaxes. In several instances, they play the role of brokers or middle persons for friends and family who are interested in investing in cryptocurrencies. These situations have tainted their relationships with these personal networks as scammers cause them to forfeit their investments. As well, the unfortunate reality has impeded their business progress due to the loss of crucial earnings. Although these incidents are deplorable, they portrayed the tenacious faith that cryptocurrency merchants in Ghana have in the innovation's growth. Even with the heavy losses they discussed, they reported that their negative experiences do not deter them from continuing to trade. The same cannot be said for the people they interact with in their efforts to encourage wider adoption. They have noticed an increase in blockchain rejection, with people basing their opinions on widely publicized scams. In addition to this, early adopters are also dealing with people questioning their character when they find out they deal with cryptocurrencies. The following quotations illustrate this point.

> You talk to other people and they are like 'oh this thing somebody told me it's like this, somebody told me it's a scam, so I don't want to'. (Jojo)

> …some friends who are not into Bitcoin, you know, when you talk to them about it, they think it is a scam. They think you are a fraudster. (Afiba)

As I discussed at the beginning of this section, respondents from both the innovator and early adopter categories are opinion leaders because of their dissemination activities and people seeking them out as investment brokers. Their statuses are further enhanced by general discourse about Bitcoin's value as an investment option. However, they have also lost their credibility in some circles because of the fraudulent activities in which they are inadvertently embroiled. This situation, therefore, renders them both opinion leaders and social deviants (Rogers, 2003).

Lastly and most notably, the early adopters group has the highest female representation, 10 out of 12 of the investigation's female participants. This number shows that most women working in some capacity with blockchain are traders. Nonetheless, it does not actually reflect the percentage of women in the entirety of the blockchain community. I interacted with this number because I persistently sought them out towards my ultimately unattainable goal of an equal number of male and female respondents. It was a surprisingly difficult undertaking to reach enough women. Using the snowball method in participant recruitment, my final question at the end of each interview was if they could connect me with other contacts. Even the women found it difficult to point me towards other women.

> [T]o give a ratio I would say maybe 95:5, That is 95 men, is to 5 ladies… throughout the whole time that I was buying and selling BTC, I think I only dealt with two females… one was from the USA and she wanted to buy BTC and the other one we had a deal to sell BTC… even with her she was in the business because her husband was in the business. So she was kind of standing in for him, so it's not like it was the main thing that she does… And the platforms too it's the same thing… mostly I am the only female in the group. (Dewa)

> I was interested in bringing girls that are in crypto together. Unfortunately, it didn't succeed. Yeah because there wasn't, there was almost nobody… It was just her and, I guess, me. I made announcements, lots of announcements, that if you are a girl please contact me on all the pages that we were involved. She was the only girl at the time who contacted me. So I'm sure probably she was the only girl at the time (Manza)

Dewa and Manza detail here the considerable gap that exists when it comes to female participation in their trading activities. In Manza's case, her inability to network with other women in the space is not from a lack of trying. She set out to organize a collaborative female group and only managed to connect with one other person. These gaps are likely because of the digital world being the primary medium of interaction among them. There are probably other women present in the groups, but they might prefer to hide their actual identities behind nonidentifiable profile names. Moreover, the negative experiences that some have endured from investment scams generate further reticence for opening up to each other and building deeper relationships. I develop a more extensive analysis of gendered participation in Ghana's blockchain society in chapter six.

The relevant social groups are only one part of this sociotechnical environment. Next, I further outline blockchain's ecosystem with a description of the other components of the network, the socioeconomic environment. This laid the groundwork for the innovation's introduction and facilitated its uptake. Conditions of the financial services sector are the major factors in this discussion. The aim here is to establish the interconnection between blockchain and the specific contextual conditions of Ghana, an illumination of the social embeddedness of the framework of its adoption.

5.1.2. Enabling environmental influences

From 2017 onwards, several occurrences which I detail below contributed to an explosion of the innovation's reputation as a viable option for investment in the public eye. Although these conditions involved Bitcoin specifically, I must note here that in popular discourse, Bitcoin, cryptocurrency, and blockchain appear to be interchangeable terms. Notably, being that these events emanated from economic conditions, they have fostered a situation in which blockchain is overwhelmingly pigeonholed as digital technology for the financial sector.

Bitcoin's spectacular peak

The first and most preeminent event is when Bitcoin's value peaked at $19,783.06 in December 2017. This was an exponential rise from $780 in November 2016, and approximately $1000 at the beginning of 2017 (Coin Desk, 2020; Salzman, 2019).

Although Bitcoin had a volatile past, this sharp rise in value heightened cryptocurrencies' reputation in Ghana's public consciousness concerning business and investments.

> I'm very curious so I turned out to be researching on new technology. So it was much more of a research work. And also, well what actually drew my attention was when Bitcoin was sold at $20,000 per coin it actually made me think that oh, this is something that is profitable. (Ayebia)

> But I think it was within that year, from the beginning of that year to the end of it. Bitcoin was on the rise, everyone was talking about Bitcoin and all of that. So, and then again I needed a way to make money. It was my friend that introduced me to it. (Dewa)

In Dewa's case, even though her initial introduction to cryptocurrencies was through a friend, the surge in the currency's value solidified her interest. To further attest to Bitcoin's popularity in Ghana during this period, Paxful, a global leader in cryptocurrency exchanges, attributed its immense growth in Bitcoin trading in 2018 and 2019 to transactions from Africa, with Ghana and Nigeria leading the charge. Google trends ranked Ghana eighth with Bitcoin searches in 2017. 2018 however saw Ghana climbing the charts to become the second country worldwide with the most searches on 'Bitcoin' (Cuen, 2018; Google.com, 2018; Paxful Press, 2019).

The upswing in Bitcoin's value and its consequent intensification in Ghanaians' interest created a narrative about cryptocurrencies being an effortless moneymaking tool. Those who were already actors in the blockchain space found themselves at the center of probing conversations with family and friends about how to cash in on the Bitcoin hype. Ebo's quote below exemplifies how they progressively attained expert status and doled out tips about the steps they took themselves in their trading activities. Some participants even formed online groups to share trading advice with Bitcoin novices.

> [i]t's always about Bitcoin… (they ask me) 'oh Ebo so you know about blockchain' and then it jumps to crypto, 'how can I make money?'… The people that I've been talking to mostly are much concerned about cryptocurrencies and how they can benefit. Buying Bitcoin today or ether today and then see a price that they can sell. (Ebo)

> So I was in this group, and somebody told me that, oh there is this… get rich scheme. Yeah, it sounded interesting to me, like, I spoke to the guy and I joined, like, I wanted to learn more about Bitcoin. But because these people normally they do not want to explain things to you, they just need

> your money, so it was through that I got, I got into the crypto space after I decided to do my own research. (Baaba)

Baaba first heard about Bitcoin during her National Service[17] period when she needed extra income to supplement her allowance. The investment scheme she was introduced to turned out to be fraudulent, but it started her interest in cryptocurrency trading on WhatsApp chat groups. This occurrence was common. As the reputation of Bitcoin climbed in investment considerations, people quickly established companies to take advantage of this mounting interest. Information about these companies and their high-profit margins spread through WhatsApp. They were successful especially because of people's propensity to make transactions through brokers or middle persons rather than doing so in their own stead. Additionally, people acted in blind confidence based on the hype about Bitcoin's price surge, there was little fear about encountering any losses. The companies would receive cash deposits from clients supposedly to invest in Bitcoin and share the profits by paying depositors back with interest. There was no information on any losses should the value of the cryptocurrency fall. The profits appeared to be guaranteed. Some of these institutions were not legal business entities at all, while others were licensed for operations other than taking cash deposits from people. A number of them were also national and international online businesses with no physical presence in the country. Depositors would realize after a period that the websites were suddenly nonexistent, with no knowledge of where or from whom to retrieve their investments.

These occurrences prompted the Director of the Cybercrime Unit of the Criminal Investigation Department (CID) of the Ghana Police Service, Dr. Yankson, to warn people from being tempted to invest in cryptocurrencies even if they were promised high returns (Akese, 2018). One of the most infamous cases was with the Global Coin Community Help (GCCH) syndicate. The directors of the company were arrested for disappearing with the investments of over 110,000 clients. They operated a Ponzi scheme where the common technique was to have clients deposit varying amounts for 27% interest payouts over 12 months. It is not clear if they actually invested in any cryptocurrencies. The Economic and Organised Crime Office (EOCO) spearheaded

[17] This is a year of mandated employment particularly in underserved sectors like rural education and agriculture. It is a requirement for every Ghanaian after their tertiary education. Although National Service personnel are not paid salaries, they receive token monthly allowances (National Service Scheme, n.d.).

efforts to retrieve depositors' funds from GCCH and the other similarly fraudulent cryptocurrency entities. These widely publicized events further popularized Bitcoin and other cryptocurrencies, albeit in a somewhat negative manner (Mustapha, 2018).

Another pull factor that enhanced cryptocurrency's investment feasibility was the demand for financial services that is relevant to the needs of the socioeconomically marginalized.

Inadequate financial services for the socioeconomically marginalized

Many citizens of countries in the Global South can be described as socioeconomically marginalized. This is based on their exclusion from standardized employment structures, whose attendant benefits and responsibilities are enshrined in governmental regulatory frameworks (Organisation for Economic Co-operation and Development [OECD] & International Labour Organization [ILO], 2019). Ghana is no stranger to this unfortunate reality. Projections of the percentage of Ghanaian working adults who are employed in the informal sector range from 80% to 90% (Ghana Statistical Service [GSS], 2016; Osei-Boateng & Ampratwum, 2011). Osei-Boateng and Ampratwum rightly assert that there is an inherent difficulty in attempting to adequately define income generation activities that fall outside of the formalized employment sector (2011). This difficulty lies in the fact that the boundaries that separate formal and informal employments sites are not clear-cut. Certain workers engage in labor relations within formal structures, but their work precarity, as well as their blockage from legally mandated benefits like sick leave, render their employment informal. Many people also engage in paid and unpaid jobs in homes. This is, however, not an environment that is readily perceived as an employment site. These types of work, such as cleaning services and nanny positions, commonly do not have contractual agreements that spell out rights and benefits, nor do they come with formal guarantees. The ILO provides a definition that appropriately captures the complexity of the informal economy.

> The term 'informal economy' refers to all economic activities by workers and economic units that are –in law or in practice – not covered or insufficiently covered by formal arrangements. Their activities are not included in the law, which means that they are operating outside the formal reach of the law; or they are not covered in practice, which means that – although they are operating within the formal reach of the law, the law is not applied or not enforced; or the law discourages compliance because it is inappropriate, burdensome, or imposes excessive costs. (2002, p. 53)

The GSS (2016) in its description lists such impediments of informal employment as not being entitled to “paid holidays or leave, sick or maternity leave and where there was no verbal or written contract at the time a person started to work” (p. 83). Thus, anyone engaged in employment that has any of these conditions is in the informal worker category. Altogether, examples of characteristics of informal economic activities include not being registered as businesses in the national directory and therefore not taxed or monitored, existing on a small-scale basis, being subject to uncertain work security, and low and irregular wages. The complexities of the reality of persons engaged in the informal economy are myriad. They span such issues as exemption from social protection, income insecurity, risk of getting stuck in the poverty cycle due to volatile work conditions, and inadequate recourse to legal frameworks to address occupational and other injustices. On the positive side, some informal workers could benefit from flexibility in work schedules. This makes it possible for them to engage in other income generation activities. Even as partakers in Ghana’s informal sector make substantial contributions towards the nation’s GDP, the barriers they face generate inequalities that tend to get solidified as the economy continues to grow. Beyond their basic rights to equal opportunities as other social groups, the fact of their importance to the economy encourages an economic argument for governments to implement measures to mitigate the risks and vulnerabilities in which their employment situations are embroiled (Haug, 2014; OECD & ILO, 2019).

Informality in employment imposes on the people involved levels of vulnerability that vary across social groups, urban versus rural locations, and areas of employment (Haug, 2014; ILO, 2002; OECD & ILO, 2019). Women are disproportionally affected by the vulnerabilities associated with informal employments because they are the largest population in this economic group. Further compounding this, the disparities within the various groups that make up the population of informal workers are further skewed against women. Compared to male informal workers, the female populations are more likely to endure income insecurity, poverty, occupational risks, and harassment (ILO, 2002; OECD & ILO, 2019). Rural dwellers are also more likely to be engaged in informality compared to urban citizens, as well as seniors in both rural and urban localities (ILO, 2002; OECD & ILO, 2019).

According to a study in a municipality of the Greater Accra Metropolitan Area, people in the informal business sector are largely averse to using formal banking

services because they do not think that they are geared towards their specific needs. In the first place, many of them do not have the required national identity documents to access these services. Those who do have them report that they are repelled by the long queues at the banks. Considering their employment precarity, they do not have enough breaks during their long working hours to afford the excessive wait times (Sobers & Verella, 2018). Informal workers are further disadvantaged because they are more likely to not have access to credit facilities from financial institutions. The banking industry imposes high interest rates on them due to their elevated risk as borrowing clients, which compounds their marginalization even more (Dovi, 2008; Kshetri, 2017; Thomason, 2017). As a solution to these phenomena, an informant for this study described the feasibility of the blockchain-enabled financial services he provides for myriad clients, including small- and large-scale retailers in the public markets. They can transmit money within Ghana as well as to and from other African countries at a considerably minimal fee. His service comes without documentary restrictions, and from any location using mobile technology.

Considering that these social groups constitute such a large proportion of the population, their inability to access services from the traditional financial structure means that there is a huge gap to be filled. Atoapem, who opted to forgo a career in the formal sector to pursue entrepreneurial interests with blockchain, opines that cryptocurrencies afford him financial services that he does not access from the banking sector.

> The advantage is it makes us to have access to our funds anytime anywhere, as compared to mobile money where there is restrictions, and compared to banks. And because of that I personally don't even have a personal bank account… so maybe with cryptocurrency for instance, you can have access to your funds anytime you want without any third party. That is what I like about this blockchain. (Atoapem)

One of the prominent options informal workers have for accessing capital is the Susu[18] collector. These are usually individuals lugging around notebook ledgers who go to collect savings deposits directly from clients like market sellers, store owners, and other such small-scale business owners. Compared to banks, Susu collectors have more relaxed regulations about minimum contribution amounts, the regularity of contributions,

[18] Susu means 'savings' in the Akan language.

and withdrawal schedules, and their lending terms are not tightly clad in burdensome regulations (Sobers & Verella, 2018). Another avenue that until recently was a popular investment and credit preference was Microfinance Institutions (MFIs). Both of these options have proven to be risky, as the cases of these entities pilfering clients' money abound (Boateng et al., 2016; Nyansapor, 2018). Considering that these are the primary options for low-income and other socioeconomically marginalized populations, their eroding image of trust and the rampant collapses spell great loss in financial services for those affected. Relevant blockchain-based applications, therefore, stand to reconfigure the access points and drive monetary inclusion if pundits put in place the appropriate trustworthy and public awareness measures.

The dramatic rise and crushing fall of MFIs

Related to the preceding discussion, another deficit in the financial services sector that facilitates blockchain's spread is the inaccessibility to affordable investment opportunities. Azima described her wariness of investment options that MFIs offered, although she considers them to be economical. Her hesitation with MFIs was what motivated her to invest in Bitcoin. She was first introduced to cryptocurrencies when she was saving towards a master's degree. As the first-born child of a low-income family who had been fortunate to attain a well-paying job in a gold mine, she also had a responsibility towards the education and general upkeep of her younger siblings. These circumstances compelled her to be circumspect with her financial plans. Hence, investing with MFIs, even the ones which were still operational and not directly implicated in any rumors of impending closures, was not an option.

People generally consider MFIs as providers of financial services for low-income and marginalized persons. Nonetheless, a recent spate of closures caused by bankruptcies, as well as news of owners swindling patrons and absconding with their money, has created an atmosphere of mistrust among their target clients. These events have been catastrophic because numerous clients have lost their life savings and livelihoods, forcing many into poverty (Belnye, 2011; Boateng et al., 2016; Sobers & Verella, 2018). One of the most recent and widely devastating examples is the fall of the very popular MenzGold, which was operating as an MFI without a license. The Precious Minerals Marketing Company (PMMC) only officially accredited them as gold traders. MenzGold marketed itself as a gold investment company, which guaranteed customers

very high returns. To legitimize the company's operations, they put out publicity campaigns spearheaded by celebrities. Their reputation was further enhanced when various media reports showed the owner, Nana Appiah Mensah, in meetings with venerated leaders like the president Nana Addo Dankwa, and the King of the Asante kingdom, Asantehene Otumfuo Osei Tutu II.

The first widely publicized sign of illegalities was in 2017, the Bank of Ghana (BoG) queried them about providing financial services for which they did not have a license. They denied this, though by this point they had amassed an immense base of cash-depositing clients. The BoG issued a public warning against investing money with MenzGold since they did not have clearance for "the solicitation, receipt of money and payment of dividends to its clients" (Otoo, 2017). Amid the ensuing uproar, the Managing Director of the PMMC Kwadwo Opare Hammond stated in an interview that they had revoked MenzGold's license for gold trading because of dubious operational strategies which went beyond their accreditation to buy and export gold. He added that the PMMC had announced this in a newspaper article two years prior to the BoG's warning. This publication however did not receive widespread attention at the time (Laryea, 2018; Zurek, 2018). The Securities and Exchange Commission (SEC) which oversees the capital and securities market in its turn probed MenzGold for contravening regulations by promising clients guaranteed returns on investments and fixed deposits. Initially, instead of exercising its mandate to levy penalties for operating without an applicable license, the SEC opted for forbearance and followed in the footsteps of the BoG. They published a letter in the most widely circulated national newspaper Daily Graphic asking the public to desist from investing with MenzGold (Nyansapor, 2018; Ofori, 2020; Tagoe, 2019; Zurek, 2018). The SEC eventually issued a directive for them to shut down their services, and MenzGold suspended operations. This action brought to a head a tumultuous period characterized by intense public debates on the lethargy of the BoG, SEC, and other regulatory bodies in curtailing the actions of fraudulent companies before people invest their monies with them. There was a massive public outcry and clashes between MenzGold customers and security forces as the former thronged the companies' closed offices as well as the home of the CEO demanding the return of their investments (Ofori, 2020; SEC, 2018; Tagoe, 2019; Zurek, 2018).

To mitigate the occurrences of such events and prevent an imminent financial sector crisis, the BoG over the previous decade had taken steps to overhaul the sector.

Starting from 2008, they closed down several insolvent MFIs and circulated their identification details publicly to deter people from conducting further business with them. In 2016, the BoG revoked the licenses of about 70 MFIs upon expiry of their provisional licenses (Belnye, 2011; Ofori, 2017). They similarly castigated another 39 insolvent MFIs in 2019 for reasons such as severe under-financing and inadequate lending and risk management practices (BoG, 2019). These sweeping changes appear not to have sanitized the financial industry enough, as it did not stop the MenzGold and other MFI debacles from happening. Reasons for the collapse of MFIs include unsustainable promises of high returns, mismanagement of funds, indiscriminate branching, and external factors like rumors of closure which causes waves of panic withdrawals by clients (Boateng et al., 2016; Ofori, 2019). These incidents make it altogether riskier and more cumbersome for people who are already facing various forms of socioeconomic barriers to access financial services. Thus, interview participants like Aziama and Lariba observed that the volatile environment of the MFIs resulted in a shortfall of trustworthy investment options. This led to an uptake in cryptocurrencies trading. This circumstance is especially true for individuals who do not perceive traditional entities like banks adequately representing their interests in the financial system.

Expensive and relatively inaccessible remittance services

The final factor which the respondents pointed to as facilitating blockchain's spread is the need for low-cost and easily accessible remittance services. International and national remittances are a key feature of Ghana's financial services climate, helping to link marginalized persons with financial services and provide income sources. They have a significant impact on the households that receive them. They are also beneficial for the wider Ghanaian economy because they enable national socioeconomic development by helping to reduce current account deficit (Teye, 2016; Teye et al., 2017). Additionally, financial institutions and telecommunication companies earn revenue through their remittance services. At a more societal level, some people support community development projects through the remittances they send. Monies received also form the basis of financial support for family members. Recipients report using them for such expenses as school fees and other educational needs, for feeding families and operating businesses. They also ensure a circulation of funds in displaced and marginalized communities (Teye et al., 2017).

Corresponding to this broad need, in 2015 up to 24% of the population used remittance services, compared to just 5% in 2010 (Ministry of Finance [MoF], 2020c). A study by the Center for Migration Studies in the University of Ghana revealed that the flow of remittance income has increased significantly in recent years. In 2015, people sent up to US$5 billion through formal channels like banks and wiring services provided by international Money Transfer Operators (MTOs) like Western Union and MoneyGram. This was an increase from US$2.1 billion in 2010 (Teye et al., 2017). As migrations from Ghana increase, and migrants widen the selection of destination countries, the origins of international remittances have concurrently increased. The largest source country is the United States, followed by Nigeria and then the United Kingdom. The statistics on the amounts being sent in, however, do not account for informal remittance transfers which use such channels as hiding in mailed letters, self-carrying when visiting home or sending through friends and family. Research shows that the percentage of people using informal means is substantial, amounting to approximately 47 to 59% of remittance streams. Even though there are many instances of remittance carriers fleeing with people's money, they are still preferable because of MTOs' unfavorable conditions (Ahinful et al., 2013; Teye, 2016).

MTOs operate their services through partnerships with specific banks and other major financial institutions. However, these access points are sparsely available, especially for people living in rural areas. To improve accessibility, some MTOs now transfer payments directly into recipients' mobile money wallets. Notwithstanding, they charge very high fees, which are particularly disadvantageous for low-income social groups. Their rates are on a sliding scale, thus the larger the sum, the lower the fee. This means that those who need to send regular monies to friends and family, amounts which are usually not very substantial, end up with exorbitant fees. To illustrate, on July 19, 2020, Western Union fees for sending Canadian dollars to Ghana are 11% on CAD50, versus to 3.5% on CAD200 and 2.8% on CAD600 (Teye et al., 2017; Western Union, 2020). In addition, MTOs only pay out local currencies to the recipient at currency exchange rates they set themselves. These are much lower than prevailing market rates, hence on top of the fees, they earn even more revenue on the difference in the exchange rate. Recipients therefore make a significant loss compared to if they had used a forex bureau to convert the foreign currencies into Ghana cedis themselves. These have a negative effect on the income levels of those who depend on remittances

for their livelihood and business transactions (MoF, 2020c; Teye, 2016; Teye et al., 2017).

A relatively recent local remittance service that has grown to become a major player is mobile money (Momo[19]). Momo is a well-established fintech that has transformed the remittance and digital payment landscape for government agencies, businesses, and the public in several countries in the Global South. Momo conducts basic banking services through mobile devices. This falls in line with the essence of fintech as an increasingly consumer-oriented system of technologies that seek to "improve and automate the delivery and use of financial services" (Kagan, 2019). Mobile Network Operators (MNOs) control Momo in Ghana. Consumers maintain a mobile wallet protected by a pin number. The wallets are the accounts for receiving and sending money. Users deposit into and withdraw cash from their wallets at the MNOs' retail offices, or with mobile money agents diffused all over cities, small towns and villages. Pundits credit Momo with galvanizing national financial inclusion measures, and the increasing ubiquity of mobile phones in Ghana further propel this phenomenon (Yu & Ibtasam, 2018). Momo's impact on widening the participatory reach of the financial sector is a key consideration in the analysis of blockchain's diffusion in Ghana. I will deliberate further on its significance in the next section.

As popular as this service is, where Momo falls short in the remittance needs of Ghanaians is with international money transfer services. This is because MTOs which channel transactions through mobile wallets still maintain their high costs. Using the ready accessibility that mobile phones afford, blockchain innovators are therefore taking advantage of the immense need for affordable international remittance services. Remitting funds through blockchain-enabled platforms means very low costs compared to extant services. Baaba, a Ghanaian international student in Europe, operates a small-scale cryptocurrency-based remittance service for other students and immigrants. Manza also runs a similar service but from Ghana to other African countries. She is presently working on widening her network to other continents.

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[19] Scancom PLC first deployed mobile money services in Ghana, which they named MoMo. Although mobile money services by other MTOs have their official names (AirtelTigo money, Vodafone Cash), people generally refer to all of them as Momo. This could be because it was the name that was first popularised, and Momo is short for mobile money which applies to all these services.

> The advantage, it's cheaper, the speed, you being able to do it from right from your bed. Also, not a lot of restrictions. Oh I think being cheaper is a deal breaker for a lot of people… So Western Union can send it, but there is a limit on what they can send. I wanted to get 5000 dollars. I don't know if I met the limit at the time. And also about 10% of my money will disappear, and I'm like wow! So, it's something like, Bitcoin and blockchain maybe 1% or 2% of the money will go, and that's, to a lot of people, that is perfectly fine. (Nyameke)

Nyameke's blockchain remittance company, BitSika, lets people send money between Ghana and other African countries using Bitcoin as the background operating currency. When a user uploads an amount into their account and transfers it into the recipient's account, they have essentially bought and transferred Bitcoin. Users either withdraw money in their national currencies or as Bitcoin at a nominal fee. He emphasizes here how much cheaper the service is in comparison with MTOs like Western Union. Nyameke reiterated the need to make his services affordable to even the most marginalized by maintaining low service fees. Coupled with the fact that being a mobile application means it offers the convenience of easy accessibility, BitSika has grown rapidly in popularity. Four months after opening, the company reached a volume of $1 million in transactions (Davoh, 2020; Udoh, 2020). Its position in the blockchain remittance market has gained such clout that the CEO of Twitter Jack Dorsey on a trip to Ghana met up with Nyameke to deliberate on blockchain diffusion in Africa.

In sum, the enabling factors for blockchain's uptake in Ghana served two principal functions. In the first instance, they enhanced its quick adoption among entrepreneurs. Public opinion framed blockchain as the avant-garde innovation with high profit margins. This impression attracted a lot of attention and caused people to invest in crypto assets. The rise of MFIs with their get-rich schemes and high interest rates had already laid a foundation for investments leading to quick wealth. This came to a head with Bitcoin's skyrocketing value by the end of 2017. A whole new crop of small-scale financial institutions emerged with investment offerings based on Bitcoin and other cryptocurrencies. With accessible investment options dwindling amid anxiety over the instability of MFIs, people turned their attention to these opportunities. Cryptocurrency schemes provided investment prospects for people for whom the more established investment avenues are inaccessible.

Secondly, they shaped the diffusion of the technology along a specific trajectory, blockchain has gained a decidedly fintech face in Ghana. In the banking sector, it

endeared itself to the socioeconomically marginalized because of barriers such as identification documentation required to open traditional bank accounts. They also benefit from access to a cheaper and trustworthy remittance system which would still be applicable even for their irregular incomes. Ghana has a huge remittance market, although it is rife with issues of accessibility and costs. Blockchain therefore mitigates both obstacles, people can access their wallets directly on their phones and in principle do not need to transact business through third parties of any kind. The cost of these transactions is also comparatively low. Additionally, Nigeria being the second largest source of remittances in Ghana facilitates blockchain's diffusion. With the Nigerian blockchain market enjoying rigorous activity and interest, remittances through blockchain-based applications are popular. MTOs and Momo service providers impose a cap on transfer amounts, while blockchain-based services have no such limitations, making it an even more attractive option.

5.2. Mobile money services versus blockchain

I would like to expound the relevance of Momo to an analysis of blockchain's adoption patterns in Ghana because of their relationship to each other. Also, because of the exigencies of the environment they operate in, the two innovations inhabit a technology cluster. This term refers to the interdependence of different innovations coexisting in a specific setting with similarities in functions or target market. Thus, these innovations could mutually influence their adoption and diffusion. "An adopters experience with one innovation obviously influences that individual's perception of the next innovation to diffuse through the individual's system" (Rogers, 2003, p. 15). Blockchain and Momo have this relationship because of blockchain's prevalent application in the remittance market.

Despite the proclivity of blockchain to address identified problems, it has not experienced widespread adoption by everyday users in Ghana. Presently, blockchain is popular among specific social groupings and is grappling with a poor reputation which is standing in the way of mass adoption. The primary reason for this is the perception of fraud people associate it with. Most significantly, blockchain is facing stiff competition from Momo services in its principal implementation space, remittances. The reasons are primarily about state support for Momo. The erratic mode of adoption that characterizes

blockchain's diffusion in the Ghanaian society contrasts with Momo's systematic journey. Unlike the very individualized blockchain adoption patterns, Scancom Ghana, a multinational telecommunications company, pioneered Momo in Ghana. It is a service regulated by the Bank of Ghana and sanctioned by the government. Indeed, the government further legitimizes the fintech by disbursing certain public service funds through Momo. Moreover, Momo transactions are in the national currency, Ghana cedis, unlike the novel cryptocurrencies which the government does not regulate. Dealing with cryptocurrencies needs an extra level of trust in the unknown, whereas people already have an affinity with the established national currency (MoF, 2020a; MoF, 2020b; Payment Systems Department, 2017).

Three major MNOs, Scancom Ghana, AirtelTigo, and Ghana Telecom, offer digital financial services through wallet accounts which customers register for and set up on their mobile devices. The Momo space has experienced a rapid improvement in operations, with various national and private services collaborating with the MNOs to integrate their platforms with payment services. The Bank of Ghana has spearheaded an interoperability project which has now made payments between Momo services, bank accounts and other digital financial products seamless (Mattern, 2018; MoF, 2020b). Customers can make myriad transactions, including grocery shopping, paying school fees, utilities, and bank deposits directly from their wallets. Momo agents are small-scale deposit, transfer, and withdrawal service points for the MNOs. There are 151,745 active agents. They use kiosks or simple tabletop establishments and can be found on practically every street corner, especially in urban areas (Amoah et al., 2017; MoF, 2020a; MoF, 2020b).

Researchers and government officials alike credit Momo services with driving financial inclusion, thus tripling the financial services access rate by 2015. The number of Momo accounts countrywide rose from 4 million in 2015 to 11.1 million active consumers in 2017, (out of 23.9 million Momo accounts), accounting for 39% of Ghanaian adults (Amoah et al., 2020; MoF, 2020b; Zetterli, 2015). In line with its higher inclination to serve marginalized communities, these figures contrast with the lower penetration rates of banks and other financial services which have existed for decades; 2,044 automate teller machines (ATMs), 1,636 urban and rural bank branches, and 637 Non-Bank Financial Institutions (NBFIs) and registered MFIs (Amoah et al., 2017; MoF, 2020b).

The proliferation of mobile money operators leading to better penetration has increased local remittances. Across all Momo operators, a sender pays 1% of the amount to be sent, and the recipient pays 1% to withdraw the money. Momo remittance services are thus comparatively cheaper and more accessible than bank transfers. Even if the recipient does not have a wallet with the sender's service provider, they can withdraw the amount from the Momo agents with a pin code that the service generates to the sender, in addition to a nationally issued ID for MTN MoMo (Amoah et al., 2020; Yorke, 2021). Recent governmental activities further support Momo's firm stance in the Ghanaian financial market compared to blockchain. In the last 10 years, the government of Ghana has sped up its efforts towards a digitized financial ecosystem in Ghana. It collaborates with bilateral partners and private sector organizations to implement feasibility studies and other forms of research to identify issues, set baseline figures, establish financial indicators, and draw up policies that will guide the implementation of measures towards the adoption of a national framework of digital financial services (DFS) (Mattern & McKay, 2018; MoF, 2020a; MoF, 2020b; Payment Systems Department, 2017). According to one such policy brief from the Ministry of Finance (MoF):

> [O]ur goal for this Policy is to drive financial inclusion by increasing both the depth (i.e., the number of formal financial services used by each individual and frequency of the transactions), and breadth (i.e., the range of services available to customers, the quality of their experience and how it caters to their health, housing, education, and sanitation needs) of their everyday financial lives. (2020c, p. 18)

Even in the face of these digitization endeavors that Momo has facilitated, there are still many people who do not participate in the financial system. In 2015, only about 36% of the population accessed formal banking operations, with 22% in non-formal banking relationships (like Momo) and 25% financially excluded with no access to financial services (MoF, 2020b; Zetterli, 2015). Momo's track record does demonstrate a promising increase in the number of previously excluded people taking part in the financial sector. However, these strides reveal further disparities among marginalized populations. Women, people living in rural areas, and the poor, make up an overwhelming percentage of the populations without access to formal banking services. In the specific case of gender, more men own bank accounts compared to women; 43% versus 31% of women in 2015, whereas 26% of women have informal bank accounts, and 19% for men (MoF, 2020c). The reasons accounting for the inaccessibility to formal

banking services are socioeconomically, politically, and geographically determined. These barriers consequently perpetuate people's economically disadvantaged positions because it bars them from access to capital through loans and other financial products (Amoah et al., 2020; MoF, 2020c).

Unfortunately for the blockchain community's quest for wide acceptance and growth, these governmental endeavors in digitizing the financial industry are moving more towards centralized systems, with no apparent intent to enable the growth of DeFi. The government has been hesitant to even informally endorse blockchain innovations. The BoG even issued a public notice cautioning people against holding and trading in cryptocurrencies. They stated they were conducting further investigations into integrating blockchain into national digitization efforts, meanwhile, "these activities in digital currency are currently not licensed under the Payments System Act 2003 (Act 662)" (Otoo, 2018, para 1). The SEC has circulated a similar warning, "it **does not currently regulate** these types of products offerings and their accompanying on-line trading platforms or Exchanges" (SEC, 2019, emphasis in original). These pronouncements augment the existing unease that people have towards blockchain innovations.

The inherent capabilities that blockchain applications proffer should be attractive for a country which has problems in various sectors like the supply chain networks in agriculture, national and international remittances, and procurement processes. We can ascribe many of these issues to such deficiencies as the lack of widespread digitization, which is an area in which blockchain can excel. A participant of this research highlights the fact that even though Momo services are cheaper than the average MTO, the multiple charges per transaction are still a detriment to economically marginalized populations. A blockchain platform however has the potential to eliminate these.

> …if I want to buy for instance… a mobile phone, I have to send mobile money of which they will take me charges. The person who will have to also get the mobile money they will take him charges, and even the platform will also charge. So it's like triple charges on the same money. So why don't we represent this value by virtual time so that, ok I will move my coin to you and then when you are changing the coin to fiat currency, it's just like ok pushing the money into your mobile money account and then withdrawing so that you will be charged just once. (Kobe)

Interestingly, even though the government does not appear excited about activities involving digital currencies, they have taken steps towards applying blockchain

in other national spheres, notably in land registrations. The Ministry of Lands and Natural Resources signed a Memorandum of Understanding (MoU) on behalf of the Government of Ghana with International Business Machines Corporation (IBM), represented by the Country Director Angela Kyerematen-Jimoh (Amlanu, 2018; Eder, 2019; Myjoyonline.com, 2018). This high-profile agreement endorsed IBM's introduction of its blockchain platform in the digitization of land registry in Ghana. Despite the publicity that the MoU generated, as of May 2021, neither the government nor IBM has subsequently provided any updates as to the progress of the project. Bitland is another notable Ghanaian blockchain entity which issued a white paper on establishing a blockchain-backed land registry (Bates, 2016). They also announced their collaboration with the government through the Lands Commission for this project (Aitken, 2016).

To summarize, the social embeddedness of an innovation results from the dynamic negotiation between its affordances and the exigencies of the social context. The characteristics and demands of the social system engage in mutual alliances with technologies towards achieving common goals (Wajcman, 2004). Thus, an innovation's adoption curve is intricately linked to the social structure, which comprises such factors as norms, hierarchies, opinion leaders, consequences of the innovation's use, and effects of a technology cluster (Rogers, 2003). These circumstances run the gamut of the socioeconomic, political, and other spheres. The influences of the research setting discussed in this chapter illustrate these assertions. Notwithstanding the influence of the society's structures in the sociotechnical domain of an innovation, the inner workings of the relationship between various social groups and with the network of norms and conventions are equally significant. This point emphasizes the changing terms of the negotiations between individuals and groups in the society with technology adoption. In the succeeding chapter, the analysis shifts from a macro perspective to a group and individual level. With the analytical components of afrofemtrism, I analyze the gender dynamics of the space. An understanding of these dynamics among society members is germane to explain digital inequalities, particularly between different genders. Gadzekpo argues that not only are ICTs not gender neutral, but they can also be the tools that further marginalize disadvantaged social groups. The absence of a critical analysis of the adoption patterns, and the opportunities that they provide heightens this (2009). The interest that Ghanaians portray in blockchain and its potentially wide adoption need critical feminist-oriented research of gender dynamics in the space (Bosch, 2011).

Chapter 6.

The gendered world of blockchain in Ghana

At the onset of mass internet usage, people believed the internet was a space where one's identity and status in the physical world did not matter, anyone could connect, anyone could participate, anyone could progress along with developments in digital technology. However, studies have revealed the internet's contribution to various forms of stratifications and concretizing power and privilege in society (Nakamura & Chow-White, 2012; Nelson, 2002). Proponents advance these same optimistic ideas with blockchain, contending that it is a platform which forestalls the pervasiveness of social inequalities in its engagement with society. Ultimately, technologies purportedly provide avenues for society to co-opt and subvert hegemonic structures to enable social justice and progressive social transformation. They reformulate and reconstitute discriminatory norms (Haraway, 1991; Wajcman, 2004, 2010).

In the face of this positivity, the present chapter focuses on the extent to which aspects of the sociocultural context influence women's participation with blockchain innovation, adoption, and use. The principal interest is to examine what the gender dynamics are in the blockchain sociotechnical environment and ultimately the interaction it would have with the progression of the gender digital divide in Ghana. Towards this end, I employ afrofemtrism to analyze and interpret the empirical material. Both the theory and the data will function as partners in occasioning a critical examination of the context at hand (Alvesson & Kärreman, 2011). This is really an opportunity for an iterative process where the data serves as the baseline mechanism to help develop the theory. The chapter begins with a discussion on gender digital inequalities and its relationship with inequalities in Science, Technology, Engineering and Mathematics (STEM) education and professions. I then examine how blockchain interacts with these realities. Based on the empirical material, the second part of the chapter is an analysis of the state and the future of gender digital inequalities in Ghana through an afrofemtric lens.

6.1. Gender and digital disparities

As a precursor to discussing the relationship between gender and digital disparities, it is important to first clarify this study's understanding of gender. I consider gender a multidimensional and dynamic concept whose definition I cannot place in a dogmatic frame. It is a reality that morphs into the time, environment, circumstances, and multivariate setting of society. Gender is a socially ascribed construct that aligns with the religious, social, cultural, and other attributes of a society's context (Connell & Pearse, 2015). As a concept and system of identification, it embodies intersecting identities, relations and roles influenced by, among others, one's sex, age, religion, social status, marital and parenthood status. We imbibe gender through our socialization at the various stages of our lives, where we learn to perform in ways that befit the mold in which society casts us (Abagre & Bukari, 2013; Connell & Pearse, 2015). Intrinsically embedded in an ascribed gender are various forms of inequalities that people perceive as 'natural'. It is important to highlight the situatedness of the embodiment and performance of gender in different social systems in theorizing the gender construct. Blockchain's sociotechnical environment presents a unique context for examining how the Ghanaian society's gender construct is manifesting in a technology's adoption processes. Although blockchain's early stages appear to be emulating the well-worn path of male dominance in the technology industry, data from in-depth research will go a long way to address emerging issues regarding diverse participation.

In line with fomenting this diversity, resolving the gender problem of the technology industry should be a sustained, multilevel, multidisciplinary approach. To ensure an enabling environment for the equal participation of all genders, irrespective of the social groups they belong to, is to permeate structures like formal and informal education, social and cultural norms, politics, and media representations (McCarrick & Kleine, 2019). Morris pinpoints the unfortunate reality of people's persistent denial of implicit bias in science fields. Without the wide recognition of systemic prejudices, they operate unfettered on both overt and subtle levels, consequently hindering the progress of an entire social group (2020). Thus, in recognition of the need to approach this discussion with a broad perspective while maintaining its focus on gender inclusiveness in blockchain adoption, my research shows an awareness of the contributory conditions from other relevant areas of society.

In connection with the multiple layers of determinants, defining the parameters of the gaps that denote digital inequalities can be a tricky endeavor. Hilbert (2010) considers it so flexible that it adapts to whatever meaning an author intends, causing confusion and semantic controversies. A popular definition is the chasm between people in the digital age and those excluded from it, or the gap between low income, middle and high-income countries regarding access to and diffusion of information technologies (Fu et al., 2011; Graham et al., 2014). Hilbert (2010, p. 758) volunteers a comprehensive definition; the existence of distinctions among a "group of users (countries or population segments), the technology under consideration (mobile or fixed; voice or data; communication or computing, etc.) and the stage of adoption." Determinants of digital divides include income, infrastructure, education, geography, ethnicity, and gender (Castells et al., 2009; van Dijk, 2020). Overall, the same indicators that delineate the contours of socio-economic inequalities are explanatory variables for digital disparities as well (Hilbert, 2010; van Dijk, 2020).

Specifically, gender digital inequality is a pervasive phenomenon (Biggs et al., 2013; Bimber, 2000; ITU, 2020; Steeves & Kwami, 2017) which refers to the unequal representation between men and women in the design and production of, access to, and meaningful usage of digital technologies. This disparity cuts across the various sectors of the digital world including innovators, developers, investors, and users (Bimber, 2000; Herbert, 2017; Kwami, 2020; van Dijk, 2006). The reasons for its existence are as varied as the social, economic, cultural, and political contexts in which they occur (Fuchs & Horak, 2008; Herbert, 2017; van Dijk & Hacker, 2003). They include lack of and underestimation of skills, and perceived lower interest in ICTs displayed by women compared to men (Hargittai & Shafer, 2006; Hilbert, 2010). Digital technologies are gendered entities in terms of the values that we ascribe to them in their design, production, and usage (Kline & Pinch, 1996; Lohan & Faulkner, 2004).

Digital divides are especially manifest in the systematic exclusion of marginalized social groups like women from the design and production of the technologies. Knowledge asymmetries are therefore rife. Added to this, inclusion efforts for marginalized groups are mostly towards consumption, with less emphasis on meaningful participation in the dominant spaces of knowledge production in the ICT field (Bogdan-Martin, 2020; Lohan & Faulkner, 2004; Shevinksy, 2015). Furthermore, men have a greater advantage in employment opportunities in global STEM fields (Bowles, 2018;

Eisenhart & Finkel, 1998; Shevinksy, 2015). A study commissioned by the World Economic Forum (WEC) (Stofan, 2017) showed that women are underrepresented in engineering, and information, communication and technology, and this gender disparity reflects in the wider STEM job fields as well (Leonard, 2018; Wall, 2019). A key explanatory variable is the type of skills that women attain through education to prepare for the job market (Blau & Kahn, 2016; Schieder & Gould, 2016; Stofan, 2017).

Based on a longitudinal study of students enrolled in STEM programs in Canada, Wall (2019) reports that there are fewer undergraduate female students in STEM courses compared to male students. Various socio-cultural constraints explain these educational choices, including societal expectations, low access to technologies at home and at workplaces resulting in fewer opportunities for familiarization, and perceptual bias against their skills in professional and other environments (Biggs & Zambrano, 2013; Stofan, 2017). On top of this, the lowest representation of women in STEM is in engineering and computer science. What makes this particularly concerning is that these fields have the highest concentration of STEM employment (Wall, 2019). Specific to education in the Ghanaian context, there are very few women in the tertiary educational sector, irrespective of the discipline (Atuahene & Owusu-Ansah, 2013). Added to this, men represent overwhelmingly in the STEM educational and professional fields. This is especially notable in higher education (Andam et al., 2015). From 2013 to 2015, women made up only 27% of enrollments in high school science education, which is the prerequisite for being accepted into science and technology programs in the universities. Additionally, 4,121 male researchers in public STEM research institutions sharply contrast with the mere 1,452 female researchers (Appiagyei, 2018; Ministry of Environment, Science, Technology, and Innovation, 2017).

On the subject of gender disparities with digital technologies, there is little empirical data on the differences between access and meaningful usage of digital technologies between men and women. This lack of information is even more stark for design and production of digital innovations, as well as early adoption patterns. Where some information exists, most of the data which informs these results are from countries in the Global North (Hilbert, 2011). In one of the few studies that focuses on the Global South, Hilbert disabuses the notion that women are either uninterested in or have a negative attitude towards digital technologies. Using survey results from several African and Latin American countries, a cursory look showed that women appeared less likely

than men to use the internet and mobile phones. However, when he computed the data for only the employed and formally educated, more women than men use the internet and mobile phones (Hilbert, 2011). Therefore, although the overall findings agreed with traditional perceptions about more men using ICTs than women, controlling for employment, education and income showed a different story (Fallows, 2005). This aligns with a similar study in Ghana which showed that although internet demand and usage patterns reflect gender inequalities, one's educational level is the most reliable predictor of internet use (Townsend et al., 2013). Thus, the gender disparity, especially in higher education, is worrying since that is where in depth learning about ICTs happens. At the primary school level, there are 95 girls for every 100 boys. The ratio is more skewed at the secondary and tertiary levels, with 88 and 71 girls respectively for every 100 boys (Osei-Assibey, 2014).

According to the International Telecommunications Union (ITU) (2020), the internet parity score between men and women in Africa has decreased from 0.79 in 2013 to 0.54 in 2019[20]. This gap promises to widen more without concerted efforts towards addressing digital inequalities. This phenomenon is especially worrying in this era of the global Covid-19 pandemic, which has sharply highlighted the importance of internet access both personally and professionally. To stem infection spread, many countries instituted forms of social distancing and workforce restrictions. People with ready access to the internet and digital devices are therefore better able to connect to their social networks and engage in professional activities. Those who work in industries outside of the IT arena have been especially hard hit with job losses. These are particularly in areas where a shift to online work is difficult to achieve, like service work in the restaurant industry. Tellingly, more women work in these hard-hit fields than men (Bogdan-Martin, 2020; ITU, 2020; Nicola et al., 2020).

My interest in blockchain technologies' relationship with social change is to examine how it interacts with these kinds of inequalities. Presently, the emerging phenomenon of blockchain adoption is faithful to existing digital disparities, with very few

[20] "The gender parity score is calculated as the proportion of women who use the Internet divided by the proportion of men. A value smaller than one indicates that men are more likely to use the Internet than women, while a value greater than one indicates the opposite. Values between 0.98 and 1.02 reflect gender parity" (ITU, 2020, p. 8).

women engaging meaningfully in areas such as investment and development (Stamm, 2016). A respondent to this study asserts that

> In the Science, Technology, Engineering, Mathematics ratio, the proportion of males that we have here is the same thing that will persist in the blockchain arena… but when you go more downstream towards applications… those that are using the applications, then I believe the proportions will change. Because then… you don't need to have the technical skills to be able to use it… (Ebo)

Ebo observes here that participants in the blockchain space are primarily men, a reflection of the general STEM field. He opines that fewer women have the technical knowhow beyond using applications. Usage is, however, only a minor aspect of active participation. As I will expound on later in this chapter, diversity in design and development is essential for enabling a sociotechnical ecosystem which benefits the interests of all members of society. We cannot wholly foretell blockchain's advancement and possible impact on socioeconomic disparities because it is still at the early stage of development and diffusion (Kshetri, 2017; Yli-Huumo et al., 2016). Notwithstanding, research in technology and society studies shows that innovations do not merely occupy the technological ambit, but also effectuate modifications in the social and other spheres (Wajcman, 2004, 2010). Blockchain innovations could provide the right measures to counter and destabilize the determinants of the gender digital inequality (Molinier et al., 2019; Schwab, 2016; Wajcman, 2010). In analyzing these transformative affordances, feminists (Plant, 1997) signal a new era which blurs the boundaries between men and women, humans, and machines. Women have the opportunity to develop new relationships with digital technologies that remove them from the traditional hierarchical gender establishments. "Industrial technology may have had a patriarchal character, but digital technologies, based on brain rather than brawn, on networks rather than hierarchy, herald a new relationship between women and machines" (Wajcman, 2010, p. 146-7). She, however, sounds a cautionary note for this enthusiasm, pointing out that with the mutual impact that technology and society exert on each other, realities of the material world seep into the digital as well. This could inhibit the advancement towards an erasure of digital gender imbalances (Wajcman, 2010).

For blockchain to make strides in addressing digital gender inequalities, there needs to be a critical analysis of both its positive and negative qualities, and their outcomes. This is especially important since applications based on this innovation have diffused rapidly before we get a clear picture of its sociocultural, economic, and political

ramifications (Kshetri, 2017). Issues like data-integrity and scalability need rigorous resolution (Yli-Huumo et al., 2016). Not least of these concerns are the inadequate policy frameworks which could help address questions of privacy, risks of volatility like those related to certain cryptocurrencies, and localization of applications in a way which appropriately converges with such a globally networked technology (Adriano & Monroe, 2016; Morabito, 2017). To enhance the investigation into how blockchain can engage positively with existing gender digital inequalities in Ghana, the next section establishes a connection between blockchain and principles of ICTs as contributing mechanisms for social change.

6.2. Blockchain as ICT for social change

The heightened commendation that blockchain enjoys globally is an illustration of the high hopes that pundits have portrayed over time in ICTs' positioning as impetus for exponential economic growth in low-income countries. In line with scholars like Castells' characterization of the present digital society, proponents of ICT4SC[21] posit that ICTs like mobile phones and their applications have the power to accelerate socioeconomic growth because of their global importance and impact (Avgerou, 2010; Melkote and Steeves, 2001). Being a digital innovation, blockchain fits right into the mold of ICT4SC. Much like contemporary digital trends like big data and artificial intelligence, blockchain has increasingly become a buzzword in the series of technological paradigm shifts marking the digital face of the network society (Adriano & Monroe, 2016; Salmony, 2016; Underwood, 2016; Woyke, 2017). Purportedly, blockchain is also on the path to rewire the neoliberal economy as we know it by institutionalizing the sharing economy. In this sense, blockchain has shifted the role of the crowd in capitalism to the forefront. They are no longer merely recipients but also co-participants in dominating and organizing market forces (Nica & Taylor, 2017).

Swan considers this a wholly disruptive innovation, in the sense that as it grows into a universal reality for the world, blockchain will modify human activity on a scope akin to the internet (2015). The present digital system, which is replete with

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asymmetrical pathways of exploitation and profit-making accrued by selected sectors of the global digital society, enhances this hype. Blockchain's decentralization thus eliminates hierarchy in access and control of information among users. Therein lies the innovation's ingenuity, by truncating these negative attributes of the network society, while guaranteeing services that address myriad gaps in areas such as economic relationships and the political arena. To illustrate, since financial transactions do not need to be validated by third party institutions like banks, blockchain facilitates a higher level of speed in value exchange irrespective of distance and national boundaries (Tapscott & Tapscott, 2016, 2018). The elimination of third-party entities also removes the costs that are associated with their input, making blockchain transactions largely cheaper. It also impedes the intrusion of data mining institutions, which profit off users' information (Till et al., 2017).

Another area in which blockchain takes part in engendering equal wellbeing is in formal identification. As an immutable ledger with time-stamped information, blockchain provides a platform for creating authenticated digital identity documentation for the so-called 'identityless' members of society (Kewell et al., 2017). A World Bank report stipulates that there are approximately one billion 'invisible' people, because the place and circumstances of their birth inhibit them from legal registration and therefore access to official proof of identity (Marskell et al., 2018). These include internally displaced persons, refugees and people born in rural areas which are far-removed from formal institutions that facilitate identification processes. In many cases, the processes that one needs to go through to secure these identification documents are unaffordable. People without formal identification are inadvertently marginalized, they have no recourse to partake meaningfully in socioeconomic and other sectors like financial services and healthcare (Kewell et al., 2017). The Identification for Development (ID4D) dataset shows that overall, women and the poorest people represent overwhelmingly among unregistered people (Marskell et al., 2018). This situation highlights the systemic factors that perpetuate the marginalization of certain social groups.

To address this issue, an Alliance of organizations including Microsoft and the Rockefeller Foundation, in partnership with the United Nations High Commissioner for Refugees (UNHCR), is implementing a blockchain based global digital identification project dubbed ID2020. Grounded in the belief that access to proof of identity is a human right, the principal aim is to collaborate with partners worldwide to use digital

mechanisms like blockchain to provide formal identification services to those who do not have it. The Alliance opines that not only would these individuals have better governmental protections and transact in the modern economy, but digital identification would also put them in control over their personal data in terms of who can access it and how it is used. The Alliance is addressing issues like technical design patterns across industries, and interoperability standards especially since the organization aims to operate on a worldwide scale. Another factor to consider is country-specific policy frameworks and how these interact with digitization of identification (ID2020 Alliance Partners, 2018). Nonetheless, the very attributes of blockchain that facilitate its appeal prove pejorative under some circumstances. For instance, with the ability to participate on certain blockchain platforms in total anonymity, people could carry out illegal activities with little fears of being traced. In 2019, cryptocurrency transactions linked to criminal activity amounted to about $21.4 billion. This figure reduced to $10 billion in 2020. Although these are monumental amounts, they represent 2.1% and 0.34% of the entire cryptocurrency transaction volume (Chainalysis Team, 2021; Popper, 2020).

The advantages made possible by blockchain are certainly enticing, but what is important for me through this research is to understand how this virtual reality becomes an actual one. In the adoption processes of blockchain, I seek to understand the lived realities of the participants. I am interested in how their engagement with the technology is translating into any perceived improvement in their social relations and gender experiences in the Ghanaian society. With blockchain's impending disruption, could it be the phenomenon that severs the link between the ICT field and male dominance by challenging privilege? To make an economic case, gender equality in digital spaces matter because research data attest to increased productivity when teams are diverse. An explanatory factor is the diverse perspectives and experiences that people from different racial, gender and other backgrounds contribute towards innovative solutions (Stofan, 2017). My study adds to this complex conversation by expanding on the sociocultural and economic ramifications of blockchain geared towards social change, especially in terms of gender injustice. As the next sections show, afrofemtrism provides a uniquely reliable framework to facilitate this discussion.

6.3. Afrofemtrism and blockchain in Ghana

Afrofemtrism is an activist endeavor in the interest of gender justice for women and other marginalized groups. It is particularly relevant for people and issues in any geographical setting which originate from or have an affiliation with the African continent. Although its original operationalization is through the specificity of an urban Ghanaian setting, the theory recognizes that we cannot generalize experiences without the risk of essentializing certain contexts (Dosekun, 2007). Its systematic parameters for analyzing data, however, are generalizable in their ability to draw connections between an innovation, the individuals that engage with it, their communities, the national structure, and global conditions (Eisenhardt, 1989). Further, the theory amplifies the cross-cultural and cross-boundary sites of affiliation in cognizance of the intersecting objectives of activists like Black and other feminist-minded people. In relation to these, afrofemtrism emphasizes the changing realities of what it means to belong to an African fraternity, whether by lineage, location or by affiliation (Mohanty, 1991).

The theory development process involved a recursive iteration with the primary data. I inductively formulated the components of the framework for analysis and interpretation from the empirical material. These components are, 1) individual, community, and social group dynamics, 2) culture, tradition, and the contemporary setting, 3) overarching national parameters, and 4) transnational conditions. Using the empirical material as the building blocks for constructing afrofemtrism ensures that the theory grounds itself in and reflects material realities. After transcribing the data and checking for errors, the first step in the theory development was a preliminary analysis through a close reading of the data. I used this process to identify thematic patterns that were common to more than one participant to create an initial coding scheme. I also highlighted contrasting stories as they are valuable for enhancing the framework's generalizability. This is because divergent experiences establish how the same underlying conditions could produce contradictory results depending on the setting. I then reread the data, synthesized and refined the scheme, and constructed the analytical framework based on the principal themes (Christensen, 2006; Eisenhardt,1989). Subsequently, I finalized the framework by consulting literature on relevant fields like critical gender justice from African writers (Dosekun, 2007; Gadzekpo, 2009; Mekgwe, 2006; Mohanty, 1984, 1991; Steady, 1987). Works on the intersection

between gender inequalities and digital social systems were also instrumental (Kline & Pinch, 1996; MacKenzie & Wajcman, 1999; Pinch & Bijker, 1984; Wajcman, 2004). Importantly, literature on theory construction from primary data guided the entire process (Christensen, 2006; Eisenhardt,1989). This foundational literature helped to augment my insight into the context of the emerging themes and the attributes of gender performance and identity. I also engaged my firsthand experience in the research context in determining which information to include under the various categories. In this chapter, I implement the greater part of the iterative analysis by applying afrofemtrism's framework to the primary data. The succeeding development of afrofemtrism continues from the prior exploration of the transnational conditions in chapter four, as well as rich descriptions of the national context of blockchain in Ghana in chapter five (Christensen, 2006; Eisenhardt, 1989; Gehman et al., 2018). The interpretation consequently comprises postulating the causative linkages between the conditions of the blockchain space and the existence and progression of gender disparities.

A key aim is to explore and address the structures inherent in an ICT ecosystem to dismantle facets that cause or perpetrate inequalities. This is a theory for analysis and interpretation, whose conclusions propel social transformation. In this sense, it is intrinsically a normative theory in its unreserved agenda for social change through the erasure of monopolization and marginalization. Normative theories build on the systematic descriptions of empirical data to establish causal linkages between observed phenomena and the characteristics of the setting in which they occur (Christensen, 2006). Accordingly, normative concerns insist on processes that lead to diversity and unbiased access in the ICT arena (McQuail, 2002). As a theory that engages with empirical material towards an egalitarian ICT environment, afrofemtrism relies on a continuous interrogation of what meaningful participation means and how people achieve it. Indeed, normative theorization stubbornly clings to a certain idealization of the "presumption of reasonable outcomes" based on rational motivation (Habermas, 2006).

Another facet of afrofemtrism's data-analytical approach is in not limiting the focus to the technology in question, but the wider environmental system. This is in consideration of their mutual contribution to adoption processes. Indeed, overly emphasizing the role of innovations in studies of this nature connotes a certain bias pertaining to scholarship from the Global North (McQuail, 2000). Accordingly, the units of analysis are the participants who operate in the blockchain community in Ghana. These

are the relevant social actors whose realities are helping to define and shape Ghana's blockchain environment. Key to this outlook is an exploration of the (in)agency that participants express in their performative roles in the blockchain community (Klein & Kleinman, 2002; Kline & Pinch, 1996; Pinch & Bijker, 1984). This includes such instances as female participants resisting subjugation and persisting despite the discriminations that they face.

In exploring the agency of human actors in a technological space, afrofemtrism establishes patterns of relationships between individuals, groups, nations, and their lived realities. Based on this, the theory acknowledges and highlights how variables coexist in a murky complexity of relationships which variously adapt in response to interferences from internal and external elements (Mekgwe, 2006). Essentially, afrofemtrism foregrounds contextual reality. It operates through the lens of empirical material to arrive at the complex connections that explain the phenomenon in question. Human relationships, decisions and choices are not always rational and certainly not generalizable. To decipher these in the sociotechnical environment of a digital technology's adoption patterns, elements like culture, economics and politics are central. Afrofemtrism is a significant contribution to knowledge, as it theorizes about a Global South reality from a subjective positioning of people with lived experiences in the study context (Willems, 2014).

As another principal actor in the sociotechnical system, blockchain's affordances and how these contribute to demarcating the mode and scope of its adoption in Ghana is another key feature of afrofemtrism's examination (MacKenzie & Wajcman, 1999; Wajcman, 2004). For instance, being a digital technology means that the social actors involved in certain aspects, like designing and developing applications, belong to particular social groups. They must have the necessary educational and professional background. Also, the innovation's strong presence in the international and local remittance system is another example of its peculiarity. Thus, afrofemtrism connects with the multiple levels of the interactions in which blockchain, participating individuals and social groups engage. These interactions could be conscious or subconscious. They could also involve structural conditions like internet network accessibility and more interpersonal level conditions like relevant mentorship in the space. The analysis interrogates even those taken-for-granted conditions, like socialization, which operate below the threshold of our awareness and yet have an overt impact on agency in the

technological ambit. The next sections present afrofemtrism's analytical schema, informed by the data, to explore blockchain's sociotechnical setting in Ghana. This encompasses distinct but related categories that form the micro, macro and meso analytical components of the research context.

Individual, community and social groups analysis

Afrofemtrism posits that we cannot divorce technologies from the context in which they emanate and/or diffuse. In dissecting the positioning of gender and how it relates to provoking change towards eliminating gender digital disparities, I underscore the pertinence of the individual, their community, and the social group in which they operate. This section considers how people who engage with blockchain technologies perceive and perform gender based on said characteristics of the social system. A starting point is to acknowledge that gender is a socio-cultural construct (Gadzekpo et al., 2020) whose identification and performance owes largely to contextual factors. To take this idea of a construct further, contacts with foreign cultures enhance or impart certain customs pertaining to the asymmetrical power relations between men and women which we deem indigenous (Mikell, 1997). This outlines the complexity of society's normative structure and the ensuing conflicts in deliberating on what constitutes 'natural' versus 'socially ascribed' attributes of one's sex. Construct or not, it is key to appreciate that the gendered expectations that an individual's culture has of them greatly influence their actions and perceptions in the research setting (Sossou, 2006).

Further, afrofemtrism delves into the minutiae of the exigencies that a sociocultural context exerts on the members of the society. This is in their roles as individuals, their positioning in the family or wider community, or in the relations that exist between them. An added dimension to this is the consideration of the dynamics of belonging to a social group, for example through one's affiliation with an ethnic group or one's social status (Pinch & Bijker, 1984). In furthering the analysis, relevant questions include, what is the nature of interactions between individuals and communities? What are the overt and covert power dynamics? The distinctions in inequalities between and within groups and among individuals are pertinent areas for highlighting the variations of marginalities that exist. Added to this is the understanding that digital inequalities are cross-sectoral, and therefore mirror existing socioeconomic and other inequalities (Kwami, 2020; van Dijk & Hacker, 2003).

I explore these concepts further with the most obvious feature of the membership composition of the Ghana blockchain community, which is the overwhelming gender imbalance. Ayebia is a self-declared blockchain enthusiast whom I met at a blockchain meetup. She was the only female facilitator on a panel of four.

> The people who are in the top more about blockchain are the males… I've not met any female who has actually showed interest in blockchain technology.

She explained that she had met very few women in the blockchain community, and they are primarily traders. In this statement, her emphasis on the hierarchy is very fitting to the present discussion. She refers to the designers and builders of applications as people at the 'top' and these are predominantly men. Kobe explains this occurrence by rightly describing the blockchain space as an extension of the technology field.

> [A]lmost everything you can attribute to tech can be attributed to blockchain as well. Generally, you find that you find more women who are interested in blockchain kind of focused on the user experience.… You find more women there than you find doing some of the other stuff like software development, protocol development, and I think this cuts across the tech industry as a whole.

As Kobe relates here, those women who do participate are primarily in the end user group, the traders. Women are therefore missing agents from the relevant social group made up of designers and builders of blockchain-based applications. Hence, their exclusion effectively eliminates their voices, realities, and perspectives from the issues to be addressed and areas in which innovators employ applications. I inquired further about these gendered patterns of participation, and respondents offered various reasons for this.

> Yes, in as much as the group we have, and the people who I engage with, I meet more males than females. I don't see that as a gender gap. All I see is interest. Where are the interests of the females? And that's driven by awareness.… I really don't care about those kinds of things (gender biases). All I care about (is) there are people, people that care about a technology that is new in our ecosystem and they want to play around it… The gender thing you need to relax on it. (Yoofi)

Yoofi's perspective here matches with most respondents, they explained women's low participation rates with blockchain innovations as a result of lack of interest. They allude to the fact that people's interest in digital innovations and technologies are because of a combination of factors including individual choices, lack of awareness, and inadequate

personal drive. This means that participants place the onus overwhelmingly on an individual to succeed in any professional field without recognizing the covert power dynamics that influence their choices. For example, Senyo thought there are more males because men are more inquisitive about technology. He added that women only display high levels of curiosity about fashion or food. These kinds of assumptions solidify systems of hierarchy and variations of marginality that exist in different professional domains. They are dynamics that are intimately related to the wider sociocultural frameworks which the next section will develop. Egya, a male entrepreneur, also surmised that women do not have enough of an interest in blockchain.

> And why I am not buying the bias idea, it's because bias is when I have an application and… I allow only 30% of women to have access. But if it's equality, we are saying, okay, the application is there. Who and who is interested in using the application? The man raises their hand and is like "okay we want to use the application". The women say "we are not ready yet but we are still preparing ourselves." This is not bias, this is equality and opportunity. Until they wake up that they really want to use it…

I asked respondents what made them think women were uninterested in digital technology. Some of them said that is just the way things are. Ayebia, for instance, said she had not had direct conversations with any women about the topic but opined that it had to be a lack of interest. A few others substantiated their claims with experiences of trying to get a female friend into cryptocurrency trading and being rejected because the person thought it was illegal business. Yao added that although some female friends approached him about cryptocurrencies, they did not want to involve themselves directly. They insisted that he be the middle person for their investments. The interesting counterpoint to their assertions is that respondents presented these same reasons in discussing male contacts as well. However, they did not consider these instances as an automatic confirmation of their apathy towards technology because they were men. Yao, for instance, is a middle person in cryptocurrency trading for several male friends as well. Edem is a male participant who said his initial encounter with cryptocurrencies repelled him from the space because the person who introduced the innovation to him told him it was only for fraudsters. He only got involved years later because someone else gave him a more positive perspective. Sedem's experiences also show that women lacking interest cannot be generalized. He recounted many instances where women approach him for information on blockchain because he markets himself as an educator who enables open and inclusive spaces for women to learn. I argue here that the gender

imbalance has more to do with the perpetration of the perception that the technological field is a man's world. These are stereotypical narratives which place individuals or social groups in fixed categories even when they share the same characteristics and behaviors with members of other groups. That more than one person attributed the gender imbalance and the developing hierarchical order to reasons like lack of interest and unwillingness to participate in fraud, bears witness to sociocultural undertones that warrant investigation.

Yao distinguished between the interest that he thinks the average woman displays in digital technologies and his own pursuits.

> [W]hat they mostly use digital devices for, maybe, let's say, these snapchats… That is why most ladies in our society now kind of, everybody wants iPhone all because of the pictures, social media pages… IG, Facebook and stuff like that… Because right now, for instance, a lady will pick her phone and all that she cares about will be social media… But me, I will pick up a phone, and I will think of how that same phone could make me invest in other areas.

His assertion here exemplifies the opinion of some participants that women are inclined to use technological innovations in a limited manner. They opine that the average woman uses digital devices primarily for social media. With this narrow interest, they are least likely to utilize other aspects of their digital access, like researching on the internet or delving into the technical characteristics of innovations. This therefore explains their low rates of agency with the design and development of ICTs compared to males. Research, however, does not support this viewpoint. From an investigation of the about 14.76 million internet users in Ghana, more men than women use social media across all age groups. The Global System for Mobile Communications Association (GSMA) Mobile Index shows that on a scale of 0 to 100, the gender gap between male and female social media use is 33.1, with males presenting higher figures (2020). In another report based on advertising audience statistics from Facebook, Instagram and Facebook Messenger, the percentage share of Ghanaian male social media users is 20.2% in the 18–24 age group, 23.6% for 24-24-year-olds and 8.1% for men aged 35–44 years. For women in the same age brackets the figures are 12.8%, 14.2% and 3.9% (Kemp et al., 2020).

To accentuate the perspective about a lack of interest being the reason for low female participation, some participants like Adom described economically deprived

familial circumstances. They presented these as illustrations of their personal drive to pursue their interest in technology irrespective of their difficulties. If their determination superseded these constraints, therefore, being female should hinder no one in attaining their IT aspirations. Egya asserted that his inner resolve and drive propelled him past his socioeconomic challenges. Hence, any impediment that one perceives has to do with their gender is misplaced. He then justified the inadmissibility of gender using his sister as an example. He is supporting her by providing the digital devices that she wants. Her having an interest at all shows that there is no gender bias. He ends this point by saying,

> I try to support her because I know how hard it is, like trying to go out from that side of the world, you know. Like, make it so easier for her. Whatever it takes. And being a lady, you know, you just have to be there for them (more) than gents.

He does not appear to recognize that his comments distinguish his maleness and the capabilities it affords him, versus his sister's gender identity. This distinction persists even though they are from the same home and endured similar circumstances before he made his present economic gains. These kinds of utterances which dismiss the impact of gender related inhibitions, however, underscore the multidimensional impediments that women face in pursuing their STEM interests. They might very well share the economic and other constraints of their male counterparts. They must, however, also contend with additional barriers, like perceptual biases of inadequacy, based on their gender (Harding, 2016; Morris, 2020). As the next part of this discussion shows, community interactions are principal elements in development and pursuit of professional interests.

In considering professional groups as relevant communities in an afrofemtric analysis, I focus on people's experiences in their various professional fields and how traditions either facilitate or impede their progress. As the head of an ICT company, Adom detailed some difficulty he has had in recruiting and maintaining female participation in the blockchain training programs he organizes. He attributes this to a societal outlook which discourages women from what he terms "high tech" areas. In his opinion, even when women want to pursue an occupation in technology-oriented fields, society's opinions will dissuade them. Men, on the other hand, do not face the same barrier. In a similar vein, Ayebia noted that IT jobs seem to be marketed for men and this deters women from applying for them. Zeinab expressed a strong opposition to the

exclusionary traditions that IT professionals perpetrate in workspaces which overlook the interests of women. She intimated that she has lost interview opportunities and a job because of her gender. In her position as a software developer for a financial institution, she noticed that the frequently changing day and night shifts were affecting her health. She asked her boss if she could maintain a consistent night or day shift, and his immediate response was that this request is why he did not hire women. In essence, he perceived her voicing her dissent with detrimental work practices to be a negative female attribute. It gave the impression that she did not have the perseverance that her male colleagues had. Ironically, the men had discussed similar concerns with her but had hesitated to speak up. She eventually had to quit because her health worsened. She is still friends with her colleagues from this company and knows that they have hired no woman in the years since she left. Interestingly, the human resource manager has implemented the very suggestion she gave to address the frequent shift changes.

The professional environment that blockchain facilitates is another focal point for analyzing the effect of community level interactions. Manza shared that she chose to be a cryptocurrencies trader because she could be in solitude and still advance her professional pursuits. Her interactions with clients and other professional connections only happen in a virtual space, thus, it is the best option for her introverted temperament. Her isolated reality, however, clashes with friends' and family members' idea of culturally prescribed levels of human relations in the professional ambit. They insist that people must necessarily interact and work together in a physical environment of shared experiences. To avoid further conflict, she has consequently stopped discussing her work with members of her community.

Manza's experience explicates the multiple projections of work relations in cultures which emphasize constant communal interactions. In this instance, the existence of a digital technology which facilitates professional networking with no physical contact interacts with these viewpoints. Notwithstanding, community exigencies do not preclude individual agency, as we observe from Manza's actions. What I seek to illustrate here is the tension that could exist between individual choices and actions on one hand, and community dynamics on the other. It is important to highlight the pathways of subversion that marginalized persons and groups adopt with ICTs. The focal point is to broaden the research scope beyond their conceptualization as 'victims' to show their agency and the conditions that they surmount. An overemphasis on the

aspects of their contexts that inhibit them is in itself a form of oppression. This is because it strips people of their autonomy and whatever progress they have attained. In the next section, I expand on the cultural context of the research and its interplay with blockchain adoption.

Influence of culture and traditions and how they play out in the contemporary society

The cultural dimension is summarily important in any analysis of gender equality because culture is the bedrock for the creation and reproduction of gender as a concept. Afrofemtrism posits that culture is not perfect. Thus, we must critically assess the negative qualities and work towards eradicating them in the interest of equity and equality for all members. A quick illustration of discriminatory dogma is the gender discourses of Akan proverbs from Ghana. Passed down for generations, these are cultural outputs which act as mediators of moral standards. We consider proverbs repositories of society's wisdom and therefore not to be challenged (Appiah et al., 2001; Gyan et al., 2020). Many of them are, however, deeply chauvinistic in a way that perpetrates patriarchal ideals. They help to maintain a perception of female inferiority that is damaging to gender justice. In the specific instance of female intelligence, for instance, proverbs tend to portray women as infantile or careless. "ɔbaa te sɛ abɔfra" (A woman behaves like a child and as a result needs guidance). Another example is "ɔbaa ennwene ɛntera ɛmpa a ɔdaso" (A woman's thinking capacity does not go beyond the bed she sleeps on) (Appiah et al., 2001; Gyan et al., 2020). Proverbs have generational validity in their interminable relevance as cultural pillars and consequently impact on present ideals of female agency and gender equalities in various spheres.

Indeed, through my personal socialization in Ghana, I have consistently experienced culture to occupy quite an enviable position as untouchable. People quickly defend many negative social practices as cultural, as if we cannot change attributes of a culture to address evolving needs or even in the interest of justice. Years ago, I attended a seminar where a graduate student from Nigeria gave a presentation on indigenous women's activisms against oppressive patriarchal social systems in her country. One of her examples was the 1929 Women's War during British colonization. To further their commercial interests, the British government had instituted and increasingly cemented a patriarchal administrative structure which gave political and social power to certain men to carry out the colonial mandate (Arewa, 2019). This system eroded the traditional

power and autonomy that women previously had. Things came to a head when the colonizers tried to levy taxes on market women in a bid to curtail their economic growth. This caused an uprising of thousands of women from various linguistic backgrounds, especially in the southeastern parts of the country. They employed various indigenous strategies such as “sitting on a man”. This is a sanction involving women invading the domestic and public spaces of the British appointed warrant chiefs, banging pestles on their homes, dancing and singing “scurrilous songs which detailed the women’s grievances against him and often called his manhood into question” (Van Allen, 1972, p. 170). Many of them also embarked on topless demonstrations to emphasize the importance of their role as propagators of society (Matera, 2013). During the question-and-answer session after this presentation, the presenter’s husband, who was also a Nigerian graduate student, opined that her presentation lacked legitimization because he did not think the women she spoke about would support her feminist agenda. Feminism is, after all, alien to Africa. He added that enemies of the warrant chiefs must have certainly instigated the women’s demonstration. He doubted that they genuinely had a problem with the structures against which they were protesting. How could they oppose them when they came from the very patriarchal culture that generations of Nigerians have been born into?

I found his comments jarring because his very dismissal of their agency in organizing these protests sought to empty them of self-awareness and autonomy in taking decisions that affect their lives and communities. He was ignoring their voices by casting them as social actors who do not possess the capacity to participate in public discourse. He also displayed a profound ignorance of the culture he made claims about. He did not appear to know about indigenous activisms for gender justice, which predate any interaction with foreign cultures (Amadiume & Caplan, 2015; Mama, 1995; Mohammed & Madunagu, 1986; Salo & Mama, 2001). Furthermore, he was making essentialist claims about the culture of the southeastern communities, as if there were only specific sets of traditions that could be authentic. Modernity usually heightens such conflicts between perceptions of authentic characteristics of culture and people’s differing lived experiences (Dosekun, 2007). The application of this theory must engage with these dynamics to construct a more verisimilar picture where the milieu of the present times is not separate from the culture and history of a society. These attributes intersect in the construction and performance of gender identity and gender relations.

Markedly, the repeated practice of some colonial influences has reinforced their place in indigenous traditions, giving them an appearance of authenticity. The body of customs and traditions that makes up the very diverse Ghanaian culture today results from thousands of years of migrations and conquests, interactions between various ethnic groups, Islamic and European trade, and other contacts, and recently an influx of migrants mostly from West African countries, especially Nigeria (Salm & Falola, 2002). To illustrate, the Dutch Schnapps gin holds a distinctively symbolic position in many cultural traditions of Ghanaian society. It is an imported product which has evolved into a widely popular West African commodity. In the early 19th century when it was first imported, a combination of marketing efforts and local interest in adopting it to validate modern advancement drove its sale. However, advocates denounced it as detrimental to consumers' health, which curtailed its importation. The colonial government and the producers, with the collaboration of local faithful consumers, adroitly modified the narrative of its marketing. They presented the gin as medicinal and integral to culture, as it was a ritual liquid (van den Bersselaar, 2007). This was so successful that till date there is hardly a traditional ritual that we do not seal with the Schnapps gin in Ghana. Its image as a pillar of society is so naturalized that, for example, it is the principal symbol of exchange between families when they accept a marriage proposal. Also, if one were to go before a king or local priest without offering Schnapps as a customary introductory gift, in many cases they would have insulted the station and authority of the person. I have presented the examples of my Nigerian colleague believing a certain concept of his culture, and schnapps becoming an 'authentic' cultural symbol, to emphasize the dynamism that culture holds in a social setting. Culture is at the same time shockingly static in the way people adhere to them through traditions and socialization. Building on the previous section's discussion on the relationship between one's gender and their interests in ICT, I focus next on the characteristics of the sociocultural context and socialization, and how these are affecting blockchain adoption patterns in Ghana.

Socialization is a process of identity formation, meaning making, and interaction through social norms and conventions (Gecas, 2017). This is a dynamic process of contestation and negotiation between individuals and other individuals, their social groups, society at large, and the national and international structure in which they exist. It could be overt in a way that is readily perceptible, and/or covert. Gecas argues that any socialization is contextual to its setting, that is whether it be in the home, church or

in professional spaces. Sometimes, it occurs incidentally, where the values that people imbibe are unintended consequences of their attachment to the groups or organization (2017). This unintentional characteristic could explain why some people are not conscious of its effects on their beliefs, actions, and choices. In the various settings in which socialization occurs, the impact of the family is the most intense (Gecas, 2017). Although most of the participants refer to their homes when they discuss their initial engagements with digital technologies and the impressions it made on them, some of them do not always appreciate any linkages it could have with their present endeavors with ICTs. The perfunctory standpoint of the participants' responses attests to their obliviousness to the import of one's sociocultural upbringing in their social, educational, and professional choices (Atuahene & Owusu-Ansah, 2013; Steeves & Kwami, 2017). In unpacking the effects of socialization on access, use and interest in digital devices, as well as educational and professional pursuits in STEM fields, support from immediate family members proves to be the most influential. This was particularly the case for those respondents who work in IT. Many of them credit in their interest in ICTs to their parents for giving them digital access early on, even when it was not a reality for the average person in their social networks. Correspondingly, within the family unit, most research respondents specified their parents as the dominant agents of socialization. Egya maintains that he only considers the opinion of his parents about his educational and professional pursuits. Even though they had meagre finances, his parents bought him video games when he was a child. They did this because they did not want him going out to play with the other children in the neighborhood. He remembers it being a rough area. Because he could not afford professional help when they broke, he learned to fix them himself, which sparked his professional interest in ICTs. When he needed a computer, he and his mother had to save several months' worth of proceeds from selling produce at the market. He described the pride with which they carried the equipment on their heads onto the bus.

> So we bought it at around Abokom, my mum was carrying… the monitor on her head, then I was also carrying… the system unit (and) the keyboard, and we were looking so happy… now… it's like I'm emotionally attached to technology and my motivation, everything, that comes from my family, my parents. (Egya)

Other agents of socialization respondents mentioned are siblings, uncles, and aunts. These instances were mainly relevant where the extended family members were

providing financial and other support. Zeinab's account is the most pertinent illustration of female innovators who signal families as the main factors that either inhibit them or boost their confidence in engaging with digital devices. She is a software engineer who organizes women-centered blockchain conferences and seminars in Ghana and Nigeria. She also gives blockchain coding lessons to women. After completing a diploma in broadcasting and while waiting to start a degree in journalism, she got into an internship program at a national museum. Apart from her assigned duties, she used to help the secretary out with her administrative responsibilities. She picked up digital skills so quickly that the administrator of the museum suggested she switch from journalism to study IT. Her main impetus for following his suggestion, however, was her mother's encouragement when she went to ask her opinion. In addition, her uncle who contributed financially towards her upkeep backed her because it impressed him that she was challenging cultural norms on appropriate female professions and getting into a male dominated area. He even gave her his laptop for her lessons in the university. She said this act was particularly encouraging because he sacrificed his only computer. She reiterated that her male cousins did not get the same treatment from him, which is why she is certain that she garnered that level of support because she did not allow gendered cultural expectations to impede her. These familial influences are demonstrably important in steering people's uptake in IT fields. It is not only through resource provision, as the accounts above evince the immense value of encouragement. Zeinab's experience also portrays that especially in a setting where one is going against established norms, support from family members is invaluable compared to support from other persons (Gecas, 2017).

Another channel of socialization in the domestic context is the gendered difference in regulating children's leisure time and activities. Yao insisted that his socialization had no bearing on his interest and activities with ICTs. He emphasized that our individual interests and aspirations drive our actions. He then intimated that women do not readily get involved in IT because they only care about pictures and using social media. When I asked him what informed that impression, his response pointed directly to his familial socialization, which influence he had roundly dismissed.

> [M]e and my sister, okay, we are about the same age… my dad bought me a phone first even before considering my sister. Okay, I had my first gaming device because… my dad told me that guys would like those kinds of device more than ladies. So when we were growing up, my dad will buy me

> a gaming device and give my sister a toy or… some ladies' stuff… we grew up to know that guys kind of like digital device more than ladies.

His father raised him and his sister to believe that women are not ICTs-oriented. He advanced this notion by facilitating Yao's access, while giving his sister toys he considered more gender appropriate. Although Yao does not perceive it, I daresay that this influenced the interest that he developed over time compared to his sister's apparent indifference. Contrastingly, Nyameke recognizes how much he benefitted from the preferential treatment that he got from his parents because of his gender.

> [M]y parents had an internet café. And I think that was like, when I was 13 years or so, that was my first sort of like real consistent experience with web technology… I have a twin sister and I quite remember, you know, she not being allowed to explore as much as I did. Because she always had to go help (with) cooking or, you know, when we had the internet café it was like "oh why are you sitting in a room full of boys" or something of that sort. There was always that bias against her as far as technology.

Internet cafes are popular public spaces for young people to meet and socialize. They are notably important in providing access to computers and the internet for those who do not have them at home (Burrell, 2012; Steeves & Kwami, 2017). The determination of appropriate leisure activities is learned and enforced according to the society's cultural format of gender roles (Sossou, 2006). Nyameke's experience correlates with the results from an empirical study in urban centers in Ghana which found that some cafes actually prohibit girls from accessing their services. Hence, boys have a marked advantage with easier access and familiarity with computers (Steeves & Kwami, 2017).

Moreover, several participants alluded to the phenomenon of parents' expectations that girls take responsibility for domestic chores while boys are free to familiarize themselves with digital devices as the reason for the present inequality. Manza for example opined that boys having the free time to interact with digital devices from an earlier age give them an edge over women in IT courses and professions. However, she concedes that although this unfortunate reality is widespread, it was not her personal experience. She credits her mother for facilitating her quest to deepen her ICT skills by paying for extra ICT courses, although she was a single parent and had financial difficulties. She adds that not being burdened unnecessarily with household chores was also beneficial.

> I grew up with my mum only… at home I didn't have so much home responsibilities, like chores, those kinds of errands. So, like, I had a lot of time on my hands… to be able to, like, sit online for hours on end which has definitely, like, been a facilitator. Because with blockchain… you need to have the time to go here and there, learn stuff, trade… a girl in Ghana, all you do is mainly, mostly chores. Not like your brother who just comes in and eats or does something and just goes out and then goes probably somewhere and do his own things. You have to cook, clean. Others around me (other girls) they do… almost all these things.

Girls bearing the brunt of domestic chores give up much of the after-school time that they could have allotted to further studies and leisure activities. Hence, there is little leeway to deepen their interest and skills in digital devices. They are also less likely to enroll in out-of-school ICT classes because of their scarce spare time. In some cases, if the family has limited finances for these classes, they would prioritize paying for the boys because they perceive ICTs to be more relevant to them (Abagre & Bukari, 2013; Boateng, 2015). This section focused on cultural frameworks as espoused in the domestic enactments and embodiments of socialization. Stepping out of the home into the wider social system, respondents also presented various perspectives about the interplay between societal conditions, ICTs and blockchain specifically, which I will expand on next.

Overarching national parameters: social, political, economic, religious, and other characteristics

Added to familial influence is the perspective of the wider society. People act as agents of discipline based on a communal psyche (Dei, 2011; Sossou, 2006). They enforce conventional moral and other standards. Sometimes, this enforcement could prove more influential than admonishments from parents, particularly when participants are adults. Society also projects gender specific frames of preference when it comes to choosing educational paths and the career fields they lead to. People then inculcate these values through varying channels of socialization and to different degrees. Women are more likely to lean towards the humanities and social studies as they aspire to occupations like law, teaching, nursing, and social work. Indeed, in the instances where some women pursue science courses, they appear to prefer the human centered variants like the biomedical sciences (Abagre & Bukari, 2013; Atuahene & Owusu-Ansah, 2013; Tsikata, 2007). As the research material shows, societal influences can be covert, seeping into the assumptions and statements that one makes when discussing certain phenomena.

Adom illustrated this in his assessment of his female classmates' computer use during his undergraduate studies in computer science.

> [B]eing a guy, it made logic that we would have other uses for a computer… because then when a lady has a computer the only thing that we think of is to watch movies and nothing else… And then if they have an assignment then they type on it… But for a guy there were other usages… music videos, editing software… watching animations, gaming… guys tend to have different range of things that they do with the computer.

Nhyira's undergraduate education was also in computer science, and she explained the intricacies of her and her female colleagues' attachment to their program and how that relates to the kinds of equipment that they invested in. Her statements explain the impact of gendered social perceptions and prescriptions. She affirmed the gender digital divide in Ghana and evinced its persistence by recounting how her educational choice set her apart.

> I remember when I was in undergrad, we used to be 11 ladies and 22 men. And in my class, you could notice that for those of us ladies who happen to do a lot of coding, we were seen as different. Because typically they would expect the ladies to be interested in the MIS, etc.

Even within the IT field, people generally expect the women to study 'softer' courses and leave the 'hardcore' ones to the males. She then commented on the tools that she observed her course mates using. She acknowledged that the computers her male colleagues used had more cutting-edge specifications. On the other hand, the average female student's computer had Office and other more mundane applications, not advanced software development. I asked why this was the case and she referred to a conversation she had with her female friends on this topic. They came to a consensus that they were all in the wrong field. They aspired to be in other programs like nursing or pharmacy, but for various reasons those did not work out. With no passion for becoming pacesetters in IT, their focus was only to pass exams and earn degrees. Not only that, the cacophony of societal expectations of suitable female careers and the treatment from their male colleagues who viewed their presence in the IT program as misplaced, had demoralizing effects. Therefore, there was no motivation to invest in advanced computers and software. Beyond the educational setting, Azindoo asserted that he has female friends who are dissuaded from even attending blockchain meetups and seminars due to the magnitude of the masculine presence. On the whole, added to the aforementioned factors which deter female participation, these conditions maintain the

persistent perpetration of the viewpoint that IT is not for women, and consequently strengthen the underrepresentation of women in STEM fields.

Some female participants' experiences regarding their presence in the blockchain ecosystem manifest people's generalized perspectives that they do not belong there.

> Sometimes when people get to realize that… you're female, there's always this kind of "is she sure? Wow!"… some people are surprised to find you in that group because mostly it's only dominated by guys. So people are surprised, some want to ask you questions… they are like "maybe she's just lost, she doesn't know what she's doing here". (Manza)

> [W]hen I joined the… Bitcoin escrow pages, a lot of people will be like, "you a lady too what are you doing here eh?" When they see the name… "eii you are a lady. So we have ladies here?" that kind of thing… if someone wants to sell Bitcoins, they try to sabotage me, and we fought a lot… but it is good, we never gave up. (Afiba)

Their comments make it obvious that their presence on the WhatsApp traders' platforms confounds their male counterparts. They have endured various forms of affronts including disparaging comments alluding to their ignorance, and overt attempts to swindle them based on this assumed ignorance. Their experiences involve advantages or disadvantages that they link specifically to their being women, and the gendered framework of identity and character that people expect them to embody.

On the positive side, their gender has been beneficial in the sense that people perceive their dealings to be more trustworthy and less inclined towards duplicity. As Baaba put it, clients are more likely to trust her because "the word is fraud boys, not fraud girls". Afiba is the only female trader on over 40 WhatsApp cryptocurrency trading platforms, and she told me about several scenarios where people would purposefully seek her out because she is a woman and insist on only buying coins from her. This situation consistently compels the males who initially ridiculed her to request that she fronts their transactions. Some traders even have her certify a platform as reliable before they decide to participate on it. If she has never interacted with the administrator(s) and some traders on there, those seeking her approval would refrain from joining in.

> [T]his thing (cryptocurrency) is mostly associated with scams, so you being a female… they see females as, as innocent, like they are that cool. So if someone is even approaching you to buy, the person is not afraid, you get it? So… at a point it helps. (Sisi)

> [I]f a random stranger meets myself and another guy selling BTC, they will trust me than the guy because I'm a female… They will trust me more because they feel like, "we can easily get scammed by a guy"… There were times that when people will reach me out for BTC, I wouldn't have some, and I will refer them to a male friend, and then they will send the money to me to do the transaction for them… They wouldn't, you know, want to transact with the male. (Dewa)

Sisi and Dewa's opinions further reinforce Afiba's experiences. They attested to their gender and its connotation of innocence, which inspires strangers' trust in them more than their male counterparts. Some female participants also detailed instances where they have received various forms of support and coaching from male members of the blockchain communities. They again attribute this to their gender. The men they interact with appear to express protective instincts towards them. For Manza, although the male traders assume she is ignorant of cryptocurrency trading because she is a woman, they are usually willing to answer her questions. This has helped her gain appreciable levels of knowledge. Edwoba pointed to similar experiences of being supported by male attendees of blockchain seminars because the very low female representation makes her stand out. These points above show the influence that social perceptions are exerting in gendered blockchain adoption processes. The first notable facet is the image of honor that society expects women to uphold, as they are supposed to be the more nurturing sex (Amenga-Etego, 2014; Bosak et al., 2018; Dankwa, 2009). Ghanaian society perceives women as models of social value and thus holds them to higher ethical standards compared to men. This image of women could explain why the average cryptocurrency trader prefers to transact business with women, because they assume they are less likely to be so morally corrupt as to defraud them. In view of this status, some respondents like Nhyira, Edem, and Ayebia posit that compared to men, few women would involve themselves in any blockchain activities because they would not want their community to think of them as fraudsters. This challenge is further heightened by the relative lack of knowledge about blockchain's other applications beyond cryptocurrency.

> Because I don't know if they feel intimidated or they just think that as a woman, you are not supposed to. So sometimes the perception of certain technologies would make people probably feel intimidated or judgmental. Because they feel if it's a man doing it, oh ok, it's possible, its normal. But a woman it's like, "oh yeah?" (Ayebia)

Participants like Oheneba, Atoapem, Yao, and Baaba assert that government regulation of the space and public education on blockchain's multifaceted value would help to curb its notoriety. It would also widen the network of participation to include people, like women, who ordinarily would not work or socialize in circles which are connected to blockchain.

The male respondents have their own accounts of when their gender has been advantageous to them. For Egya, he has brokered several large-scale cryptocurrency trades, and he believes he would not have had those opportunities if he were a woman. Conversations with his business associates informed this opinion as they mentioned to him that they do not think women would have easy access to capital. Therefore, they would not bother to trade with them. Adom, Azindoo, Egya, and Ebo round off this section with their submission that people more readily perceive them as knowledgeable on blockchain because of the legitimacy that their maleness grants them. Overall, these accounts are interesting instances of gendered conditions which have very real implications on people's progress in the space. The sociocultural frameworks that shape the encounters described here interact directly with the diffusion patterns of blockchain. People more readily accepting the authority of blockchain knowledge that male participants propound determine a hierarchy that marginalizes women. On the other hand, with female cryptocurrency traders inspiring more trust on virtual platforms, this advantage shapes the opportunities and mechanisms of inclusion for them. These dynamics are fundamental to understanding adoption and diffusion processes of blockchain and other digital innovations.

Another characteristic of the underlying sociocultural setting in this study is the role of social capital in participants' activities, and its contribution to shaping blockchain adoption in Ghana. I borrow principles from Bourdieu in conceptualizing social capital as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition" (1986, p. 248). Here, the male hegemonies that are so ingrained in the present blockchain community could be a condition that sidelines women's fair access and engagement.

> [F]or a few friends that I have, when you talk to them about BTC, the girls especially, they are not really interested in it. So you can't blame them, they don't have friends that are interested in stuff like that. For me, I'm mostly

> surrounded with boys so getting into that was quite easy… Because at the end of the day, even if I want people to sell it to, it was easier for me because I was already surrounded by boys. (Dewa)

Dewa recognizes that the average woman whose social network does not include men is more likely not to encounter blockchain. With the society being dominated by males, having the right connections means one has the benefit of access to information and a ready market. Yoofi also acknowledged that his social connections helped promote his professional development in ICTs. After he dropped out of school and moved out of his home, he spent all his time with his network of friends at a popular ICT center, Busy Internet. This was integral to deepening his involvement with ICTs. Another respondent, Kobe, credited his circle of friends for the successes he has had so far in cryptocurrency trading. They pool their resources together to invest in initial coin offerings, sell them when the values appreciate, and split the profit. Many female respondents conversely reiterate that they do not have access to appropriate social and professional networks. This means that they are less likely to have the resources, information and relationships which would motivate their participation and augment their skills. Social capital is also an imperative tool for marginalized social groups who are obliged to compete on unequal levels.

As the information above demonstrates, men in the Ghanaian blockchain community have such advantages as being socialized to internalize their place, skills, and superiority in studying and working with science and technology (Boateng, 2015; Abagre & Bukari, 2013). Particularly with the negative connotation that blockchain has in Ghana, someone who does not belong to a social network in which a change agent has a positive relationship with blockchain would be relatively less willing to adopt it (Atuahene & Owusu-Ansah, 2013). Linked to this is the consequences of a lack of adequate role models. The adage, you cannot become what you do not see, particularly applies in this instance. Representation matters to the point that as more women gain education and engage professionally in the STEM fields, a naturalized perception of their belongingness and capabilities becomes more conventional. The increase in female experts as role models would be influential in motivating further female participation (Atuahene & Owusu-Ansah, 2013; Boateng, 2017; Tsikata, 2007).

In a broader sense, people's lived experiences are also integral to understanding the details of existing hegemonies and subordinations (Dosekun, 2007). The

experiences of women in a village in the Central region of Ghana, for example, would be markedly different from that of someone from another village in the Northern region. The conditions of their respective communities instantiate parameters of marginality that could be unique to them even though they share some similarities. One's gender, age, socioeconomic standing, ethnic affiliation, political association, and myriad other factors determine their access to and control of resources (Bosak et al., 2018; Sossou, 2006). "It is realities like this that signal to us the importance of interrogating the conditions under which shades of access and affordability, as well as empowerment, innovation and creativity, occur in women's relationships with digital technologies" (Gadzekpo et al., 2020). For example, infrastructural challenges that affect inhabitants of localities on the outskirts of urban centers and in rural areas could be unique to their context. These challenges include lack of access to electricity and potable water, mobile phone networks, and health facilities. Urban dwellers also grapple with their unique issues depending on where they fall on the socioeconomic scale. For instance, the homeless female street porters working in the major markets contend with rapists and other abusers who attack them while they sleep unprotected on the streets, while slum dwellers usually have to deal with overcrowded and unsanitary living spaces and the infections that are rife there (Awumbila & Ardayfio-Schandorf, 2008; Yeboah, 2010). The multiplicity of needs and barriers are crucial considerations in addressing deficiencies in ICTs. Thus, implementing technological interventions could further silence some voices through the privileging of certain experiences over others (Postman, 1993). The needs and interests of the populace drive the services that they seek and this in its own way affects the manner in which we develop technologies. It is important to perform a critical examination of whose needs are determining the technological and other developments, as hegemonic interests come into play in these processes (Pinch & Bijker 1984). We cannot take for granted the intricacies of the voices that are highlighted in identifying 'public interests' (McQuail, 2002).

Moreover, even in areas where infrastructural setups facilitate easier connectivity, precarious economic activities hinder people's ability to afford mobile phones and/or internet data. Even so, they are dependent on ICTs as actors in the increasingly digital world that is developing around them. To illustrate, low-income earners who are unable to access financial services from traditional institutions like banks are increasingly saving with and making transactions from their Momo accounts.

The government and the MNOs publicize Momo as widely inclusive, an ICT initiative that serves the needs of even the poor and vulnerable (Ministry of Finance, 2020a; Ministry of Finance, 2020b; Zetterli, 2015). This notwithstanding, marginalized people are proverbially stuck between a rock and a hard place. They need the security that using mobile money affords them in the absence of other secure financial services, but they can hardly afford to maintain mobile phones (Masiero, 2018). Relating these underlying socioeconomic dynamics to the digital sphere, van Dijk (2020) concludes that social inequalities and digital divides buttress each other. Interventions aimed at bridging any digital gaps cannot be successful without addressing the social inequalities as well. The next part concludes the analytical exercise by unpacking the respondents' perspectives on the interplay between blockchain and Ghana's manifestation of a gender digital disparity.

As portrayed above, the conversations with this study's respondents reveal that the gender dynamics of one's socialization and how they relate to people's activities with ICTs sometimes exist below the threshold of our consciousness. Hence, we do not always readily conceive of the way our socially ascribed gender identity interacts with our environment till their effects confront us. These prevailing realities of the members of Ghana's blockchain society underscore the necessity of studies such as this to explore the linkages and inform policies and change initiatives. Notably, some respondents disagreed with the existence of a gender digital inequality and blamed women's low participation in blockchain on lack of interest or personal drive. This line of thought ignores the pervasive issues of discriminatory social conventions and cultural outlooks. These need widespread recognition before we can adequately address them. Nonetheless, 24 participants (about 73% of the sample) acknowledge that Ghana has a gender digital inequality and gave varying reasons for this. Some respondents like Selorm, Adom, and Abu attributed it to the educational system. Adom pointed out that it took a while for many Ghanaian communities to accept female education. This situation established a foundational inequality because there are more educated men. It gave them a historical monopoly in attaining the requisite skills for the formal job market. Equally pertinent is other participants reiterating the influence of childhood educational options shaped by social expectations, which consequently affect women's low representation in STEM education and professional fields. Sisi opined that it is principally a case of financial discrimination, with men in most families usually earning more money

and thereby having the capital to own and experiment with technologies. The last explanation I present is Edwoba's. She asserted that we could blame gender digital inequalities on the IT companies with discriminatory hiring practices. Their insistence on hiring men hinders women's participation in the field.

With regards to blockchain mitigating gender digital inequalities, Nhyira opined that the only way is to broaden public awareness of what the technology entails. People's negative perception is a key factor hampering its uptake among women. Sisi sees the entrepreneurial opportunities that blockchain has occasioned through trading in cryptocurrencies. She foresees it becoming a financially emancipatory avenue for women. Ebo went beyond cryptocurrency trading to discuss the egalitarian inroads that blockchain can make with microcredit facilities. Where women appear to be marginalized from accessing credit facilities, as is the case in many rural areas, blockchain could open up easier access paths. This is because they would not need to satisfy certain conditions like formal identification and collateral which banks demand. A cryptocurrency wallet is available anywhere, one only needs to have access to an appropriate device. They would also maintain control over their digital identification and not have the government and other organizations accessing their data. In agreement with Azindoo, he added that when Ghana completes the establishment of the land title system on a blockchain platform, women stand to gain the most since they usually face discriminations in official ownership of property. Abu highlighted the difference that blockchain can make for rural farmers if it were to be the database to provide oversight of the transportation and sale of agricultural products. It would be a more effective avenue for curtailing losses and ensuring fair pricing. Nyameke sees blockchain as a system that will enforce accountability, and thereby level the playing field for all social groups. Using banks as an example, he described instances of discriminatory credit systems based on racial and socioeconomic stereotypes. Attributes of blockchain, like the automated consensus and ability for people to be anonymous, help to guarantee platforms which are based on unbiased data. Under these circumstances, it would curtail gender and other inequalities.

Altogether, the sociocultural conditions which presently undermine women' participation in STEM fields severely undercut these possibilities (Bosak et al., 2018; Dei, 2011; Sossou, 2006). Inasmuch as blockchain's affordances are beneficial for attending to digital inequalities, the context in which the innovation diffuses can still be

restrictive. Women would have to strive against looming odds like ridicule and outright dismissiveness just by occupying various positions in the field. Blockchain in itself is therefore not enough of a panacea. In order to renegotiate the cultural equation between masculinity and technology, technofeminism insists on attending to women's and men's concrete sociotechnical practices. "We must not forget that the future is open, and its direction will depend upon the forms of agency that shape it" (Wajcman, p. 114). I agree with submissions from respondents that blockchain could help to facilitate a reformulation of gender roles through the new skills, educational, and economic opportunities that they grant women. Determinants of the digital divide like education, income, and gender, which affect women unduly, can certainly be overturned with digital inclusion (Kewell et al., 2017; Kshetri & Voas, 2018; Thomason, 2017). This notwithstanding, erasing inequalities is not a straightforward process of merely granting digital access. Adom gets to the core of this point.

> [W]e all build solutions based on insight. A man might not really get an insight into a woman's issue to build a solution for, the way that a woman will understand women's issues to build solutions for… definitely women are going to be excluded, because they are currently not partaking in the conversation, and women are not being given the opportunity to build capacity to potentially design solutions around that. Even in terms of usage too it becomes a problem because the solutions that will be created will be excluding of women's perspective and stuff like that, and that will create a lot of bias in it.

As he points out, the biases of our socialization and peculiar needs and aspirations seep into professional pursuits in digital technologies. The understanding that men would have about issues that women primarily encounter would not be to the extent of a woman's insight. We should not easily overlook an emic appreciation of certain realities and the role they play in the IT field. To this end, afrofemtrism asserts that digital inclusion requires an attendant reconfiguration of the patriarchal values and sociocultural views which form intrinsic aspects of the barriers that women encounter in their engagement with IT ecosystems. This is especially pertinent considering that female underrepresentation is profoundly detrimental since it has sweeping effects on society. The male consciousness that permeates all aspects of the blockchain sociotechnical environment means that the development, diffusion and use of the innovation would be geared towards a patriarchal value system (MacKenzie & Wajcman, 1999; Wajcman, 2004). Ultimately, all genders have the right to an equal digital playing field to thrive in the knowledge economy. This is successful when we abhor prejudice and sociocultural

biases against skills and educational objectives, and opportunities are respectfully cognizant of the differing socializations of men and women.

6.4. Concluding thoughts on the afrofemtric analysis

In this chapter I iteratively construct afrofemtrism through the lens of the investigation's primary data, with afrofemtrism in turn functioning as the mechanism for examining the data. The theory construction has relied generously on principles inspired by Eisenhardt (1989), the first of which is knowledge gleaned from literature like those on digital inequalities and gender justice. Afrofemtrism's operationalization is in sync with Feenberg's (2002) postulation of the detrimental effects on social progress if the workings of a sociotechnical system marginalize certain member of the society. Digital inequalities emanate from and are perpetrated by social power configurations along lines such as ethnic groupings and gender (Kwami, 2020). Afrofemtrism's fundamental recognition of this leads to an analysis that comprises a systematic deciphering of the international, national, societal, and individual facets of the research context to unearth the manifestations of these power configurations. An illumination of these conditions enables a pathway towards dismantling them and ensuring the necessary justice. The theory therefore contributes to the agenda of gender justice by providing an analytical space for the material and other instantiations of gender injustice in participants' interaction with blockchain (Mama, 2011; Salo & Mama, 2001). Afrofemtrism's multiple levels of analysis are also integral to explaining the intersecting and diverging conditions of gendered experiences which contribute to digital disparities. In effect, the theory rejects a single-axis approach in addressing gender inequalities by inculcating a broad perspective that includes such characteristics as educational background, culture and tradition versus contemporary realities, and sex (Chair, 2019; Dosekun, 2019; Gadzekpo et al., 2019).

The next principles, researcher's common sense and subjective experiences, inform each other. As a woman born and raised in Ghana, I am an insider in that I was already familiar with the conditions of gender inequalities in ICTs (LaSala, 2008). In my own familial network, I had experienced the gendered hierarchy of digital access with men at the forefront. For instance, I have had several experiences of feeling out of place in internet cafes where I was the only or one of the few girls surrounded by a throng of

boys. I was, however, an outsider in the specific research setting because I was not a member of the blockchain society. Furthermore, I was a researcher with some education and conditioning from the Global North. Inasmuch as I could rely on my common sense in interpreting my findings, it was imperative that I foregrounded the unique experiences of the participants to uphold the legitimacy of their lived experiences. These combined to form my subjective positioning as a researcher, an outlook which I transparently manifested in interpreting the data. These tenets are central in the afrofemtric approach.

The most salient principle from Eisenhardt is the involvement of primary data in theory development using inductive logic. This emphasizes using the lens of empirical material to arrive at the complex linkages that explain the phenomenon in question. Afrofemtrism prides itself on being proactively critical. This means that the goal of its application is to challenge and engender a destruction of the social conditions and structures that create and perpetrate gender injustice. To achieve this successfully necessitates a deep understanding of the context to establish the underlying patterns (Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Morse & Field, 1995). The initial stages of afrofemtrism's development involved rich descriptions of transnational linkages among Global South contexts, national conditions of blockchain's adoption, and the community and individual level circumstances of the sociotechnical system. This context-setting process was vital to the study's justification for building a theory rather than testing extant theory. It brought to the fore the complex reality of participants in the ICT space. This is an environment with a diversity of cultures and experiences navigating contemporary globalized conditions in the socioeconomic and other spheres (Mohanty, 1991). Afrofemtrism thus facilitates a unique appreciation of the modalities of the context's multivariate dimensions of gendered oppression while advancing an inclusive purpose of justice (Steady, 1996). Moreover, existing African feminist theories are not directly applicable to investigations in social systems of technological innovations. This study's aim to address this gap is crucial because an agenda towards dismantling established hegemonic perspectives should not follow this same tangent by analyzing an African reality through the lens of extant dominant voices from the Global North. Additionally, the analytical development of the empirical material evinces afrofemtrism's internal validity. The direct linkages that the data helps to establish between the phenomena and the conclusions that the interpretations advance bear this out (Christensen, 2006). Notwithstanding, I recognize the value of varied empirical

evidence. Further studies which apply afrofemtrism to data from other settings and in different disciplines will be valuable in enhancing the internal validity. This will also lead to external validity in establishing the transferability of the theory's analytical structure to similar contexts (Christensen, 2006; Eisenhardt & Graebner, 2007).

Finally, I would like to point out that the interrogation of exceptions to the norm bolsters the theory's strength and robustness. An example is Zeinab's experience of support in her ICT education. It is noteworthy, however, that hers was still a gendered experience, albeit a positive one. Her uncle sponsored her precisely because she was a woman and her participation in a field with such dismal female representation impressed him. The exceptions are therefore outliers in terms of the norm, but not exceptions to the analytical element. They are still phenomena that occur because of a cultural frame of thinking. The conventional and contrasting social and cultural influences that shape our gendered interactions in ICT spaces are both therefore very key to an afrofemtric interrogation.

Chapter 7.

Blockchain unbound

7.1. The Global South context

This investigation explored the diverse elements of the sociotechnical environment of blockchain in Ghana to understand how its adoption is interacting with the gender digital divide. I drew the empirical material from three months of fieldwork with stakeholders based in two major cities, Accra, and Kumasi. This was a qualitative process, it involved semi-structured interviews with 33 participants engaging in various aspects of the blockchain economy. I found that in Ghana, participants in the blockchain ecosystem appear to be carrying out their activities as a chiefly virtual community, most interactions occur through the social media platform WhatsApp. The findings also showed that most players in the Ghana blockchain society are end-users of the technology, primarily focused on investing and trading in cryptocurrencies. These entrepreneurial opportunities that the innovation presents are fueling the spread of blockchain. In this context, the technology is highlighting a need for affordable investment options. It is also resolving the demand for an inexpensive system for local and international remittances. Another dearth at play is entrepreneurial opportunities, especially via digital platforms, which consequently address infrastructural challenges like access to formal working spaces and scheduling flexibility. An unfortunate fallout of blockchain's adoption is the fraudulent face that it currently has because of widespread scams. The innovation's narrow implementation in cryptocurrency trading facilitates the scams. The principal function of blockchain as a DeFI mirrors initiatives in other Global South regions such as Bitt in the Caribbean and the Thai-based OMG Network.

On the other hand, a few participants are designing and building applications to address other identified needs in the society beyond the DeFi space. The factors that determine people's affiliation to either trading in cryptocurrencies or developing applications center on their educational backgrounds. Predictably, the designers of applications studied and are working in STEM fields. Added to this, the sociocultural configuration of gender realities is also manifest in the practices and interactions of the blockchain participants. Ultimately, blockchain has the potential to bridge the gender gap

of participating in digital economies with an increase in the popularity of cryptocurrency trading as a viable economic activity. It, however, does not appear to contribute to facilitating an inclusive environment especially in the design and development aspects, as there are fewer women in STEM fields. This results from reasons like entrenched social systems that discourage female participation in STEM. Blockchain's adoption patterns therefore throw into sharp relief the multivariate conditions of sociocultural marginalization over which digital technologies draw their boundaries of inequalities.

7.2. Knowledge contribution

This study's most salient contribution to knowledge is afrofemtrism. This is a critical theory which draws on the lived realities of individuals and social groups to analyze their relationship with technological innovations. A central component of afrofemtrism is its elemental interest in advancing gender justice. Afrofemtrism focuses on people and issues in any geographical setting which originate from or are affiliated with the African continent. It is particularly fitting to these contexts because of its appreciation for interweaving cultures and traditions with dynamic contemporary realities.

Indeed, this process of theory development was a vital step towards a critical engagement with existing theoretical outlooks on science, technology, and society. The fact of technology's involvement in societal evolution is undeniable (Castells, 2010; Schwab, 2016). Contesting the centrality of digital technology marking new ages as Castells contends, for example, is a necessary intellectual exercise that enriches our knowledge base on our relationship with technology. These debates are also necessary because they give a macro-level understanding of global economic, social, and political advancements. This is an expansive level of analysis that theories like SCOT do not engage with. One area in which these theories fall short, however, is in their inability to make gender concerns a central aspect of their analysis. Technofeminism, on the other hand (Wajcman, 2004), fully recognizes that while gender is not the only determining marker in social relations, it is a foundational pillar of social change that deserves concerted attention. Interlacing aspects of these theories therefore provides a platform to decipher the extent to which digital technologies like blockchain can help to meet the needs of marginalized social groups.

Afrofemtrism addresses a profound gap by mainstreaming intellectual outputs from a Global South context. As well, it is a crucial addition because the realities of African and Africanist women are material embodiments of unique experiences which warrant emphasis. These include colonization's forced reconfiguration of religious, cultural, and socioeconomic structures and resulting gender marginalizations. Furthermore, it is an important contribution in the specific knowledge field of digital inequalities. As van Dijk (2020) identifies, existing literature on digital divides is skewed towards theorization and data from the United States and Europe. The field lacks multidimensional perspectives, and this investigation contributes to filling this gap. Largely, the study advances the broader literature on the importance of systematically unpacking sociocultural norms and traditions in researching society's relationship with innovations.

A primary strength that bolsters afrofemtrism is its translatability across borders within African countries, and beyond the continent. This is underscored by the theory's stance against essentializing people and cultures. People of African descent embody identities which constitute such facets as a multiplicity of ethnicities, languages, cross-continental realities, and cultural characteristics. They also live varying shades of privilege and marginalities. Afrofemtrism therefore affirms this richness of self in seeking to elucidate experiences of inequalities in the sociotechnical ambit. Thus, an afrofemtric analysis would be as applicable in a Cuban context as it would be in an African diasporic community in Germany. Indeed, these types of translations are essential in improving vulnerable aspects of the theory. To illustrate, afrofemtrism could be applied in a critical analysis of Canada's thriving Artificial Intelligence (AI) community. Several researchers have interrogated the racial and gender bias that AI helps to perpetuate (Gupta et al., 2021; Noriega, 2020; Prates et al., 2019; Yapo & Weiss, 2018). They critique AI for discriminatory and exclusionary practices which follow standardized codes of human categorizations. This is due to the general under-sampling of marginalized populations like women and people of color in the datasets used for machine-learning in AI systems. These populations are however an overwhelming majority in the data for training systems about negative practices like crime. With these biased datasets, AI is therefore largely a tool optimized for the privileged few, white males (Angwin et al., 2016; Makhortykh et al., 2021; Manyika et al., 2019). Consequently, predictive policing can be more fatal for men of color, for instance, because AI technologies overwhelmingly

perceive them as dangerous because of the color of their skin (Angwin et al., 2016). Another example would be credit score applications which would give low scores to people based on their places of residence if these are in areas primarily inhabited by people of a marginalized ethnic group. An afrofemtric analysis would therefore investigate 1) the connections that exist among afro populations and with other social groups in this ecosystem, 2) the relevant aspects of their wider communities, 3) the national structure, and 4) the global conditions that frame AI development and implementation. This study would ask such questions as; How do these individuals negotiate the rudiments of their identities and its manifestation in the AI systems they work with? What pertinence does their insider and/or outsider positioning in minority communities have in their roles in these professional spaces? What historical legacies in Canada impact on their identities as visible minorities, and their outputs with AI? What are their experiences of human and societal biases in their communities, in their professional spaces, and through their interactions with AI systems? What are the counternarratives and counter actions that they employ to combat AI biases? Ultimately, a principal endeavor in this type of afrofemtric study would be to foreground their lived experiences in the research context.

In conjunction with the original contribution to knowledge, another relevance of this research is its impact on society. The empirical data has introduced a novel understanding of gender justice in digital spaces. Specifically, it involves the relationship between the sociocultural context of one's upbringing, their professional aspirations, and digital innovations. The study has therefore enhanced the social awareness of the implications of gendered conventions in framing people's upbringing and their very far-reaching impact on career progression. Hence, even in the very disruptive environment of a new technology like blockchain, these effects persevere and influence the innovation's diffusion. Additionally, this research shows how members of a given sociotechnical network adopt an emerging innovation by broadening our understanding of the facilitating elements. The stated contributions are integral to advancing studies in gender inequalities whether in a sociotechnical arena or in cultural, economic, and other settings. This advancement also applies to widening the knowledge base of the theoretical and analytical field of digital technology's symbiotic relationship with society.

7.3. Reflections

In this section, I reflect on the key components of the dissertation's chapters to summarize the various themes of the investigation. To begin with, blockchain's perceived pertinence has buoyed its adoption in Ghana. Characteristics such as its inherent trustlessness and decentralized user participation endear it to efforts for social change in the socioeconomic ambit of society. The specific applications of blockchain in this sphere are those which operate beyond cryptocurrencies and smart contracts in initiatives including aid distribution and identification creation and validation for marginalized persons. Equally important is blockchain's application in the financial sector to mitigate problems related to underprivileged persons who do not have easy access to financial services like bank accounts, investments, and local and international remittance services. These applications are relevant in Ghana because of the variety of challenges that marginalized populations encounter in their participation in the nation's socioeconomic structures. The underlying features of blockchain help to frame the environment of its diffusion in Ghana and other countries with similar social and economic conditions. That is why it was important to establish associations across the region by highlighting the blockchain-based DeFi infrastructures from Thailand and Barbados. Tellingly, they focus on financial inclusion and empowerment through the provision of accessible financial services for the unbanked and underbanked.

To advance an in-depth analysis of the context, the study examined the features of the environment that spurred adoption along its current trajectory. The interview data informed this discussion. Implicit in understanding the social setting is a deeper perspective on the relevant social groups who make up the blockchain society. These are the principal players contributing to constructing the blockchain ecosystem through their own socializations, experiences, and projections about the applicability of the innovation in Ghana. A salient aspect of the composition of these relevant social groups is the distinctiveness between the activities that people with an educational and professional background in a STEM field have. I placed the participants into two categories, the innovators and early adopters. The STEM affiliates were mostly innovators who were among the first to hear about blockchain and engage with it. This is because of their constant preoccupation with digital innovations through their regular online research and interactions with international contacts.

7.3.1. Expected outcomes and unanticipated insights

To further my reflection process, it would be necessary to discuss the expectations I had at the onset of the research process. I will then delve into unexpected outcomes and the insights that these provide. My most influential socialization framework has been through the social and cultural experiences I have had as a Ghanaian woman. I say this to underscore the familiarity that I have with the structuration of gender relations among individuals and their communities and with digital technologies. In line with research data, I know that inequalities between men and women with ICTs persist in Ghana and women are at a disadvantage. With the highest determining factor being one's educational level, gender disparities in higher education are disquieting (ITU, 2020; Steeves & Kwami, 2017; Townsend et al., 2013). I fully expected the data I collected to support this, and it did. I also anticipated that not only would women be underrepresented in the blockchain community, but they would not feature among the designers and developers. In this respect, it is necessary to note that understandings of divides appear to be limited. Those respondents who acknowledged some gender inequalities usually only considered digital access and use. They did not consider the worldviews and interests that are marginalized with the exclusivity that exists right now on the technology creation and innovation side. Another foreseeable finding was that the sociocultural context of the Ghanaian society was a significant element in the contributory factors that influence people's decisions about educational and career paths (Herbert, 2017; van Dijk & Hacker, 2003). My investigation clearly outlined these findings in concert with a substantial body of research reviewed in previous chapters. Nevertheless, it also brought attention to aspects of this sociotechnical ecosystem that I did not foresee.

The first was some participants' denial or ignorance of the existence of gender inequality in any component of the ICT space. One person even opined that I was merely investigating this subject because it was a popular concept, but it could not be fact. In his view, women could not be at any disadvantage if we considered the number of slay queens[22] dominating social media. Related to this, the lack of recognition of the important role that one's socialization plays on their educational and career paths also

[22] The popular definition of slay queen in Ghana is a woman with a lavish lifestyle displayed on social media platforms (https://yen.com.gh).

surprised me. Ironically, even those who rejected the import of sociocultural upbringing would inadvertently signal these exact components to buttress other points they are making. Thus, Yao asserted he does not think his sister (or any other Ghanaian woman) faces any barriers that are unique to their gender. If a low representation exists, it is because they are just not interested. He then adds that his father raised him with this principle while also encouraging his interest by giving him digital devices. His sister got more gender-appropriate toys because, again per his father's opinion, girls are not interested in digital devices. As this example shows, even what I considered a glaring demonstration of gendered socialization which potentially influences people's eventual relationship with ICTs was not an obvious illustration for others.

Another unexpected finding of my investigation was the secretive air cast around participants' activities. Blockchain enterprises outside of the cryptocurrency sphere are occurring covertly because community members are safeguarding their intellectual properties. Hence, collaboration is minimal, which could harm widespread innovation. Although they interact among themselves about generalized information on blockchain, this does not include discussing their personal ventures. Indeed, some participants intimated that they are more willing to share information with international networks. With stakeholders vying to be pioneers in blockchain innovation, Atoapem submitted that he is not open about his ideas because people might steal his concepts and present them as their own. In the same vein, advancing one's ideas without sharing information with other community members safeguards their pacesetter role. It does not help matters that respondents feel insecure about the apparent lack of governmental support and regulation of the blockchain space. Yoofi said he prefers not to promote his project too much out of fear of penalization if the government were to clamp down on blockchain initiatives. Finally, he also pointed out that people are modest in publicizing their innovations to maintain a socially prescribed air of modesty.

A third attribute of blockchain adoption in Ghana that was not previously obvious to me is WhatsApp's position in advancing communication, community-building, and trade. This speaks to the ingenious adaptation of communication tools to maneuver between local exigencies and barriers. WhatsApp makes it possible to build trading and information sharing communities in a society with expensive data rates which render regular online activities unfeasible. This is principally pertinent for the traders and information disseminators. As the trading platform of choice, respondents reported that

almost their entire buying and selling activities happen on WhatsApp. They do this through their membership in various local and international group chats. This could account for the apparent lack of online traffic from countries like Ghana on the webpages of various DeFI initiatives. Hence, although my investigation signals the increasing popularity of blockchain in Ghana, the activities are not occurring on DeFI websites where analysts can track them. Combined with the favored secretive approach that people are taking, it is hard to assess the space statistically.

Another unexpected and unfortunate outcome is the widespread occurrence of fraud. This is largely a consequence of criminals taking advantage of people's ignorance of cryptocurrencies and the impression of easy profits. These incidences are common because of the pervasive use of middle persons in cryptocurrency trading and investment. They are essentially investment and trade brokers, a characteristic of finance sectors. I found their entrenched popularity interesting because of the decentralizing capability of blockchain. People's reticence to engage directly in the space reveals perceived barriers that do not align with blockchain's democratizing affordance. Society's aversion to the unknown also plays a part. Thus, in a somewhat traditional society encountering a new technology that operates outside of established structures, one can expect that people would hesitate to involve themselves directly. Moreover, admonishment from the government about avoiding cryptocurrencies because they are unlicensed augmented the impression that they were illegal. Finally, people synonymously using the term blockchain with cryptocurrencies. All these factors have combined to foment blockchain's negative reputation in Ghana.

In light of the above, participants' perseverance and professional dedication to blockchain are quite notable. Irrespective of the social grouping participants belong to, it was interesting that even those who had been victims of various scams had no intention of withdrawing from the space. This is a testament to the confidence that they have in the innovation's eventual prominence. In sharp contrast to this is the apparent disinterest portrayed by tertiary educational institutions. I expected that they would be more amenable to leading research and innovation on its purported applicability to many gaps in Ghana. Ebo however describes the refusal of authorities from one of the lead universities in finance, impact entrepreneurship, and innovation to even consider partaking in exchange learning programs on blockchain with international universities. In

the next sections, I reflect on the effectiveness of various aspects of the study and how this shaped the results.

7.3.2. Lessons learned

To begin with, I recognize that the hopes and fears that members of a sociotechnical environment have in a digital technology contribute to shaping the adoption processes. Much like the perspective proffered by Wajcman (2010), I undertook this research to describe the entire dynamics at play for the members of Ghana's blockchain community. As a ground-breaking study in a space lacking scholarly investigation, I realize it is important to be open to all viewpoints by elucidating the multifaceted perspectives of participants. This research, therefore, presented a panorama of the various mechanisms involved in blockchain adoption in Ghana. Thus, I undertook a journey savoring the positive ideals that the technology is occasioning while highlighting and critically dissecting the negative.

Reflecting on the data collection method I employed for the study, qualitative semi-structured interviews, produced key lessons. The first was about the mode of participant recruitment. I opted for this method to unearth the unique experiences that members of the Ghana blockchain society have in their sociotechnical setting. Moreover, this is the most appropriate avenue for investigating a context that lacks readily available comprehensive information. My initial attempts at recruiting study respondents were through virtual platforms like LinkedIn and Twitter. This was ineffective, as many of the people I contacted were hesitant to interact with a stranger about blockchain. It was only after I had met some participants face-to-face at a blockchain meetup that my recruitment efforts yielded some fruits. Interacting with me in person also inspired their willingness to introduce me to other contacts in their networks. All but two of the respondents opted to have the interview either by phone call, Skype, or WhatsApp. I find it intriguing because even though virtual platforms are their preferred channels for communication, I still needed to find an in-person means to break the barriers of mistrust for our initial contact.

Secondly, I concede the possibility that obtaining most interview data virtually rather than through face-to-face conversations might have deprived me of certain nuances in expressions that could have given a depth of meaning to the data. I might

have lost out on aspects of nonverbal communication like facial expressions which could convey a range of information that words alone might not. Another important element that I possibly missed out on is the camaraderie that in-person interactions can build. These could have given a deeper connection that could have led to more comprehensive data. However, I consider the value of respondents being in interview settings that suit their comfort levels more integral. This is especially relevant considering the atmosphere of wariness that people in the space have towards sharing information on their activities. Despite the value that in-person interactions could have added to this study's empirical material, participants' discomfort in being in that kind of interview setting could have caused hesitant conversing and diminished the richness of information that I garnered.

Another aspect of the interviews to consider here is the thematic areas that the questions addressed and the ones that were left out. For example, they did not delve into the differences in experiences and marginalization that people from different socioeconomic statuses face. This sacrificed a level of intricate dissection of the realities of various social groups in the space. Studies on communities involved in ICTs show that some individuals confront multifaceted forms of marginalization, even among disadvantaged groups (Wall, 2019). Considering that about 90% of future jobs will require ICT skills, already marginalized persons and groups will be even further relegated. Increasing the means of access to ICTs is not enough if we do not address issues such as disrespecting knowledge and skills from marginalized groups, as well as sociocultural, economic, and other determinants (Hanna, 2017; Wall, 2019; Warschauer, 2003).

The above points notwithstanding, investigating the general gender chasm that exists in blockchain's ecosystem in Ghana is vital. To summarize the root of this inequality, I posit that it stems from the cultural undertones of relevant professional trajectories for different genders. As well, the preferential treatment in facilitating males' access to ICTs early helps solidify their interest and proficiency and gives them an advantage over their female counterparts. Markedly, the low female representation has far-reaching consequences, including the diminished employment opportunities for women in the increasingly digital job market. The journey towards social and economic mobility is also that much harder for women when there is a paucity of role models to look up to (Ochwa-Echel, 2011). Another consideration is that when a particular social

group dominates a field, as men do in IT and similar areas, they network among themselves and perpetuate a 'boys club' system in which they circulate information on opportunities and trends (Adams et al., 2020; Bowles, 2018; Shin, 2019). This could impact the evolution of blockchain's environment because the connections and networks that participants have could influence their engagements. In the early stages of an innovation's adoption and spread, the dynamics in a social system are crucial for determining its unbiased interaction with relevant actors. Ultimately, the paramount principle which guided the structuring of the interview guide was the importance of establishing a panoramic baseline of gender inequality in digital spaces.

7.3.3. Recommendations and further research

The findings that I have highlighted in this dissertation have very practical implications which inform the following recommendations. Firstly, with the focus this investigation places on the components of the blockchain community which marginalize female participation, an overriding impetus is gender-inclusive interventions. This would be in the specific interest of organizations and government agencies whose mandates include ICTs for social change, addressing gender disparities, and similar thematic areas. Female underrepresentation results from myriad factors outside of their abilities with ICTs. A layered approach to tackling social, cultural, and economic barriers that impede activities of women in the STEM fields is integral to attaining gender justice. Technological advancements on their own do not erase the underlying constraints that women live in various aspects of their lives.

To this end, initiatives should include multi-pronged public-awareness campaigns aimed at issues like burdensome domestic responsibilities, restrictive perceptions about gendered interests and pastimes, unwelcoming professional and other ICT environments, and underrepresentation in higher education and STEM courses. Widespread conscientization of this nature is essential when sociocultural norms are at play because of how naturalized they are. The research material illustrated this, as some respondents completely dismissed the existence of gender biases in any aspect of ICTs. Public conversations on the forms and propagation of such biases would facilitate people's appreciation for what constitutes biases and their deeply ingrained state. Conscientization also prepares the way for easier acceptance and uptake of practical measures to mitigate these gaps. Mainstreaming these conversations should

help normalize the belongingness of women in STEM courses and professions not only in the eyes of their colleagues but in their own eyes. These would further engender and normalize female representation in positions of power in sociotechnical spheres. In a more specific sense, I look forward to interacting with the study's participants and other players in exploring ways in which they can propagate inclusionary cultures through their activities. These findings have very real implications for generating conversations around developing blockchain in Ghana with values which attend to dismantling inequalities.

In addition, relevant institutions need to implement affirmative interventions to give women opportunities to enter the educational and professional arenas from which society usually prohibits them. These initiatives must involve projecting role models to serve as motivational images and to project possibilities. Moreover, Kumasi Hive has provided a blueprint for how institutional support promotes gender inclusion specifically for blockchain. Their incubation programs designed for women aim to deepen diversity. We should, however, be careful not to give an impression of women-only pockets within the wider blockchain arena. That is why multifaceted approaches are best to achieve the objectives. In this sense, creating more welcoming spaces for women is just as important as ensuring equitable representation in mainstream enterprises. To be sure, these steps would be highly beneficial to blockchain's development and adoption in Ghana. A sanitized space and secured public trust are probable outcomes of creating a blockchain sociotechnical environment that is overtly inviting to women. This is because of the almost automatic trust that female participants appear to inspire in their cryptocurrency interactions. Of course, it would depend on the female actors themselves being trustworthy and not partaking in fraudulent activities to taint the image that they hold. Also, increasing uptake among presently excluded social groups like women would spur innovation, broaden the innovation's interpretative flexibility, and widen the areas of applications that exist currently.

Next is a policy recommendation for governmental regulation and support of blockchain innovations specifically, and new digital innovations in general. Notably, the government has demonstrated some interest in blockchain through its partnership with IBM to create a blockchain-based land title registry. The overall messaging that the Ghanaian populace has received from various state agencies, however, has been negative, albeit focused narrowly on cryptocurrency trading. This is still harmful to the diffusion and development of blockchain since the two terms are so intimately linked. If

the state apparatus were to research the technology's applicability to relevant national areas and publicize these overtures, it would boost enthusiasts' confidence in furthering blockchain innovations. Likewise, I would recommend the government setting up a creative regulatory framework that does not hamper innovation but provides protections and sanctions in situations of fraud and other negative practices.

It might appear counterintuitive to advocate for state regulation of a decentralized innovation that, at its core, upholds principles of non-mediation. This notwithstanding, a framework for streamlining compliance is important to help grow the blockchain environment of asset exchanges and innovation. Blockchain is, after all, a decentralized technology developing within a centralized sociopolitical system. Added to this, a national structural framework governs the areas in which we can apply the technology in the interest of social transformation. An illustration is the concept of a blockchain-based identification system which would be a secure and efficient way to meet the needs of people who cannot access national identification. If the government were to recognize such a system, people could use these digital IDs to take part in and contribute meaningfully to the national and international economy. Digital identities could be used to access services and for exchanging goods and services in economic relationships. The immutable quality of blockchain ensures that digital IDs eliminate the risks associated with physical documents like counterfeiting. Despite these advantages, people would not accept them as legitimate if they are not government sanctioned. In essence, the government's hesitation to regulate the space is augmenting the suspicion that the public has towards blockchain.

Because of the extent of damage to blockchain, a national approach to regularizing the sociotechnical ecosystem, educating people on best practices, and castigating scammers, would most likely be the best way to dispel the negative perception. This accounts for the emphasis I am placing on the government's role in tandem with the private sector. Furthermore, investigations of legal precedents to align present practices with existing regulations would be beneficial for creating an initial disciplinary structure. Indeed, government support could secure blockchain and establish its image as a viable instrument in the attainment of social change. The frequent comparisons that participants made between blockchain's present remittance functions and Mobile Money applies to this point. They refer to this technology cluster hoping blockchain would become as widely accepted as Momo. It is significant to note

that Momo presently has an established image based on the governmental and institutional backing which ushered it in, and which anchors it now. State organizations even pay some workers' salaries into their Momo accounts. This level of support for blockchain would propel its adoption substantially.

Correspondingly, it is no accident that many consider blockchain well suited to countries like Ghana with lower economic resources (Kshetri, 2017; Thomason, 2017; Underwood, 2016; Woyke, 2017). Areas of concern such as financial inclusion for the socioeconomically marginalized are key to boosting the overall national economy. Through the sterling performance of Bitsika, blockchain is presently showing how it can cheaply and securely expedite domestic and cross-border remittances via mobile devices. This is a ground-breaking initiative that casts the financial inclusion net even wider to embrace financially challenged persons. More needs to be done to reach those who are still falling through the cracks, those who do not have access to digital devices for instance. The Ghanaian government has affirmed its commitment to ensuring financial and digital inclusion (Mof, 2020c). It thus behooves them to support organizations and individuals researching into and working on applicable blockchain innovations aimed at filling these gaps. This would involve the support of the Ministry of Finance, Ministry of Special Development and Initiatives, Ministry of Gender, Children and Social Protection, and other applicable state institutions.

I am painfully cognizant of the reality of digital devices enabling and concretizing elites due to issues of access, education, opportunity, and financial means. To make blockchain innovations germane for partaking in social transformation, these applications must rely on values of equality and purposeful elimination of marginalization from the very onset of conceptualization. Equality is however not possible without addressing myriad problems such as the sociocultural and other barriers that impede meaningful participation by women. It is essential that initiatives for social change do not kowtow to the status quo of lip service without meaningful change. Persistent research and an inclusive, diverse, and intersectional innovative environment would help beget multidimensional blockchain solutions that are truly disruptive for all sectors of society.

This dissertation is a launching pad for future research on advancing gender justice. A key consideration in this regard is investigating the relationship between gender inequalities, postcolonialism and digital technologies. Since her independence

from British colonial rule in 1957, Ghana occupies a marginal global positioning in terms of the economic, ideological, and other relationship that she maintains with Britain and other powerful countries. This is a manifestation of historical power imbalances with contemporary implications on international relations and national experiences. The resulting characteristics of this is wide-ranging, from English being Ghana's official language, to her relegation in the global market as described in chapter four. As a lens for deciphering the ramifications of this relationship between peripheral and core countries, postcolonial theory affords a framework to analyze and critique persistent colonial legacies. A postcolonial analysis therefore aims to deconstruct the enduring influence of colonization on the culture, language, ideology, and other aspects of previously colonized countries (Loomba, 2015; Pinto, 2019).

While acknowledging the relevance of postcolonial theory to this study, I made a less than popular choice not to engage it deeply. This is because I needed for this to be a project which foregrounds African stories without sifting them through the deplorable legacy of our colonial pasts. Particularly, the development of afrofemtrism is an emancipatory exercise asserting my ability as an African woman to create and develop intellectual products. In my opinion, inculcating values of postcolonial theory in a more expansive manner than I did would have diminished the emphasis that I preferred to place on the development of afrofemtrism. This notwithstanding, I am interested in exploring the intricacies of Ghana's postcolonial reality in blockchain's ecosystem in future research. This is especially applicable considering the focus this study maintains on power and stratification in the sociotechnical space. ICT ecosystems are integral to understanding the nature of postcoloniality. This is through considerations like the foreign languages and values encoded in them. There is also the elitist categorization based on educational backgrounds which dictate the autonomy and positionality of the people that engage with them as well as those who do not. Especially with blockchain, this means an interrogation of the complex global flow of innovations and transactions, and their contestation with local realities and adaptations (Anderson, 2002). Further, Pollock and Subramaniam (2016) highlight the relevance of an incorporation of feminist, postcolonial, and science, technology, and society thoughts in research of this nature. This is because the variable manifestations of inequalities both construct and are constructed by science and technology. Further research on blockchain and other ICT

ecosystems in the Global South would benefit greatly from a postcolonial analytical frame which critically engages STS (Harding, 2008).

Additionally, introducing a critical race theory (CRT) framework to future research on gender justice in blockchain's digital realm will provide the means to foreground people's subjectivity and lived experiences. CRT would be important to further analysis because blockchain is a global technology, global issues of race and various forms of marginalizations would therefore have their unique expressions in this space. The theory would facilitate an analysis that delves into the undergirding facets of race and gender and their interaction with dominant ideologies which construct personhood and social categorizations. With this critical outlook, a researcher posits a narrative through the voices of participants in the research context. They would also highlight counternarratives which kick against the reproduction of gender marginalization (Crenshaw, 1995; Delgado & Stefancic, 2017; Verjee & Butterwick, 2014).

Another area that I am interested in investigating further is the positioning of local languages in blockchain's ecosystem in Ghana. Inherited from colonialism, the English language permeates all aspects of Ghana, it is the primary language of instruction in the entire educational system, the medium for governmental communication and activities, and for business transactions. Tellingly, I conducted all the interviews for this study in English. With the multiplicity of local languages, English is the default communication tool particularly in professional exchanges. This is especially true when it involves parties who do not have personal relationships and cannot be certain if they share a Ghanaian language. These conventional rules of engagement persist in large part because of their enforcement in the educational system. Throughout my primary and high-school years, there was a strict rule against students speaking local languages. If a student were caught communicating in any language other than English, they would be severely punished. These regulations prevailed in all public schools as well as in many private institutions which sought to maintain high standards of English mastery. We therefore learn to perceive fluency in English as a marker for social, educational, and professional ascension. The above reasons contribute to the pervasiveness of English in most professional spaces, as evidenced by my communication with respondents. The precedence of English in our interactions however necessitates a critical look at the erasure of local communicative channels. It also means an interrogation of the extent to which Africans can attain intellectual liberation if the means of expression is through a

predatory language inherited from colonization (Mazrui, 2004; 2019; Prah, 2001). This evidences the postcolonial power relations that has created and bolsters this context of the relegation of local languages in professional and technological spaces. I would be interested in investigating the presence of local languages in transactional and other relationships among blockchain users in Ghana. This would enrich our understanding of the existing collaborations and stratifications beyond gendered realities. Respondents reported that the virtual communities that they engage in were impersonal and global, thus requiring English as a communicative tool. However, considering the foundational influence that language has for forming and maintaining identities (Tackie-Ofosu et al., 2015), further research would be important in highlighting the role that Ghanaian local languages are playing in the sociotechnical space (Pinto, 2019). It would also expand understandings about imperialist trends which promote English language standardization as a facet of globalized capitalism (Phillipson , 2001).

Further studies could also appraise gender disparities beyond the presentation of women as a heterogeneous whole. A simple delineation along male and female gender lines is not enough to highlight the marginalizations that exist in the ICT space. Although the focus of this investigation did not present an opportunity for a more detailed assessment, women from different ethnic groupings, age brackets, geographical locations, educational and other backgrounds would have different experiences in their engagement with ICTs. In a similar vein, other areas to address include the difference in experiences for women with families and for those who have not fulfilled the socially prescribed responsibilities of marriage and/or childbearing. As well, what are the peculiarities for those working from home? Do their specific situations present enabling or constraining parameters? This level of analysis would further enrich research on gender and technology.

Added to these, based on the similarity of the use patterns in alleviating the gaps that pundits deem most relevant to blockchain's affordances, South-South collaborations could help solidify the viability of the technology to address identified needs. Further research would be valuable in determining the impacts of these types of linkages between different societies in the Global South. Studies of this nature would further the society and technology field. As well, it would spur the development of necessary skills and expertise and result in the expansion of services to meet more marginalized populations. Of equal importance is an exploration of the role that digital platforms like

WhatsApp are playing and would embody in blockchain's growth and spread, whether through trading in cryptocurrencies or other facets of the innovation.

Although the prevailing conditions in the ICTs sphere in Ghana do not evince this, gender justice is actually an intrinsic part of our culture. While aspects of our oral traditions project discriminatory perspectives of women, they are also compelled to acquiesce to the value of womanhood. For instance, society considers women (represented by the figure of the elderly woman) as the ultimate repositories of wisdom. The popular saying during times of important deliberations illustrates this, "yɛrekobisa aberewa" (we are going to consult the old woman). This refers to the decisive symbol of wisdom which would determine the final verdict (Appiah et al. 2001; Diabah & Amfo, 2015). The patriarchal structural tendencies that are subverting our human values should not constrain these inherent ideologies. I end this dissertation with a call to action using a popular quotation by famed Ghanaian educator Kwegyir Aggrey who advocated fiercely for gender-equal education. I extend the idea of education to meaningful inclusion in all spheres, particularly in the digital arena. This is in line with Aggrey's insistence that education must be holistic to socialize individuals who contribute meaningfully to society's progression (Jacobs, 1996). Aggrey's saying appreciates women's pivotal societal positioning, which must propel a destruction of debilitating gender biases. "The surest way to keep people down is to educate the men and neglect the women. If you educate a man you simply educate an individual, but if you educate a woman, you educate a whole nation" (Jacobs, 1996; Konotey-Ahulu, 2004). Women, as major constituents of society, should not have to contend with barriers to their progress and self-actualization in their interactions with ICTs. Blockchain's evolving disruption lends itself to the perfect opportunity to disrupt all forms of gender injustice in the mutually impactful medley that is society and technological innovations.

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Appendix.

List of Interview Participants

Pseudonym	Interview date (2019)	Interview location	Language of interview	Native language	Occupation
Adom	March 14	Phone call	English	Unknown	CEO of an ICT company
Elorm	March 26	Phone call	English	Unknown	Computer scientist
Nhyira	March 29	Phone call	English	Unknown	Computer scientist
Ebo	April 3	Skype	English	Akan (Twi)	Accountant, IT enthusiast
Mantse	April 2	Phone call	English	Unknown	Blockchain Developer
Oheneba	April 1	Dome, Accra.	English	Unknown	Field sales specialist for a blockchain-based properties firm
Edem	March 31	Phone call	English	Unknown	Network marketer, cryptocurrency entrepreneur
Ayebia	March 31	Phone call	English	Unknown	Cryptocurrency entrepreneur, Assistant program officer at the Environmental Protection Agency
Kobe	April 1	Phone call	English	Unknown	Cryptocurrency entrepreneur, blockchain agrobusiness manager
Koshi	April 3	Phone call	English	Unknown	Cryptocurrency entrepreneur, accountant
Egya	April 5	Phone call	English	Unknown	CEO of a blockchain IT company, cryptocurrency entrepreneur
Azindoo	April 20	Phone call	English	Unknown	Cryptocurrency entrepreneur, Computer scientist
Yoofi	June 5	WhatsApp voice notes	English	Ewe	Founder of blockchain-based educational platform
Yao	June 11	WhatsApp call	English	Akan (Twi)	Cryptocurrency entrepreneur, Veterinarian

Pseudonym	Interview date (2019)	Interview location	Language of interview	Native language	Occupation
Zeinab	June 13	WhatsApp call	English	Akan (Twi)	Software developer, blockchain coding educator
Lamptey	June 13	WhatsApp call	English	Unknown	University professor
Kissi	June 17	WhatsApp call	English	Akan (Fanti)	Cryptocurrency entrepreneur
Sedem	August 5	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur, university teaching assistant
Selorm	August 7	WhatsApp call	English	Akan (Fanti)	Cryptocurrency entrepreneur, teacher
Kabenla	August 11	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur, student
Lariba	August 20	WhatsApp call	English	Unknown	Journalist
Afiba	August 25	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur
Edwoba	October 3	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur
Manza	September 13	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur, student
Kodzo	September 21	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur, engineer
Atoapem	September 24	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur, nurse (non-practicing)
Edwoba	October 3	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur
Jojo	October 5	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur
Sisi	October 11	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur
Baaba	November 10	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur
Dewa	November 10	WhatsApp call	English	Unknown	Cryptocurrency entrepreneur
Nyameke	November 26	WhatsApp call	English	Unknown	Founder of cross-border blockchain-based remittance platform
Azima	December 1	WhatsApp call	English	Akan (Twi)	Metallurgist