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Revalorization, frugal innovation, and circularity: A qualitative exploration of African used automotive parts business

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ABSTRACT

This paper aims to analyze the nexus of revalorization, frugal innovation, and the circular economy in the under-explored African used automotive parts business context. Based on 30 in-depth interviews with key players including dealers, mechanics, and jobbers, our findings illuminate how these players leverage modern electronic communication, video sharing apps, and barter trade in African used automotive part business. We further found local players employing unique practices to renovate, restructure, alter, restore, reuse, extend, and recycle these used parts, emphasizing maximum value extraction from minimal resources. This paper is one of the first academic works to highlight the criticality of local independent actors (non-dealerships) in the automotive aftermarket sector, especially in non-western contexts. It further showcases these local actors' contributions to circular economy via revalorization, while at the same time creating social value for the bottom of the pyramid (BoP) consumers. Finally, the paper contributes to several literature streams including circular economy beyond formal systems, scalability of frugal and circular practices, and resource-constrained value creation, among others.

1. Introduction

Increased environmental awareness has led to a surge in circular economy, and sustainability research, especially in the automotive industry due to its significant carbon footprint (e.g., Orsato and Wells, 2007; Klink et al., 2014; Wu et al., 2016; Yu et al., 2022). The automotive and mobility industries are systemic elements enabling economies to function, from simple transportation to complex innovation activities and aftermarket repair and service (Elo and Katsardis, 2024). Moreover, the automotive sector is globally present and highly complex in management and sustainability while leading many innovative practices (Ferdows, 2018). Current research typically focuses on sustainable manufacturing, manufacturer initiatives, regulations, and technological advancements towards circular economy and sustainability goals. However, research on the automotive sector and its circularity practices in the global south, particularly Africa, is notably lacking, as is the implementation of circularity in the overall automotive sector (Prochatzki et al., 2023). Our paper addresses this gap by focusing on the automotive sector's circularity and aftermarket operations in Africa.

Sustainability conversations emphasize the 3Rs—reduce, reuse, recycle—to lessen resource consumption and support net zero targets (Cooper and Gutowski, 2017). Bottom-of-the-pyramid (BoP) markets practice such circularity due to poverty, however, many automotive parts represent safety-relevant, regulated, and investment-heavy items that make the situation more difficult. Research shows a surge in sustainable recycling of automotive parts at the end of their lifecycle, but less on Global South (Zhou et al., 2019; Mohan and Amit, 2020, 2021). The fate of automotive parts from recycled vehicles in developed economies, and their shipment to developing countries in the global south, including Africa, is an area of increasing research interest (e.g., Karkare and Medinilla, 2023). The trade of used automotive parts from developed to developing economies, highlighted by the World Economic Forum (2023), is driven more by affordability than sustainability. However, it inadvertently aids environmental sustainability through reuse. Current research illustrates a notable lack of research on developing contexts, their trade and service practices as major markets and primary manufacturers represent the main focal interest.

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We address matters affecting the key BoP actors involved in the automotive aftermarket business as well as their circular practices around car parts, repair and service via a qualitative exploratory approach. Focusing on used parts and exploring their revalorization and circularity, our research contributes to the sustainability and circular-economy research literature and enhances our understanding of the automotive aftermarket, especially in developing countries in the global south. When discussing used automotive parts, it is important to refer to frugal innovation capabilities of local entrepreneurs and businesses in emerging and developing economies, which has also been referred to as "jugaad innovation" (Radjou et al., 2012; Rosca et al., 2018; Igwe et al., 2020; Ebolor et al., 2022). In such contexts, business is not similar to the Global North (developed, primarily Western economies). The resource limitations call for efficient and innovative products, processes and uses of products, which are conceived and developed in order to keep the circle of material life going (Gelbmann and Hammerl, 2015). This underlines the different ontology of such a BoP business (Elo et al., 2022). The creative, necessity-driven approach connects the potential of frugal innovation with sustainability in an African context (Ebolor et al., 2022). For example, automotive aftermarket businesses and mechanics in developing countries of Asia and Africa may use imported used car parts in multiple ways rather than a single use in different vehicles, even develop new products out of those parts. Such so called scrap parts management practices may differ radically from formal revalorization such as remanufacturing that major supplier undertake to increase circularity of materials and reduce environmental impact (Elo and Kareila, 2014). Here, we apply the term "revalorization" in a broader business actor context and meaning; literally meaning creating value out of something which was earlier thought to be of no or low value (e.g., Suarez-Visbal et al., 2023). This term also captures the value creation part linked with agile innovation and management of used automotive parts in Africa. Revalorization and remanufacturing are fundamental elements of the global automotive aftermarket and its circular practices deserving more attention on the practices in developing countries (Elo and Kareila, 2014; Koeler, 2024; Elo and Katsardis, 2024). Our paper examines innovative practices, solutions and business actors serving BoP markets, for example, with imported used automotive parts, and theorizes on this intersection. To address these issues, this paper focuses on the following research questions:

1. How is circularity and revalorization of used automobile parts established as a practice in resource-constrained BoP environment and supply chain in the automotive aftermarket?
2. Who are the key players involved in circularity and revalorization of used automobile parts, and how can their locally developed practices justify frugal innovation?
3. What roles does digitalization play in these contexts, and how does it contribute to sustainability in this business sector?

This paper is one of the rare academic works to stress the criticality of local independent actors (non-dealerships) in the automotive aftermarket sector and their management of parts business in Africa while reflecting upon the circularity element and its potential (Halaszovich and Deitersen, 2024). This study specifically examines various aspects, including informal knowledge and management practices as well as export-imports (Halaszovich and Mattfeld, 2020), circular economy, value creation and frugal innovation among non-Western (e.g., Wickert et al., 2024) BoP automotive aftermarket actors. Additionally, this paper highlights the vital role of digitalization for BoP value creation and revalorization that takes place despite economic constraints on technology resources. The BoP perspective has been largely ignored in prior literature, and hence, our paper introduces the nexus of revalorization, automotive aftermarket management and frugal innovation-circularity in sustainability and management literature streams.

This paper is structured as follows: First, a literature review is presented, followed by discussion on the research design and methods. These are followed by the presentation of study findings. Finally, the paper concludes with the presentation of implications and future research recommendations.

2. Literature review

2.1. Bottom of the pyramid markets and innovative practices

The Bottom of the Pyramid (BoP) markets represent certain features related to developmental level, business actors and resources, purchasing power in business and consumer markets, and non-Western management and solutions generation on business challenges, such as frugal innovation. Hence, the BoP market conditions are visible in many African countries. Due to the differences between the BoP markets and those higher up the pyramid, researchers argue that any successful technological innovation must reframe the 'normal' rules of the game and challenge the core assumptions, such that the frugal innovation is tailored to the challenges facing the BoP market (Kuo and Ng, 2016; Mwangi, 2023). Furthermore, due to divergences in culture and management practice, there is no "one size fits all" approach to innovation. Consequently, serving the BoP market of Africa requires sensitivity, local knowledge, real-time intelligence, flexibility, and customized solutions for local needs at individual, community, and value chain levels (Park et al., 2022; Patwa et al., 2021). Likewise, addressing the unmet needs of the BoP consumers via frugal innovation requires an inclusive approach to business practices, i.e., by including [the BoP] consumers as employees and business owners in the value chain (Lange et al., 2023).

2.2. Practices and technology

Digitalization and technology spread through global supply chains and production, often transferring from developed to developing countries as systems, requiring digital inclusion (Choudrie et al., 2022). However, these elements typically relate to the primary manufacturing of goods and parts and processes around them, there is less knowledge on secondary or tertiary markets (Katsardis, 2024). Thus, practices in aftermarkets can develop also independently from primary markets and technologies, especially, if they are not included in the global value network. Particularly innovation practices follow different patterns under resource constraints in developing countries and incorporate different actors (Radjou et al., 2012; Rosca et al., 2018; Igwe et al., 2020; Ebolor et al., 2022).

Research on frugal innovation and sustainability in the automotive engineering sector often focuses on tangible rather than digital assets proliferating daily lives. For instance, see the case of Hyundai in India (Sharmelly and Ray, 2018), the German auto components industry (Achtelik et al., 2023; Tiwari and Bergmann, 2018), Tata Motors Nano and Citroën 2CV (Lim and Fujimoto, 2019). These studies focus mainly on design changes, cost-performance, frugal engineering, bricolage, modularity, and quality issues. More inclusive, cost-effective technology-driven frugal innovations in design are crucial for addressing the needs of low-income individuals in developing countries, the BoP markets. Using a qualitative approach and data collected from interviews, Jagtap (2022) notes that innovations not tailored for BoP often fail to make an impact, leading to low adoption. Co-design in these contexts is challenging due to factors such as low literacy and limited resources. Successful co-design requires adapting methods like pictorial communication to these specificities. Researchers also argue that a great opportunity lies for the BoP ventures across Africa to be innovative and sustainable (e.g., Arslan et al., 2022; David-West et al., 2019; Onsongo et al., 2023). Consequently, implementing cost-effective technology driven frugal innovations to serve the BoP markets in Africa while fostering environmental sustainability remains an under-researched area. This indicates a need for broader research in sustainability, especially in supply chains and digital technologies, and exploring revalorization processes in diverse settings.

2.3. Automotive aftermarket and circularity challenges

Aftermarkets are central for circularity. The automotive aftermarket is among the major sectors contributing to both circularity and human mobility as well as transporting, yet there is little academic research on its role regarding circularity beyond product level manufacturing processes (Prochatzki et al., 2023; Elo and Katsardis, 2024). Such secondary and tertiary service, repair and maintenance markets, also innovative and sustainable practices in less privileged or under-recognized business markets are often overlooked in the research literature. For instance, car battery recycling in the automotive aftermarket business serves as an early example of an impactful yet under-recognized process in environmental sustainability and value chain operations.

The automotive aftermarket sector is a field where further and more interdisciplinary research into supply chain and service management and circular economy practices is needed, as highlighted by Moradlou et al. (2023), Elo and Katsardis (2024), and Koeler, 2024. The role of the automotive aftermarket is crucial serving BoP markets, acting as a vital network linking suppliers and service sector actors towards the drivers and users of vehicles serving and maintaining also older and lower value vehicles, which are typical in the BoP context (Katsardis, 2024). Facing increasing regulative changes regarding sustainability across contexts, this industry underscores the need to understand the nuances of activities that are actually related to circularity and diminishing of the carbon footprint, for example, by revalorization of parts and materials (e.g., Malik et al., 2022; Zhu et al., 2022; Subramoniam et al., 2009; Zhang et al., 2011; Elo and Kareila, 2014).

2.4. From waste to circularity and revalorization

Circularity and revalorization are interconnected concepts (Confente et al., 2020; Gerrard and Kandlikar, 2007; Elo and Kareila, 2014) that focus on extending product and product material lifecycles. These management practices reduce waste, increase efficiency of material use and thus align with global sustainability goals and contribute to the UN's Sustainable Development Goal 12. However, the Bottom of the Pyramid (BoP) countries remain an underexplored context despite their very versatile approaches to revalorization. These supply chain processes face demanding, often irregular, market conditions, and thus, the supply chain learning and knowledge transfer differs from the developed country context (Yang et al., 2023). Responsible circularity can create economic opportunities in developing nations, fostering a more inclusive global circular economy (Gerrard and Kandlikar, 2007). Revalorization strategies (Hockerts et al., 1998; Elo and Kareila, 2014; Koeler, 2024) offer economic benefits like cost savings, innovation and job creation. These strategies in BoP countries highlight their potential to alleviate economic challenges and promote local forms of entrepreneurship. Despite unique challenges and resource constraints, BoP countries offer insights into frugal innovation and locally developed practices that support local development (Barnard et al., 2017; Zoogah et al., 2023). Prior studies (e.g., Gerrard, 2005; Elo and Kareila, 2014; Svensson et al., 2018) recognize issues such as different processes, intellectual property rights, and regulations, which may be amplified in countries with weaker institutions. Local contexts illustrate very different socio-economic factors, skill and knowledge levels, infrastructures, and regulatory frameworks across regions (Elo and Katsardis, 2024). The automotive aftermarket employs advanced technologies, but their feasibility in resource-constrained environments (cf. Digital divides, scalability, and affordability), is essential to consider when implementing them in developing nations.

Circularity and revalorization are often limited to conventional Western management thinking, which suggests following classic supply chain structures and practices, e.g. on, collecting cores and trading with remanufacturing and other reuse actors. However, this view falls short when dealing with business in BoP contexts, given the unique challenges related to limited infrastructure, sustainability awareness, and constraints in technology, knowledge, and finance. To integrate a circular economy perspective in research, we need a nuanced approach that addresses socio-economic disparities and understands how local businesses and communities engage in this sector. Studies on recycling initiatives in developing nations stress the importance of community involvement, informal recycling networks, and supportive waste management policies (e.g., Debrah et al., 2022). Nevertheless, research should expand beyond the "waste" concept (Subramoniam et al., 2009) and consider the various life cycles of a product and its end of life. Material sourcing and energy usage relate directly to costs (Elo and Kareila, 2014). Consequently, practices such as remanufacturing and revalorization can significantly impact sustainable use of resources, especially in low-cost solutions enabling mobility in poorer and rural regions and of older vehicles (Elo and Kareila, 2014; Skare et al., 2023). Additionally, the different actors creating circularity practices pose country- and region-specific characteristics and activities that call for novel theorizing (e.g., Ziegler et al., 2023).

3. Research design and methodology

We employed a qualitative approach with an interpretivist epistemology to delve into unfamiliar research dimensions, focusing on circularity, revalorization, and frugal innovation in the African automotive business management that contributes to circular economy and sustainability on the continent, a strategy akin to Halme et al. (2024). This research focuses specifically on the used automotive parts business (so called scrap business) and how it is conducted.

Our study centered on the experiences of three key stakeholder groups in Nigeria's automotive aftermarket sector: used automotive parts dealers.,[1] jobbers, and mechanics. We conducted 30 in-depth semi-structured interviews (see Table 1), concluding at the 30th interview when data saturation was reached (Agarwal et al., 2022). Participants, selected through convenience sampling and data access, comprised 10 representatives from each group, randomly chosen from Lagos and Ebonyi State. Initially, for participants selection, snowball sampling was employed, leveraging the lead author's networks to connect with one used automotive parts dealer, one jobber, and one mechanic in Lagos only, because the Ladipo (Lagos) auto spare parts market in Nigeria is considered the largest market for used car parts in Africa (Ezeoha et al., 2022; Okebalama et al., 2024). This approach not only facilitated access to additional participants but also gathered pertinent demographic and background information about them and their firms (Harvey, 2011). For instance, during our initial fact-finding quest with these three initial contacts, they revealed that the major destination of their products is the Southeastern part of the country. Hence, our reason for also adding a Southeastern state – Ebonyi – as our place of interest.

However, this focus on the three principal stakeholder groups was crucial due to their significant role in revalorization, ensuring a balanced representation in the value chain (Oliver-Simancas et al., 2020; Thoresen et al., 2020). We aimed to avoid biased judgments or conclusions regarding their roles and positions, preventing undue privilege or underrepresentation. Demographically, the industry is male dominated, with jobbers typically younger and less experienced compared to part dealers and mechanics.

3.1. Data collection

We adopted the qualitative interview approach. This involved more than merely asking and listening between the parties (Edwards and Holland, 2020), as we treated our participants as the principal actors whose side of the story must be captured to validate our research

[1] These used part dealers are independent actors, i.e. traders, in the automotive aftermarket, unrelated to the formal dealerships of primary car manufacturers.

Table 1
Participant information.

Participant number and Code: Lagos (L); Ebonyi (E)	Gender	Age	Years of relevant experience	Trade	Founding year	Interview duration (in minutes)
Dealer 1 (L)	M	41	19	Seller	2010	33
Dealer 2 (L)	M	54	33	Seller	1998	26
Dealer 3 (L)	M	39	12	Seller	2012	32
Dealer 4 (L)	M	44	10	Seller	2014	28
Dealer 5 (L)	M	53	25	Seller	2005	31
Dealer 6 (E)	F	42	15	Seller	2014	34
Dealer 7 (E)	M	57	31	Seller	2000	28
Dealer 8 (E)	M	53	18	Seller	2013	30
Dealer 9 (E)	M	45	23	Seller	2008	33
Dealer 10 (E)	M	43	16	Seller	2014	27
Jobber 1 (L)	M	31	10	Middleman	2014	29
Jobber 2 (L)	M	27	7	Middleman	2016	32
Jobber 3 (L)	M	35	11	Middleman	2013	31
Jobber 4 (L)	M	30	9	Middleman	2015	30
Jobber 5 (L)	M	29	6	Middleman	2018	33
Jobber 6 (E)	M	26	8	Middleman	2016	28
Jobber 7 (E)	M	33	7	Middleman	2017	29
Jobber 8 (E)	M	28	10	Middleman	2014	33
Jobber 9 (E)	M	25	6	Middleman	2018	29
Jobber 10 (E)	M	22	5	Middleman	2019	31
Mechanic 1 (L)	M	46	25	Repairer	2003	34
Mechanic 2 (L)	M	51	32	Repairer	1998	32
Mechanic 3 (L)	M	38	15	Repairer	2014	23
Mechanic 4 (L)	M	59	40	Repairer	1990	28
Mechanic 5 (L)	M	48	19	Repairer	2012	33
Mechanic 6 (E)	M	42	23	Repairer	2008	36
Mechanic 7 (E)	M	39	17	Repairer	2013	25
Mechanic 8 (E)	M	37	20	Repairer	2009	33
Mechanic 9 (E)	M	40	19	Repairer	2010	29
Mechanic 10 (E)	M	45	24	Repairer	2006	31
Total = 30						

(LaDonna et al., 2021). Therefore, participants were encouraged to share their experiences freely, with minimal interference from the interviewer. They were also prompted to provide specific examples or stories to support their responses. We were also aware that the quality of data collected will depend on two instruments – the researcher and the interview questions (Gioia et al., 2013). Consequently, we ensured that the interview questions were appropriate, robust, and capable of capturing detailed answers to our research questions, but at the same time allows flexibility within the interview process (Roberts, 2020). Also, we ensured that the conversation was informal and relaxed to obtain in-depth information that explains how participants' activities and operations align with the circular business model (CBM) and the core principles of the circular economy.

Data collection began by establishing rapport and familiarity with participants. During interviews, participants were first introduced to the researcher, and the research objectives and potential outcomes were discussed. Ethical considerations and mitigation strategies were addressed within this context. The interviewer then outlined the interview structure and process.

The interviews included themed, open-ended questions, starting with lead questions and followed by probing and follow-up questions to maintain focus, clarify issues, and enrich the data (Leavy, 2017; see Appendix 1), although new questions emerged based on the direction of each conversation (Agarwal et al., 2022; Collis and Hussey, 2014). Each interview lasted approximately 30 min and was recorded. With English being the official language in Nigeria, this facilitated our data collection process and the quality of data, as all participants were fluent in English. Data collection took place during store visits between August and December 2023. Informed consent was obtained via email, and participants were given flexibility to choose interview slots. The conversations were paused as needed to accommodate participants' business requirements.

3.2. Data coding and analysis

The data analysis process commenced by thoroughly listening to the recorded oral interviews to gain familiarity with the raw data before transcription. This preliminary step helped ensure a deep understanding of the interview content. In the subsequent transcript analysis, our approach involved identifying and analyzing our 1st-order concepts, 2nd-order themes, and aggregate dimensions, as suggested by Gioia et al. (2013). Initially, we recognized common patterns within the dataset, which allowed us to categorize the data. As these categories that emerged early in our analysis were overwhelming (Gioia et al., 2013), to help us make sense of them (a process akin to Gioia's [2004] notion of hanging them together), we adopted open coding (Strauss and Corbin, 1998) which helped us to generate our 1st-order concepts (Gioia et al., 2010). With our 1st-order analysis completed at this stage, our 2nd-order analysis aimed at reducing the categories to a more convenient number by tying up as many categories as possible, based on their similarities and differences. Consequently, we adopted axial coding (Strauss and Corbin, 1998) to help us generate our 2nd-order themes. Researchers argue that this approach is key to addressing the important question of "What is happening here?" theoretically. Therefore, we ensured that both the 2nd-order theoretical levels of our themes and their dimensions align with the larger narrative (Gioia et al., 2013)—answering the important question of how our participants' activities and operations align with CBM and the core principles of the circular economy. Developing such tentative answers to this critical question through concepts generated from our interview data (a process akin to Gioia & Chittipeddi's [1991] notion of "gestalt analysis") is the hallmark of "theoretical sampling" (Glaser and Strauss, 1967). However, it is important to note that this process was incessant till we reached "theoretical saturation" (Glaser and Strauss, 1967). We must also highlight that, in this 2nd-order analysis, we were able to identify some emerging theoretical concepts with "identity ambiguity" (Corley and Gioia, 2004) because they had no theoretical relevance to the extant literature, as well as some existing concepts which "leaped out" due to

their "optimal distinctiveness'' (Gioia et al., 2010) as they were only relevant to a new domain. Finally, to help us make sense of our 2nd-order themes, we further distilled them into "aggregate dimensions" (Gioia et al., 2013). These are illustrated in Fig. 1 below.

To enhance the rigor of our analysis, we subjected both our methodology and data analysis sections to member-checking, drawing upon the perspectives of team members who served as research auditors (Filho and Rettig, 2016) and critical friends (Kember et al., 1997). Through these collaborative efforts, we meticulously vetted the coded data (Mantere and Whittington, 2021) and provided constructive feedback at various stages of the data analysis process. These enhanced both reliability and validity of our data (Knight and Jarzabkowski, 2023) and ultimately leading to the formation of a comprehensive set of aggregate dimensions directly linked to (a) revalorization, (b) circularity, (c) frugal innovation, (d) digitalization, and (e) circular economy. Fig. 2 below clarifies this further.

We carefully labelled and compared all interview discussions with the relevant existing literature. To ensure verification and validity, we shared our findings with the participants, following Patton's approach (2015), and actively sought their feedback. The feedback received not only validated our study but also underscored the reliability of our findings. The next section presents our detailed findings.

4. Findings

Despite our focus on the three primary stakeholder groups (dealers, jobbers, and mechanics), several common themes emerged from the interview data. Firstly, participants openly presented their views and management practices on revalorization and circularity in used automotive parts. Secondly, they revealed their roles and those of other actors in managing revalorization and circularity in used automotive parts. Thirdly, they described how their locally developed practices link to frugal innovation, and how this has been transforming their resource-constrained environments. Fourthly, they highlighted the moderating roles of digitalization in achieving these objectives.

To make sense of these interview responses, we categorized them into five overarching themes:

(a) Revalorization and circularity in the African used automotive parts industry,
(b) The roles of actors in facilitating revalorization and circularity,
(c) Linking locally developed practices to frugal innovation in Africa,
(d) The impact of digitalization, and
(e) Connecting the African used automotive parts sector to advancing circular economy on the continent.

4.1. Revalorization and circularity in used automotive parts in Africa

This theme explores our participants' ability to promote sustainable production by renewing, restoring, reviving, regenerating, recycling, or reusing second-hand automotive parts, rather than discarding them. This is especially important as many of our participants deal with damaged or faulty cars that might have limited economic value. The quotes below highlight common themes in our participants' responses, emphasizing the concepts of renewing, regenerating, and reusing:

> *"Most times I do buy completely faulty cars, then after I dismantle the car, I take some parts such as the Hub. I check if the hub is noisy which means it is faulty, then I will lubricate it with grease, or I change the bearing and couple it back. Then I will sample it in my shop"* (Dealer 4).

> *"I deal on second-hand tyres … I wash the tyres and if I discover any leaks or if I observe any holes in the tyre, I will take it to people that will re-fill it to avoid leaking of air. They also use machines to draw a line on the [worn] tyres, then rub potty on the body to give it a good look as if it is a new tyre"* (Dealer 10).

> *"I buy accident cars* [i.e., cars that have been involved in accident] *from Nigeria and overseas, and I will normally modify the parts before selling them"* (Dealer 1).

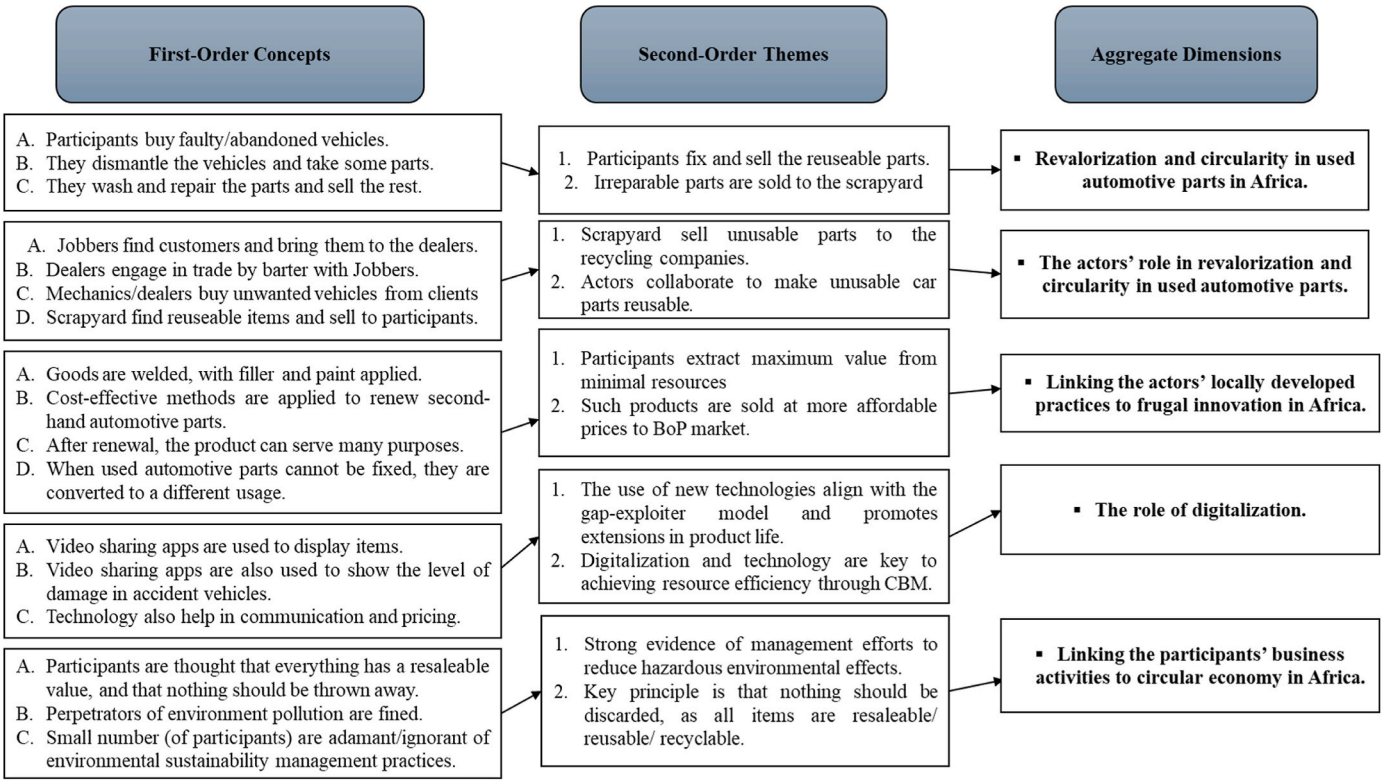

Fig. 1. 1st-order concepts, 2nd-Order themes, and aggregate dimensions.

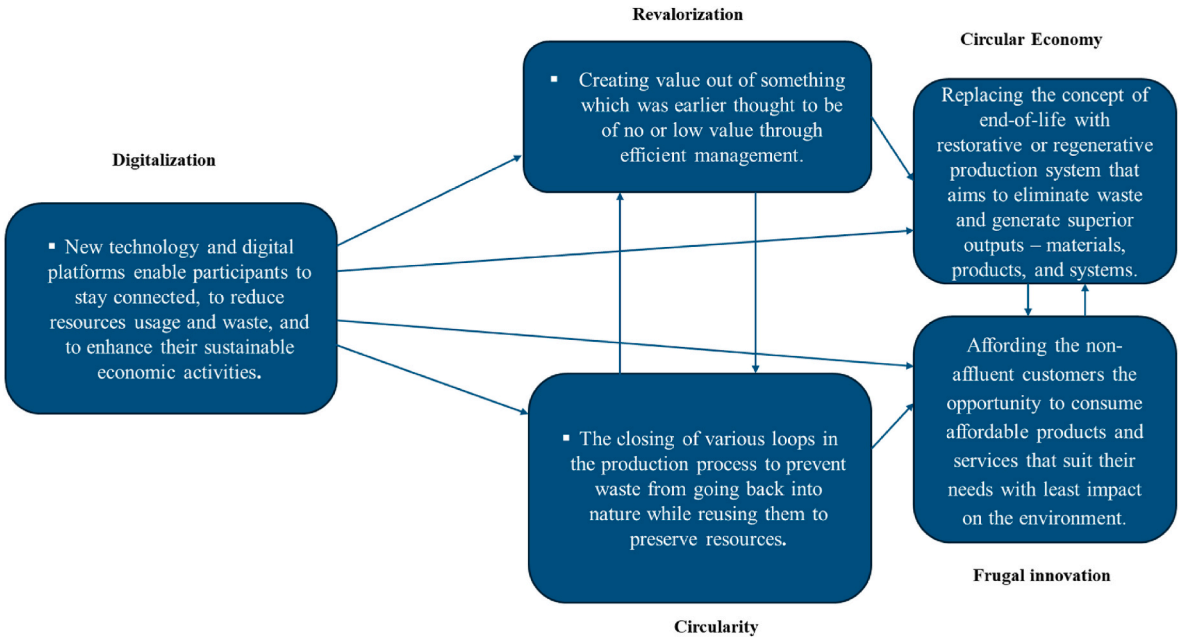

Fig. 2. Linking the participants' role in revalorization and circularity in used automotive parts in Africa to frugal innovation and circular economy.

The above quotes show that in addition to the traditional purchase of fairly used automotive parts from overseas which [conventional] automotive parts dealerships are commonly known for, the modern-day automotive dealership in Africa has taken their economic activities one step further, which also helps to provide more value for the BoP consumers in the resource-constrained environment of Africa. Consistent with the tenets of the CBM models, our participants also purchase faulty/abandoned vehicles both from within and outside the country, dismantle these vehicles, take some reuseable/repairable parts, wash, repair these parts and sell them. Our interview data also reveals that the irreparable parts are sold as scrap to the scrapyards, signifying that everything that comes with used automotive parts has an economic value. These are further illustrated in our next set of quotes:

> *"We do not waste/dispose unwanted parts, rather we sell them to companies that need them. Whether it is plastics, metal, aluminum, we sell them to scrapyards or to recycling companies that need them. That is the way we manage our waste products. We do not waste any parts of used car parts"* (Dealer 8).

> "No parts in used car parts are useless. Whether it is the engine, the plastic and metallic parts, or even the engine oil, they are all resaleable. Even the used engine oils, we fill them in cans, there are some people who normally come around to buy them from us. The waste management company also always sends their trucks on weekly basis to collect the condemned tyres and other parts that we do not need" (Dealer 2).

> "Yes. We readjust these used car-part to be reusable. For instance, if the fiber of a gearbox is no longer good, it is because of oil. If it's leaking somewhere, it will burn the fiber making the car not to move, the gearbox will be brought out and the fiber changed to a new one and the car starts working again" (Mechanic 6).

The quotes mentioned above align with the principles of the circular economy, which prioritize waste reduction and resource optimization through closed-loop systems (Aguilar et al., 2021; Chirumalla et al., 2024). Circular economy proponents argue for maximizing the environmental and economic benefits of car parts as they near the end of their lifecycle. This involves repairing, refurbishing, remanufacturing, reusing, and ultimately recycling them when reuse is no longer feasible (e.g., Zhu et al., 2021; Chirumalla et al., 2023, 2024). The quotes from our participants illustrate that their business activities closely align with these circular economic objectives.

4.2. The actors' role in revalorization and circularity in used automotive parts

In this section, we focus on evaluating the distinct and collective contributions of our diverse sample, which encompasses dealers, mechanics, and jobbers, to the processes of revalorization and circularity in the African automotive aftermarket and used parts industry and its non-Western management (Wickert et al., 2024). The interview quotes below emphasize recurring themes such as renewal, recycling, collaboration, and trade-by-barter:

> *"We wash them and do make-up on them before selling them. There is no waste in second-hand car spare parts. When we have any waste or unsold items, we will contact the scrap yard …. Also, sometimes the scrap yard will find some item of value at their disposal, and they will invite us to buy them. And sometimes we do trade by barter with them"* (Jobber 3).

> *"We have jobbers that take care of the plastic waste products. They send them to companies that recycle them into another type of product. So, in terms of spare parts, there are no wastes. Jobbers also have customers and when their customers need useable parts, they will bring them to us …"* (Dealer 5).

> "Sometimes when I receive accidental cars, I sell them the way I receive them to others [including mechanics and jobbers] who buy and amend some of the parts, including the underneath, the body parts, and sometimes the engine, before they can be reused or resold" (Dealer 1).

The above quotes show a high level of well-coordinated collaboration between actors to ensure that all used automotive parts are reusable. This goes beyond the commonly known [economic] activities between the middlemen and dealers in the supply chain but involves a direct exchange of automotive parts between actors without the use of a common currency. This aligns with the microeconomics theory of the barter system and fosters a speedy sale of goods and most importantly, helps to minimize waste. These are further illustrated below:

"As a mechanic, sometimes I see a customer that doesn't need their car anymore and they want to sell them off. Sometimes I buy them, check what is good in them, such as the body, wires, underneath, etc, take it, repair, or refurbish them and sell, and I then sell the good remaining parts to the scrap guys. For instance, when you lose the hob, you will hear some sound. There are some hobs that are repairable, I will repair the ones that are repairable. For the ones that are not repairable, I will sell them to those that buy iron/scrap. They will buy it and sell them to the scrap companies" (Mechanic 7).

"We work so closely with the middlemen/jobbers/wingers a lot because they know when the goods arrive from overseas and they will contact us … Sometimes, *they also negotiate on your behalf with the importers, so you do not need to go to the importers, as the middlemen pay for the goods and bring it to your shop"* (Dealer 9).

"Yes, we do modify it after buying and before selling it to the customers. For instance, something like an alternator, when we discover that it is not giving us what we want, we normally open it and change some of the parts that are not good and by so doing, it will start working effectively" (Dealer 10).

The provided quotes highlight the crucial roles played by all three categories of stakeholders in attaining circularity and revalorization within Africa's used automotive parts industry. Moreover, these insights align with Albertsen et al.'s (2021) exploration of CBM strategies, which encompass repair, refurbishment, remanufacturing, repurposing, and recycling, serving as pathways toward sustainability. This alignment is evident when considering the three core dimensions of sustainability: environmental, social, and economic.

4.3. Linking the actors' locally developed practices to frugal innovation in Africa

In this section, we explore our participants' ability to employ cost-effective methods and designs for renewing and transforming second-hand automotive parts. In some instances, this transformation can occur seemingly from nothing, allowing these products to be sold at more affordable prices to underserved populations at the lower end of the mass-market, often referred to as the bottom of the pyramid (BoP). Common themes evident in the interview quotes below include restoration, conversion, alteration, and extension:

"Yes. There are ways these used car parts can be modified and readjusted, like camber 2.2 Camry you can use it to fix small sienna and Lexus 300. Camber old model sienna with Avelon is the same and can be used to fix old model Avelon. Hub big hole, i.e., big sienna can be used to fix new model previer. Camry 2.4 hub, the small hole is on it's own. 2.4 camber can be used to fix new model previer, Avelon jeep, Spider, Old model high lander, Lexus 330, Lexus 350 both the car and the Jeep. Camber big sienna is on it's own. Hub Spider can be used to fix Avelon jeep and old model high lander. Back hub big sienna can be used to fix 2.4 Camry back, old model high lander back, Spider and Avelon jeep" (Mechanic 6).

From the above quotes, in their pursuit of revalorization and frugality, actors extract maximum value from minimal resources. This helps to ensure that such products are sold at more affordable prices to BoP consumers. Specifically, participants reveal that they apply cost-effective methods to renew second-hand automotive parts. The interview data also shows that after renewal, the product can serve many purposes, but when such second-hand automotive parts cannot be fixed/renewed, they are converted to a different usage. These economic activities align with the CBM approach of – waste reduction, eliminating pollution, circulating products, regenerating nature, shifting from ownership to access, promoting collaboration, supporting repair and maintenance, while using bio-based materials to refurbish and extend the life cycle of products and facilitate various use for them. These are further illustrated in the next set of quotes:

"I buy those cars that had accident and dismantle them, then select those parts I need. Most times I buy some abandoned cars and after dismantling the body, I bring out those parts that are still good and useful … I readjust it by giving it to panel beaters [i.e., those that specialize on car body parts] *in which they will weld the iron, apply filler, and paint it to a desired color such that you cannot believe it was an abandoned vehicle"* (Dealer 2).

"Sometimes, we look for what it can be converted to. For instance, if an engine is not suitable for use in a car, we see if such an engine can be used in flying boat. Or when something cannot be fixed, we can convert it to another useful thing. For instance, in shock absorber, the spring can be used to construct a chair. Metallic parts in a car can be used to create another thing like cooking pot or frying pan" (Mechanic 10).

In line with previous research highlighting the economic value of used car parts in various contexts (e.g., Martinez-Laserna et al., 2018; Vu et al., 2020; Haram et al., 2021), the quotes above illustrate our participants' ability to extract the maximum potential-also material-wise - from used automotive parts. Furthermore, research has consistently shown that such objectives, aimed at maximizing the value of used car parts, are typically achieved through collaborative efforts among stakeholders (Costa et al., 2022; Schulz-Monninghoff and Evans, 2023; Albertsen et al., 2021; Júnior et al., 2023). Importantly, our findings align closely with this collaborative approach.

4.4. The role of digitalization

In this section, we investigate whether participants have access to modern technology and whether they recognize its pivotal role in their business operations. Specifically, we aim to determine if they leverage new technologies to attain revalorization, circularity, and frugality in their endeavors. Noteworthy themes present in the interview quotes below encompass modern electronic communication devices and video-sharing applications:

"We use WhatsApp to communicate with our contacts overseas and send them the models and specifications to avoid them sending us the wrong goods, otherwise, it adds to the amount of waste that we deal with on daily basis" (Dealer 3).

"When customers call me, they will normally name the goods they need but sometimes the name they call the goods is confusing, so, I will request that they send me some sample pictures via WhatsApp or any other picture sharing app. So, without technology I don't think that we can do our business effectively" (Dealer 6).

One common theme running through these quotes is the crucial role of video sharing apps in displaying items. This is critical in businesses dealing with tangible goods such as used automotive parts. Video sharing apps also help to reveal the level of damage in accident vehicles before buying decisions can be made. The role of modern technology can also be viewed as key in communication and pricing. Specifically, the use of new technologies aligns with the gap-exploiter model and promotes extensions in product life and is thus key to achieving resource efficiency through CBM. These are further illustrated in the next set of quotes:

"The internet is a great way of communicating with my customers … Before customers come to buy, they will need to send pictures of what they need, and you send them pictures of what you have" (Dealer 10).

"For instance, when someone has an accident vehicle to sell to us, they use WhatsApp to share the pictures with us and we can see the type of accident car that we are buying, whether it was involved in a major or minor accident. From there we can negotiate on the price for the parts to buy" (Dealer 1).

Despite the advantages of modern technologies in facilitating circularity, revalorization, and frugal innovation within the used

automotive spare parts sector, participants also highlighted the drawbacks associated with these technologies in their business activities.

> *"The danger with new technology is that it doesn't allow the younger generation to go through apprenticeship as they need to do. They always feel that the knowledge they learn through [online] technology is enough to establish their businesses with"* (Dealer 1).

The quotes above underscore the centrality of digitalization and technology in achieving resource efficiency through CBM. Moreover, the adoption of new technologies in the used automotive parts sector, as indicated by our interview quotes, aligns with the gap-exploiter model (Bakker et al., 2014) and promotes extensions in product life (e.g., Kühl et al., 2023) and product value (Bocken et al., 2016). This suggests a diverse form of digital inclusion that is based on the benefits of technology being paramount rather than digital skills and other factors that have been viewed critical for adoption (e.g., Choudrie et al., 2022). However, participants also revealed the downsides of embracing new technologies, especially among the new generation of entrepreneurs. Interestingly, the respondents are not applying the digital technology that prevails in developed contexts, e.g. digital diagnostics, but find alternative ways of operating, which illustrates a major market difference.

4.5. Linking the participants' business activities to the circular economy in Africa

In this section, we assess the participants' management practices and efforts to reduce hazardous environmental effects and to advance their environmental sustainability management. The findings show mainly awareness on pollution and waste management aspects, but less reference on frugal innovation on solutions. The quotes below consistently highlight the principles that nothing should be discarded, all items are recyclable, and environmental offenders should face penalties.

> *"I have attended a few seminars on waste management, and we were taught that everything has a resaleable value, and that nothing should be thrown away, even your old phones"* (Dealer 2).

> *"Although I have never attended any training on waste management, but I am aware that the oil that is poured inside the gutters pollute our environment"* (Jobber 5).

> *"We dispose of our waste by selling them to the scrab dealers after gathering them to a large quantity, then the scrab dealers will now sell it to the company where they can be recycled"* (Dealer 7).

> *"No. we don't need such training [on waste management]. Everyone here knows that when you pour waste like engine oil on the ground, you will be penalized"* (Dealer 9).

As can be seen above, participants are aware that everything has a resaleable value, and that nothing should be thrown away. Although perpetrators of environmental pollution are fined, a small number (of participants) are still adamant/ignorant of environmental sustainability management practices. This also undermines management efforts to reduce hazardous environmental effects. However, the key message in these sets of interview responses is that in the context of used automotive parts, nothing should be discarded, as all items are resaleable/reusable/recyclable. This message that *'nothing should be discarded'* is further illustrated in the next set of quotes:

> *"We have an association that manages everything we do. For instance, if you want to pour engine oil from the car, you must make sure that none pours on the ground, otherwise you will be fined N5,000. So, we are very careful about the way we handle our waste products like engine oil to avoid environmental pollution, otherwise the person will be fined"* (Dealer 4).

> *"The effects of used car parts on our environments is that since used car parts contain pollutants like engine oil and grease, and you need to wash them out by the use of fuel or diesel, and recall that petroleum products, sewage and garbage are among the most common sources of environmental and water pollution, when the oil, grease and fuel find their way to water body, they float on water and kill most of the marine in the affected area. It can even prevent people from using the beach for recreation. Sometimes, detergents which can be used to clean up oil sticks can themselves be harmful because they contain large amount of tetra oxo sulphate (vi) which promotes algae and weed growth"* (Dealer 6).

Next to basic understanding of waste management among some participants, certain interview responses revealed a notable level of ignorance. For example, some participants debated perceived advantages of engine oil disposal on the soil and the notion of a safe time of day to release pollutive substances into the atmosphere.

> *"No. we have not been trained in waste management"* (Dealer 3).

> *"The effect is that any place you pour something like engine oil, all these harmful organisms like snake, scorpion etc. will be very far from such place and grasses cannot grow in that place too"* (Mechanic 4).

> *"Any place you pour the diesel, harmful organisms like Snake, Scorpion, ant will be far from there and it eradicates grasses as well"* (Dealer 8).

> *"Burning of tyre in the daytime should be avoided but should be done at night when people have left the environment to avoid air pollution. But this can be controlled by passing strict laws that will make people to comply with anti-pollution regulations and be burning the tyres in an incinerator in other to eradicate environmental, air and water pollution"* (Mechanic 6).

Participants also attributed the issue of unwanted spare parts from overseas being dumped in the continent to importers, placing blame on them for this practice.

> *"It will be nice if importers will only import better parts, just as you will have in overseas, so they don't create more work for us, as we sometimes work harder to make some of the goods saleable when they arrive from overseas"* (Dealer 4).

> *"Another problem here is that some of the second-hand car parts that are imported from overseas are almost nonreusable, and you will not realize this until you receive them from the importers … Then you will realize that they have outlived their usable lifespan"* (Dealer 10).

This section aligns with the CBM strategy and circular economy principles that focus on value creation and delivery (Kirchherr et al., 2017). It reflects the restructuring of product and service lifecycles, emphasizing how participants aim to extract maximum value from minimal resources (Geissdoerfer et al., 2020). The quotes demonstrate how participants reformulate value propositions and develop value chains, highlighting their commitment to achieving frugal innovation. The findings also emphasize the significance of multi-stakeholder collaboration and the role of new technology in advancing circularity, revalorization, and frugal innovation in the used automotive parts sector while developing localized solutions (Chirumalla et al., 2022; Okorie et al., 2021; Reim et al., 2021).

5. Discussion and implications

Our findings offer theoretical, practical and policy implications. This research sheds light on the unique characteristics, practices and potential of the used automotive parts business in the developing automotive aftermarket, an area that has been largely overlooked in the broader discourse on the circular economy (Elo and Katsardis, 2024). These findings establish a significant connection between revalorization, localized frugal innovation, digitalization, and the sustainability dynamics of the used automotive parts business through employed

management and operational practices as shown in Fig. 2 presented earlier. The study implications are discussed in detail as follows.

5.1. Theoretical implications

This study contributes significantly to the theoretical understanding of frugal innovation and circular economy practices, particularly in resource-constrained environments like Nigeria's automotive aftermarket sector. By examining the interplay between revalorization and frugal innovation principles, the findings advance multiple theoretical domains, as discussed below.

Frugal innovation in informal economies: The study extends the concept of frugal innovation by demonstrating how resource-constrained contexts foster creative solutions to achieve sustainability and economic goals. Practices such as refurbishing and repurposing automotive parts exemplify resource optimization, cost-effectiveness, and adaptability, core principles of frugal innovation (e.g., Radjou et al., 2012; Rosca et al., 2018). By addressing the economic needs of low-income consumers and leveraging local ingenuity, this study provides empirical insights into how frugal innovation operates in informal settings, enriching theoretical discussions on its application beyond structured industrial systems.

Circular economy beyond formal systems: Traditional circular economy literature often emphasizes formal, structured supply chains in developed markets. This study highlights how circular practices, such as revalorization, can thrive in informal economies, driven by local expertise and cultural contexts. These findings broaden circular economy theory by demonstrating how informal networks and practices contribute to sustainability goals, aligning economic resilience with environmental preservation (Gelbmann and Hammerl, 2015; Geissdoerfer et al., 2020).

Socio-technical perspectives on circularity: The integration of revalorization and frugal innovation emphasizes a socio-technical lens, where social structures (e.g., informal networks, cultural norms) and technical solutions (e.g., repair and reuse methods) interact to create value. This study reveals how local conditions shape the implementation of circular practices, extending the socio-technical perspective in sustainability literature (e.g., Zoogah et al., 2023).

Framework for resource-constrained value creation: The study introduces a framework for value creation in resource-constrained environments by showing how revalorization aligns with frugal innovation principles. These practices minimize waste, reduce costs, and foster sustainability, creating value for both consumers and businesses. This dual focus on economic and environmental outcomes advances theories on circularity in developing and under-researched markets (e.g., Ebolor et al., 2022; Barnard et al., 2017).

Scalability of frugal and circular practices: By exploring how revalorization practices are localized to specific contexts, this study contributes to theories of scalability and adaptability. The findings suggest that frugal innovation frameworks must incorporate contextual constraints while enabling the transfer of circular practices to similar markets. This theoretical insight provides a pathway for future research on the global application of localized practices, contributing to both frugal innovation and circular economy literature (e.g., Radjou et al., 2012).

5.2. Integration with existing literature

This study offers significant novelties to the existing literature on Bottom of the Pyramid (BoP) markets, circular economy, and frugal innovation, particularly within the African context. Prior research has emphasized the importance of customized, locally relevant innovations to address the unique challenges faced by BoP markets, especially in Africa (Kuo and Ng, 2016; Mwangi, 2023). Our research extends these insights by exploring how revalorization and circular practices in Nigeria's automotive aftermarket sector align with frugal innovation principles, thereby creating value in resource-constrained environments.

The literature on frugal innovation has traditionally focused on tangible products and manufacturing processes in sectors like automotive engineering (Sharmelly and Ray, 2018; Tiwari and Bergmann, 2018). This study expands the discussion by highlighting the role of digital tools in supporting these practices within the BoP context. The integration of modern technologies, such as WhatsApp for communication, underscores the importance of digital inclusion in enhancing business operations and sustainability efforts in BoP markets (Choudrie et al., 2022).

Furthermore, our research addresses a gap identified in previous studies by focusing on the underexplored area of circularity and revalorization in the African automotive aftermarket sector (Subramoniam et al., 2009; Elo and Kareila, 2014; Gerrard and Kandlikar, 2007; Prochatzki et al., 2023). The practices of refurbishing, repurposing, and recycling automotive parts demonstrated by our participants are critical to achieving circular economy objectives, thus contributing to the broader global sustainability agenda and its practices.

5.3. Comparison with alternative contexts

Compared to more traditional, Western-centric approaches to sustainability and circular economy, this study's focus on locally developed practices in a BoP market provides unique insights into how these principles can be applied in resource-constrained environments. While much of the existing literature emphasizes structured supply chain models in developed markets, our study reveals that flexibility and adaptability are crucial in the BoP context, where formal structures may be less prevalent.

The interpretivist epistemology guiding this research allowed for a deep understanding of the participants' perspectives, which is crucial in contexts where informal practices play a significant role. This approach contrasts with more positivist methodologies that might overlook the nuanced, context-specific strategies employed by stakeholders in BoP markets.

5.4. Practical implications

The practical implications of this study are significant. The findings reveal that revalorization and circularity practices in African automotive aftermarket sector are not only feasible but essential for promoting sustainability and economic resilience in BoP markets. These practices enable stakeholders to maximize the use of limited resources, thereby contributing to local economic development while minimizing environmental impact.

The findings elucidate how automotive parts can undergo repair, refurbishment, and recycling processes to extend their lifespan, value and even revalorization into something different. Further, they contribute by underscoring a different, but pivotal role of digital technology in modern African daily operations, which also contributes to resource efficiency, operational streamlining, and the promotion of a circular economy diverting from the practices employed in developed countries. Furthermore, our study introduces a bottom-up approach; the importance of stakeholder collaboration involving dealers, mechanics, and jobbers in managing circularity and sustainability in the automotive aftermarket. Such collaborations may nurture more sustainable management within businesses partnerships and maintain open communication channels to optimize the extraction of value from the finite resources they handle, and they may transfer instrumental learning for others (e.g. concerning problem solving). These aspects present significant takeaways for large multinational firms and other players in the automotive sector as how they can utilize revalorization potential to contribute to sustainability especially in BoP markets.

Our findings further highlight BoP characteristics in the value chain where classic suppliers and aftermarket organizations are yet less

present, while smaller local actors are more dominant actors. Findings also reveal the roles of these actor types – the mechanics, the dealers, and jobbers – in reaching local innovative solutions. This illustrates a different management context, level and practices from that of developed countries and a different need for cost-efficient circularity. For instance, mechanics acquire these second-hand automotive parts, sometimes apparently rather irregularly or even informally. Then they modify, readjust, and use the same commodity for repair of different types of vehicles. This revalorization reflects frugal innovation and creative practices; where an engine is no longer suitable for use in any car, the mechanics convert such an engine for use in flying boat, or for another useful purpose. For instance, where a shock absorber cannot be used in a car, the spring can be used to construct a chair. Metallic parts of a car are also converted into other household items like cooking pots or frying pans. For the jobbers, they sometimes visit the scrapyard to exchange unusable items at their disposal with items of value at the scrapyards. Also, when the jobbers receive any item, they spend time washing and get it cleaned up to make them resaleable. For the dealers, they buy completely faulty vehicles, dismantle such vehicles, take some parts that can be fixed, repair such parts themselves before sampling them in their shops. For some items that have outlived their useable life spans, such as second-hand and worn tyres, the dealers wash the tyres and if any leaks or holes are discovered on any tyre, they re-fill them, redraw the lines on the tyres, rub potty on the body to give it a new look, before displaying it on their shops. Even used engine oils are never a waste, as the dealer fills them in cans before selling them to potential buyers. These practices show how our participants exercise sustainability by creating value to BoP customers through a range of waste minimization and local resource optimization practices. These value creation activities originating from revalorization have the potential to be benchmarked by large automotive sector players as well as in developed economies in some way as well, where the focus on sustainability is even higher these days.

5.5. Policy implications

The automotive aftermarket encompasses a wide spectrum of enterprises, ranging from large corporations to small and medium-sized enterprises (SMEs) and micro businesses of less than 10 employees. Smaller businesses, like jobbers or mechanics, often contend with limited resources, including workforce, financial means and managerial knowledge. Consequently, policy efforts should be directed towards assisting and bolstering these smaller organizations as a form of capacity building following a bottom-up approach. Despite their resource constraints, small business actors play a pivotal role in advancing circularity and revalorization and benefit from support in adopting modern technologies and sustainable practices, e.g. via policy incentives. Policymakers bear a crucial responsibility in shaping the trajectory of the independent players in the African automotive aftermarket towards circular economy practices. Implementing regulations and policies that align with circularity can prove instrumental. Such policies may encompass incentives to encourage recycling, penalties for environmental violations, and the establishment of standards for safety and eco-friendly disposal of vehicles and automotive parts.

The study confirms the questionable approach of developed countries to export their waste and used materials, e.g. scrap, to developing countries. Waste management and sustainability are not achieved with simple exports. Given the global nature of the used car and automotive parts business, international collaboration and agreements may be imperative to address the challenge of importing unwanted spare parts and to promote responsible disposal practices on a global scale.

Furthermore, the growing familiarity with circular economy principles, sustainability, and related concepts underscore the importance of education and knowledge dissemination. Government initiatives can play a pivotal role in promoting educational and training programs designed to enhance understanding among all automotive industry stakeholders. These programs may focus on circular economy principles, waste management, and sustainable practices. Finally, fostering development in the field of circular economy necessitates investments in research and development (R&D) initiatives aimed at driving innovation in circularity and revalorization techniques for used automotive parts. Government funding can provide essential support to initiatives exploring new technologies and sustainable business models, ultimately contributing to advancing circular economy practices in the automotive sector.

6. Limitations, future research directions and conclusions

Despite its contributions, this study has certain limitations inherent to qualitative research and BoP research context, including constraints related to generalizability. For instance, the research was conducted within a specific context—Nigeria's independent automotive aftermarket sector—which may limit the generalizability of the findings. Emerging economies across Africa, Asia, and Latin America demonstrate similar circularity-poverty dynamics in their informal, independent automotive aftermarkets, while other formal and more internationally connected markets differ contextually.

Circularity practices are also culture, management, and digital infrastructure-related. Future research could explore similar practices in different industries to validate and extend the applicability of these findings, including longitudinal studies addressing the economic viability of circular practices in the B2B fields (Fig. 2). Quantitative studies could measure the broader impact of these practices on environmental sustainability and socio-economic outcomes across the value chain, even including the spin-off material usage for unrelated purposes to capture the total impact. This would contribute to better data, as data limits and inhibits performance tracking needed in Africa to reverse the negative trend on climate action (Goal 13) and strengthen statistical systems to track performance particularly on good governance (SDG 16) (Africa Sustainable Development Report, 2024).

As this study represents pioneering work highlighting the significance of revalorization, frugal innovation, and digitalization within the circularity of the automotive aftermarket business, it opens up numerous avenues for future research from business management to governance. Additionally, given the growing importance of circularity in developed Western economies, there is a need for specific interdisciplinary and multi-method research on revalorization in contexts involving used vehicles, machinery and other second-hand products. There is limited research on international circularity and waste management. However, used goods and materials constitute a complicated and criticized field of export business, partly involving also hazardous materials and inappropriate waste processing in destination countries. Thus, assessing critically what 'exports' represent beyond custom items is of relevance also for sustainable international business. This calls for a more holistic understanding of the different actors and their networks, trade routes, and activities for supply chain sustainability.

Institutionally, as regulatory measures drive many circularity initiatives, future scholars should explore the specific role of regulations in the context of used automotive parts and revalorization settings, also internationally. Issues such as safety, transnational traceability and practices deserve attention in policy studies.

Finally, building on our findings on theory, context, content and methodology, we interconnect those and propose a range of research questions related to future revalorization and circularity in used automotive parts research in the BoP setting (see Appendix 2).

In conclusion, this study provides valuable insights into the application of circular economy principles and frugal innovation in the African (Nigerian) automotive aftermarket sector. By focusing on revalorization and digitalization, the research demonstrates how BoP markets can achieve sustainability and economic resilience through locally developed practices. The findings contribute to the broader discourse on sustainability and circular economy by highlighting the

unique challenges and opportunities in BoP markets, particularly within the African context. The qualitative, interpretivist approach used in this study has allowed for a nuanced understanding of the local practices that drive sustainability in the Nigerian automotive sector. Future research should continue to explore these themes, expanding the scope and applicability of the findings to other contexts and regions.

CRediT authorship contribution statement

Obinna Alo: Writing – original draft, Methodology, Investigation. **Ahmad Arslan:** Writing – original draft, Project administration, Conceptualization. **Jyoti Choudrie:** Writing – original draft. **Maria Elo:** Writing – original draft, Conceptualization.

Declaration of competing interest

The authors have no conflicts of interest to declare that are relevant to this article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.technovation.2025.103231.

Data availability

The data that has been used is confidential.

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