Adoption of Production Tools in Agro-allied Artisanal Metal Fabrication in Southwestern Nigeria: Implications for Access to an Essential Tools Infrastructure

Waheed O. Oladele[1], Olawale O. Adejuwon[2]
[1]Department of Management Technology, Lagos State University, Ojo, Nigeria
[2]African Institute for Science Policy and Innovation, Obafemi Awolowo University, Ile-Ife, Nigeria.

ABSTRACT

The local production of industrial machinery is vital for industrialization and a diversified economy. The artisanal metal fabrication sector in Nigeria significantly contributes machinery for small-scale value-added activities in food processing. However, many of these machines appear crude and inefficient. Access to modern tools is essential for creating complex and precise machinery. This study, conducted among 326 agro-allied metal fabricators in Southwestern Nigeria, examined the use and factors influencing the access to tools during the production and finishing stages of machine fabrication to inform public mechanisms that may enable artisans more access to essential tools. Results revealed that 98.8%, 99.4%, 99.4%, 98.2%, 85.3%, and 67.3% of the artisans own essential tools for welding, cutting, grinding, drilling, bending, and folding metal, respectively. However, milling, tapping, and notching machines are often unavailable, forcing 88.3%, 96.0%, and 100% of the artisans, respectively, to seek the use of these tools where available. Only 1.2% of artisans have a foundry on-site, while 12% possess lathe machines. In the finishing processes, access to tools for hot blackening, anodizing, galvanizing, and sandblasting is severely limited, with only 3.7%, 0.6%, 6.7% and 1.2%, respectively, having access to these tools. These limitations contribute to the crude appearance of the machines. The adoption of tools such as the tapping machine is positively and significantly influenced by age ($r = .18$; $p < .05$), experience in years ($r = .11$; $p < .05$), number of machines fabricated per annum ($r = .12$; $p < .05$) and total initial capital investment ($r = .26$; $p < .05$) among others. These results indicate that costs, the complexity of use of machines and socio-demographic characteristics of the fabricators significantly affect tool accessibility. These findings highlight the urgent need and areas for intervention in tool infrastructure to support the growth of Nigeria's artisanal metal fabrication industry.

KEYWORDS

Production Tools
Agro-allied
Artisanal Metal Fabrication
Tools infrastructure
Nigeria

1. INTRODUCTION

Artisanal metal fabrication industries play a crucial role in the economic development of many countries, providing employment opportunities and contributing to the growth of the manufacturing sector. The industry is especially a vital component of the industrial environment of developing countries with a nascent formalised industrial machinery manufacturing industry (IMMI). The machine manufacturing industry is essential to the success of many other sectors especially in providing machines used in value-adding activities in the agricultural, manufacturing, exploration, automotive, and construction sectors among others. The importance of metal fabrication in economic growth cannot be overstated. It serves as a chain block of infrastructural development, driving economic progress and enhancing technological advancement (Mikell, 2013).

With the high cost of imported and technologically advanced machines, most developing countries have turned to artisanal metal fabricators to provide machines used in value-adding manufacturing activities and because of this, the artisanal part of this industry has experienced rapid growth. The artisanal metal fabrication sector is growing quickly in Nigeria and is playing a crucial role in shaping the country's future. The sector is creating jobs, improving productivity and fostering innovation through practical application of skills, learning-by-doing and interacting with other fabricators and users of their machines (Jensen *et al.*, 2007; Adejuwon, 2019)

An artisanal metal fabricator is a skilled manual worker who crafts and/or fabricates machines and equipment by employing procedures such as cutting, bending, and assembling metal structures (Eneh *et al.*, 2011). In Nigeria, most of these artisans operate mainly in the informal sector of the economy and acquire skills primarily through apprenticeship and learning-by-doing. Artisans who are able to master these skills are able to make high-quality metal items that are in demand both locally and also in the low-technology demanding neighbouring countries such as the Republic of Benin and Ghana (Adejuwon, 2019).

However, the artisanal metal fabrication sector faces numerous challenges that hinder productivity, efficiency, and overall performance resulting in the production of inefficient and crude machines that break down frequently. Literature reveals that the problems confronting the local artisanal metal fabricating industry in Nigeria include erratic power supply, high cost of raw materials, low level of automation, noise pollution, occupational hazards, instability in government policies, marketability of products, and a general bias for imported machines by large-scale companies (Omobowale, 2010; Arinze, 2023). Other studies report that limited access to scientific modes of learning, access to formal knowledge infrastructure (especially for engineering designs) and linkages to a technical know-how of metal fabrication techniques are major challenges in developing this industry (Adejuwon, 2018; Obi, 2022).

Eneh (2010) reports that one of the major challenges facing artisanal metal fabrication industries is the lack of modern tools, infrastructure, and inadequate workshop spaces which lead to decreased productivity and poor product quality. Yildirim *et al.* (2020) infer that without access to modern and appropriate tools, the fabrication of complex precision machines will continue to be a challenge in machine production. The artisanal metal fabrication sector may however play a role in the industrialisation of Nigeria's economy with apt public

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intervention for providing the necessary tools and infrastructure for the artisanal metal fabrication sector. However, studies to provide information on the influence of particular tools and infrastructure on specific metal fabrication processes to guide policy intervention are scarce. This study therefore provides information on the availability of specific tools and infrastructure on particular work processes and their likely impact on final machine quality. The study is conducted in the Agro-allied metal fabrication hubs in Southwestern Nigeria due to the prevalence of artisanal metal fabrication activities in the region. It focuses on specific stages of machine construction and finishing. The next section deals with the literature review which reports metal fabrication processes and tools that may be used to carry out the processes. This is followed by the methodology, results and discussion and the concluding sections.

2. Literature Review

This section reviews the typical processes carried out in the fabrication of machines and machine parts and the types of tools required to carry out the tasks.

2.1. Common metal fabrication processes

The machine fabrication process involves various unit operations. The most common are casting, cutting, folding, forging, punching, welding and turning. These described below.

Casting which has been practiced for over 6,000 years (Karbasuab and Tekkaya, 2010) involves compressing liquefied metal into a particular shape or mould and cooling it to become hardened into the desired shape. Casting can also be an art where liquefied metal is emptied into a special pattern known as mould or die and then left for some time to cool. This results in a hardened metal in its desired shape. When mass production of metal parts or components is to be processed, casting is the best method to reproduce identical metal products in high volumes using the same mould. However, its dependence on high initial investments and susceptibility to material-specific limitations restricts its applicability in low-budget or experimental manufacturing scenarios (Brad, 2007).

Another very important process is cutting, which involves dividing a metal workpiece into smaller sections using various tools (Degarmo *et al.*, 2003). It utilizes cutting blades which may be straight or rotary to cut different materials into required sizes and shapes, while the modern method employs automatic sawing. Examples include laser-cutting, water jet-cutting, power scissors, and plasma arc cutting. Another notable cutting process tool is die cutting which uses dies to slice metal (Degarmo *et al*, 2003). Metal cutting metal involves many technologies which include manual, machine, welding/soldering and chemical technologies. These cutting processes have evolved to accommodate a range of materials but cost considerations for advanced technologies limit accessibility in certain markets (Hyunok, 2008).

Machine fabrication especially involves bending metal to achieve a specific shape. This process, referred to as folding, is commonly used in industries like construction and consumer appliances. It involves a process in which the metal has been hammered till it curves or by employing a machine which is called a folding machine (Brad, 2007). Folding is highly effective for creating standardized shapes in thin to medium-thickness metals, such as in construction or consumer appliances. However, its restricted application to specific metal types and thicknesses limits its broader industrial utility. The method is also energy-intensive and often requires substantial equipment investments, making it more suitable for large-scale production (Hesse, 2007).

Another method of achieving desired shapes is called forging. This is the process of shaping metal with a compressive force. The process can be done in numerous ways (Brad, 2007). Forging can be categorized based on temperature (cold, warm, and hot). Forging is ideal for producing high-strength components such as tools, automotive parts, and structural elements. Despite its efficiency for these purposes, its high costs and material constraints reduce its feasibility for smaller projects or intricate designs (Hesse, 2007).

The fabrication of machines usually requires making holes in metal usually to accommodate parts such as fasteners or to make indents. This process commonly called punching, involves applying a heavy force with a punching tool to “strike” the metal sheet to indent or shear it from one end to the other (Hellwig and Kolbe, 2012). The punching operation involves creating a pattern of holes in metals and may include number stamps, ribs, louvers, or countersinks in metal components by applying greater force to a tool by striking the metal sheet to create a hole or shear through it. Punching is most advantageous in high-throughput environments such as the production of stamped metal components. Its waste generation and limited flexibility in non-sheet applications pose challenges for resource-conscious operations (Todd *et al.*, 1994; Nneji *et al.*, 2010).

Welding plays a crucial role in metal fabrication. It is a process which involves joining multiple metal pieces into a single structure, ensuring structural integrity and versatility. The diversity of welding techniques, from MIG to ultrasonic welding, ensures adaptability across industries. However, welding requires skilled labour and precise control to avoid defects such as weak joints or warping (Gregory *et al.*, 2008).

Finally, the turning unit operation involves the process of cutting a metal workpiece to produce a cylindrical surface with a one-point turning tool (Razali and Qin, 2013). It is primarily executed on lathe machines, which produce cylindrical components with high precision. Turning is well-suited for manufacturing shafts, bearings, bearing housings and similar components used extensively in agro-allied machinery. Its precision and speed make it a critical process in mass production, though its material waste and shape limitations require complementary processes for broader applications (Brad, 2003).

2.2. Modern tools and equipment used in metal fabrication

Machine tools are used in the process of treatment of machining metal or some other fixed substance, typically by cutting, drilling, grating, and trimming among other modifications (Zelinski, 2013). Various tools are used for the types of unit operations mentioned in the preceding section. The source of power of the machine tools is usually electrical energy which is converted to mechanical energy used in driving the machine in carrying out the activities that transform metal to the various required shapes and sizes that make up the structure of machines (Nneji *et al.*, 2010; Bamiro *et al.*, 2015). Examples are the Lathe machine which is used for turning, facing, boring and threading metal pieces among others. It is also used in the design of several hard substances (Albert, 2011). The main function of the lathe is the fabrication of metal objects to a specified size and shape by removing or chopping parts of the work piece. Automated versions mitigate time inefficiencies but require higher investment and maintenance (Groover, 2007). Another important tool is the Power hacksaw machine which is mainly used for cutting metal workpieces into various sizes to be employed in the production of items. The hacksaw excels in durability and ease of use. However, their coarse cutting limits the precision required in delicate or intricate projects (Oberg *et al.*, 2004).

The Grinding machine is another tool, which most fabricators must possess. This is a machine tool employed for sharpening tools, and breaking up parts of a metal workpiece. Its primary function is workpiece finishing which entails bringing out high surface quality as well as the desired shape and dimension. While indispensable for surface finishing, grinding machines can be time-consuming and energy-intensive, particularly for high-volume production (Nneji *et al.*, 2010 and Bamiro *et al.*, 2015).

Another cutting tool is the Shaping machine which is used for cutting key-ways and slots in the workpiece. It is capable of being employed to attain facing on a sheet of metal. This tool provides flexibility in achieving complex designs but often requires skilled operation and can be less effective for bulk production (Bamiro *et al.*, 2015). For fitting boring holes in a metal workpiece, drilling machines are the most versatile. The art of creating a hole in a metal workpiece is referred to as drilling (Bamiro *et al.*, 2015; Nwosu *et al.*, 2010). Drilling machines are also crucial for creating threads. They are efficient but may require auxiliary processes to address design complexities or improve surface finishing (Bamiro *et al.*, 2015).

Another tool is the milling machine which possesses a spinning multi-toothed cutter fed into the moving metal workpiece that removes metal on the workpiece. While instrumental in shaping robust components, milling machines are capital-intensive and less adaptable to smaller or intricate designs (Nwosu *et al.*, 2015). For the folding unit operation, the metal sheet is typically folded using a folding machine. Either a buckle or knife is applicable for metal folding. There are three main types of folding machines which includes buckler, knife, and paper folder (Bamiro *et al.*, 2015)

The Forge is another essential type of tool and it is used in metalworking to modify metal into various desired shapes (Rattan, 2009). Forging is a process of shaping metal by subjecting it to heat or a high compressive force. The forging process is based on the type of temperature required in the process. It can be cold, warm, and hot forging (Bamiro *et al.*, 2015).

Cutting threads in holes to accommodate fasteners is the work of Tapping machines. This kind of machine is typically used in generating internal and external threads in various materials, such as metal, wood or plastics (Hilsher, 2020). The process of tapping involves cutting threads inside a pre-drilled hole. (Bhavya machine, 2024). Usually, the tapping machine is applicable to various industries such as fabrication, automotive, and construction companies, where their production techniques or methods solely depend on accurate and effective thread forming. They are mainly used to form internal threads in components such as, bolts, nuts, pipes, and fittings (Albert, 2011). Another cutting tool is the Notching machine which is a specialized appliance used for cutting sheet metal, metal plates or tubes into suitable sizes and shapes by removing a portion of the metal, forming a notch or a curved cut. It is also used to remove the outer edge of materials with the aid of a punch press (Albert, 2011). This specialized tool is highly effective for niche applications, such as sheet metal shaping and casting, but their limited use and high operational costs restrict their broader utility (Williambeke, 2020).

The casting process is normally achieved using a Foundry. Metals are cast into shapes by melting them into a liquid (Hilsher, 2020). The liquid is then poured into a mould and when the metal set is cooled, it is removed from the mould to form the pre-determined shape. Aluminium and cast iron are two of the most usually treated metals (American Foundry Society - AFS, 2022). Foundry machines are highly applicable to various industries such as fabrication, manufacturing, construction, and automotive among others (Groover, 2007).

The foregoing describes some of the unit operations usually carried out in the manufacture of machines and machine parts and some of the tools required to carry them out. It is assumed that a proper infrastructure to deliver efficient and precision machines will comprise these tools. This study proceeds to assess the factors influencing availability of these tools and infrastructure and their impact on particular work processes and final machine quality

3. Methodology

The study was conducted in three purposively selected states in Nigeria namely; Edo, Ogun and Oyo. These states were purposively selected because they are major artisanal metal fabrication hubs in Nigeria. The field study was conducted between March and July, 2023. A multi-stage sampling technique was used to select the respondents for the study. In the first stage, towns known for the prevalence of artisanal fabricators were selected from the States namely; Abeokuta, Ibadan, and Benin located in Ogun, Oyo, and Edo States respectively. Clusters of artisanal metal fabricators were purposively selected from each of the towns. The clusters were identified by a snow-ball sampling technique. The Cochran formula was used to determine the sample size for the study (Cochran, 1977). At 95% confidence level and 5% margin of error, 384 agro-allied artisanal metal fabricators were selected as respondents for the study. The study utilized primary data. This was collected by the use of one set of questionnaire administered on the fabricators and interviews. Interviews based on the questionnaire were conducted with 10% of the respondents. Thirteen respondents for interviews were selected from each State making a total of 39 respondents. Elected representatives of the associations of artisanal fabricators at the clusters were selected as respondents for the interviews. Saturation was reached at the eighth interviewee. Information on the socio-demographic characteristics and business profiles such as age, level of education, years of experience on the job, number of machines fabricated per annum, initial capital outlay and the form of access to the tools for the fabrication process were elicited by the questionnaire. Access was categorized into tools actually owned by the fabricator and by other means. Respondents were asked to indicate types of access on a two-item code owned and other access. Interviews were based on the use and consequences of lack of access to the tools. Copies of the questionnaire were hand delivered and later collected within a week. Interviews were conducted at the point of collection of the questionnaire.

4. Results and Discussion

Three hundred and twenty-six usable copies of the filled questionnaire were retrieved. Table 1 shows the sociodemographic characteristics of the fabricators. The largest proportion (44.2%) of the fabricators were aged 41 years and above, and 1.2% of the respondents were below 18 years of age.

Adejuwon (2014) also reported that the largest proportion (37%) of fabricators were between the ages of 41 and 50 years old. A majority (58.9%) have secondary school certificate as their highest level of education, none held primary school certificates, and doctoral degrees, while about 13% each held certificates from technical schools, National diplomas and HND/Degrees. Adejuwon (2014) however reported that 69% of respondents had primary school education. This implies that people with higher levels of education are going into the fabrication business. About 29% of the fabricators had between 21 to 25 years of experience in the trade. These findings are similar to Owolarafe *et al.* (2023), who also reported that 26.9% of the agro-allied artisanal fabricators had 21-25 years of experience. Adejuwon (2014) however reported 41.6% in this category ten years ago indicating less experienced fabricators in the profession. Furthermore most (80.4%) fabricate above 31 machines per annum. This indicates that most respondents have had a lot of experience in the trade and are suitable respondents for the study.

Table 1 also shows the level of investment of respondents in the business. Majority (94.8%) started their fabrication workshop with an initial capital ranging between ₦100,000.00 and ₦900,000.00. Oyelaran-Oyeyinka (2006) reported that Small and Medium Scale Enterprises (SMEs) in Africa started their business with initial capital of less than ₦1million. Only 5.2% started their businesses with initial capital in excess of N1million. Thus, it can be concluded that the agro-allied metal fabrication business can be classified as small to medium-sized enterprises characterized with low initial capital outlay.

Table 1: Socio-demographic Characteristics of the Fabricators

Characteristics		Frequency	%
Age	Below 18 yrs.	4	1.2%
	19 - 30 yrs.	51	15.6%
	31 - 40 yrs.	127	39.0%
	41 years and above	144	44.2%
	Total	326	100%
Educational level	Primary school certificate	0	0.0%
	Secondary school certificate	192	58.9%
	Technical certificate	43	13.2%
	National diploma	44	13.5%
	HND/Degree	45	13.8%
	Masters	2	0.6%
	Doctoral degree	0	0.0%
	Other certificates	0	0.0%
	Total	326	100%
Years of Experience in metal fabrication	Below 5 yrs.	28	8.6%
	6 - 10 yrs.	63	19.3%
	11 - 15 yrs.	43	13.2%
	16 - 29 yrs.	53	16.3%
	21 -25 yrs.	93	28.5%
	26 - 30 yrs.	16	4.9%
	31 - 35 yrs.	10	3.1%
	36 - 40 yrs.	8	2.5%
	Above 41 yrs.	12	3.7%
	Total	326	100%
Total number of machines fabricated per annum	s1 - 10 per annum	2	0.6%
	11 - 20 per annum	39	12.0%
	21 - 30 per annum	23	7.1%
	31 and above per annum	262	80.4%
	Total	326	100%
Total investment in Naira	100,000 – 900,000	309	94.8
	1m – 1.9m	17	5.2
	2m – 2.9m	0	
	3m – 3.9m	0	
	4m – 4.9m	0	
	Above 4million	0	

Table 2 shows the results of a survey that asked fabricators to indicate their access to various machines or tools for their fabrication activities. It also, provides an insight into the access and availability of various machines or tools for the fabricators, and how they perceive and evaluate their needs and preferences for their fabrication activities. It also reveals some potential gaps or opportunities for improvement in terms of enhancing or diversifying their access to various machines or tools, especially those related to milling, lathe, notching, and foundry.

The table reveals that the most commonly owned machines or tools by the fabricators are the welding machine, the cutting machine, and the grinding machine (shown being used in plate 1), with 98.8%, 99.4%, and 99.4% of the fabricators respectively reporting that they own these machines or tools in their workshops. This indicates a very high level of ownership and suggests that these machines or tools are very essential and basic for fabrication activities, and that most of the fabricators have invested in acquiring them. Fabricator **01** mentioned that:

> *"These are machines necessary in carrying out fabrication of machines. All fabricators must acquire it"*

Others are the drilling and the bending machines, which are owned by 98.2% and 85.3% of the fabricators respectively. This also suggests that these machines or tools are also very important and useful for the fabrication activities, and that many of the fabricators have invested in acquiring them. Fabricator 02 mentioned that:

> *"I acquired this tool because it is a highly important input in the fabrication process as it shapes metal into the required size and shape."*

Table 2: Access of Fabricators to Machine or Tools

		Frequency	%
Welding machine	Owner	322	98.8
	other access	4	1.2
Milling machine	Owner	38	11.7
	other access	288	88.3
Cutting machine	Owner	322	99.4
	other access	2	0.6
Grinding machine	Owner	324	99.4
	other access	2	0.6
Lathe machine	Owner	13	4.0
	other access	313	96.0
Drilling machine	Owner	320	98.2
	other access	6	1.8
Bending machine	Owner	278	85.3
	other access	48	14.7
Folding machine	Owner	218	67.3
	other access	106	32.7
Tapping machine	Owner	37	11.3
	other access	289	88.7
Notching machine	Owner	0	0.0
	other access	326	100.0
Foundry	Owner	4	1.2
	other access	322	98.8

Furthermore, 67.3% of the fabricators possess the folding machine. However, 88.3%, 88.7%, 100% and 98.8% of the fabricators indicated that they did not own the milling, lathe, tapping and the notching machines respectively. Interviews suggested that these machines or tools are very expensive or difficult to acquire. Interviews also revealed a shortage of precision machinery such as lathe machines which affect the manufacture of precise machine parts. Though these tools are primarily basic and low-cost in highly formalised industrial sectors they are most often customized for multi-functionality due to limited resources and a lack of formalized ownership structures in the local artisanal fabrication sector (Ebhota *et al.*, 2016). Various fabricators (01, 03, 04 and 05 respectively) indicated during interviews that:

> *"I cannot afford the ready-made modern folding machine because it is expensive, but I fabricated the one we are using in the workshop for bending or folding jobs and it is working perfectly* (Shown in Plate 2)"

> *"All categories of the machines used for turning jobs are highly expensive so when I have a job that requires the application of those machines, I do contract it out to machinists or turners"*

> *"The lathe machines available for jobs are old and the parts made on them sometimes lack the precision required for the machine under construction"*

> *"Key-ways usually procured from machinists with lathe machines do not last as they are not accurately made and at times made from cheap material"*

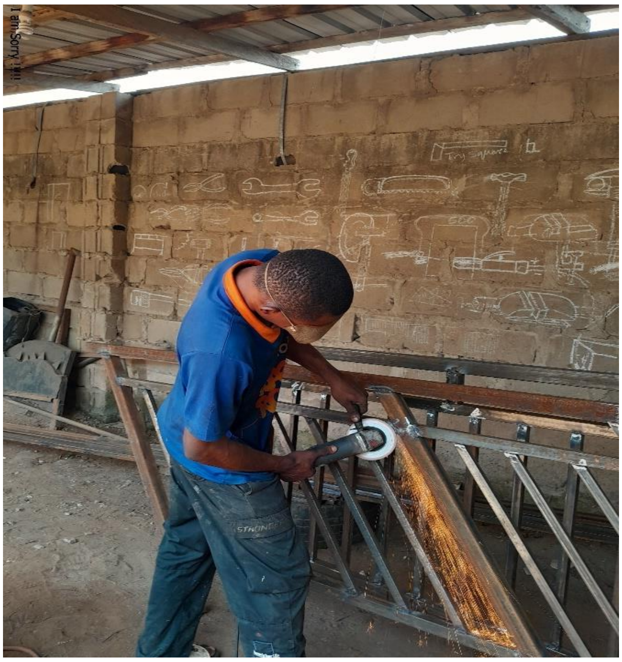

Plate 1: Artisanal Metal Fabricator using Grinding Machine (Source: Sanusi Engineering. Ent. ltd, Ogun State)

Plate 2: Artisanal Metal Fabricator using self-designed bending machine (Source: Soaben Technical Company Ltd, Ogun State)

Table 3 shows the results of a survey that asked fabricators to indicate the availability of various tools for finishing fabricated machine and machine parts. The table reveals that about 97.5% had a metal grinding machine, available in their workshops while 2.5% did not. This machine is used to achieve a smooth even surface to enhance aesthetics of the machine. This suggests that this tool is very essential and basic for the finishing process, and that most of the fabricators have invested in acquiring it.

Another commonly available tool for finishing fabricated machines and machine parts is the metal vibratory finishing machines, with 73.3% of the fabricators reporting that they have this tool, while 26.7% indicated that the machine is not available to them. This tool is also used to remove imperfections to provide a uniform finish. This indicates a high level of availability. This also suggests that this tool is also very important, easily acquired and useful for the finishing process, and that many of the fabricators have invested in acquiring it. Also, 56% of the respondents claimed that they possessed the two-part epoxy equipment, which indicates a moderate level of availability. This is used to deliver a hardener to form a protective layer on the metal to protect the surface from corrosion. This suggests that this equipment is somewhat easy to procure, relevant and helpful for the finishing process, but it may not be as widely available or affordable as the other aforementioned equipment.

Table 3: Available Tools for Finishing Fabricated Machine

		Frequency	%
Hot blackening	Available	12	3.7
	Not available	314	96.3
Metal grinding	Available	318	97.5
	Not available	8	2.5
Metal vibratory finishing	Available	239	73.3
	Not available	87	26.7
Two-part epoxy	Available	193	59.2
	Not available	133	40.8
Anodizing	Available	2	0.6
	Not available	324	99.4
Galvanizing	Available	22	6.7
	Not available	304	93.3
Sand blasting	Available	4	1.2
	Not available	322	98.8

Table 3 also shows that about 96.3, 99.4, 93.3 and 98.8% do not have hot blackening, anodizing, galvanizing and sand blasting machines respectively. These machines are used in the finishing of metal fabricated machine or parts and protecting the surfaces from wear, corrosion and insulation and also improving aesthetics. This suggests that this equipment is not used in the finishing process of many machines. They are however special equipment or tools that occasionally involve complex and hazardous chemical processes. Adejuwon *et al.* (2014) also reported that the informal nature of agro-allied enterprises impedes access to financial support, modern training, and advanced tools. Interviews with fabricator 01, 03, and 06 revealed that:

> *"I will rather go the market and get the suitable ready-made finished metal than deploying any of these machines"*

> *"If corrosion resistance is required, I anodize metal by applying an aluminium oxide layer manually on the surface part of aluminium "*

> *"Because the process involved in deploying these machines is complex, I go for ready-made finished materials if provided for in the order"*

These responses suggest that machines used in the finishing stages of machine production were scarce in the study area and may be the reason why some of these machines appear crude and lack any form of aesthetics. In addition, the decision of some of the artisans to patronise imported ready-made parts shows some lack of self-sufficiency in machine production in the sector.

Table 4 shows the relationship between the socio-demographic characteristics and business profile of the fabricators and ownership of fabrication tools. The results show that older fabricators are more likely to own the tapping

Table 4: Relationship between socio-demographic Characteristics and Business Profile of the Fabricators and Ownership of Fabrication Tools

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age	1														
Level of Education	.14*	.1													
Experience (Years)	.76*	-.076	1												
No. of Machine Fabricated/Yr	- .18*	.11	-.21*	1											
Total Capital Investment	.053	.05	.03	.12*	1										
Welding Machine	-.057	.05	-.06	.09	-.03	1									
Milling Machine	. -.014	.15*	-.00	.03	.09	.31*	1								
Cutting Machine	-.041	.13*	-.09	.17*	-.02	-.71*	.22*	1							
Grinding Machine	.082	.13*	.06	.04	-.02	-.01	.03	-.01	1						
Lathe Machine	-.067	.15*	.00	.09	.05	.26*	.02	.39*	.39*	1.					
Drilling Machine	.01	.07	-.07	-.05	-.03	.39*	-.09	-.57*	-.01	.67*	1				
Bending Machine	.11	.05	.08	-.07	.21*	-.05	.09	-.03	-.03	.14*	.07	1			
Folding Machine	.03	-.08	-.14*	-.05	.12	-.08	.20*	-.06	-.06	.08	-.09	-.12*	1		
Tapping Machine	.18*	-.06	-.11*	.12*	.26*	.04	-.13*	.03	.03	-.27*	-.10	-75*	-.08	1	
Foundry.	.12*	.09	-.085	-.055	.03	.012	-.04	.01	-.02	015	.05	.07	-.04	.67	1

machine as the relationship between age and ownership is positive and significant ($r = .18; p < .05$). Only 11% of the fabricators indicated that they owned this machine. Fabricator 07 noted that:

> *"I got my tapping machine a long time ago when the value of the Naira was strong against the dollar."*

This suggests that work that requires tapping machines may be contracted out to fabricators who own these machines. Older fabricators are also more likely to own foundries ($r = .12; p < .05$). Only 1.2% of the fabricators owned foundries while others contract their jobs to them. Observations and interviews during the survey support this conclusion as most of the tools seen seem very old. Interviews revealed that most of the machines or tools are very expensive or difficult to acquire. This was also revealed in interviews with Fabricators 01 and 03 mentioned above.

Fabricators with higher levels of education were also more likely to own milling ($r = .15; p < .05$), cutting ($r = .13; p < .05$), grinding ($r = .13; p < .05$) and lathe ($r = .15; p < .05$) machines. While majority of the fabricators owned cutting and grinding machines (99.4% each), very few owned milling (11.7%) and lathe machines (4%). The smaller proportion of ownership of these machines may be due to higher costs of acquiring them. In addition, the milling and lathe machines are precision machines that may require knowledge and skills to operate. Number of years of experience is inversely and significantly related to ownership of the folding ($r = -.14; p < .05$) and tapping ($r = -.11; p < .05$) machines. This may imply that the more experienced fabricators may contract these jobs out rather than use up capital to buy these expensive machines as indicated in the interviews. However, there were significant and positive relationships between number of machines produced per annum and the ownership of cutting ($r = .12; p < 0.05$) and tapping ($r = .12; p < 0.05$) machines. These machines are applicable in the manufacture of a wide array of machines and essential to have in-house to save time in contracting the jobs to machinists. Fabricators with higher total capital investment at the start of the business were most likely to own folding ($r = .21; p < .05$) and tapping ($r = .26; p < .05$) machines. This may be associated with the initial high costs of acquiring these machines.

5. Conclusion

The study shows that the agro-allied artisanal metal fabrication industry in the three selected States in Nigeria face significant challenges of producing precise machinery due to deficiency in the availability of tools. These challenges may hinder the industry's growth, productivity, and competitiveness. This study calls for investment in modern machinery and specialized tools in the artisanal metal fabrication sector. In addition, tool adoption incentives targeted at younger artisans may counteract the lower adoption rates linked to age in addition to programs that encourage artisans to utilize advanced tools as they grow in expertise. By addressing these infrastructural deficiencies and socio-demographic influences, the agro-allied artisanal metal fabrication industry in Nigeria can overcome its challenges, increase productivity, and contribute to the country's economic growth and development. While the link between tool access and manufacturing capabilities is supported by qualitative data in this study, the specific magnitude of improvement from increased tool access remains to be quantified. This may be the focus of future studies

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