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Process Upgrading and Value Added in Community-Based Pottery Production: A Micro-Level Value Chain Analysis

Friesca Erwan[1*], Nisrina Salsabila[2], Awal Aflizal Zubir[3]

[1,2,3]Industrial and Mechanical Engineering Department, Engineering Faculty, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

*Corresponding author: Friesca Erwan, Industrial and Mechanical Engineering Department, Engineering Faculty, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia. Email: friesca_erwan@usk.ac.id

Abstract

Traditional pottery enterprises continue to face structural challenges that limit their ability to generate economic value, particularly in micro-scale, community-based settings where production relies heavily on manual techniques and tacit knowledge. These constraints often manifest in inefficient process design, uneven time allocation, and inconsistent quality control, all of which restrict value creation and weaken the economic resilience of artisans. Responding to these challenges, this study aims to examine how value is created within a traditional pottery production system and to assess whether targeted, context appropriate interventions can enhance value added without compromising artisanal identity. Using a production-oriented value chain approach, the research employs detailed observation, cost analysis, and semi structured interviews to map production activities and quantify value added across stages. This methodological combination enables a granular assessment of how specific production practices shape economic outcomes. The findings show that baseline value creation is weakly embedded in production activities and heavily dependent on extended labor input. Structural inefficiencies limit reinvestment capacity, particularly in drying and firing. However, targeted process improvements, including enhanced forming tools and controlled firing, significantly increased quality consistency and reduced defect rates. These interventions nearly doubled value added per production cycle while preserving traditional product characteristics. The study contributes to value chain scholarships by demonstrating the importance of production level granularity in informal manufacturing contexts. Practically, the results highlight the potential of modest, culturally aligned process improvements to strengthen productivity, income stability, and long-term sustainability in traditional craft industries.

Keywords: Value Chain Analysis, Community-Based Pottery, Production Process, Value Added, Micro Manufacturing

Introduction

Traditional manufacturing industries continue to play a central role in local and regional economies, particularly in developing countries where micro and small enterprises generate employment, preserve cultural heritage, and contribute to inclusive economic growth (Alhawat, 2024; Umar & Anbuselvi, 2023; Ayalu et al., 2022). Pottery production exemplifies this contribution through its labor-intensive techniques, reliance on tacit knowledge, and deep integration with local materials and cultural identity. Despite their socio economic and cultural

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importance, traditional pottery enterprises are increasingly vulnerable to shifting consumption patterns, material scarcity, productivity constraints, and limited integration into modern value creation systems (UNIDO, 2020; OECD, 2019). These pressures have intensified as urbanization and land conversion reshape the environments in which artisans operate.

From a production process perspective, community-based pottery manufacturing typically depends on manual forming, natural drying, and open firing. While these methods reflect long standing artisanal traditions, they often result in inefficiencies related to time, cost, and output consistency, leading to high defect rates and limited scalability (Su et al., 2025; Aini et al., 2023; Zaccaron et al., 2022). These internal constraints are compounded by external pressures, including competition from industrial ceramics and the effects of urban land conversion, both of which threaten the long-term sustainability of pottery production in urban and peri urban areas (Porter & Kramer, 2019). As a result, many pottery clusters have experienced declining productivity, shrinking profit margins, and the gradual exit of skilled artisans.

Within manufacturing studies, improvements in productivity and value creation are widely understood to depend not merely on market expansion but on process redesign, cost structure optimization, and the strategic alignment of production activities within broader value chain systems (Slack et al., 2022; Porter, 1985). Porter's value chain framework has become a foundational analytical tool for examining how interconnected primary and supporting activities contribute to value creation within a firm. In production-oriented research, value chain analysis is frequently used to identify cost drivers, diagnose process inefficiencies, and uncover opportunities for value addition across manufacturing stages (Javed et al., 2025; Bai & Zhao, 2023; Al Sfan et al., 2022).

Empirical studies show that value chain analysis is particularly useful in contexts where production activities are fragmented, resource constrained, and weakly formalized—conditions common in micro manufacturing and artisanal industries. By decomposing production into discrete activities, the framework helps identify where value is created, where costs accumulate, and where targeted interventions may yield the greatest impact (Porter, 1985; Ketchen et al., 2014). Although value chain approaches have been applied to agricultural processing, food industries, and traditional craft sectors (Anindita et al., 2019; Hartati et al., 2018), their application to traditional manufacturing systems remains uneven. Much of the existing literature focuses on marketing channels, export upgrading, or governance structures, often overlooking the central role of production process design in shaping firm level value creation (Oh et al., 2025; Su & Zhang, 2020). Research on traditional pottery industries, meanwhile, tends to emphasize cultural preservation and artisanal identity rather than systematic analysis of production processes and cost structures. While these perspectives are valuable, they offer limited guidance for enhancing productivity and economic sustainability under contemporary market pressures.

Quantitative assessments of value added in traditional manufacturing systems remain scarce, particularly those comparing production configurations before and after targeted interventions. There is limited empirical evidence on how modest, context appropriate technological improvements interact with traditional production practices. Moreover, most value chain studies in small scale industries focus on export-oriented clusters or globally integrated value chains, providing limited insight into locally embedded manufacturing systems that primarily serve domestic markets (Solórzano Venegas & Hidalgo, 2025; Fragnoli, 2021). As urbanization and land use changes disrupt traditional raw material supply chains and production infrastructures, understanding value creation dynamics within such localized contexts becomes increasingly important.

Taken together, these gaps highlight the need for a production centric investigation that integrates value chain analysis, value added calculation, and process redesign within a traditional manufacturing context. Such an approach can contribute to academic debates on value creation and small-scale manufacturing while offering practical strategies for sustaining traditional industries under structural constraints.

In response to these gaps, this study analyzes and enhances value creation in a traditional pottery production system using a production-oriented value chain framework. The research focuses on a micro scale pottery enterprise operating within an urban craft cluster in Indonesia, where declining raw material availability, labor scarcity, and low productivity threaten long term viability.

The study pursues three primary objectives. First, it systematically maps the pottery production process using Porter's generic value chain framework, with explicit attention to primary production activities and their associated cost drivers. Second, it quantifies value added at each stage of the production process by comparing input costs and output values across production cycles. Third, it evaluates the effects of targeted process and technological interventions on value added performance, production efficiency, and economic sustainability. By situating traditional pottery production within a rigorous production systems framework, this study contributes to broader discussions on sustainable manufacturing, inclusive industrial development, and the future of artisanal industries in rapidly transforming economies.

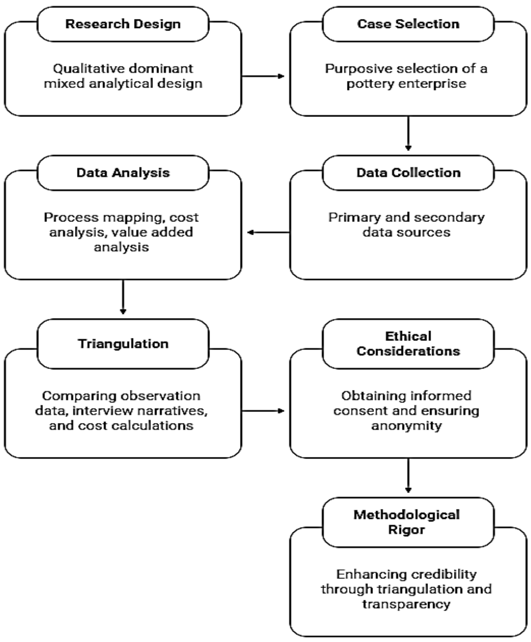
The structure of this study is designed to support a coherent analytical flow. The introduction presents the research context, preliminary literature review, problem formulation, objectives, and scope of the study. The methodology section outlines the research design, study location, data collection techniques, and the procedures used for value added analysis and intervention evaluation. The discussion section elaborates on the main findings, including the mapping of production processes, value added calculations, and performance changes following the interventions. The limitations and future studies section examine the theoretical and practical implications of the findings and situates them within the relevant literature. Finally, the conclusion summarizes the study's contributions, acknowledges its limitations, and offers recommendations for future research.

Methods

Research Design

This study employs a qualitative-dominant mixed analytical design with an embedded quantitative component, using a single case study approach. The case study design enables an in-depth examination of production processes, cost structures, and value-creation mechanisms within a real operational environment. This approach is particularly suitable for micro-scale traditional manufacturing systems, where production activities are highly contextual, informally organized, and deeply embedded in local practices. The research is explanatory in orientation, seeking to understand how value is generated along the production process and how specific process-level interventions influence value added. To capture both structural and numerical dimensions of value creation, the analytical framework integrates production-oriented value chain analysis with quantitative value-added calculation (Figure 1).

Figure 1. Research process sequence



Context and case selection

The empirical setting is a traditional pottery enterprise located within a long-established pottery cluster in Indonesia. The enterprise operates as a micro-scale manufacturing unit characterized by manual production techniques, a single primary artisan, and minimal formal management structure. Case selection followed three criteria. First, the enterprise represents a typical traditional pottery production system reliant on localized raw materials and artisanal knowledge. Second, it has recently experienced constraints related to raw-material scarcity, production inefficiency, and declining economic returns. Third, the enterprise granted full access to production activities, cost information, and process documentation, enabling comprehensive data collection.

Data sources

To ensure analytical robustness and triangulation, the study draws on both primary and secondary data. Primary data constitute the core dataset and include production-time observations, cost records, process-flow documentation, and semi-structured interviews (Aceh, Indonesia). Secondary data consist of policy documents, industry reports, and statistical information related to small-scale manufacturing and traditional industries. These sources were used to contextualize the empirical findings rather than to generate primary measurements.

Data collection

Primary data were collected through direct observation, in-depth interviews, and document examination. Participant observation was conducted across multiple production cycles to capture detailed information on each stage of the pottery production process. Observations focused on task sequencing, tool usage, material flow, process duration, and defect occurrence. Each activity was observed repeatedly to verify consistency and reduce observer bias.

Semi-structured interviews were conducted with the primary artisan and a local intermediary involved in product distribution. Interview topics included production decision-making, cost considerations, perceived constraints, and experiences with previous process changes. An interview guide ensured thematic consistency while allowing respondents to elaborate on issues they considered important.

Document examination involved reviewing production notes, informal sales records, and expenditure lists maintained by the artisan. These documents provided essential information for cost estimation and validation of observed practices. Secondary data were obtained from government publications, industry reports, and scholarly literature on traditional manufacturing, value chain analysis, and micro-enterprise development.

Instruments

Several instruments supported systematic data collection. An observation checklist was developed to record production activities, required inputs, tools used, processing time, and output quantities at each stage. This checklist ensured consistency across observation sessions. A cost-recording template captured input costs, including raw materials, auxiliary materials, fuel, transportation, and tool depreciation, recorded annually and allocated proportionally to production cycles. An interview guide containing open-ended questions explored production routines, bottlenecks, and value-creation strategies. The guide was reviewed for clarity and relevance prior to field deployment.

Procedures

Data collection proceeded in several stages. First, a preliminary visit familiarized the researchers with the production environment and established rapport with participants. Initial observations were conducted and the scope of data access was confirmed. Second, detailed production observations were carried out across complete production cycles, from raw-material preparation to final product storage. Time measurements were recorded using direct timing techniques, while qualitative notes documented process variations and decision-making patterns.

Third, interviews were conducted following observation sessions to clarify observed practices and capture contextual explanations. Interviews were audio-recorded with consent and transcribed verbatim. Fourth, cost data were compiled using production records and participant recall. When numerical records were incomplete, costs were cross-checked through repeated questioning and comparison with local market prices to ensure reasonable accuracy.

Measurement and operationalization

Value chain activities were identified and categorized using Porter's generic value chain framework, with emphasis on primary production activities such as inbound logistics, operations, and outbound logistics. Supporting activities were considered contextually but analyzed primarily through their indirect influence on production efficiency.

Value added was operationalized as the difference between output value and total input cost for each production cycle. Output value was calculated based on actual selling prices and production volume. Input costs included raw materials, consumables, fuel, transportation, and estimated depreciation of production tools. Production time was measured in hours for each activity to identify time-intensive stages and potential efficiency improvements. Quality outcomes were assessed qualitatively through observation of defect rates and product acceptability.

Data analysis

Data analysis proceeded through several interconnected stages. First, process mapping was used to visualize the sequence of production activities and identify structural relationships among tasks, forming the basis for value chain decomposition. Second, cost analysis allocated input costs to corresponding production activities, enabling identification of cost drivers and high-cost stages. Third, value-added analysis compared total input costs and output values before and after proposed process interventions, allowing assessment of the economic impact of production redesign.

Fourth, qualitative interview data were analyzed using thematic analysis. Transcripts were coded to identify recurring themes related to production constraints, adaptation strategies, and perceptions of value. These qualitative insights were used to interpret quantitative findings and strengthen explanatory depth. Finally, triangulation was achieved by comparing observation data, interview narratives, and cost calculations, enhancing the validity of findings and reducing reliance on any single data source.

Ethical considerations were addressed through informed consent, voluntary participation, and anonymity in reporting. Methodological rigor was strengthened through triangulation, repeated observations, and transparent documentation of analytical procedures, contributing to the credibility, dependability, and transferability of the findings.

Findings

Structure of the production process

The production system is organized as a sequential and highly centralized workflow conducted entirely by a single artisan. The monthly production cycle comprises six main activities: raw-material preparation, forming, natural drying through air circulation, surface finishing and coloring, sun drying, and open firing. Each cycle yields approximately 150 units, consisting of 100 small pots and 50 medium-sized pots.

Figure 1: Community-based pottery products (source: author's documentary)

Time-measurement data reveal substantial variation across activities. Natural drying is the most time-consuming stage, requiring approximately 144 hours per cycle, nearly half of the total production duration. Forming and finishing activities collectively require around 150 hours, while sun drying and firing are comparatively brief, averaging one to two hours each. Observation notes indicate that prolonged drying increases exposure to weather fluctuations and accidental damage, contributing to product defects and production delays.

Material-usage data show reliance on externally sourced clay and sand, with annual consumption of roughly 1,200 kilograms of clay and 1,000 kilograms of sand. Declining local availability has eliminated access to nearby clay sources, increasing dependence on external suppliers and transportation.

Cost-structure analysis identifies total annual production costs of IDR 4,500,000. Raw materials and firing inputs constitute the dominant cost components. Fuel materials used during open firing account for IDR 2,700,000 annually (60% of total costs), while transportation contributes IDR 800,000 per year. Other stages, such as forming and finishing, incur no direct monetary expenses, as tools are self-made and labor is unpaid family labor.

Table 1 summarize the structure of production process and expenditure incurred by earthenware artisans during the production process in Aceh community-based pottery smallholders, covering both equipment-related and material-related costs.

As the artisan explained, “Before, clay could be taken nearby. Now we must buy and bring it by truck, which increases costs and risk.”

Table 1: Production process and cost structure (source: author’s observation)

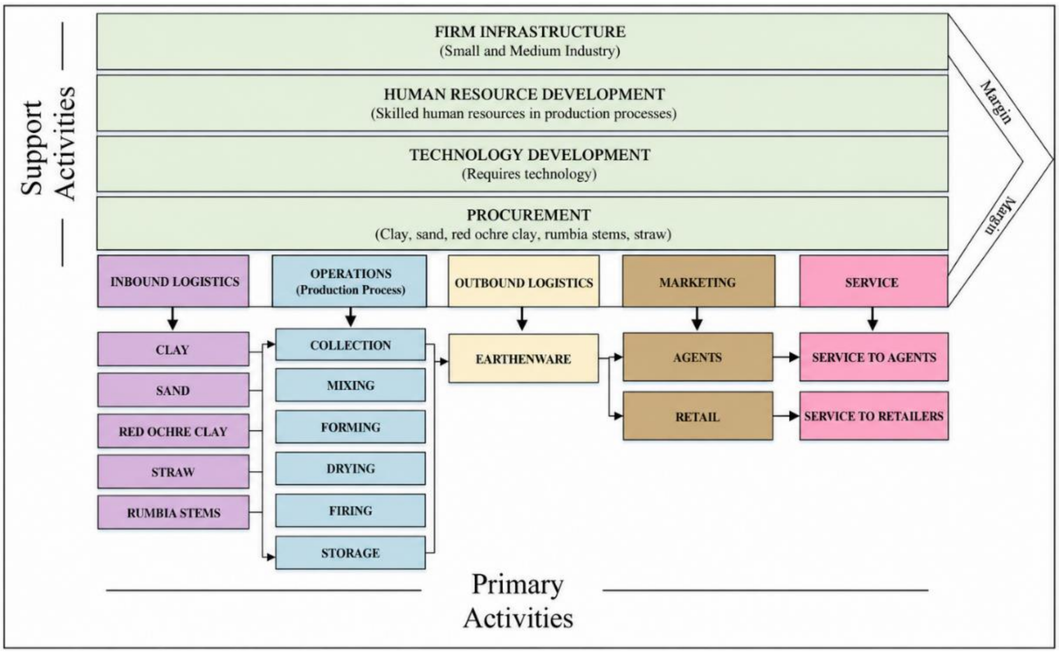
No	Activity	Equipment/tools			Materials			Time (hrs)
		Item	Qty	Cost (IDR)	Item	Qty (kg)	Cost (IDR)	
1	Mixing	Manual method	-	-	Sand	1,000	500,000	2
					Clay	2,000	500,000	
2	Shaping/ forming	*Para*/mold	2	-	-	-	-	75
		Sheel	1	-	-	-	-	
3	Drying (air-drying)	Wooden boards	2	-	-	-	-	144
		Plastic sheets	2	-	-	-	-	
4	Coloring and smoothing	Stone	1	-	-	-	-	75
5	Drying rack (sun-drying)	Tarpaulin	2	-	Clay	1,200	-	1
		Wooden boards	2	-				
6	Firing	Zinc sheets	-	-	Rumbia stems		1,800,000	1
		Wooden blocks	-	-	coconut midrib	900	600,000	
		Defective earthenware	-	-	straw	1	300,000	
7	Transportation	Truck	1	500,000	-	-	-	-
		Pick up car	1	300,000	-	-	-	
Total		**-**	**-**	**800,000**	**-**	**-**	**3,700,000**	**-**

Value chain configuration

Figure 2 illustrates the value chain of earthenware production, which consists of primary activities and support activities. Mapping production activities within a value-chain framework demonstrates that value creation is concentrated almost entirely in operational activities. Supporting functions such as procurement planning, accounting, and technology development are either absent or conducted informally. The enterprise operates without written procedures, production scheduling, or financial separation between household and business expenditures. This configuration reflects a highly personalized production system in which artisanal skill substitutes for formal organizational structures.

Additionally, the value chain shows that earthenware production is strongly dependent on the availability of local raw materials, skilled labor, traditional production processes, and distribution networks through agents and retailers. The findings also indicate that improvements in technology, human resource capacity, and procurement management may enhance the efficiency and competitiveness of earthenware-based small and medium enterprises.

Figure 2: Porter's generic value chain of the community-based pottery smallholder production



Analysis of activities and value added

Although the cost structure shown in Table 1 appears low, it masks hidden costs associated with labor intensity and prolonged production time. The absence of labor valuation leads to underestimation of real production expenses and constrains accurate pricing decisions.

As the artisan noted, "There is no fixed amount to save for production. When there is money, it is used for daily needs first."

This pattern underscores structural vulnerability: value creation occurs primarily at the point of sale rather than through efficiency gains, making economic sustainability dependent on continuous labor input rather than productivity improvement.

Table 2 underscores the proposed technology and equipment recommended to improve the pottery production process. Technological upgrading is an important strategy for improving the competitiveness of earthenware production. The adoption of simple supporting tools, combined with more advanced firing technology, can strengthen product quality, reduce production risks, and support the development of earthenware-based small and medium enterprises.

Table 2: Proposed technology for the pottery production process

No	Technology	Proposed value added	Price (IDR)
1	Para-para/mold	Improve the uniformity of product shape and reduce reliance on fully manual forming methods.	460,000
2	Modelling tools	Improve product aesthetics and higher finishing quality.	72,500
3	Firing kiln	Improve temperature control, reduce product defects, enhance product durability, and increase overall production efficiency compared with traditional firing methods.	45,120,000

Outcomes of process-level interventions

The introduction of targeted process improvements produces notable changes in value-creation outcomes. The use of improved forming molds and modeling tools reduces repetitive shaping and surface correction, resulting in more uniform product dimensions and shorter handling time. Observational data show that these tools eliminate repeated drying and reshaping stages, thereby reducing overall production time.

The proposed adoption of a controlled firing kiln represents the most transformative intervention. Although it substantially increases capital and operational costs, the kiln reduces defects caused by uneven heat exposure and incomplete firing. Observations confirm that open firing frequently results in partial cracking or surface damage, requiring the production of surplus units to meet orders.

Following implementation of the interventions, total annual production costs increase from IDR 4,500,000 to IDR 47,452,500, primarily due to kiln investment. Table 3 shows the difference of cost affected before and after the proposed value added in the community-based pottery value chain.

Table 3: Value added before and after value chain implementation

No	Activity	Value added (IDR)	
		Before implementation	**After implementation**
1	Mixing	1,000,000	1,000,000
2	Forming/shaping	-	532,500
3	Drying (air-drying)	-	-
4	Coloring and Smoothing	-	-
5	Drying (sun-drying)	-	-
6	Firing	2,700,000	45,120,000
7	Transportation	800,000	800,000
	Total	**4,500,000**	**47,452,500**

If the total annual production of the pottery is 1,800 units and the expected profit is assumed to be 70% of the capital, the cost of goods per unit is calculated as follows:

Cost of goods per unit = Total production cost / Total production output
= IDR 47,452,500 / 1,800 units
= IDR 26,362.50 per unit

Next is calculating the proposed selling price as follows:

Selling price per unit = Production cost per unit + Expected profit
= IDR 26,362.50 + (IDR 26,362.50 × 70%)
= IDR 26,362.50 + IDR 18,453.75
= IDR 44,816.25 per unit

The maximum annual revenue, assuming that all 1,800 units of pottery are sold, is calculated as follows:

Annual revenue = Selling price per unit × Total units sold
= IDR 44,816.25 × 1,800 units
= IDR 80,669,250T

Output value rises significantly to IDR 80,669,250 per year, represents total sales income before deducting production costs. The resulting annual value added reaches IDR 33,216,750 following below calculation:

Annual profit = Annual revenue - Total production cost
= IDR 80,669,250 – IDR 47,452,500
= IDR 33,216,750.

To determine the value added obtained by artisans in each production cycle, the value added per production cycle was calculated as follows:

Value added per production cycle = Annual value added / 12 months
= IDR 33,216,750 / 12 = IDR 2,768,062.50

On a per-cycle basis, value added increases to IDR 2,768,062.50, an improvement of approximately 94% compared to baseline conditions. This demonstrates that value creation can be substantially enhanced when production efficiency and quality consistency are improved through process redesign rather than through increased labor input. Interview responses indicate that technological acceptance is closely tied to maintaining the traditional aesthetic of the products.

As one respondent emphasized, “Customers like the traditional look. Tools are acceptable as long as the results do not look modern.”

This suggests that production improvements can coexist with cultural authenticity when interventions are carefully selected and aligned with artisanal identity.

Discussion

The findings of this study reinforce the broader argument that value creation in traditional manufacturing systems is shaped primarily by production process configuration rather than by market access alone. This aligns with a growing body of literature showing that value chain analysis is increasingly used to diagnose inefficiencies in small scale and artisanal industries (Mangubhai et al., 2024; Chadda et al., 2023; Utomo et al., 2021). Prior research suggests that artisanal producers often remain locked in low value trajectories because process inefficiencies become normalized as cultural practices (Chadda et al., 2023).

However, empirical evidence on how fine-grained production activities contribute to value added in traditional pottery enterprises remains limited, and existing studies offer mixed conclusions on whether productivity improvements can be achieved without compromising artisanal authenticity (Singhvi et al., 2024; Utomo et al., 2021; Luvhengo et al., 2018). This study contributes to this debate by providing detailed evidence on the relationship between production efficiency, process time allocation, and value accumulation in a micro scale pottery enterprise.

The first research question examined how value is distributed across activities within the pottery production system. The results show that operational activities dominate the value chain, while supporting functions such as procurement planning, financial management, and technology development are largely absent. This pattern is consistent with previous findings that micro scale artisanal enterprises tend to rely on personalized, skill-based production systems rather than formal organizational structures (Aguilar et al., 2024; Utomo et al., 2021; Liverpool Tasie et al., 2020). The study also confirms that value creation is weakly embedded in production activities and instead depends heavily on extended labor input. Natural drying alone accounts for approximately 144 hours per cycle, illustrating how non transformative activities exert disproportionate influence on total production time.

Baseline value added per cycle is relatively low when compared to the labor and time invested. This supports earlier arguments that artisanal enterprises often under price their products due to incomplete cost accounting and the absence of labor valuation (Javed et al., 2025; Widhajati et al., 2024; Bigambo et al., 2023). The limited reinvestment capacity observed in this study further reflects structural vulnerability: income is absorbed by household needs, leaving insufficient capital for upgrading. These findings highlight the importance of understanding how production constraints shape economic outcomes in traditional manufacturing systems.

The second and third research questions focused on identifying bottlenecks and assessing the impact of targeted production interventions. The results demonstrate that small scale, context appropriate improvements can yield substantial value gains. The introduction of improved forming moulds and modelling tools reduced repetitive shaping and surface correction, while the adoption of a controlled firing kiln significantly reduced defect rates. These findings align with studies showing that operational upgrading can generate higher returns than market-oriented interventions alone (Javed et al., 2025; Bigambo et al., 2023; Anindita et al., 2019).

The most striking result is the near doubling of value added from IDR 1,425,000 to IDR 2,768,062.50 per cycle, following process improvements. This suggests that traditional manufacturing systems possess latent productivity potential that can be unlocked through targeted interventions. Importantly, value enhancement was achieved without altering the traditional aesthetic of the products, contradicting claims that artisanal authenticity is inherently incompatible with production upgrading (Zou, 2024; Aini et al., 2023; Tripathi et al., 2021). This unexpected outcome indicates that cultural identity and technological adaptation need not be mutually exclusive.

A key insight emerging from the analysis is that quality consistency contributes more to value creation than time reduction alone. Controlled firing reduced hidden production losses by minimizing defects, lowering the need for surplus production, and increasing predictability of output. This predictability, in turn, improved pricing accuracy and strengthened the artisan's confidence in meeting orders. These findings suggest that stabilizing production processes may be more critical for value creation than increasing production volume.

The results also indicate that artisans are willing to adopt new tools and technologies when these align with existing skill practices and do not compromise product identity. This challenges assumptions that artisanal producers inherently resist technological change and suggests that cultural authenticity and process upgrading can coexist when interventions are carefully selected. A general hypothesis emerging from this finding is that technological acceptance in artisanal industries is contingent on perceived compatibility with established craft norms.

The findings corroborate earlier research demonstrating that production efficiency is positively associated with value added in small manufacturing enterprises and support the argument that operational upgrading plays a central role in value chain performance. However, this study diverges from literature suggesting that artisanal industries are structurally resistant to productivity improvement or that modernization inevitably erodes cultural value. Instead, the results show that modest, well aligned interventions can enhance value creation without diminishing traditional characteristics.

Several limitations should be acknowledged. First, production estimates rely on participant recall, introducing potential bias. Second, cost figures may not fully capture informal expenditures or opportunity costs. These limitations suggest caution in interpreting the findings as representative of all pottery clusters and highlight the need for more systematic time and motion studies.

Despite these constraints, the findings offer important implications. They suggest that value added in traditional manufacturing is highly sensitive to quality consistency and process stabilization. Production upgrading may therefore be a prerequisite for successful market upgrading. The results also highlight the need for development programs to integrate operations management principles into support strategies for heritage industries. Strengthening production diagnostics and reducing defect rates may help prevent enterprise exit in traditional sectors.

Finally, the study demonstrates that traditional production systems retain underutilized value potential and that detailed process analysis can reveal practical upgrading pathways. Future research should examine multiple cases across different clusters, incorporate longer observation periods, and explore how social, cultural, and spatial factors mediate the adoption of production improvements.

Conclusion

This study sets out to examine value creation within a traditional pottery production system by applying a production-oriented value chain framework. The research aimed to map production activities at a granular level, quantify value added across stages, and assess how targeted process level interventions influence productivity and economic outcomes. Through this approach, the study sought to clarify whether low value added in traditional manufacturing is an inherent feature of artisanal production or the result of modifiable structural constraints.

The findings demonstrate that baseline value creation is limited not because of artisanal identity, but because of inefficiencies embedded in process design, time allocation, and quality control. Under initial conditions, value creation was weakly linked to production efficiency and heavily dependent on extended labor input, resulting in low reinvestment capacity and heightened economic vulnerability. The study also shows that targeted, context appropriate interventions can substantially enhance value added without altering the traditional aesthetic of the product, particularly those improving quality consistency and reducing defect rates. The near doubling of value added per production cycle following selective tool and process improvements illustrates the latent productivity potential within traditional manufacturing systems.

These findings carry several implications for the broader field of value chain research. Theoretically, the study reinforces the importance of production level granularity in understanding value creation within micro scale enterprises. It supports the argument that operational dynamics, rather than market access alone, shape value outcomes and challenges assumptions that artisanal authenticity is incompatible with production improvement.

Methodologically, the integration of value chain analysis with detailed time and cost assessment demonstrates a useful approach for studying informal manufacturing contexts where standardized data are often unavailable.

The study's contributions should be interpreted alongside its limitations. Production estimates relied partly on participant recall, which may introduce bias, and cost calculations may not fully capture informal expenditures or opportunity costs. While these limitations constrain the generalizability of the findings, they do not diminish the study's core contribution: demonstrating that modest, well aligned interventions can meaningfully enhance value creation in traditional manufacturing systems. Acknowledging these constraints also highlights the need for more systematic and longitudinal data collection in future research.

Several avenues for further investigation emerge from this study. Future work should examine multiple pottery clusters or other traditional craft sectors to assess the transferability of the findings. Longer observation periods would allow researchers to evaluate the durability of process improvements and their interaction with seasonal production cycles. Additional research could also explore how social norms, skill transmission, and inter household labor arrangements influence the adoption of production technologies.

Finally, the findings offer practical and policy relevant recommendations. Support programs for traditional industries should prioritize production diagnostics, quality stabilization, and defect reduction alongside marketing initiatives. Investments in context appropriate tools and controlled technologies may yield greater economic returns than strategies focused solely on product promotion or market expansion. For artisans, the results underscore the value of modest production redesign in strengthening income stability and long-term viability. For policymakers, the study highlights the importance of integrating operations management principles into heritage industry development strategies to ensure that traditional manufacturing systems remain economically resilient in changing environments.

Ethics approval

The study was conducted in compliance with the Declaration of Helsinki.

Competing interests

The authors declared no potential conflicts of interest with respect to the activities, authorship, and/or publication of this article.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

During the preparation of this manuscript, the authors used Copilot and Grammarly to assist with language editing and readability only, when necessary. The tool was not used to generate scientific content or analysis. We confirm that all AI-assisted processes were critically reviewed by the authors to ensure the integrity and reliability of the results. The final decisions and interpretations presented in this article were solely made by the authors.

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