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THE IMPACT OF ENVIRONMENTAL FACTORS ON POTTERY PRODUCTION IN GHANA: A PERSPECTIVE STUDY OF INDUSTRY SUSTAINABILITY AND THE JUST ENERGY TRANSITION

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Abstract

The traditional pottery industry in Ghana, a vital source of cultural heritage and livelihoods for many, operates at the critical intersection of cultural heritage, rural economic survival, and environmental vulnerability, including energy consumption. These dynamics pose significant sustainability challenges due to their reliance on resource-intensive production methods. The study examines the complex relationship from a multidimensional sustainability and industrial ecology perspective, focusing on divergent production hubs in Volta Region, Ashanti, Eastern, and Upper East. A qualitative approach grounded in a comprehensive 75-question survey instrument is utilised. The study adopts a microeconomic context for production and evaluates socio-cultural dynamics, resilience, and environmental impacts. Critical concerns from the survey point to deforestation and air pollution from traditional firing techniques, and to the long-term viability of the Ghanaian pottery sector. Through the lens of climate resilience practice and energy efficiency, support is proposed to move away from traditional methods towards a sustainable pathway that advances practitioners' livelihoods. The findings reveal a severe "efficiency trap" characterised by high-emission, resource-intensive biomass firing, with thermal efficiencies ranging from 12.4% to 21.6%, alongside a demographic crisis in intergenerational knowledge transfer. To reconcile cultural preservation with modern decarbonisation imperatives, the paper presents a quantitative analysis of fuel consumption and environmental impacts to assess the adoption of cleaner energy technologies within the Just Energy Transition (JET) framework. This advocates targeted capital subsidies for technological innovation and institutional capacity-building. This will ensure the sector's viability for the female-dominated occupation in Ghanaian pottery production, while sustaining *a fair transition for all stakeholders and preserving cultural identity and ecological health.*

Keywords: *Traditional pottery, industrial ecology, just energy transition, industry sustainability, Ghana pottery microeconomics*

1. Introduction

The traditional artisanal pottery industry in Ghana embodies a vital convergence of cultural heritage, rural economic sustenance, and intricate environmental considerations. For many generations, the extraction of clay, along with the subsequent processes of shaping and firing ceramic vessels, has served as a fundamental pillar supporting socio-economic stability within rural communities across the nation. Nonetheless, this venerable industry presently operates amidst a progressively unstable environment characterised by external macroeconomic shocks, environmental degradation, and evolving demographic preferences. The sector is notably dependent on local natural resources, chiefly clay deposits and biomass used for fuel, which positions it at the forefront of energy concerns, climate change susceptibilities, and the global pursuit of sustainable industrial methodologies. The contemporary Ghanaian pottery sector must address an increasing "Efficiency Trap," characterised by ongoing dependence on thermodynamically inefficient traditional firing methods amidst rising scarcity and costs of fuelwood. Moreover, the industry faces the urgent necessity to conform to the principles of the Just Energy Transition (JET), a framework that mandates the decarbonisation of energy-intensive industries without worsening the socio-economic marginalisation of vulnerable populations. This transition necessitates a careful balance between conserving ancestral knowledge and implementing modern, low-emission technologies.

2. Concept Approach

Pottery has been a fundamental element of Ghanaian culture for centuries, serving both functional and ceremonial roles and forming an essential part of the informal economy. Within Ghana's broader macroeconomic landscape, the private informal sector is a dominant force, accounting for approximately 77.1% of the total national workforce (Ghana Statistical Service, 2022). In 2021 alone, this sector generated an estimated 118,628 million Ghana cedis in output, representing more than a quarter of the country's Gross Domestic Product (Ghana Statistical Service, 2022). Deeply embedded within this sprawling informal economy is the artisanal pottery sector, a highly specialised, female-dominated craft that sustains rural households across multiple ethno-linguistic regions (Asamoah & Baah, 2020). Nevertheless, the environmentally intensive nature of conventional pottery production, which relies primarily on open-pit firing with locally harvested firewood, has raised significant concerns about its ecological repercussions and long-term viability.

This traditional approach causes severe localised deforestation, accelerates soil degradation, and leads to the uncontrolled release of greenhouse gases (GHGs) and toxic particulate matter pollutants (Jerneck & Olsson, 2013; World Health Organisation [WHO], 2021). Consequently, these practices pose immediate threats not only to the stability of regional ecosystems but also to the public health of artisans and their surrounding communities. The World Health Organisation and subsequent epidemiological studies have repeatedly linked inhalation of fine particulate matter (PM) and incomplete combustion by-products from biomass burning to acute respiratory illnesses, which are estimated to claim an estimated 13,000 lives annually in Ghana alone (WHO, 2021). As Ghana and other developing nations strive to achieve a Just Energy Transition, a paradigm that insists on equitable, inclusive pathways towards decarbonisation, it is imperative to examine how this macroeconomic transition can be operationalised within small-scale traditional industries (African Development Bank [AfDB], 2022; Ghana Statistical Service, 2022). To date, national climate action strategies have predominantly targeted large-scale energy generation, formal transport networks, and heavy industry (Ghana Statistical Service, 2022). However, neglecting the informal sector risks leaving millions of vulnerable workers, particularly rural women, disproportionately exposed to the economic shocks of decarbonisation.

This research contends that an effective transformation in the pottery sector requires more than mere technological interventions. It demands a comprehensive socio-cultural and economic framework that preserves potters' livelihoods while advancing environmental sustainability. Specifically, integrating medium-scale electric kilns offers a definitive technological solution to the emissions crisis (Quansah et al., 2021). Yet the prohibitive capital expenditure (CAPEX) required to install such infrastructure remains an insurmountable barrier for artisans operating on marginal profits (Adubah, 2025). With this strategic methodology, the study demonstrates how the financial barriers to clean technology can be dismantled, fostering robust rural enterprise growth and safeguarding the heritage of Ghana's female potters. The analysis provides a holistic overview of the sector. Mathematical modelling is used to quantify the parameters governing profitability, resource depletion, and thermal energy efficiency. Ultimately, this analysis delineates the necessary institutional, technological, and socio-economic pathways to ensure the viability and sustainability of the Ghanaian pottery industry.

3. Review of Related Studies

Academic discourse on energy transitions frequently emphasises large-scale industrial and national policy changes, often overlooking small-scale, traditional sectors that remain underexplored yet are no less critical to the economies. A robust body of literature addresses the modernisation challenges faced by traditional crafts in sub-Saharan Africa. For instance, Adubah (2025), a foundational study on the challenges faced by small-scale enterprises, illustrates the profound difficulties encountered during modernisation, particularly regarding access to resources for pottery firing, capital acquisition, and the integration of advanced technologies within highly traditional socio-economic structures.

3.1 Deforestation, Biomass Combustion, and Environmental Degradation

Research on deforestation and energy consumption highlights an inextricable link between informal rural industries and severe environmental degradation. Studies of biomass combustion in developing nations, such as the comprehensive reviews by Jerneck and Olsson (2013), document the catastrophic public health and environmental consequences of cooking and heating with solid fuels over open flames. Open-pit combustion is highly inefficient, leading to massive emissions of short-lived climate pollutants (SLCPs), particularly Black Carbon (elemental carbon) and organic carbon compounds (Bond et al., 2004). Bond et al. (2004) and Johnson et al. (2008) have extensively quantified these emissions, demonstrating that artisanal and domestic biomass combustion is a primary driver of regional atmospheric warming and disrupted precipitation cycles in the tropics. While much of this literature focuses on domestic cookstoves, the physical chemistry and environmental implications scale exponentially when applied to the volume of wood consumed in artisanal pottery firing (Bensah et al., 2015; WHO, 2021).

3.2 Just Energy Transition Concept

The concept of a Just Energy Transition (JET) has gained significant traction following the codification of the Paris Agreement, which explicitly embedded protections for vulnerable populations and the imperative of gender equality into international climate frameworks

(United Nations Framework Convention on Climate Change [UNFCCC], 2015). The Friedrich Ebert Stiftung and the African Development Bank have both articulated guiding principles for a JET in the Global South, emphasising that transitioning away from fossil fuels and natural resource depletion must not exacerbate existing socioeconomic inequalities (AfDB, 2022; Stiftung, 2021). Aldieri et al. (2020) and research from the Climate Strategies network note that simply replacing one polluting industry with another or abruptly outlawing traditional fuels without providing viable economic alternatives frequently results in the displacement of informal workers and the collapse of localised economies (Aldieri et al., 2020; Climate Strategies, 2022; Ghana Statistical Service, 2022). Small-scale, decentralised clean energy production systems, equipped with smart mechanisms and robust energy storage, are consistently highlighted in the literature as an effective strategy to deliver clean technology to dispersed households and rural enterprises without relying on deficient national grids (Climate Strategies, 2022).

3.3 Carbon Finance and Gender-Responsive Mechanisms

Despite the theoretical advancement of JET principles, a notable gap persists in scholarly work that explicitly integrates the mechanisms of carbon finance with equity and social justice objectives in distinctive traditional industries, such as Ghanaian pottery. The World Bank (2021) and various independent researchers have pointed out that traditional carbon pricing mechanisms have historically ignored women's specific needs, vulnerabilities, and interests. Boyd (2002) and subsequent analyses of the Voluntary Carbon Market (VCM) suggest that while some projects meet basic needs, a minority actually advance the strategic interests of women (Boyd, 2002).

To bridge this gap, recent literature and institutional frameworks have pivoted toward gender-responsive climate finance. Organisations such as the Consultative Group to Assist the Poor (CGAP) and the Self-Employed Women’s Association (SEWA) have begun piloting rigorous measurement frameworks to quantify the impacts of climate mitigation on women's income, assets, knowledge, and time (CGAP, 2023). The emergence of the W+ Standard, a certification framework that assigns a monetary value to women's empowerment outcomes in climate projects, represents a critical advancement in the literature of carbon markets (Women Organising for Change in Agriculture and Natural Resource Management [WOCAN], 2023). This framework mandates that a substantial percentage of credit sales be returned directly to the female participants, effectively bridging the disconnect between macroeconomic climate finance and microeconomic rural development (WOCAN, 2023). The study endeavours to bridge the remaining gaps in the literature by offering a focused analysis of the Ghanaian pottery sector's particular challenges and exploring the precise methodologies required to apply these nascent gender-responsive carbon finance models to offset the capital costs of electric kilns.

4. Methodology

The research adopts two fundamental methods as separate framework to assess the industrial ecology and sustainability of traditional pottery in Ghana. Primary qualitative and quantitative data were collected using a comprehensive 75-question survey instrument. This instrument was structured into five specific thematic sections: Lived Experiences and Socio-Cultural Context; Economic Trajectories and Market Resilience; Innovation, Aesthetics, and Value-Addition; Energy, Environmental Sustainability, and Resource Management; and Institutional Frameworks and Heritage Preservation. Field interviews and focus group discussions were conducted with active female potters and master artisans across key production hubs in four Regions of Ghana namely; Volta Region (Vume and Adedome), Ashanti (Mfensi, Afari), Eastern (Mpraeso and Koforidua), and Upper East (Dagaaba and Lobi) capturing specific

Energy related operational data, local resource extraction distances, and informal economic and debt structures.

To complement the ethnographic data, the study incorporates Life Cycle Assessment (LCA) principles and thermodynamic energy audits of traditional kilns at the Mfensi Pottery Centre and other pottery production centres to quantify the aforementioned "Efficiency Trap". The analytical boundary encompasses raw material extraction, localised processing, utilisation, and end-of-life waste management. Advanced materials science methodologies, such as operating plastic limits, Scanning Electron Microscopy (SEM), and Atomic Absorption Spectrometry (AAS), provide empirical verification of the geological inputs. Finally, mathematical modelling is utilised to evaluate microeconomic profitability, resource depletion rates, and the systemic energy and heat losses associated with traditional biomass-fueled kilns, with the approach of determining carbon credits.

The quantitative component involves a systematic survey of pottery workshops to collect empirical data on fuel types, volumetric consumption rates, and production outputs. To estimate the environmental impact of current practices, the research adapts principles from the International Workshop Agreement (IWA) Water Boiling Test (WBT) protocol, a standard used to assess thermal efficiency, pollutant emissions, and the Total Global Warming Impact (TGWI) of biomass combustion (WHO, 2021). Table 1 presents regions and towns the survey covered.

Table 1: Regions and towns survey covered

Region	Ecological Zone	Key Pottery Hubs	Distinct Characteristics
Ashanti	Forest Zone	Mfensi, Afari	Hand-building, circular firewood kilns
Volta	Riverine	Vume, Adedome	Plastic fine clay, female cooperatives (black patina)
Eastern	Ridge / Agricultural	Mpraeso, Koforidua	Rugged topography, domestic & ritualistic use
Upper East	Savannah	Danji	Open-pit agro-waste firing, severe climate vulnerability

5. Results and Discussion

The synthesis of ethnographic data, energy and environmental modelling, and financial forecasting reveals a complex ecosystem where cultural heritage is increasingly at odds with ecological survival. The findings demonstrate a substantial reliance on firewood as the primary energy source, an approach sustained primarily due to its historical accessibility and perceived short-term cost-effectiveness, despite its pronounced and compounding environmental consequences.

5.1. Socio-Cultural Dimensions and Intergenerational Dynamics

The foundational architecture of the Ghanaian pottery industry is deeply embedded in the socio- cultural traditions of rural communities. The craft is rarely acquired through formal vocational training; rather, it relies almost entirely on intergenerational knowledge transfer.

The techniques, aesthetic motifs, and spiritual rituals associated with the craft are passed down through family lineages and community elders via traditional, informal apprenticeships. These apprenticeships ensure that the distinct aesthetic traditions, such as specific ethnic geometries and Adinkra symbols, are preserved and accurately reproduced.

5.1.1. Divergent Cultural Paradigms: Vume and Adedome

The cultural significance, spiritual associations, and operational demographics of the pottery industry are not homogeneous across Ghana. A comparative analysis of specific production hubs, notably Vume (North Tonu District) and Adedome (Agortime-Ziope District), reveals striking divergences in the integration of the craft into the community fabric.

In Vume, pottery operates as a ubiquitous, mass-participation economic activity, engaging approximately 80% of the local population. The output in this region is primarily utilitarian and decorative, with a heavy focus on items used in domestic settings and local ceremonies. Notably, the demographic participation in Vume is relatively fluid; while traditionally a female-dominated space, men have increasingly infiltrated the sector, frequently utilising electric machines and mechanised wheels to scale up production and capture market share. Furthermore, the production cycle in Vume is highly seasonal, showing a marked, counterintuitive increase in output during the rainy season, adapting local logistics to environmental moisture levels.

Conversely, the practice in Adedome is heavily restricted by entrenched spiritual taboos and rigid gender demarcations. Pottery in Adedome is an exclusively female profession; it is considered a strict cultural taboo for men to engage in the craft under any circumstances. This exclusion is fundamentally tied to the cosmological significance of the raw material itself. The specific clay utilised in Adedome, locally referred to as Gugu, is revered not merely as a resource but as a local deity. Consequently, the extraction and utilisation of Gugu are restricted solely to the production of pottery that holds distinct spiritual significance, preventing the commodification of the resource for mass-produced, purely functional wares. In direct contrast to the Vume production cycle, Adedome experiences a significant drop in production volume during the rainy season. Table 2 depicts the socio-cultural parameters and distinct characteristics. Figures 1(a, b, c and d) illustrate Production of pottery from Vume and Adedome sites.

Table 2: Socio-cultural parameters and distinct characteristics

Socio-Cultural Parameter	Vume (North Tonu District)	Adedome (Agortime-Ziope District)
Primary Output	Decorative and ceremonial items	Wares with spiritual significance
Demographic Participation	~80% of the population; mixed gender	Exclusively female
Male Involvement	Active; utilises electric machinery	Strictly prohibited (taboo)
Status of Clay	Standard geological resource	Gugu (revered local deity)
Seasonal Peak	Increases during the rainy season	Low production during the rainy season


Figure 1(a)


Figure 1(b)


Figure 1(c)


Figure 1(d)

Figure 1(a, b, c and d): Production of pottery from Vume and Adedome sites

5.1.2. Gender Dynamics, Household Leadership, and Psychological Resilience

For rural women who dominate the sector nationwide, pottery is one of the few viable avenues for financial autonomy in an environment otherwise characterised by limited economic opportunities. The revenue generated from pottery significantly influences intra-household power dynamics. Practitioners report that their status as successful, income-generating potters elevates their decision-making power regarding critical household investments, including children's formal education, agricultural investments, and family healthcare. The financial independence derived from the craft transitions women from marginalised dependents to key economic contributors, often resulting in increased respect from community elders, who frequently seek their counsel on traditional practices and invite them to participate in community leadership roles.

Beyond pure economics, the craft functions as a potent mechanism for psychological resilience and overcoming acute adversity. Practitioners report channelling personal grief, family tragedies, and the trauma of displacement into their work. They note that the rhythmic, creative demands of the craft provide both emotional solace and the tangible financial stability necessary to recover from economic shocks or social stigmatisation. Strong sisterhood bonds and cooperative networks among female potters further reinforce this resilience, creating a social safety net where women share responsibilities, tools, and childcare duties.

5.1.3. Crisis of Intergenerational Continuity

Despite its historical importance, the sector is facing a severe, systemic demographic crisis. The transmission of knowledge to the next generation is fracturing due to shifting youth perceptions and the encroachment of modern alternatives. In both Vume and Adedome, as well as broader production centres in other regions under study, there are pronounced apathy among young women toward learning the craft. In Vume, older artisans attribute this decline to a perception of the work as overly laborious, citing the physical toll or "wait pains" associated with the heavy manual labour of extraction and wedging, as well as the demoralising competitive effect of male counterparts utilising mechanised tools, and the firing techniques. In Adedome and other rural centres, the disinterest is heavily influenced by modernisation, digital connectivity, and social media; the youth increasingly view pottery as an outdated, unprofitable "dirty work" or chore, rather than a respected art form or a viable, lucrative modern career path. Without urgent institutional intervention to modernise the craft's image, introduce labour-saving technologies, and highlight successful potters as modern entrepreneurs, the industry's intergenerational continuity faces terminal decline.

5.2. Economic Trajectories, Market Resilience, and Profitability

The transition of traditional pottery from a basic survival skill to a formalised, tax-paying business enterprise requires practitioners to navigate a highly competitive and volatile market landscape. A formal economic analysis reveals the systemic barriers to scale and the precise variables that dictate the survival of these micro-enterprises.

5.2.1 Market Evolution and Competitive Threats

The customer base for traditional Ghanaian pottery has evolved significantly. While initially reliant on local neighbours and immediate community markets for subsistence trade, successful artisans have expanded their reach to include urban consumers, corporate clients (such as hotels, restaurants, and event planners), diaspora populations, and international tourists. However, the industry faces an existential competitive threat from the proliferation of cheap, mass-produced plastic and aluminium containers. Because traditional hand-built potters cannot compete on sheer volume or price with industrialised plastics, they are forced to adopt niche, value-based marketing strategies. Practitioners must pivot to emphasise the cultural storytelling, unique aesthetic textures, and eco-friendliness of their handmade products to justify higher price points for targeted, higher-income demographics.

5.2.2 Supply Chain Frictions and the Cost of Production

The profitability of the artisanal enterprise is severely constrained by supply chain frictions. The distance required to source high-quality clay has increased significantly over the lifetimes of current practitioners due to the depletion of nearby reserves, with some potters reporting that viable extraction sites are now up to 50 km from their communities. This geographic displacement drastically increases transport costs. Furthermore, transporting fragile, finished ceramics over poorly maintained rural road networks to profitable urban markets results in high breakage rates, directly reducing inventory, embedded labour, and revenue. Recent macroeconomic data offer a nuanced picture; while national transport costs experienced a rare deflationary streak, the baseline logistics costs for specialised, fragile freight remain a dominant strain on operating margins. Table 3, presents cconomic constraints and profitability of traditional pottery enterprise data for analysis. To formalise the economic constraints faced by the practitioners, the profitability of a traditional pottery enterprise can be expressed through a microeconomic profit function (Π):

$$\Pi = \sum_{i=1}^{n} [P_i \cdot Q_i \cdot (1-\mu)] - (C_{clay} + C_{fuel} + C_{transport} + C_{labor} + C_{overhead} + I_{debt})$$

Where:

- P_i represents the baseline unit price of pottery type; i dictated by the target market segment's willingness to pay.
- Q_i represents the quantity sold, which fluctuates heavily with seasonal demand.
- μ represents the margin extracted by market intermediaries. Interviews indicate that potters who lack direct access to urban markets must rely on middlemen, who typically extract a punitive profit margin of 20% to 30%; ($\mu \in [0.20, 0.30]$), severely limiting the producer's capture of final retail value.
- C_{clay} and C_{fuel} denote the variable costs of raw materials, which are highly susceptible to localised scarcity and national inflation. Firewood, specifically, has seen continuous price hikes due to regulatory tightening.
- $C_{transport}$ represents the escalating logistical costs associated with the aforementioned km distances for material sourcing and transporting fragile finished goods to market.
- I_{debt} represents the cost of servicing informal debt, a critical factor in rural economics.
- C_{labor} represents the costs associated with labour
- $C_{overhead}$ represents costs for miscellaneous expenses not included in the budget.

Table 3: Economic constraints and profitability of traditional pottery enterprise data

S/N	Product name	P_i (Ghc)	i	Q_i	μ	C_{clay}	C_{fuel}	$C_{transpo}$	I_{debt}	C_{labor}	C_{overhe}
1	Bell-Shape	100, 150, 200		100	30%	Ghc50	Ghc10	Ghc10	Ghc5	Ghc10	Ghc5
2	Osagyefo terracotta	400		100	30%	Ghc50	Ghc10	Ghc10	Ghc5	Ghc10	Ghc5
3	Kutu	40, 80		100	20%	Ghc20	Ghc10	Ghc7	Ghc3	Ghc5	Ghc5
4	African lady	150, 250		100	20%	Ghc30	Ghc10	Ghc7	Ghc5	Ghc7	Ghc5
5	Oase/Planter	80, 150		100	20%	Ghc20	Ghc10	Ghc7	Ghc5	Ghc5	Ghc5

Bell-Shape pot

Bell-Shape pot is offered at three price tiers (Ghc 100, Ghc 150, Ghc 200) and faces the dataset's highest middleman cut at 30%. The total per-unit production cost is Ghc 90. Table 4, presents the analysis.

Table 4. Bell-Shape profit analysis.

Price (Ghc)	Net price after μ	Per-unit profit (Ghc)	Batch profit (Q=100)	Viable?
100	70.00	−20.00	−2,000.00	No (loss)
150	105.00	15.00	1,500.00	Yes
200	140.00	50.00	5,000.00	Yes

Figure 2(a): Bell-Shape Pot Work

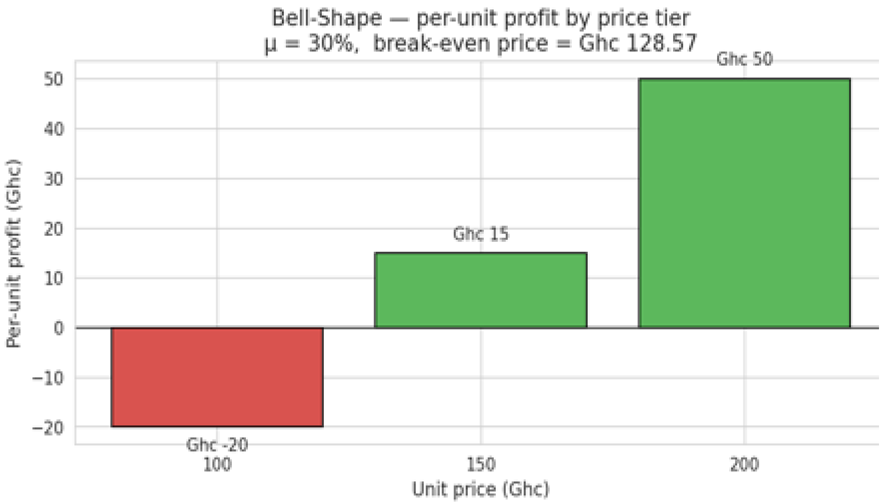

Figure 2(b): Price Tier Tnalysis.

At the Ghc 100 price tier, Bell-Shape produces a per-unit loss of Ghc 20, and Ghc 2,000 across the full 100-unit batch. The mechanism is direct and the 30% intermediary cut leaves the producer with only Ghc 70 per pot, while the per-unit cost is Ghc 90. The product becomes profitable only above its break-even price of Ghc 128.57. At Ghc 150, it yields a modest per-unit profit of Ghc 15, rising to Ghc 50 at Ghc 200. The implication is direct, when the product is sold at the lowest tier through intermediaries, Bell-Shape pot effectively transfers value from the producer to the supply chain. Red bar indicates loss.

Osagyefo Terracotta

Osagyefo terracotta carries a single high price point of Ghc 400, and has the same 30% middleman margin as Bell-Shape, and an identical Ghc 90 per-unit cost. It represents the high-value end of the workshop's product line.

Table 5. Osagyefo terracotta profit analysis.

Price (Ghc)	Net price after μ	Per-unit profit (Ghc)	Batch profit (Q=100)	Viable?
400	280.00	190.00	19,000.00	Yes

Figure 3(a): Osagyefo Terracotta Pot

Figure 3(b): Price Tier Analysis.

Osagyefo is, by a wide margin, the most profitable product in the production line. Per-unit profit reaches Ghc 190 (Ghc 19,000 per batch), and the net price after the middleman cut of (Ghc 280) sits more than three times above the break-even price (Ghc 128.57). The product effectively cross-subsidises the rest of the workshop's output. Its principal vulnerability is concentration risk: the entire upside depends on continued access to the customer segment which supports the Ghc 400 price point typically, for an urban market segment when the middleman is eliminated.

Kutu

Kutu is a budget utility item priced at Ghc 40 and Ghc 80. The middleman margin is 20% and the per-unit cost is Ghc 50. At Ghc 40, Kutu produces a per-unit loss of Ghc 18 and Ghc 1,800 per batch production. Break-even is averagely Ghc 62.50. At Ghc 80 the product has a per-unit profit of Ghc 14 resulting in Ghc 1,400 per batch production which is viable, but with the thinnest positive margin. Notably, the lower 20% middleman margin (compared with 30% for Bell-Shape) is not sufficient to rescue the lowest price tier; the price floor itself sits below cost. The most plausible interpretation of the Ghc 40 tier is a discount sale at a loss, perhaps for inventory clearance or relationship reasons. The product will yield price outcome when the intermediary is eliminated. Red bar indicates loss margin.

Table 6. Kutu profit analysis.

Price (Ghc)	Net price after μ	Per-unit profit (Ghc)	Batch profit (Q=100)	Viable?
40	32.00	−18.00	−1,800.00	No (loss)
80	64.00	14.00	1,400.00	Yes

Figure 4(a): Kutu Terracotta Pot

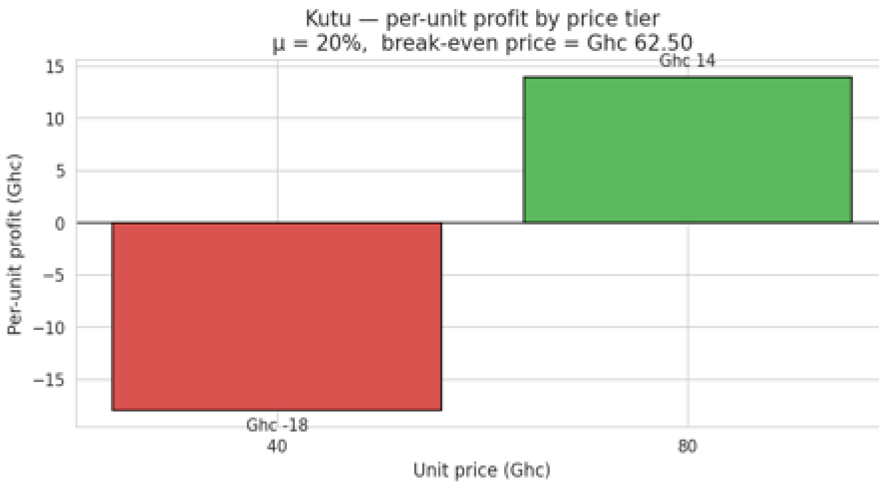

Figure 4(b): Price tier analysis

African Lady

African lady is a mid-range product priced at Ghc 150 and Ghc 250, with a 20% middleman margin and Ghc 64 per-unit cost profit.

Table 7. African lady profit results.

Price (Ghc)	Net price after μ	Per-unit profit (Ghc)	Batch profit (Q=100)	Viable?
150	120.00	56.00	5,600.00	Yes
250	200.00	136.00	13,600.00	Yes

Figure 5(a): African Lady Pot

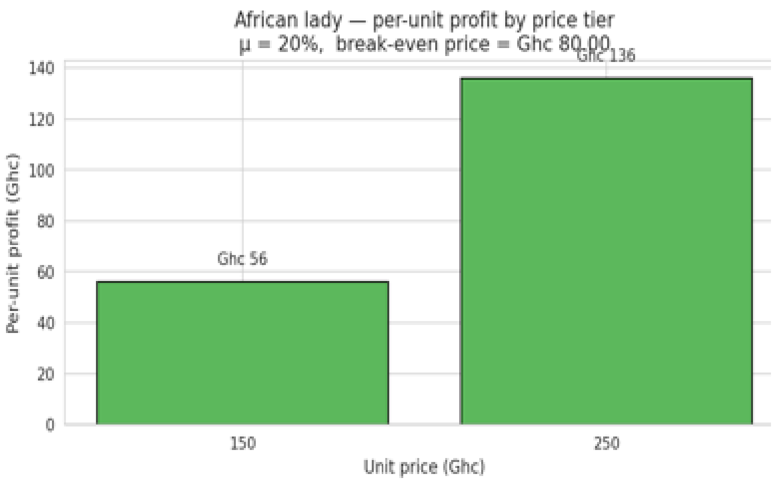

Figure 5(b): Price Tier Analysis

African lady is the most consistently profitable mid-range product in the line. Even the lower tier (Ghc 150) yields a per-unit profit of Ghc 56 (Ghc 5,600 per batch), and the upper tier (Ghc 250) yields Ghc 136 (Ghc 13,600 per batch). Break-even is Ghc 80. With a moderate per-unit cost of Ghc 64 and a 20% intermediary margin, both price tiers comfortably clear break-even. African lady represents the most resilient case in the line profitable across its full pricing range.

Oase/Planter

Oase/Planter is a horticultural utility item priced at Ghc 80 or Ghc 150, with a 20% middleman margin and Ghc 52 per-unit cost. Oase/Planter sits between Kutu and African lady in profitability. At Ghc 80, per-unit profit is a slim Ghc 12 (break-even is Ghc 65); at Ghc 150, profit rises to Ghc 68 per unit (Ghc 6,800 per batch). The product is viable at both tiers, but the lower tier offers little buffer if any cost line fuel, transport, and clay rise even modestly. This is structurally similar to the Kutu situation, except that Oase/Planter's base price clears break-even by a small margin rather than falling below it. Both tiers are profitable, but the Ghc 80 margin is slim.

Table 8. Oase/Planter profit analysis

Price (Ghc)	Net price after μ	Per-unit profit (Ghc)	Batch profit (Q=100)	Viable?
80	64.00	12.00	1,200.00	Yes
150	120.00	68.00	6,800.00	Yes

Figure 6(a): *Oase/Planter pot*

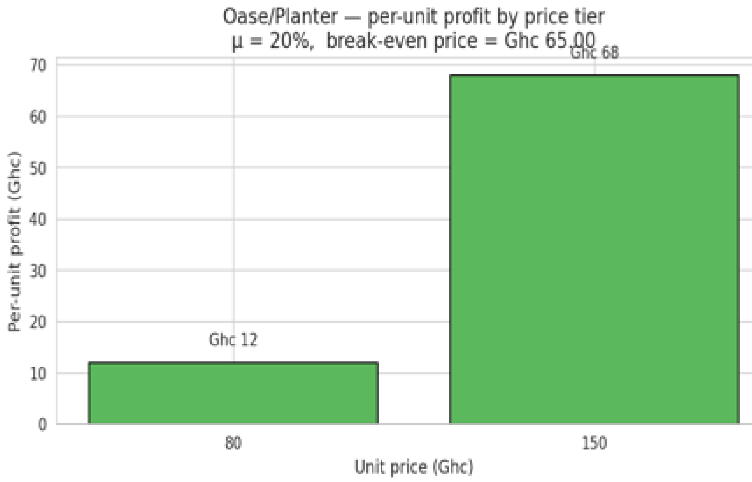

Figure 6(b): *Price Tier Analysis*

5.2.3 Comparative Analysis of Production Cost

Scenarios analysis

Bringing all the five products together yields ten distinct products and price-tier scenarios. Each scenario is treated as a separate observation in the comparative analysis. Ranking the ten scenarios by per-unit profit reveals the full distribution of outcomes across the product line. Two scenarios are loss-making (Bell-Shape at Ghc 100 and Kutu at Ghc 40); the remaining eight are profitable, with Osagyefo terracotta and African lady forming a clear top tier. Figure7, presents ten scenarios analysis.

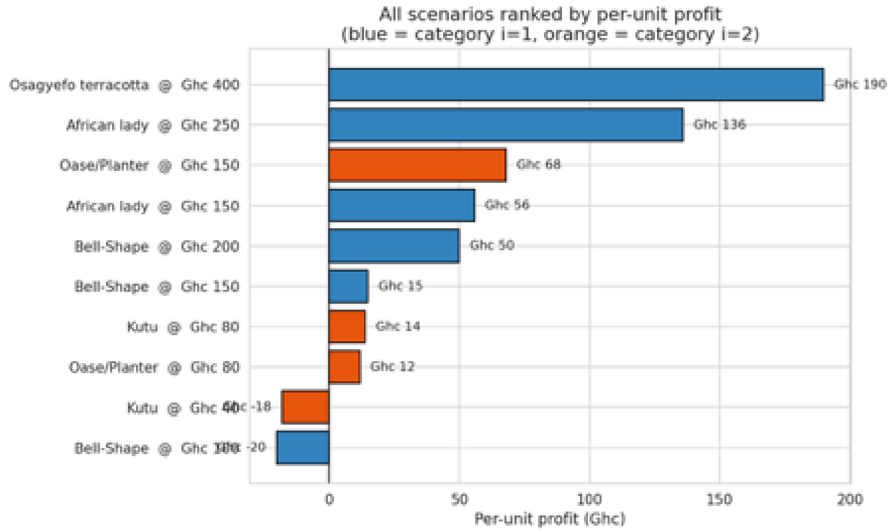

Fig. 7: *Ten scenarios ranked by per-unit profit. Blue=category i=1; Orange=category i=2.*

Cost composition by product

The stacked cost structure makes clear which cost line is most consequential for each product. Clay is the largest single cost line for every product in the dataset, accounting for between 38% of (Oase/Planter) and 56% of (Bell-Shape, and Osagyefo) at per-unit cost. Fuel and transport together form the second tier of expenditure. The implication for risk management is that any inflation in clay supply transmits directly and proportionally to margins. Firewood costs rise under regulatory pressure, including transportation cost as compounded utilities. Figure 8, illustrates per-unit cost composition by product, in Ghana cedis.

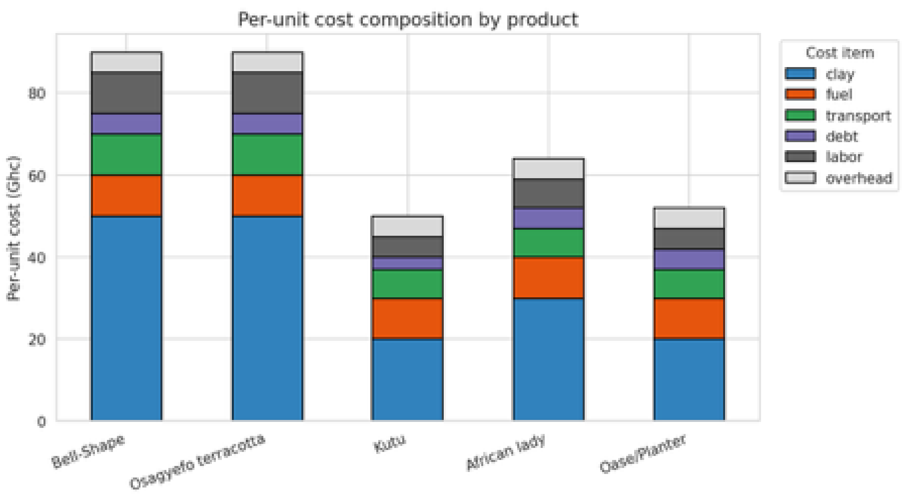

Fig. 8: *Per-unit cost composition by product, in Ghc.*

Sensitivity analysis of intermediary margin

The range of μ ∈ [0.20, 0.30] for the intermediary margin is observed in the field applicable to products sales not directly from the source of production. Ranging μ from 0% (a hypothetically direct-to-consumer scenario) to 30% (the worst case beyond the observed range) at the highest price tier of each product reveals how exposed each product is to intermediary pressure. The shaded band in figure 9 marks the observed μ range. Two observations follow. Firstly, the slope of each line being proportional to the product's unit price, whereas, high-price products lose more in absolute terms per percentage point of μ. Typically retain greater absolute profit. Second, Kutu (the lowest-priced product) is the closest to crossing zero within the observed μ range; if μ were to rise above 28%, in the unit price at Ghc 80 tier, would become loss-making. Figure 9, shows the sensitivity analysis of per-unit margin of each product for middleman.

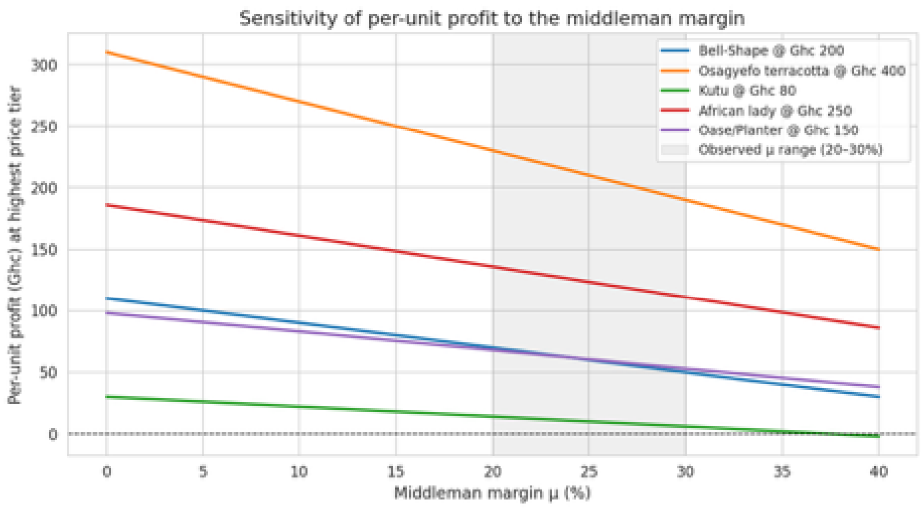

Fig. 9: *Sensitivity analysis of per-unit middleman margin at each product's top price tier*

5.2.4 Credit Access and the Debt Trap

A critical bottleneck to the economic expansion of the pottery sector is the inability of rural female practitioners to access formal financial markets. The lack of recognised collateral, formal credit histories, and land tenure prevents them from securing low-interest commercial bank loans or formalised microfinance. Consequently, to fulfil large corporate purchase orders, meet the high capital requirements of bulk material purchases, or survive seasonal fluctuations (such as periods of low market demand when households must revert to subsistence farming), artisans are forced to rely on local, informal moneylenders. The reliance on informal credit is highly extractive and stifles capital accumulation. Artisans report borrowing money for raw materials on terms that require an immediate 20% interest rate upon repayment, severely eroding the net profitability of large orders.

$$I_{debt} = L_0 \times (1 + r_{informal})^t$$

Where;

The principal loan L_0 is subjected to a punitive informal interest rate ($r_{informal} = 0.20$). When this debt servicing cost is coupled with the 20% to 30% reduction in revenue taken by middlemen, the artisan captures only a fraction of the final retail value of their product. These dynamic traps the artisan in a cycle of subsistence, stifling their ability to accumulate capital, formalise operations, or reinvest in vital technological upgrades such as insulated kilns or electric mixers.

5.3. Technological Innovation, Aesthetics, and Value Addition

To counteract the economic pressures of extractive middlemen and the influx of cheap industrialised substitutes, artisans have increasingly relied on product diversification, aesthetic innovation, and clever marketing paradigms. This involves a delicate balancing act: creating modern, functional designs that appeal to contemporary urban lifestyles while preserving the traditional cultural essence and ancestral motifs that give the product its unique selling proposition.

5.3.1 Product Diversification and Health Marketing

Recent innovations across artisanal clusters include the introduction of functional, high-value sets, such as matching mugs and plates designed for the lucrative gift and corporate markets. Potters are incorporating modern utility features, such as fitted lids, robust handles, and durable coasters, into traditional forms. Furthermore, potters are modifying traditional hand tools, such as shaping ribs, custom stamps, and wire cutters, to improve efficiency and create unique, tactile surface textures and relief designs that are difficult to replicate by factory injection moulding.

A highly effective, emergent value-add strategy has been the marketing of unglazed earthenware for specific health and wellness benefits. Rather than competing solely on utility, artisans market their pots to health-conscious urban consumers by highlighting the clay's natural, chemical-free properties, its alkaline nature, and its ability to retain nutrients and minerals during slow cooking.

Fig. 10: *CO_2 engulfing practitioner as in practice*

5.3.2 Digital Penetration and Quality Assurance

The integration of digital technology, particularly mobile phones and social media platforms such as WhatsApp, has revolutionised market access and customer relationship management for rural potters. Artisans use these platforms to bypass traditional intermediaries, advertise high-resolution digital catalogues directly to distant diaspora buyers, conduct online customer polls on design preferences, and negotiate custom, high-margin orders in real time.

To ensure the viability of these direct-to-consumer sales, practitioners have implemented rigorous, quality-control protocols. Because defective products sold directly to premium consumers can permanently damage a brand's reputation, potters conduct extensive visual inspections, physical stress tests, water-retention and leak tests, and acoustic sound tests. The sound test involves tapping the fired pot to listen for correct, resonant ring to indicate a successful, fully vitrified, and crack-free firing.

When experimental firings fail, such as when a new natural plant-based glaze turns out sticky, a clay mix is too brittle, or a rapid temperature fluctuation causes an entire batch to shatter, the defective pieces are crushed into "grog" and recycled into new raw clay mixtures. This ensures a strict zero-waste policy within the workspace, minimising material loss and improving the structural integrity of subsequent batches.

5.4. Industrial Ecology, Resource Depletion, and Material Science

The most pressing systemic vulnerability of the traditional Ghanaian pottery sector lies in its industrial ecology, specifically, its intimate, extractive relationship with natural resource bases and its use of biomass energy. The sustainability of the craft depends on the delicate management of geological and biological inputs.

5.4.1 Clay Mineralogy and Resource Extraction

The fundamental raw material, Ghanaian clay, possesses specific thermophysical properties that dictate its utility. Studies on regional clays, such as those from Assin-Fosu and Kumasi, indicate typical alumina contents of 22% to 35% and silica contents of 49% to 58%. These mineralogical profiles influence the specific heat capacity $\boldsymbol{C_{p,clay}}$ of the material, which for typical Ghanaian clays averages approximately 1254 J/kgK. This high thermal resistivity makes the material excellent for natural cooling and cookware, but requires significant energy input to fire successfully.

The extraction of this resource poses localised ecological challenges. As easily accessible clay deposits near villages become depleted through continuous, generational mining, the sourcing radius expands, driving up the aforementioned transportation costs. In response, artisans rely heavily on indigenous conservation methods and empirical resource management. In many communities, digging is kept to an absolute minimum, and extraction sites are subjected to immediate land reclamation practices, such as filling pits with organic matter to allow the local ecosystem to recover and prevent degradation.

Furthermore, extraction is heavily regulated by traditional elders and spiritual taboos. For example, in certain areas, miners are forbidden from accessing sacred clay sites on Thursdays and during local market days. While rooted in spirituality, these taboos act as a highly effective, culturally enforced quota system to prevent rapid depletion and allow the water table to stabilise. Figure 11, presents clay mineralogy and extraction. The physical depletion of these non-renewable on a human timescale clay resource can be modelled to assess the long-term viability of specific sites per the model below:

$$D_r(t) = \frac{V_{base} - V_{salvage}}{R_{total}} \times E(t)$$

Where;

$D_r(t)$ is the economic depletion rate at time t, V_{base} is the economic value of the pristine clay deposit, $V_{salvage}$ is the value of the reclaimed land post-extraction, R_{total} represents the total estimated reserves of the site in metric tons, and $E(t)$ is the volume of clay extracted during the specific period. To minimise $E(t)$ and extend the lifespan of the resource base, practitioners increasingly integrate recycled materials such as crushed fired grog into their raw mixtures. This reduces the volume of virgin clay required and acts as a temper, reduce shrinkage and improve the structural durability of final product.

Fig. 11: *Clay mineralogy and extraction*

5.4.2 The Efficiency Trap and Thermodynamic Modelling of Kilns

The primary environmental bottleneck and the greatest threat to the sector's sustainability is the firing process. Practitioners rely almost exclusively on traditional open-combustion bonfire methods or rudimentary updraft kilns fuelled by local hardwood firewood, occasionally supplemented with agricultural waste such as rice husks. This reliance on biomass has severe implications amid growing national concerns about deforestation. Regulatory tightening and forest depletion have made high-quality firewood scarce and prohibitively expensive, squeezing profit margins to breaking point. The industry is currently caught in a severe "Efficiency Trap". Traditional kilns operate with massive thermodynamic inefficiencies. Rigorous energy audits of firewood kilns in Ghana, such as at the Mfensi Pottery Centre, indicate that their thermal efficiency ranges from 12.4% to 21.6%. This data demonstrates that nearly 80% of the thermal energy generated by the combustion of wood is lost to the ambient environment. The Mfensi study further revealed a mean firewood consumption of 0.82 kg per kilogram of fired clay, resulting in excessive CO_2 emissions of 2.3 to 3.1 kg per kilogram of output.

The thermodynamic efficiency ($\eta_{thermal}$) of the kiln is mathematically defined by the ratio of useful heat work to the total heat input:

$$\eta_{thermal} = \frac{Q_{useful}}{Q_{total}} \times 100$$

Where, $\boldsymbol{Q_{total}}$ is the total chemical energy released by the fuel:

$$Q_{total} = \sum(M_{wood,i} \times GCV_{wood,i})$$

Ghanaian hardwoods exhibit specific Gross Calorific Values (GCVs) that dictate their utility as fuel. Artisans show a distinct preference for high-density indigenous species. Empirical studies of wood-fuel species in Ghana's forest transition zone confirm these energetic variations. Table 9, shows the characteristics of thermochemical wood fuel derived from thermochemical of Ghanaian wood fuels.

Table 9: Characteristics of thermochemical Ghanaian wood fuels in application

Scientific Name	Local Name	Moisture Content (%)	Volatile Matter
Afzelia africana	Papao	9.25	58.66
Anogeissus leiocarpus	Kane / Ayin	7.58	35.25
Khaya senegalensis	Mahogany	9.96	69.68
Pterocarpus erinaceus	Krayie (Rosewood)	10.74	59.12
Senna siamea	Cassia	10.55	62.41
Azadirachta indica	Neem	11.24	33.52

The useful heat (Q_{useful}) represents the energy actually required to raise the temperature of the clay mass to its vitrification point (often reaching 600-850°C for unglazed earthenware) and to evaporate both mechanical and chemically bound moisture:

$$Q_{useful} = (M_{clay} \cdot c_{p,clay} \cdot \Delta T) + (M_{H_2O} \cdot L_v)$$

Where $\boldsymbol{C_{p,clay}}$ is the specific heat capacity of the local clay (1254 J/kgK), $\Delta \boldsymbol{T}A$ is the required temperature differential, and $\boldsymbol{L_v}$ is the latent heat of vaporisation of the water content.

The fundamental problem is thermodynamics, uncontrolled airflow and insufficient insulation lead to massive heat loss. Potters burn immense quantities of expensive wood to generate heat that instantly escapes into the atmosphere.

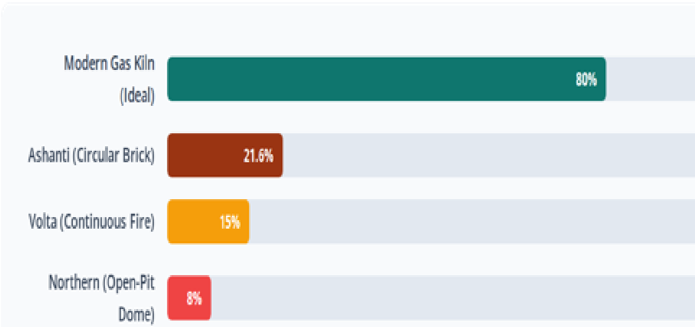

Fig. 12(a): *Firing characteristics of systems in Regions of Ghana and estimated emitted CO_2*

Fig. 12(b): *Firing characteristics of systems in Regions of Ghana and estimated emitted CO_2*

The gross inefficiency is driven by massive, uncontrolled heat losses $\boldsymbol{Q_{loss}}$ inherent to traditional kiln architecture:

$$Q_{loss} = Q_{conduction} + Q_{convection} + Q_{radiation} + Q_{exhaust}$$

Because traditional kilns are constructed from local mud and lack modern refractory insulation (such as ceramic fibre blankets or high-alumina insulating firebricks), conductive heat transfer $\boldsymbol{Q_{conduction}}$ through the kiln walls to the outside air is massive. Furthermore, uncontrolled airflow and the lack of variable dampers result in enormous amounts of thermal energy escaping via exhaust gases $\boldsymbol{Q_{exhaust}}$. Consequently, to achieve the necessary heat work $\boldsymbol{Q_{useful}}$. The potter must continuously feed excess high-calorific wood into the kiln. This directly exacerbates deforestation, drastically increases their variable costs $\boldsymbol{C_{fuel}}$, and perpetuates the cycle of poverty by consuming capital that could otherwise be invested in business growth.

Fig. 13: *Currently traditional firewood Kiln in practice and packed firewood in Ghana*

5.5 Energy, Emissions and Climate Vulnerability

The environmental consequences of thermodynamic inefficiency directly contribute to significant occupational health risks associated with the use of wood as fuel. The incomplete combustion of wood in uninsulated kilns produces substantial amounts of particulate matter, carbon monoxide, and pungent smoke. Practitioners have observed that these hazardous emissions severely affect their respiratory health and cause eye irritation, leaving them heavily reliant on the unpredictable wind to ventilate their workspaces. Although some potters attempt to mitigate these effects by wearing basic masks during firing procedures, localised air pollution continues to pose a serious health concern.

Furthermore, the industry's dependence on open-air drying and firing renders it highly susceptible to contemporary climate change anomalies. Unpredictable rainfall patterns and extreme, unseasonal heat events disrupt the delicate, slow-drying processes necessary to prevent clay from cracking or warping before reaching the kiln. Artisans are compelled to continuously adapt by utilising tarpaulins to safeguard their wares from abrupt rainfall and by rigorously managing increasingly limited water resources during prolonged dry seasons to ensure sufficient moisture for clay wedging.

Fig. 14: *Currently traditional firewood Kiln in operation by a Practitioner at Vume in Ghana*

5.5.1 Energy and Environmental Toll: Physics of Open-Pit Combustion

The ecological impact of the pottery trade is substantiated by both observational reports and quantitative emission models. Artisanal pottery firing employs large-scale, open-pit combustion, an intrinsically inefficient thermodynamic process. Research applying the IWA Water Boiling Test to traditional wood-burning stoves in Ghana indicates a baseline thermal efficiency of only 12.2%, categorising this technology as "Tier 0" within global clean cooking matrices (WHO, 2021). When this inefficiency is extrapolated to the scale of traditional pottery firing, in the absence of ceramic liners, insulation, or controlled airflow, the resulting energy wastage is substantial (WHO, 2021).

Since fires do not consistently attain the high temperatures necessary for complete combustion, they produce substantial quantities of products of incomplete combustion (PIC) (WHO, 2021). The emission factors for fine particulate matter, carbon monoxide, and elemental Black Carbon are remarkably elevated (Bond et al., 2004; WHO, 2021). Black Carbon, in particular, is highly detrimental; as a short-lived climate pollutant, it absorbs solar radiation within the atmosphere, thereby directly contributing to regional warming and unpredictable climatic patterns in West Africa (Intergovernmental Panel on Climate Change [IPCC], 2021).

The Total Global Warming Impact (TGWI) of this practice is substantial. In a baseline assessment, a single traditional wood combustion event produced 11.439 kg of equivalent impact, more than four times that of improved charcoal technologies (WHO, 2021). When scaled to a commercial firing cycle that consumes several cubic meters of forest wood, a single rural cooperative functions as a significant point source of greenhouse gas emissions. Additionally, the localised air pollution perpetuates a continuing public health crisis. The smoke produced during firing routinely surpasses the World Health Organisation's (WHO) annual average guideline of 35 $\mu g/m^3$ by an order of magnitude (Jerneck & Olsson, 2013). Prolonged exposure to this pollution directly contributes to respiratory illnesses affecting female artisans and their children, thereby reinforcing the cycle of physical deterioration and poverty (Jerneck & Olsson, 2013; WHO, 2021).

Fig. 15: *Example of Open-Pit Combustion in Ghana*

5.5.2 Institutional Frameworks and the Just Energy Transition (JET)

To ensure that the Ghanaian pottery industry breaks free from the efficiency trap and thrives over the years of production, sweeping institutional interventions and policy reforms are required. The current operational landscape is characterised by a stark lack of institutional support. The overwhelming majority of practitioners report receiving zero direct financial support, capacity-building training, or technical intervention from local government authorities or NGOs. While some local district assemblies minimally recognise the craft's economic contribution by keeping static taxes low, comprehensive, forward-looking developmental policies are entirely absent. Practitioners are still subject to daily market tolls and local levies, which constitute a constant drain on cash flow.

5.5.3 Just Energy Transition (JET) in Practitioners' Production

The traditional pottery sector, in its current form, is entirely misaligned with national and global decarbonisation goals due to its high-emission, resource-intensive nature. However, imposing strict environmental regulations or outright bans on firewood usage without providing economically viable technological alternatives would devastate the livelihoods of thousands of rural women and dismantle local economies. Therefore, the sector must be analysed and reformed through the lens of the Just Energy Transition (JET). The JET framework demands a holistic approach to shifting energy systems away from high-emission fossil fuels and unsustainable biomass wood firing, while ensuring the transformation is equitable, inclusive, and actively benefits the most vulnerable segments of society, particularly those whose livelihoods depend on legacy energy systems. For Ghana's pottery sector, a successful JET requires moving artisans away from the "Efficiency Trap" of open-fire wood kilns towards energy-efficient, insulated downdraft kilns or alternative-fuel kilns (e.g., LPG, electric, solar-assisted, or biogas) without imposing prohibitive upfront capital costs.

Practitioners have expressed a strong, pragmatic desire for this green transition. They note that while insulated gas- or electric-fired kilns offer superior temperature control, drastically reduce firing times, lower defect rates, and improve air quality, the capital expenditure required to procure them is insurmountable without external funding. They explicitly require targeted institutional support, including direct financial grants, local workshops to teach modern kiln management and glazing technologies, and hands-on guidance from visiting technical experts to facilitate the transition.

5.5.4 Socio-Economic Optimisation and Policy Integration

The implementation of JET policies can be conceptualised as a complex optimisation problem in which the state must balance environmental carbon targets with socio-economic welfare and poverty alleviation. Adapting an ultimatum game-theory model for transition policy, the societal payoff function $\boldsymbol{U}$ for the technological transition of the artisanal sector, it must ensure that the utility post-transition for the workers $\boldsymbol{W_{post}}$ is strictly greater than or equal to a minimum acceptable livelihood threshold $\boldsymbol{T}$:

$$\max U_{society} = \alpha(\Delta E_{emissions}) + \beta(\Delta Y_{economic})$$

$$\text{Subject to: } W_{post} \geq T$$

Where;

- $\Delta \boldsymbol{E_{emissions}}$ represents the total reduction in carbon and particulate emissions achieved by upgrading the artisanal kilns across the sector,
- $\Delta \boldsymbol{Y_{economics}}$ represents the net economic growth of the sector (driven by higher quality output, lower defect rates, and reduced fuel expenditure),
- α and β are policy weighting factors determined by state priorities.

If the government or international NGOs fail to subsidise the capital cost of the new kilns or provide adequate retraining, the financial burden falls entirely on the practitioners. In this scenario, $\boldsymbol{W_{post}}$ drops below the survival threshold, $\boldsymbol{T}$ leading to sector collapse, widespread loan defaults, increased rural poverty, and total non-compliance with environmental regulations. As a scenario adopted by the South African JET Implementation Plan (JET-IP), successful transitions require dedicated programme management units focused on capability building, credit-guarantee vehicles to mobilise private-sector investment, and national skills advisory forums to bridge the knowledge gap.

5.5.5 Academic Collaboration, Intellectual Property, and Future Outlook

To successfully execute this transition, the relationship between academic institutions, state bodies, and rural practitioners must evolve from passive observation to active partnership. Practitioners express a distinct desire for universities and researchers to move beyond merely studying them as historical or anthropological subjects. They actively request tangible, capacity-building collaborations. These include conducting formal market research on modern urban design trends, providing assistance in navigating complex NGO grant applications, and deploying engineering departments to co-design affordable, localised kiln technologies that utilise materials for refractory insulation.

Furthermore, robust state intervention is required to protect the intellectual property of indigenous Ghanaian pottery. Practitioners face the persistent threat that their unique designs and ancestral techniques will be copied, digitised, and mass-produced by foreign manufacturers. The state must establish official registries or patents to protect local crafts in global markets. There is also a nascent but significant interest among potters in joining eco-certification or fair-trade programmes. However, practitioners remain cautious; they require empirical evidence that the financial benefits and price premiums associated with accessing eco-conscious global markets will tangibly outweigh the stringent administrative costs and compliance burdens of joining such programmes. Ultimately, the most urgent action identified by stakeholders across the industry to secure its future is a concerted, state-backed global marketing initiative to "Brand Ghana," combined with the integration of modern ceramic design, business administration, and efficient kiln management into the formal educational curriculum of local schools. With this, the sector can fundamentally change young people's perceptions of the craft. This cultural transformation is absolutely essential to ensure the intergenerational transfer of knowledge persists and that the industry does not disappear with its current masters.

6. Conclusion

The traditional pottery industry of Ghana is at a significant, pivotal historical juncture. As evidenced by the contrasting socio-cultural realities observed in centres such as Vume and Adedome, the sector is profoundly integrated into the spiritual and economic fabric of rural communities, serving as an essential source of financial independence, household leadership, and social empowerment for countless women. Nevertheless, the industry's longstanding resilience is being systematically undermined by a combination of escalating pressures, including the alienation of youth demographic groups, exploitative informal financial systems, the depletion of local resources, and intense price competition from industrialised plastic alternatives. Most critically, from an environmental and sustainability perspective, the industry is caught in a debilitating “Efficiency Trap” in its use of energy for firing. The sector remains heavily dependent on thermodynamically highly inefficient traditional kilns. This reliance on increasingly scarce and expensive hardwood firewood not only erodes artisans’ profit margins but also drives localised deforestation and causes severe occupational respiratory health issues. Empirical data clearly demonstrate that, without technological intervention, the current energy and resource utilisation models are fundamentally unsustainable.

Securing the future of the Ghanaian pottery industry necessitates an immediate, formalised, and highly coordinated commitment to the Just Energy Transition (JET). Policy-makers, academic institutions, and NGOs must collaborate directly with practitioners to provide capital subsidies, technological infrastructure such as low-thermal-mass, insulated kilns, and direct market access, all of which are essential for modernising production. This way, the state can simultaneously attain critical environmental decarbonisation objectives, preserve an invaluable element of Ghanaian cultural heritage, and ensure the ongoing economic empowerment of its rural artisans.

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