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Case study article

Analysis of the modernity, effectiveness and safety of two industrial cutting machines

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ABSTRACT

In the face of global competition and technological advancements, modernizing industrial equipment is critical for enhancing productivity and safety in manufacturing. To explore this issue, this study assessed the modernity, effectiveness, and safety of two industrial cutting machines—a power hacksaw and a band saw—in the context of planned organizational changes to improve technological competitiveness. The study used several metrics, including the ABC technology method, Overall Equipment Effectiveness (OEE), and occupational safety levels derived from operator interviews, direct observation, and historical data analysis. The McKinsey matrix was used to summarize the findings. The results showed that both machines were below modern standards, with technology levels of 2.5 (power hacksaw) and 2.4 (band saw) on a 5-point scale. OEE measurements revealed performance gaps, with the band saw and power hacksaw operating at 65.5% and 71% of their full potential, respectively. Occupational safety levels were moderate at 3–3.2 on a 5-point scale, indicating a relatively low risk of accidents. The McKinsey matrix scores (290 and 320 out of 650) further highlight the lack of market competitiveness of the machinery. The study, limited to two small and medium-sized manufacturing companies in Bamenda, Cameroon, where reliance on outdated technology persists, underlines the need for modernization and improved equipment to increase productivity and safety. It contributes to the discourse on Africa's manufacturing challenges by suggesting actionable metrics for moving the sector forward.

1. Introduction

Cameroon wants to become a newly industrialised country by increasing its Manufacturing Value Added (MVA) from 12.9% in 2016 to 25% in 2030 and boost the share of manufacturing exports from 26.25% in 2015 to 54.5% by 2030, as outlined in the national development strategy for 2020-30 [1]. The country plans to achieve this by promoting manufacturing and technology catch-up and development. The industrial development strategy integrates the Industrialization Master Plan (IMP), adopted in 2016, which seeks to make Cameroon the switch (electricity supplier), the feeder (supplier of agro-industrial produce) and the equipment manufacturer (supplier of capital goods including furniture) of the Economic Community of Central African States (ECCAS) and Nigeria [2].

The manufacturing share of real GDP in Cameroon has remained almost constant around 15 percent between 2000 and 2012 and decreased after to less than 13 percent in 2022. On the other hand, the manufacturing share of employment slowly increased from 9.6 percent in 2000 to 15.5 percent in 2022; the GDP share of services is more than 50 percent in 2022 as depicted in Fig. 1 [2], [3].

The manufacturing share of real GDP in Cameroon has remained almost constant around 15 percent between 2000 and 2012 and decreased after to less than 13 percent in 2022. On the other hand, the manufacturing share of employment slowly increased from 9.6 percent in 2000 to 15.5 percent in 2022; the GDP share of services is more than 50 percent in 2022 as depicted in Fig. 1.

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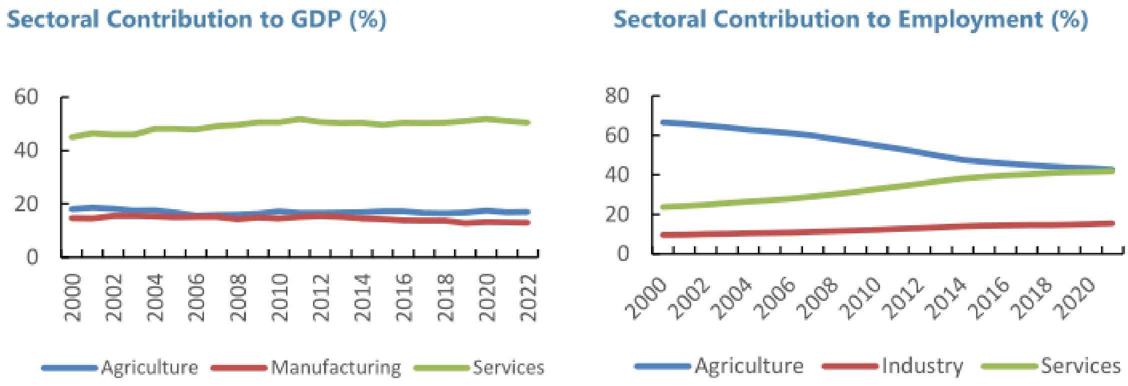

Fig. 1. Sectorial contribution to GDP and employment in Cameroon [2], [3].

The manufacturing sector is struggling to take off while services are continuously gaining weight. To meet the challenge of industrialization and technological catch-up, production equipment and machines constitute one of the elements determining the technologies used and the achieved results in terms of efficiency and productivity, which is one of the elements of market competitiveness [4].

The concept of technological catch-up in manufacturing equipment refers to the ability of countries with lower technological levels to benefit from advanced production equipment and knowledge. This helps to reduce the productivity and income gap with leading countries. To determine the status of production equipment and machines, it is necessary to use metrics [5] that are in a common format, understandable for small and medium-sized enterprises, and that can drive actions for modernization.

Therefore, stakeholders must identify key metrics in the analysis of available production equipment for planned organizational changes. However, there is a significant research gap concerning the specific and metrics-based evaluation of the modernity, operational effectiveness, and safety conditions of production machinery in small and medium-sized manufacturing enterprises (SMEs) in Cameroon. Many studies focus on macro-level industrial strategies, but in-depth analysis of the actual status of daily-used equipment remains limited, whereas this understanding is crucial for targeted technological improvement interventions.

Therefore, this study aims to fill this gap by conducting an in-depth analysis of two commonly used industrial cutting machines. The level of modernity of machines, the key metrics in the starting point in the analysis of and planned organizational changes in the production for technological catch-up in Cameroon. A case study of two cutting machines for round or square bar pieces to be cut and machined to produce machine components such as shafts, bolts, screws, etc. in Bamenda city are used for the evaluation of equipment and assessing the need for technological catch-up based on the proposed metrics. The methodology combine the ABC technology method to assess the technological modernity level of the machines, Overall Equipment Effectiveness (OEE) to measure equipment usage effectiveness, and work safety level analysis based on direct observation, operator interviews, and historical data. This multi-metric approach allows for a holistic assessment of the condition of the studied machines.

The main contribution of this study is to provide an empirical analysis of the modernity, effectiveness, and safety status of industrial cutting machines within the manufacturing context of a developing country such as Cameroon. Furthermore, this study proposes and demonstrates the utility of a set of metrics that can be adopted by other manufacturing SMEs to diagnose the competitiveness of their equipment. The findings are expected to provide a basis for strategic decision-making regarding modernization, productivity improvement, and enhancement of work safety, which in turn supports the broader national industrial development agenda.

2. Literature review

Globally, all countries in the world are increasingly prioritising the manufacturing sector in the national economy as a cornerstone of economic growth [6], [7], [8]. In comparison to Europe, Asia, and America, the African manufacturing sector performs poorly [9]. The manufacturing sector in sub-Saharan Africa has been underdeveloped and manufacturing exports, in particular labour-intensive goods have stagnated [10]. Given the underperformance of the manufacturing sector in many African countries, there is an urgent need to assess production capacity. This can be assessed through various methods, including ABC technology method, Overall Equipment Effectiveness (OEE) productivity, energy and material consumption, labor usage, work safety, and product quality [11], [12], [13].

Ingaldi and Dziuba [14] recommend using the ABC technology method for machine park analysis by assessing its level of modernity, as modern equipment with up-to-date parts tends to operate more efficiently and produce higher quality products.

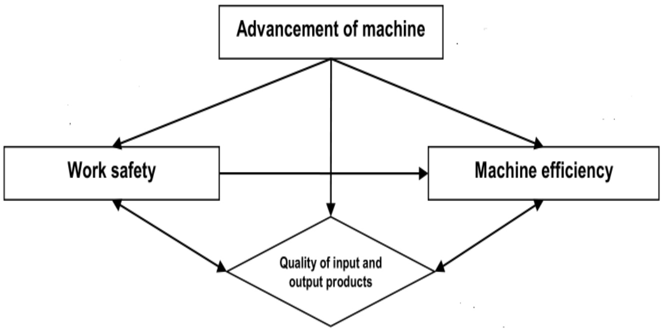

Fig. 2. Cause-effect relationship between machines modernity, efficiency of their usage, work safety and quality of products [17].

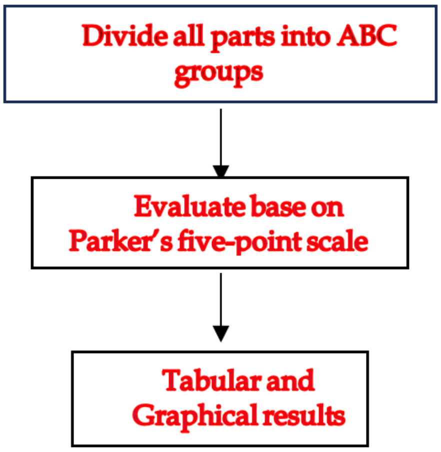

Fig. 3. Flow chart for modernity evaluation.

OEE is a valuable key performance indicator extensively used for monitoring and controlling the reliability of equipment within a production system [15], [16]. It provides a clear picture of how effectively a manufacturing operation is running, helping to identify and address inefficiencies, reduce waste, and improve productivity. Dziuba et al. [17] proposed that the advancement of machines, their efficiency, work safety, and quality are interdependent factors. Fig. 2 presents the analysis of the interdependencies between these factors. The analysis showed that the key causal factors are machine advancement and work safety, while the key resultant factors are product quality and efficiency of machine usage [18]. Fig. 2 also shows that to enhance product quality and machinery efficiency, it is crucial to begin by focusing on improving work safety and advancing the machines.

Advancement of machines: machines advancement can be evaluated based on the ABC technology method, which classifies individual parts of the machine according to the level of modernity of production [18]. This analysis can show the modernity of individual parts as well as the entire machine and determine if it should be replaced with a newer model. The ABC technology method has been applied to individual devices to facilitate decision-making by maintenance services and other related departments [19].

Work safety: The primary cause of accidents in the industry is often related to the operation of machinery and equipment, which poses a threat to both operators and the environment. According to [20], [21], occupational safety and health have a significant and positive impact on employee productivity, workplace accident reduction, and absenteeism reduction. Occupational safety and health are a crucial concern for stakeholders because of the high number of accidents and exposure to harmful agents in various workplaces [22], [23].

Machine efficiency: the OEE index was adopted for the assessment of machine efficiency. The OEE is a performance metric that is used in manufacturing sectors to measure the effectiveness of its operations or equipment. It provides insights into how efficiently equipment is being utilised in terms of availability, performance, and quality [15], [16]. The concept of OEE was introduced by Seiichi Nakajima in the 1960s as part of his work on Total Productive Maintenance (TPM). OEE has been defined as "a measure that attempts to uncover hidden costs" and has proven to be an effective framework due to the direct link between the component metrics of OEE and the TPM Six Big Losses. OEE can be used to save companies from making inappropriate purchases, and help them focus on improving performance of machinery and plant they already own [24].

Product quality: Product quality is a powerful component of a successful competitive strategy. Quality can increase productivity and profitability by reducing costs and increasing sales. The OEE index takes into account the end product quality [25].

3. Material and method

The subject of the research is two cutting machines [26], [27] employed for cutting round or square bar pieces to produce machine components for fabricated metal products, electrical machinery and transport equipment. These machines are located in two manufacturing companies, i.e. LAHMOTECH and Rollings Enterprise, based in the North West region of Cameroon, Bamenda.

LAHMOTECH is a public limited company and a vocational training center specializing in mechanical fabrication and Maintenance. As a medium-sized enterprise (SME), it operates at a moderate production scale, primarily serving local industries and providing technical training. The company focuses on skill development alongside small-to-medium batch production. Rollings enterprise, the second company, is limited liability SME that provides Automobile repairs, welding and fabrication services.

The Behringer KS 280HY band saw found at LAHMOTECH, manufactured in 1996, is the first cutting machine being evaluated. It is designed to cut steel, aluminum, and alloys, it features manual workpiece mounting and adjustment. Once powered on, the motor drives the blades through the gears system. The machine stops automatically after the final cut. Its compact design allows it to occupy less space, requiring only about 1700 x 600 x 1100mm (L x W x H).

Table 1
Work safety scale [29]

Scale	Category	Description
1	Very Low	No injuries, low financial loss
2	Low	First aid treatment, medium financial loss
3	Sufficient	First aid treatment required, high financial loss
4	High	Extensive injuries, loss of production capability, major financial loss
5	Very High	Death, huge financial loss

Table 2
Calculation procedure of OEE indicators

Factors	Formulation
Total Available Time	A
Planned Shutdown	B
Downtime Loss	C
Ideal Cycle Time	D
Scheduled Operating Time	E = A - B
Operating Time	F = E - C
Net operating time	G = D * L
Speed Loss	H = F - G
Valuable operating time	I = D * L
Quality Loss	J = G - I
Production Data	Units
Total Production	K
Good Production	L
Production Reject	M
OEE Factors	Factor %
Availability	N = F/E
Performance	O = D *K/F
Quality	P = L/M
OEE	R = P * O * N

The Rapidor Manchester power hacksaw HS14, used at Rollings enterprise, is the second cutting machine being studies. It operates using a belt-driven model with a mechanical dog-type clutch controlled by a lever. The machine's drive is a double reduction V-rope drive and operates at a speed suitable for sawing mild steel. Within the context of planned organisational changes to improve technological competitiveness in Cameroon, the two industrial cutting machines were assed using the ABC technology method allows machinery to be ranked according to technological sophistication, the Overall Equipment Effectiveness (OEE) methodology and the McKinsey matrix.

3.1. Assessment of machines modernity level

The assessment aimed to determine if the cutting machines, based on their current technology and level of modernity, could ensure the proper quality of metal cutting and work safety. The evaluation of the band saw and hacksaw machines' level of advancement was conducted using the ABC technology method, the Parker 5-level scale, and graphical analysis, as shown in Fig. 3. The structure of the advancement of machine components in the ABC method was presented on the basis of the Pareto-Lorenzo diagram, which provided information about the dominant level of advancement of the studied machines [14].

The ABC technology method assumes, before carrying out the assessment, the division of the machine components into 3 categories marked as Group A, Group B, and Group C. Group A consists of the primary assembly parts that affect the quality of the processed product. Group B consists of support components that determine the machine's functionality. Group C includes secondary components responsible for ensuring safety during device use. The assessment of machine components and assemblies is performed using a 5-point Parker scale, which corresponds to specific ratings as defined by Stasiak-Betlejewska et al. [19].

- *Level 1* pertains to basic parts that can be produced using traditional craft technologies, such as machine foundations.
- *Level 2* refers to parts that have been manufactured using technologies that have remained unchanged for many years, such as standard engine cooling systems.
- *Level 3* parts are manufactured using complex technologies that require technical skills and knowledge, such as a standard electric motor.
- *Level 4* parts are made with modern market technologies, such as a diagnosis display on the control panel computer.
- *Level 5* parts are the result of the most modern technologies, patented and not known by other producers.

3.2. Assessment of work safety

To assess the level of work safety, we conducted direct interviews with machine operators, made observations, identified potential hazards, evaluated the level of human intervention, and analysed historical data on incidents and near misses [28]. Based on these analyses and observations, we rated the level of work safety on a scale of 1-5, with 1 representing the lowest level of work safety and 5 representing the highest, as shown in Table 1. A mean score below 3 indicates a negative opinion of safety performance for the related component. Conversely, a mean score of 3 or higher for each component indicates a positive opinion of safety performance for the related component.

3.3. Assessment of machines OEE

OEE is a lean metric that reflects the health of the production equipment was used to measure the effectiveness of the band saw and hacksaw production equipment considering aspects such as availability (*A*), performance (*P*) and quality (*Q*) of the machine's operation [30], [31], [32]. In order to include the value of the OEE index on a scale of 1-5, the value of the OEE index was divided in the scope of this scale, where: "1" - <35-55%), "2" - <55-65%), "3" - <65-75%), "4" - <75-85%), 5 - <85-100%) [18].

Table 3
World class OEE [33].

No	OEE factor	World class
1	Availability	90.0%
2	Performance	95.0%
3	Quality	99.0%
4	OEE	85.0%

Table 2 shows the calculation method of the OEE index for each of the 10 weeks period, taking into account the machine's technical and organizational parameters. Calculation of the OEE using Table 2 was done with the following stages.

3.3.1. Calculation of the rate of availability value

The availability is comparison between the amount of time the machine is producing and the amount of time it was scheduled to produce (see Eq. (1)). The actual operating time is equal to the planned operating time minus the sum of all unplanned downtime losses due to equipment failures, setup and adjustments.

$$Availability = \frac{Operating\ Time}{Scheduled\ Operating\ Time} \times 100\% \quad (1)$$

3.3.2. Calculation of the rate of performance

The performance reflects losses due to speed loss. The performance of the equipment can be defined in Eq. (2).

$$Performance = \frac{Ideal\ cycle\ time\ x\ Total\ production}{Operating\ Time} \times 100\% \quad (2)$$

3.3.3. Calculation of the rate yield

Yield reflects losses due to poor quality. The yield can be expressed as the total parts produced minus the bad or defective parts then divided by the total parts produced. The yield rate is expressed in Eq. (3).

$$Yield = \frac{Good\ parts\ Produced}{Total\ parts\ produced} \quad (3)$$

3.3.4. Calculation of OEE

The OEE was calculated using Eq. (4). The OEE is compared to the world-class standard, and recommendations are provided to achieve a similar level. However, the generally accepted goals for each factor may vary significantly, as shown in Table 3. For many companies [31], when OEE is 85%-99%, production is considered world class.

$$OEE = Availabiliy\ x\ Performance\ x\ Yield \quad (4)$$

This is a score that is suitable for long-term goals. If OEE = 60%- 84%, production is considered reasonable but shows a large room for improvement. If OEE < 60%, production is considered to have a low score, but in most cases it can be easily improved through direct measurement.

3.3.5. McKinsey matrix multi-criteria summary assessment

McKinsey Matrix also known as General Electric Matrix is a multi-criteria decision analysis technique used in product management to help a company decide what product(s) to add to its portfolio [34]. A modified version of GE/McKinsey Matrix by Knop & Mikulová [18] was adopted to assess the level of work safety, technological modernity, OEE, maintenance, human labor and machine reliability. Arbitrary weights were set for each factor, defining the percentage significance from the perspective of their impact on quality. The factors were evaluated using a scale of 0-5, where the higher the score, the better the factor was assessed (the value of 0 on the scale is adopted when a given factor does not exist and is related to the improvements), and the general indicator value was calculated based on the awarded scores.

4. Results and discussions

The study of modernity was carried out for the Rapidor Manchester HS14 and Behringer Bandsaw KS 280HY. The machine subassemblies were identified based on their operation and maintenance documentation and classified into categories A, B, and C using the ABC technology method. Fig. 4 and Fig. 5 show the modernity level of the research machine broken down by individual subassemblies. The graphs illustrate the machine's level of modernity. Table 4 presents the results of the evaluation of the modernity level of both machines, which are also depicted graphically in Fig. 6 and Fig. 7.

For the primary assembly parts of the cutting machines, subassemblies at the second level of modernity are the most common (66.7%), followed by the third level (33.3%). As for the supporting subassemblies, 60% of the subassemblies for the power hacksaw were rated at the second level of modernity, and 40% at the third level. The band saw had 66.7% and 33.3% for the second and third levels of modernity, respectively. The collateral subassembly was classified as having a second level of modernity of 77.8% for the band saw machine and 22.2% for the power hacksaw machine. The subassemblies of the cutting machines have a modernity level between 2 and 3 on the Parker scale, indicating that they cannot be classified as technologically advanced machinery [4], [35], [36] .

The power hacksaw received an average safety rating of 3 out of 5 (Table 5), indicating that it is safe but suggest that these machines are outdated. In comparison, the band saw scored slightly higher (3.2/5), suggesting a greater risk of accidents.

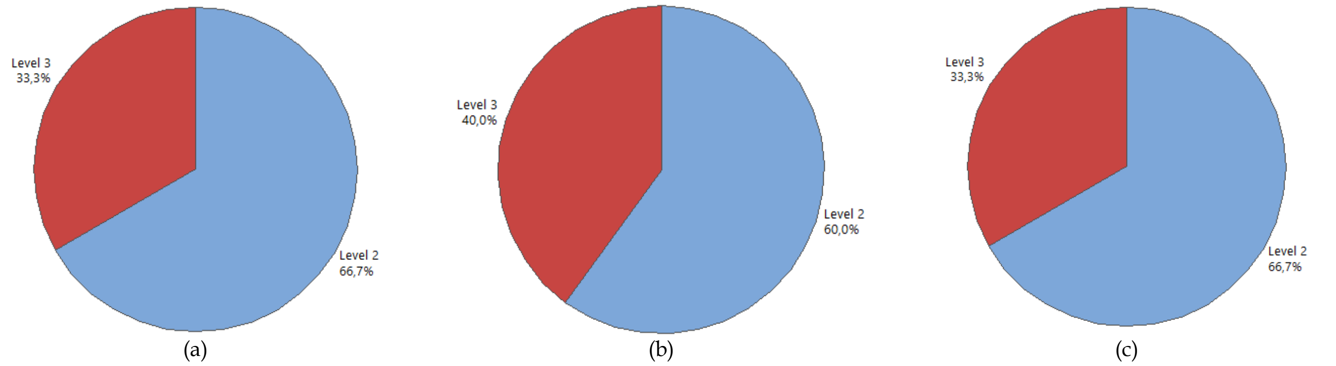

Fig. 4. Modernity structure of subassemblies of the power hacksaw machine 3XM59140: a) main subassembly, b) supportive subassembly, c) collateral subassembly.

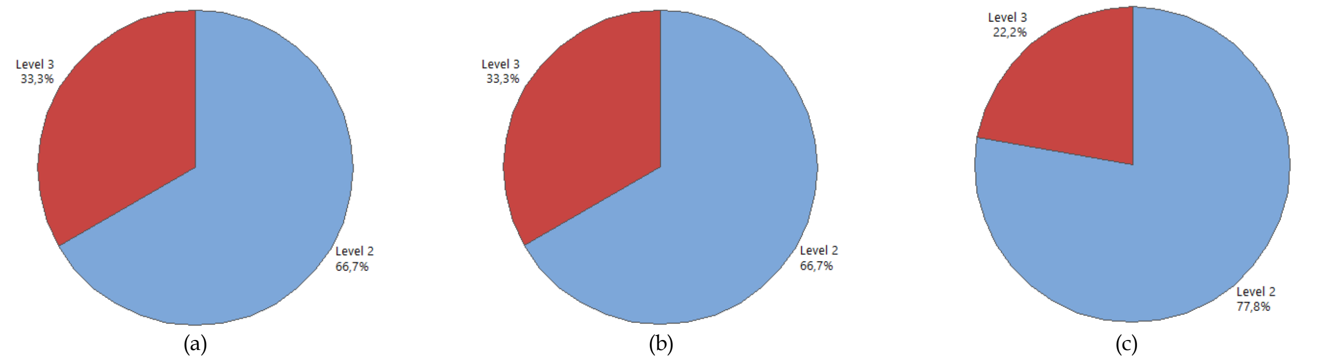

Fig. 5. Modernity structure of subassemblies of the band saw machine KS 280HY: a) main subassembly, b) supportive subassembly, c) collateral subassembly.

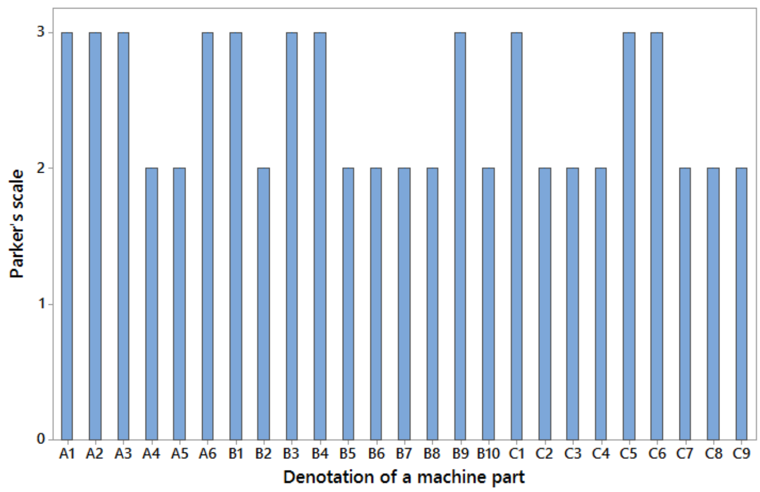

Fig. 6. Modernity levels of parts of the power hacksaw machine.

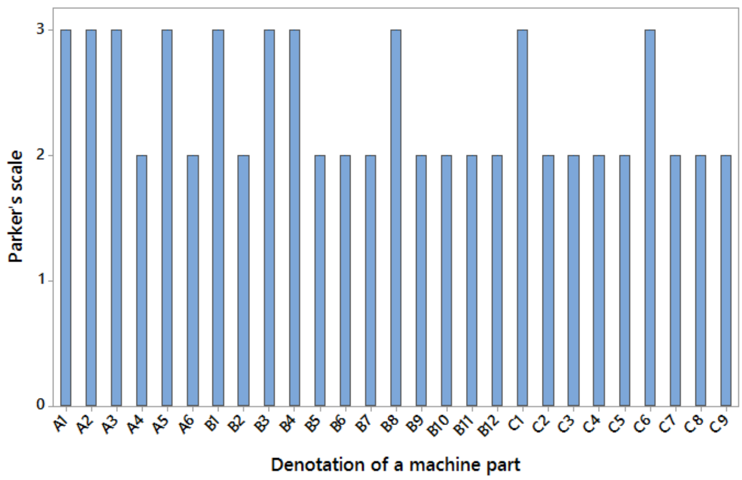

Fig. 7. Modernity levels of parts of the bandsaw machine.

Table 4
Rating of elements modernity in power hacksaw and band saw machines

Power hacksaw machine			Bandsaw machine		
Main subassembly parts (A)					
A1	Control system	Level 3	A1	Control system	Level 3
A2	Control panel	Level 3	A2	Control panel	Level 3
A3	Motor	Level 3	A3	Motor	Level 3
A4	Roller	Level 2	A4	Bow and slider bars	Level 2
A5	Cutting blade	Level 2	A5	Cutting blade	Level 3
A6	Clamping System	Level 3	A6	Clamping System	Level 2
Average		2.7	Average		2.7
Supportive subassembly parts (B)					
B1	Power unit	Level 3	B1	Power unit	Level 3
B2	Adjustable Guide	Level 2	B2	Adjustable Guide	Level 2
B3	Main power transmission system	Level 3	B3	Main power transmission system	Level 3
B4	Hydraulic system	Level 3	B4	Hydraulic system	Level 3
B5	Start-up system	Level 2	B5	Start-up system	Level 2
B6	Bearings	Level 2	B6	Bearings	Level 2
B7	Gears	Level 2	B7	Gears	Level 2
B8	Cutting head clamp	Level 2	B8	Cutting head clamp	Level 3
B9	Belts	Level 3	B9	Belts	Level 2
B10	Pulleys	Level 2	B11	Dog clutch	Level 2
			B12	Dashpot	Level 2
Average		2.4	Average		2.3
Collateral subassembly parts (C)					
C1	Machine construction	Level 3	C1	Machine construction	Level 3
C2	Four leg frame	Level 2	C2	Four leg frame	Level 2
C3	Sensors	Level 2	C3	Sensors	Level 2
C4	Control Buttons	Level 2	C4	Control Buttons	Level 2
C5	Cooling System	Level 3	C5	Cooling System	Level 2
C6	Lubrication system	Level 3	C6	Lubrication system	Level 3
C7	Switch key	Level 2	C7	Switch key	Level 2
C8	Wires	Level 2	C8	Wires	Level 2
C9	Screws	Level 2	C9	Screws	Level 2
Average		2.3	Average		2.2

Table 5
Work safety level results for band saw and power hacksaw

No	Activities	Carried out by	Safety Level	
			Hacksaw	Band saw
1	Clamping/unclamping	Operator	2	2
2	Engaging	Machine	3	3
3	Cutting	Machine	3	4
4	Cooling	Machine	4	4
5	Disengaging	Machine	3	3
		Mean	3	3.2

Table 6
OEE summary.

Machine	week 1	week 2	…	week 4	week 10	Mean
Band Saw	71.4%	74.1%	…	76.9%	62.6%	65.5%
Power Hacksaw	67.3%	74.0%	…	69.2%	69.7%	71.0%

A survey of 367 engineering students in a similar context found that only 48.3% felt confident in the safety of the workshop [37]. To minimise risks, the manufacturing organizations should place emphasis on training the employees in the use and operation of the band saw and hacksaw, as well as in correct working procedures and operations [38].

Table 6 displays the OEE indicators for the analysed machines based on Table 2. During the 10-week test period, the performance rate value for band saw and hacksaw was between 89.1% - 94.4% and 95.7% - 99.5%, respectively. The availability value for band saw and hacksaw was between 75.3% - 80.6% and 79.1% - 82.1%, respectively. The value of the rate of quality products was between 87.4% - 89.3% and 80.3% - 89.3% for band saw and hacksaw, respectively. Taking into account the evaluation of the efficiency of the use of the machines with the OEE indicator, the obtained results as shown in Table 6 indicate that the average effective use of the operating time of the power hacksaw machine is 71%, which means that for 29% of the operating time the cutting machines did not fully perform their functions as shown in Fig. 9. According to standard benchmarks, this indicates that production is reasonable but shows a large room for improvement. The average OEE of the band saw machine was measured at 65.5% of its full potential (see Fig. 8), indicating also room for improvement [15], [33] as shown in Fig. 8(a) and Fig. 8(b), where the six big losses are represented.

In Table 7, H refers to the hacksaw machine, while B is the band saw machine. The quality indicator had the largest share in the final value of the OEE indicator of the band saw, while the performance rate had the largest share in the final value of the OEE of the power hacksaw. Due to the values of OEE, on a scale of 1-5, the cutting machines were given ratings of "2 and 3" [6], highlighting productivity challenges. These are further underscored by survey results: 45.2% of students reported difficulty completing projects in a similar context [37].

As OEE is lower than expected, companies can identify opportunities to improve availability, performance and quality, reinforcing the need to modernise this two equipment. To maximise current machine capabilities and improve productivity, they can take steps to reduce the six major losses reported in Fig. 9: Startup rejects, Defects in process, Reduced speed, Idling and minor stoppages, Setup, adjustments, planned downtime, Equipment failure [31], [33].

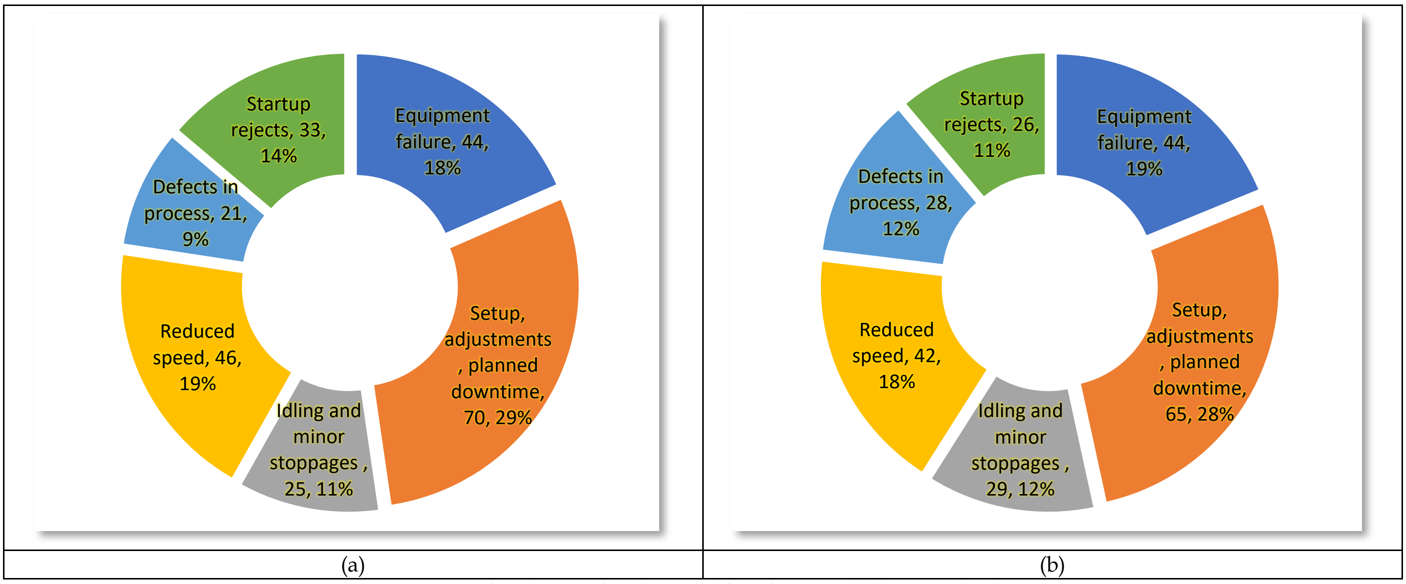

Fig. 8. Six big loses in band saw (a) band saw and (b) power hacksaw.

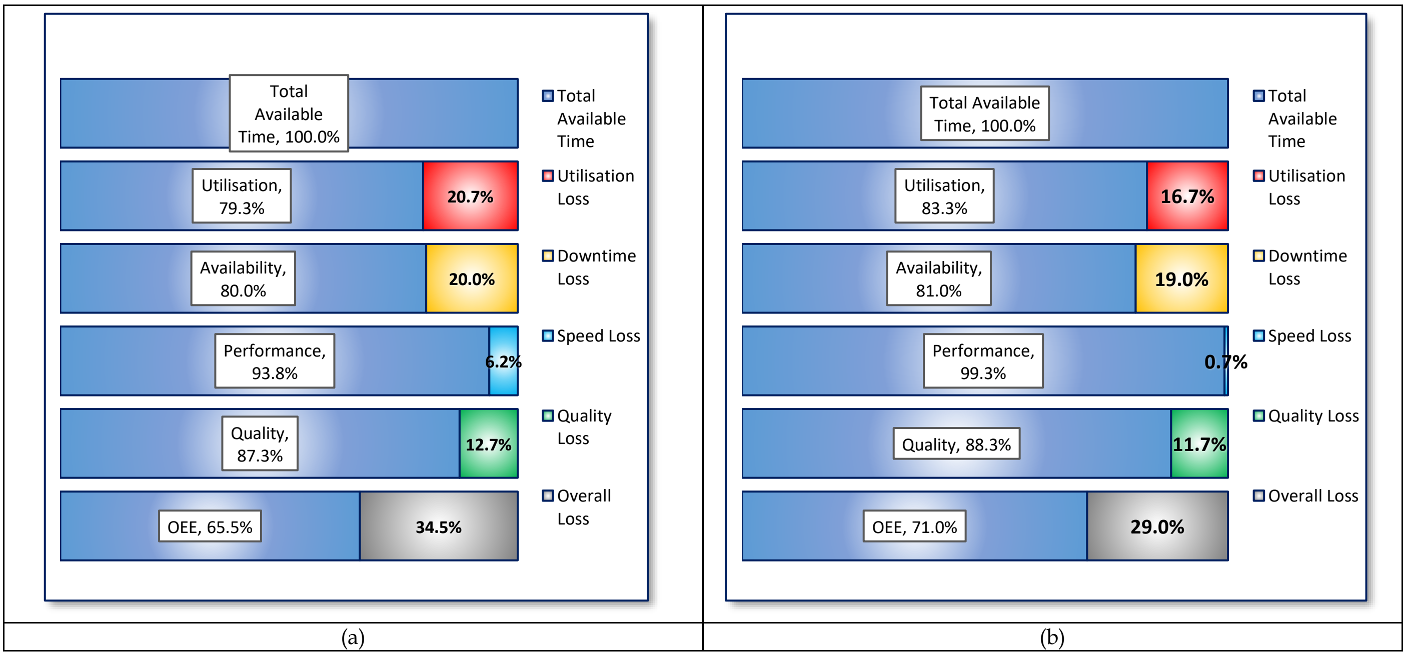

Fig. 9. OEE performance % (a) band saw and (b) power hacksaw.

Table 7
Evaluation results of cutting machines using the McKinsey matrix

Factor	Weight (%)	Ranking						Calculations
		0	1	2	3	4	5	
Technological Modernity	30				H, B			H=B=90
Safety	20				H, B			H=B=60
OEE	20			B	H			B=40; H= 60
Maintenance	10				H	B		H=30; B=40
Reliability	10				B, H			H=B=30
Human labour	10					H, B		H=B=40
MIN	0					Total		H=290
MAX	650							B=320

The result of adopting the modified McKinsey matrix for the comprehensive evaluation of the cutting machines is presented in Table 7. The McKinsey matrix was also provided with factors such as maintenance, reliability and labor for their potential impact on the final product quality and competitiveness of the machines. The scores obtained for the two machines tested are similar, with 290/650 for the hacksaw and 320/650 for the band saw. These results place the tested machines below average in terms of technological modernity, safety, OEE, maintenance, reliability, and human labor for the machines [8].

The findings of this study likely apply to other conventional machines (e.g., drill presses, grinders, or manual presses) in small and medium-sized enterprises (SMEs) across Cameroon, where reliance on outdated technology persists. While Bamenda's industrial sector differs from Cameroon's more industrialised regions, such as Douala and Yaoundé, where access to newer machinery is somewhat better. However, given Cameroon's broader manufacturing challenges (e.g., limited financing, high import costs for machinery), the study's findings remain relevance in other cities in Cameroon and reflect a broader trend in African manufacturing firms, facing similar constraints of aging equipment, low productivity, and safety concerns due to financial constraints and limited technological access to advanced technology.

5. Conclusions

This study provides a critical assessment of the modernity, effectiveness, and safety of two cutting machines - a power hacksaw and a band saw - using metrics such as technological modernity, OEE and occupational safety. The results show that both machines fall below modern standards, with technological scores of 2.4 and 2.5 on a 5-point scale, and OEE levels of 65.5% and 71%, indicating significant performance gaps. The moderate safety scores (3-3.2) suggest a relatively low accident risk; while the McKinsey matrix scores (290 and 320 out of 650) highlight the lack of market competitiveness of the machines. These results underline the urgent need for modernisation and improved equipment to increase productivity and safety in both companies.

The study emphasises the importance of assessing machinery stock to drive technological catch-up and improve competitiveness. By adopting the proposed metrics, manufacturing companies in Cameroon and across Africa can identify areas for improvement and prioritise investments in modern equipment. In addition, addressing broader structural challenges - such as human capital development, access to finance and favourable tax policies will be essential to fostering sustainable industrial growth. This work contributes to the discourse in Africa's manufacturing challenges by providing actionable insights and metrics to drive the sector's modernisation and global competitiveness.

The metrics used in this study (OEE, technological scoring, McKinsey matrix) could be adapted to assess machinery in other African countries, particularly where industrialization is still developing.

Declaration statement

Tsapi T. Kevin: Conceptualization, Methodology, Writing-Original Draft. **Soh Fotsing B. Desire**: Review & Editing. **Bienvenu Kenmeugne**: Review & Editing.

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Disclosure statement

The authors report there are no competing interests to declare.

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Data availability statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

AI Usage Statement

AI-assisted tools were used to enhance the language and readability of this manuscript. The authors have reviewed and revised all AI-generated content to ensure its accuracy and alignment with the research. The authors remain fully responsible for the work's scientific content, conclusions, and integrity, and disclose the use of AI to ensure transparency and adherence to publisher guidelines.

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