

Zipo Stove User Satisfaction and Adoption Survey Report (Zipolopolo Survey) in Dzaleka Refugee Camp (August, 2025)

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Any errors or misrepresentations in this report remain solely our responsibility.

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EXECUTIVE SUMMARY

This report presents findings from an assessment of the Zipolopolo Fast Pellet Stove (ZIPO Stove) pilot implemented in Dzaleka Refugee Camp, Malawi, between January and August 2023. The camp, home to over 54,000 refugees, faces significant challenges in accessing clean, efficient cooking solutions, with widespread reliance on traditional biomass fuels contributing to environmental degradation, health risks, and economic strain.

The study employed a descriptive cross-sectional survey design using a mixed-methods approach, combining quantitative household questionnaires with qualitative key informant interviews (KIs) and focus group discussions (FGDs). This design enabled the documentation and understanding of user experiences, satisfaction levels, and perceptions of the ZIPO Stove at a single point in time. A small group of non-users (20 respondents) was included to provide additional context on awareness, alternative cooking practices, and potential adoption barriers.

The ZIPO Stove pilot aimed to promote a locally produced forced-draft gasifier cookstove using sustainably sourced biomass pellets. Over 1,000 stoves were distributed through a subsidized sales model to encourage uptake. Following subsidy withdrawal, demand for stoves and pellets declined, highlighting persistent adoption barriers.

However, based on the Study findings, Overall, Users appreciated the stove's cooking speed, fuel efficiency, and affordability, but reported dissatisfaction with exorbitant prices after the subsidy of which many could no longer afford, Scarcity of Pellets for use within the camp, smoke emissions, ash outlet clogging, and frequent mechanical failures, which hindered sustained use. Among non-users, low awareness, high cost, limited pellet availability, and usability concerns were major obstacles, with only a quarter indicating willingness to purchase if pellets were affordable and accessible. The findings also show that inconsistent pellet supply and high costs, coupled with limited local production, further constrained adoption.

Socio-cultural factors, including entrenched cooking practices and gender roles, also influenced stove uptake. Women were primarily responsible for cooking, yet limited participation in household decision-making restricted adoption. While most users received initial training, ongoing support and accessible repair services were insufficient, contributing to stove abandonment.

To address these challenges, stove design and durability should be improved alongside strengthened after-sales support. Pellet supply chains can be enhanced through community-based production and diversified distribution channels, while flexible financing options, including targeted subsidies and pay-as-you-go schemes, could increase affordability. Culturally sensitive, multilingual training and behavior change communication campaigns, leveraging community platforms such as YETU radio and peer advocacy from satisfied users, are critical to improving awareness and correct usage. Establishing local repair networks, fostering entrepreneurship, and implementing robust monitoring and sustainability mechanisms will further support long-term adoption.

By integrating technical, social, and economic interventions, the ZIPO Stove program can achieve higher adoption rates, improved health outcomes, and long-term environmental benefits. Lessons from Dzaleka are broadly applicable across Malawi and similar contexts in

sub-Saharan Africa, contributing to global efforts toward universal access to clean cooking by 2030.

INTRODUCTION

1.1. Global and Regional Context

Access to clean, efficient, and sustainable cooking solutions remains a critical development challenge globally, particularly in low- and middle-income countries where reliance on traditional biomass fuels continue to dominate. Globally, as of 2023, more than **2.1 billion people** still depend on solid fuels such as firewood, charcoal, and crop residues for cooking, contributing to severe health risks, environmental degradation, and economic burdens (International Energy Agency, 2023) (World Health Organisation, 2024). Household air pollution from traditional cooking methods is responsible for an estimated 3.2 to 3.7 million premature deaths annually, disproportionately affecting women and children (International Energy Agency (IEA), 2022) (World Health Organisation, 2024).

In Sub-Saharan Africa and South Asia, exposure remains particularly high with over 75% of the population in some regions still using polluting fuels (Burkart, Katrin G, 2025). These impacts highlight the urgent need for accelerated investment in clean cooking technologies and scalable interventions to improve public health, environmental sustainability, and gender equity.

The slow uptake of improved cookstoves (ICS) is influenced by multiple **socio-economic, cultural, financial, and infrastructural barriers**, including high upfront costs, limited awareness, cultural preferences, income variability, and constrained market availability, particularly in rural and low-income communities. For example, a 2024 study in Ethiopia found that **low income, larger family size, limited education, and age** significantly hindered adoption, while high costs and poor awareness remained key obstacles (Ashagrie, et al., 2024). In Malawi, similar barriers emerge—economic hardship, upfront expenses, and the affordability gap stand in the way of ICS uptake (ICLEI, 2023).

1.2. Context of Clean Cooking in Malawi

Malawi's population remains heavily dependent on traditional biomass fuels. According to the 2019–20 Malawi Integrated Household Survey (IHS5), virtually **98.8% of households** rely on **solid fuels**, mainly firewood (79.1%) and charcoal (18.5%), for cooking. Reliance is particularly high in rural areas, where nearly **100%** of households depend on solid fuels, compared to around **93.7%** in urban areas (National Statistical Office, 2021). Recognizing the serious health, environmental, and economic impacts of traditional cooking practices, Malawi has committed to accelerating clean cooking access. This commitment is reflected in the 2021 Malawi SDG7 Cleaner Cooking Energy Compact, which sets ambitious national target of achieving universal access to clean cooking by 2030 (World Bank., 2023) and has a National Energy Compact, a roadmap that sets national energy targets such as **driving a sector-wide transformation** on clean cooking technologies to lower biomass demand, improve health, and enhance sustainability by 2025. aligned to the Africa Regional Energy Compact and the UN Energy Compact frameworks (Malawi Government, 2023). In addition, the country's National Energy Compact outlines a clear roadmap to transform the energy sector, including a specific goal to drive a sector-wide shift to clean

cooking technologies by 2025. This aims to reduce biomass dependence, improve public health, and promote environmental sustainability. The Compact is aligned with the Africa Regional Energy Compact and the broader UN Energy Compact frameworks (Malawi Government, 2023).

Despite these commitments, several barriers limit ICS adoption in Malawi. These include high upfront costs, supply chain inefficiencies, stove design limitations, and a lack of coordinated policies between energy and forestry sectors (Mulugetta, 2024) (Nyirenda, Banda, & Mwale, 2017). Notably, the Malawi Bureau of Standards currently lacks a formal cookstove rating system, complicating consumer choices and market regulation (Mulugetta, 2024).

Durability concerns are prominent, with studies reporting frequent breakdowns of portable wood stoves in Malawian households (Sovacool, 2023). Fuel supply challenges further impede sustained use, as consistent access to affordable pellets or improved biomass fuels remains limited, particularly in rural and refugee camp contexts (Zulu, Kamoto, Djenontin, & Jumbe, 2024). Moreover, socio-cultural norms often influence stove preferences, with traditional cooking methods deeply embedded in daily life (Kankam, Mensah, & Owusu, 2019). Several interventions seek to overcome these barriers. Programs like Foundation for International Community Assistance (FINCA) Malawi's Clean Cooking Initiative use innovative financing to increase affordability and access to energy-efficient stoves (FINCA, 2024). FINCA Malawi's program offers innovative financing to enable households to purchase energy-efficient stoves and solar-powered appliances. The loan covers all costs and is disbursed directly to suppliers, simplifying access for clients. It is supported by the Spark+ Africa Fund, with a projected reach of 10,500 clients over three years (FINCA, 2025). WFP has introduced renewable energy cooking solutions in 13 schools through its school meals program in Malawi. These include biogas systems and solar PV installations, which showcase viable, clean alternatives to traditional biomass cooking in rural educational settings (World Food Program, 2025). Additionally, community-based approaches to pellet production and distribution have shown promise in improving fuel availability and creating local employment (Inyenyeri Rwanda model; (Zulu, Kamoto, Djenontin, & Jumbe, 2024)). Pellet feedstock included a mix of **small tree branches, sawdust, and elephant grass**. However, issues such as **high moisture content** (due to rainy seasons) posed production challenges. To maintain quality, the feedstock needed to be relatively dry, aiming for a final **moisture content of 8–10%**. Inyenyeri then imported **drying equipment in 2016** to help meet this specification (Jagger & Das, 2018).

1.3. Context of Clean cooking in Dzaleka Refugee Camp

Dzaleka Refugee Camp in Malawi hosts over 54,000 refugees, many of whom face significant challenges in accessing clean, efficient, and sustainable cooking solutions. The widespread reliance on traditional fuels like firewood and charcoal is increasingly unsustainable due to resource depletion and rising costs. To address these issues, EnDev Malawi, in collaboration with Welthungerhilfe (WHH), piloted the Zipolopolo Fast Pellet Stove (ZIPO Stove), a locally manufactured forced-draft gasifier cookstove designed to operate on sustainably sourced biomass pellets.

The pilot phase, conducted between January and August 2023, involved the subsidized distribution of more than 1,000 ZIPO stoves to stimulate market demand and encourage a shift from conventional cooking methods. However, following the removal of subsidies, demand for both

the stoves and pellet fuel dropped significantly. This decline underscores ongoing barriers to widespread adoption and sustained use, including financial limitations, technical issues, and deeply rooted cultural cooking preferences.

2.0. PURPOSE AND OBJECTIVES OF THE ASSESSMENT

Despite the initial distribution of over 1,360 ZIPO stoves during the subsidy period, subsequent demand for both the stoves and pellet fuel had diminished significantly following the withdrawal of subsidies. This decline signals persistent barriers to adoption and sustained use, underscoring the need for a deeper understanding of user experiences, challenges, and the factors influencing household decisions regarding clean cooking technologies.

In this context, GIZ/EnDev Malawi commissioned this comprehensive user satisfaction survey to assess the current status of ZIPO stove adoption, usage patterns, and user satisfaction among residents of Dzaleka Refugee Camp.

3.0. METHODOLOGY

3.1. Study Location and Period

The study was conducted in Dzaleka Refugee Camp, located in Malawi, which is home to over 54,000 refugees from diverse linguistic and cultural backgrounds. The camp setting presents unique challenges related to resource availability, infrastructure, and social dynamics, making it an important context for assessing clean cooking interventions. Data collection took place over a two-week period in July 2025.

3.2. Study Design

The study employed a descriptive cross-sectional survey design using a mixed-methods approach that combined quantitative and qualitative data collection. Quantitative data were gathered through structured household questionnaires to provide measurable insights into usage patterns, satisfaction levels, and demographic factors. Concurrently, qualitative methods, including key informant interviews (KIs) and focus group discussions (FGDs), explored user experiences, perceptions, and contextual factors influencing stove uptake and pellet supply. This design was selected because the primary objective was to document and understand the experiences, satisfaction levels, and perceptions of ZIPO Stove users in Dzaleka Refugee Camp at a single point in time. The inclusion of a small group of non-users (20 respondents) provided additional context on alternative cooking practices and awareness levels, rather than serving as a statistically robust comparison group.

A descriptive survey was deemed most appropriate given the absence of baseline data, the non-comparative nature of the objectives, and the focus on generating practical, user-centered insights. Quantitative data captured household-level usage patterns, satisfaction ratings, and stove performance metrics, while qualitative data from focus group discussions and key informant interviews explored attitudes, challenges, and enablers in greater depth.

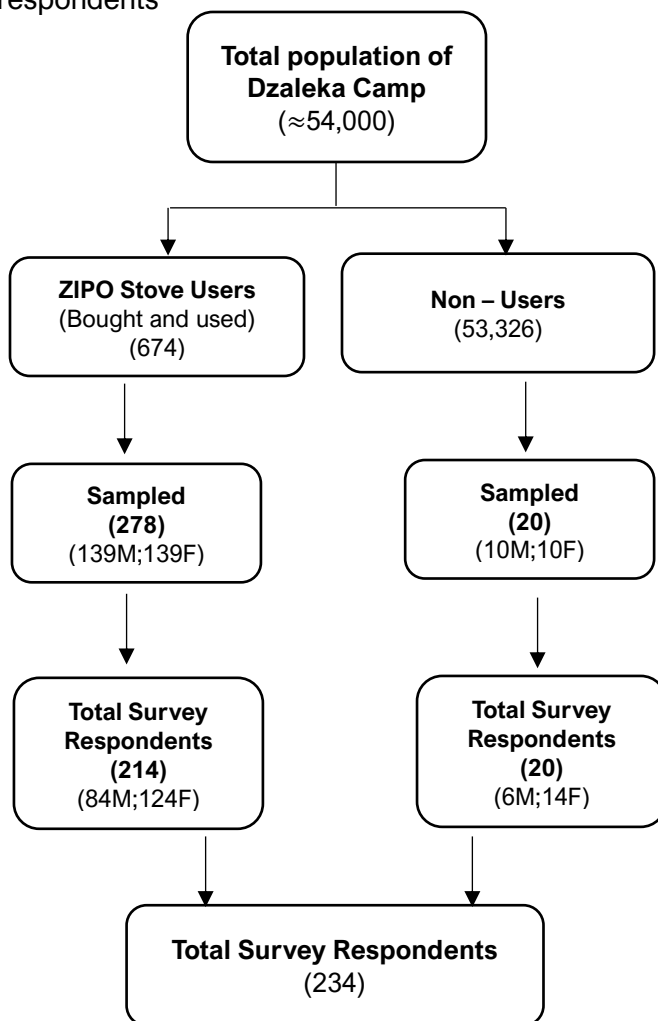
3.3. Sampling and Sample Size

The study targeted both ZIPO Stove users and non-users to capture a broad understanding of user experiences and perceptions. For stove users, a simple random sampling method was applied. GIZ initially provided a list of over 1,000 ZIPO Stove users, from which **674 users were** deemed eligible, specifically those with valid mobile phone contacts. Using this eligible list as the sampling frame, **214 users** (124 females and 84 males) were randomly selected, ensuring that each had an equal probability of being included in the survey. This random selection helped minimize selection bias and supported the representativeness of findings among stove users. The inclusion of both male and female respondents ensured that the analysis of stove adoption and cooking practices was gender-sensitive and inclusive. In addition, 20 non-users were purposefully sampled using a snowballing technique. These respondents were identified through referrals from community members and other participants to provide insights into the perspectives of those who had never purchased or used the ZIPO Stove. While non-users were not intended to form a statistically representative group, their inclusion offered contextual understanding of barriers to adoption and reasons for non-use but also insights on perceptions and misconceptions about the Stove. These insights will be very important in developing effective BCC campaigns by identifying

the most relevant communication channels and messages to address their specific concerns and motivations.

This combined approach enabled the study to collect robust quantitative data from users while supplementing it with more insights from non-users, enhancing the overall understanding of stove adoption, satisfaction, and barriers within the Dzaleka Refugee Camp.

Figure 1: Total survey respondents



To complement and contextualize the quantitative findings, the study incorporated qualitative data collection through key informant interviews (KIs) and focus group discussions (FGDs). Three KIs were conducted with representatives from the Dzaleka Camp Coordination Unit (DCCU), Welthungerhilfe (WHH), and the ZIPO stove manufacturing company, providing institutional perspectives on stove distribution processes, training approaches, and supply chain challenges. In addition, three FGDs were held with distinct user groups, male, female, and youth participants, to facilitate open discussions on user experiences, challenges, cultural dynamics, and recommendations for enhancing stove adoption and usage.

3.4. Data Collection Tools and Methods

Household Survey

Quantitative data were collected using structured household questionnaires administered by trained enumerators. To accommodate the linguistic diversity of the camp population, the questionnaire was carefully adapted and translated into French, Swahili, and Kinyarwanda. Digital data collection tools, specifically tablets, were employed to improve accuracy and streamline the data capture process.

Focus Group Discussions and Key Informant Interviews

Complementing the quantitative approach, qualitative data were gathered through semi-structured interview guides for key informant interviews (KIIs) and facilitation guides for focus group discussions (FGDs). These qualitative tools were designed to delve deeper into participants' attitudes, challenges, and enabling factors surrounding the use of the ZIPO stove and the availability of pellet fuel.

3.5. Data Analysis

Quantitative data collected through household questionnaires were systematically cleaned and analyzed using Stata 15 to generate descriptive statistics, frequencies, and cross-tabulations that highlight patterns of stove use, satisfaction levels, and demographic correlations. Data quality checks were performed to ensure accuracy and consistency, leveraging the digital collection platform's validation features.

Qualitative data from key informant interviews (KIIs) and focus group discussions (FGDs) were transcribed verbatim and translated into English where necessary. Thematic analysis was conducted using a coding framework developed both deductively, based on the study objectives, and inductively, to capture emergent themes from the data. This approach facilitated identification of key attitudes, challenges, and enablers related to ZIPO stove adoption and pellet supply. The qualitative findings were triangulated with quantitative results to enrich the interpretation and provide a comprehensive understanding of user experiences.

3.6. Ethical Considerations

The study was conducted in accordance with ethical principles to ensure the rights, dignity, and safety of all participants. Prior to data collection, ethical approval was obtained from the relevant local authorities overseeing research activities within the refugee camp, the Camp Administrator. Informed consent was sought from all participants after clearly explaining the study's purpose, procedures, potential risks, and benefits. Participation was entirely voluntary, and respondents were assured of their right to withdraw at any time without penalty.

Confidentiality and anonymity were rigorously maintained throughout the study. Personal identifiers were removed from data sets, and all information was securely stored with access restricted to the research team. Additionally, findings are reported in aggregate form to prevent the identification of individual participants.

3.7. Study Limitations

Several limitations should be noted in interpreting the study findings. First, the reliance on self-reported data may introduce recall bias or social desirability bias, particularly regarding stove use and satisfaction. Additionally, because the data were collected at a single point in time, the findings reflect the situation as reported during the survey period and may not capture seasonal or longer-term changes in perceptions.

3.1. Study Challenges

A notable challenge during recruitment was the difficulty in tracing some of the intended respondents. The household listing provided was not always complete, several entries lacked contact numbers, while others contained numbers that were either inactive or unreachable. In some cases, the listed contacts belonged to neighbors rather than the stove owners, complicating efforts to locate the correct individuals. Furthermore, a portion of respondents, though reachable, had relocated from the camp, as more than two years had passed since their stove purchase. In other instances, respondents had left the country altogether. These challenges inevitably reduced the number of eligible participants. To address this, the team used a pre-identified backup list of respondents, cross-referenced household details with local leaders, and employed multiple contact methods (phone calls, text messages, and in-person visits) to maximize the chances of reaching the targeted households.

4.0. KEY FINDINGS

4.1. Response Rate

Table 4.1 shows that 214 user households were successfully interviewed, resulting in an overall response rate of 86%. Female respondents among users had an exceptionally high response rate of 99% (124 out of 125), while male respondents had a lower response rate of 67% (84 out of 125). For the 20 non-user households, 70% were female (14 households) and 30% were male (6 households). These non-users were included to provide comparative insights into household characteristics and cooking practices.

Table 4.1: Number of Households and Response Rate				
Sex	ZIPO users		ZIPO non-users	
	Frequency	Percent	Frequency	Percent
Male	67	84	6	30
Female	124	99	14	70
Response rate	214	86	20	100

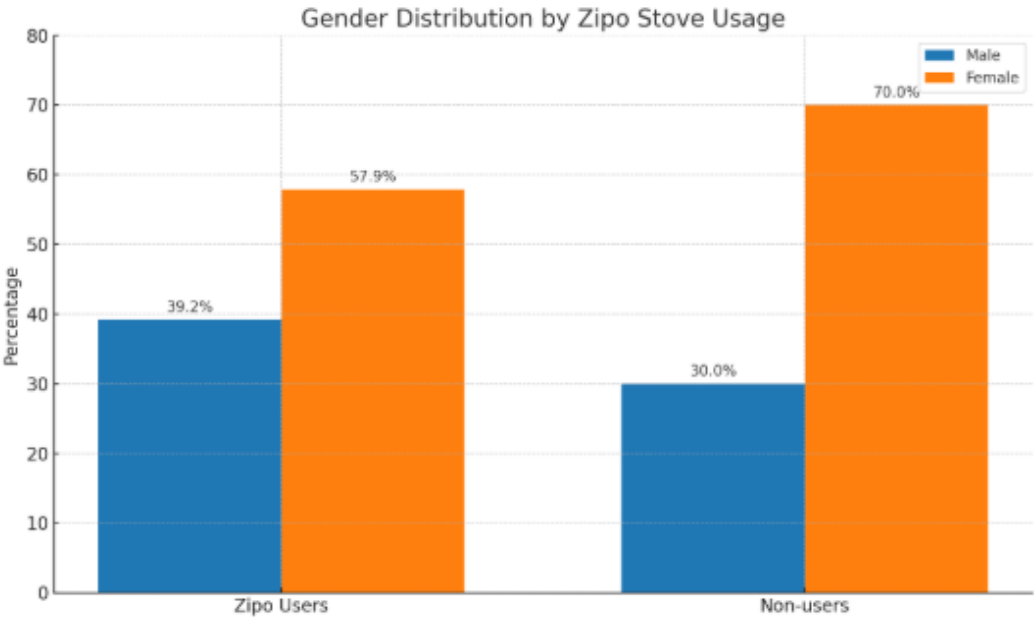
Overall, the inclusion of both users and non-users allowed for a more comprehensive understanding of stove adoption patterns, with the gender distribution highlighting potential differences in availability, willingness to participate, and household dynamics influencing study participation.

4.2. Background Characteristics of Respondents

Respondent distribution by sex

Figure 4.1 illustrates the distribution of ZIPO Users and non-user respondents by sex, showing that female participants constitute 57.9 percent of the sample, while male participants account for 39.2 percent. For non-users, female participants comprised 70 percent while male counterparts were 30 percent. Although not all female respondents, were household heads, they were more numerous, reflecting a significantly higher response rate among women (99%) compared to men (67%). Nonetheless, both genders are substantially represented. This level of representation enables the integration of gender perspectives in the analysis, supporting a more comprehensive understanding of usage patterns and satisfaction levels with the ZIPO stove in Dzaleka Refugee Camp. However, from a methodological standpoint, the lower male participation rate means the findings may be somewhat more reflective of female experiences, and this should be considered when interpreting gender-results.

Figure 4.1: Respondent distribution by sex



Respondent distribution by language

The study was conducted using multiple languages to effectively engage the diverse population of Dzaleka Refugee Camp. Figures 4.2 and 4.3 show that Swahili was the most widely used

language among both ZIPO User and non-user respondents, accounting for 72 percent (155 users) and 85 percent for non-users, followed by Kinyarwanda at 21% (44 users), and French at 7% (15 users) and 15 percent for non-users. This multilingual approach ensured inclusivity and accuracy in capturing user experiences, barriers, and preferences related to the ZIPO stove. Employing local languages not only facilitated better communication during training and data collection but also enabled deeper insights into stove adoption and usage. This linguistic diversity underscores the importance of language-sensitive programming in future projects to foster greater participation, comprehension, and sustainability of clean cooking initiatives in the camp.

Figure 4.2. Respondent distribution by language (ZIPO Users)

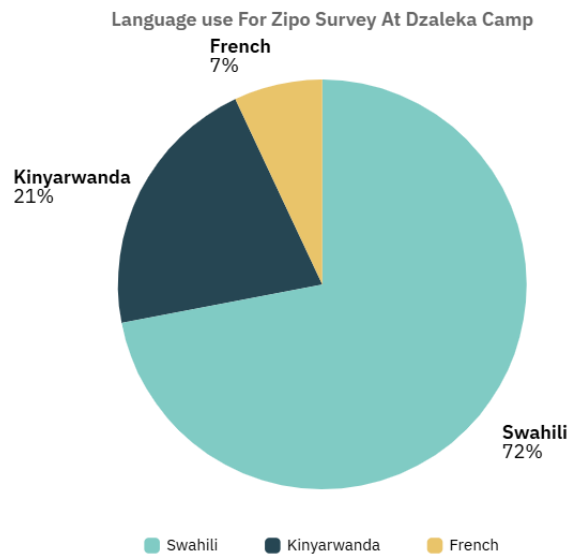
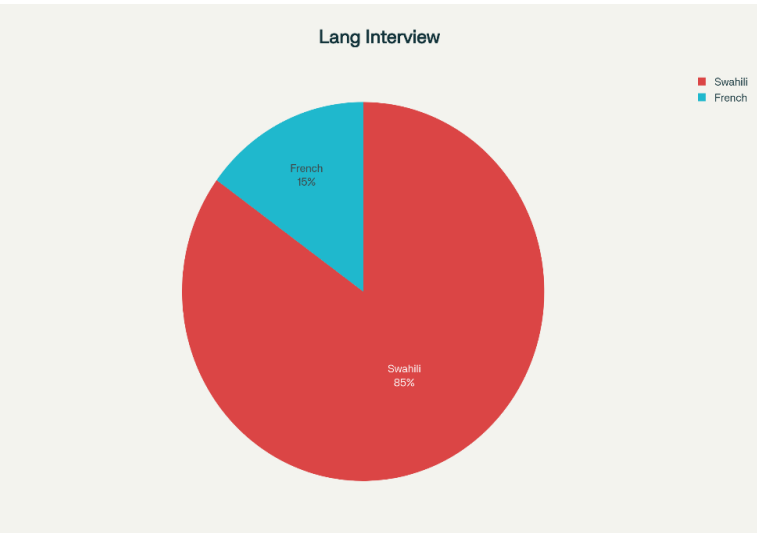


Figure 4.3. Respondent distribution by language (No-users)



Household size

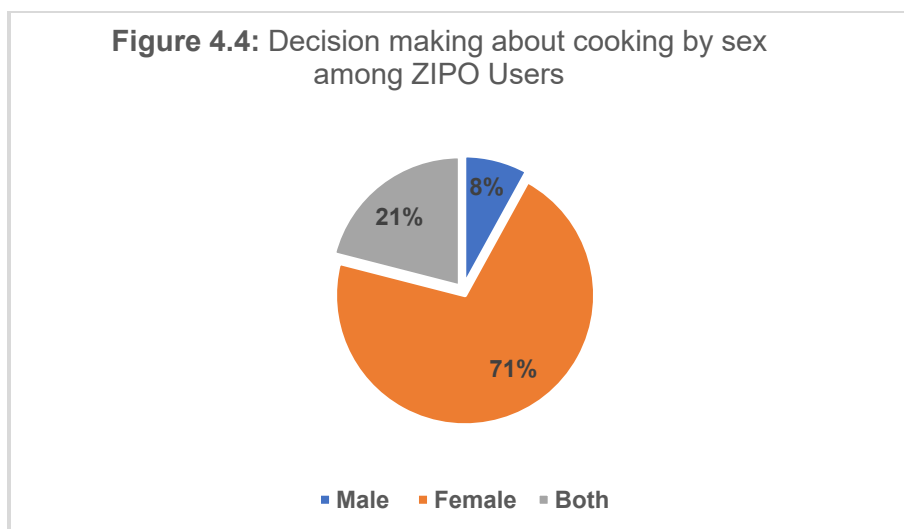
Household sizes in the sample vary widely, ranging from a single individual to as many as sixteen members, with an average of six persons per household. For the non-users, the household size varied from one to thirteen members with an average size of seven members. This reflects moderately large family units typical of the Dzaleka refugee camp context. In comparison, the average household size in Malawi is approximately 4.4 persons, according to the most recent Demographic and Health Survey data (NSO, 2024). The larger household sizes in the refugee camp have direct implications for cooking demand, stove usage frequency, and fuel requirements. Consequently, understanding household size is critical for assessing fuel needs and cooking patterns, which influence the adoption of stoves and fuel consumption behaviors. These differences underscore the importance of tailoring cooking technology interventions to the specific household dynamics of the refugee population, which may differ significantly from national averages.

The findings highlight the central role of women in household cooking decisions. Among ZIPO stove users, **71% (n=152)** reported that women are the primary decision-makers on what to cook. Similarly, **75% of non-users** indicated the same. This underscores the consistent and predominant influence of women in managing household cooking practices across both groups.

4.3. Decision Making about Cooking

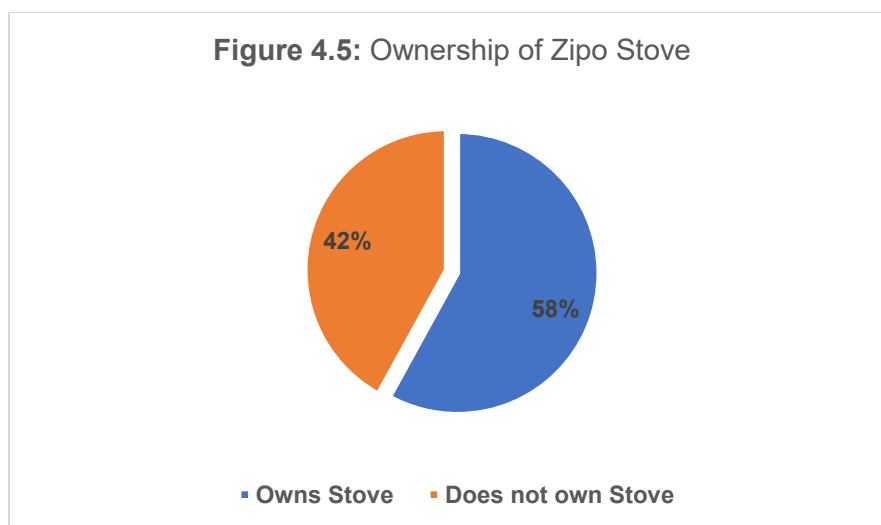
The findings highlight a central role of women in household cooking decisions. Among ZIPO user respondents, 71 percent (n=152) indicated that women are primary decision-makers on what to cook. Similarly, 75 percent of non-users indicated the same. This underscores the consistent and predominant influence of women in managing household cooking practices across both groups. This aligns with established gender norms in Malawi, where cooking is widely regarded as a woman's domain (Chirwa, Nthala, & Nyirenda, 2020) (Nyirenda, Banda, & Mwale, 2017). Joint decision-making between men and women was reported by 21 percent (n=45) of households among ZIPO users and 10 percent among non-users, reflecting some degree of shared responsibility or consultation on cooking choices. This minority group highlights potential opportunities for inclusive interventions that engage both genders to promote clean cooking technologies. Conversely, only 8 percent (n=17) of ZIPO user respondents identified men as sole decision-makers regarding cooking while for non-users, it was 15 percent, emphasizing that men rarely exert exclusive control over cooking-related decisions. This finding is consistent with prior research in Malawi that points to women's dominant role in cooking and fuel management, while also recognizing the importance of involving men to support sustained adoption of improved cooking solutions (Lewis & Pattanayak, Who adopts improved fuels and cookstoves? A systematic review., 2012) (Kankam, Mensah, & Owusu, 2019).

These gender dynamics suggest that clean cooking programs should primarily target women through tailored training and behavior change communication, while also designing strategies to engage men as supportive allies.



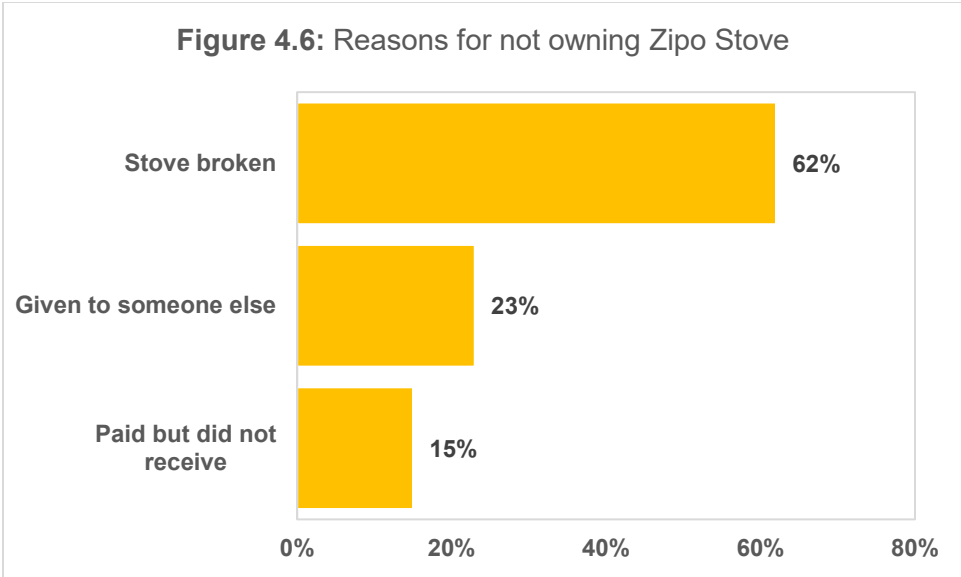
4.4. ZIPO Stove Ownership

Figure 4.5 shows that approximately 58 percent of respondents currently own a ZIPO stove, indicating a relatively high ownership rate and demonstrating the strong reach of the stove distribution program. However, the remaining 42 percent of households without a ZIPO stove highlights ongoing challenges related to adoption and attrition. This suggests that a significant proportion of households may still be relying on less efficient and more harmful cooking methods, such as charcoal or firewood, underscoring the need for targeted efforts to increase stove uptake and retention.



Factors for not owning ZIPO Stove

According to **Figure 4.6**, among respondents who do not currently own a ZIPO stove, 62% reported that the stove was broken, indicating significant concerns about the product's durability and reliability. This high rate of stove breakage mostly the fun among former owners highlights potential challenges in maintaining user trust and satisfaction. Additionally, reports of unfulfilled purchases, where households paid for stoves but never received them, point to logistical or distribution issues that may further undermine confidence in the program.



Other reasons for non-ownership included households giving the stove away, suggesting the need to better understand and address factors influencing stove retention and transfer.

4.5. User Training and Awareness on ZIPO Stove Usage

A substantial majority of ZIPO user respondents, 95.2 percent (119 out of 125), reported having received training or information on how to use the ZIPO stove. Of these, 97 percent attributed this guidance to DCCU, while 3 percent learned from friends or neighbors. Only 4.8 percent indicated they had not received any instruction. This high level of user education reflects strong outreach efforts, which are crucial for promoting correct stove use and supporting adoption. This extensive training outreach reflects strong user engagement and lays a crucial foundation for the safe, correct, and confident adoption of new technologies like the ZIPO stove. By providing effective awareness and guidance, households are better equipped to maximize the stove’s benefits and minimize misuse.

Notably, 75% of non-users had never heard of the ZIPO stove or any other improved cookstove. Only 25% were aware, and among these, 60% had learned about ZIPO through friends or neighbors. This highlights the very low level of awareness among those who have never used the ZIPO cookstove and underscores the lack of information as a key barrier to its adoption and purchase.

4.6. Cooking Fuel Preference and Alternatives

Despite the introduction of ZIPO stoves and their ownership by many households, charcoal remains the predominant cooking fuel among both ZIPO users and non-users, with approximately 89 percent of ZIPO user respondents and 75 percent non-users continuing to use charcoal stoves. Additionally, some households rely on firewood or gas as secondary cooking methods. This pattern reflects fuel stacking, where multiple cooking technologies are used simultaneously, a common behavior during transitions to cleaner fuels. The persistence of charcoal use and fuel stacking may be attributed to limited availability of alternative fuels such as pellets, user

dissatisfaction, or frequent stove malfunctions. Similar trends have been documented in other studies across Malawi, where adoption of improved cookstoves is often hindered by inconsistent fuel supply and technical challenges (Nyirenda, Banda, & Mwale, 2017) (Kankam, Mensah, & Owusu, 2019). These findings underscore the critical need to improve fuel accessibility and stove reliability to support a sustained transition away from traditional cooking methods, thereby advancing fuel savings and emissions reduction goals

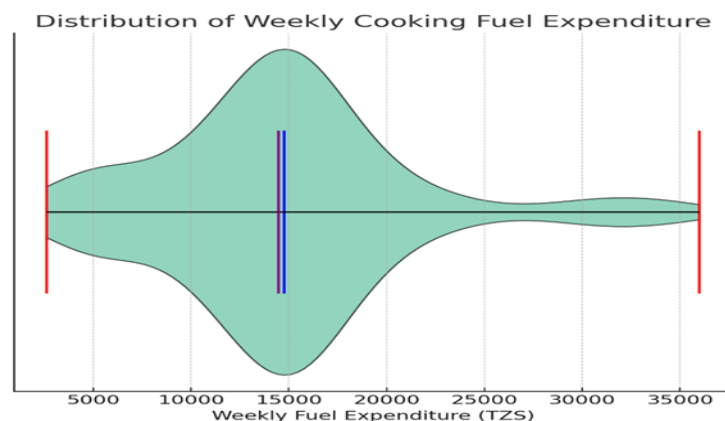
4.7. Sources and Costs of Pellets

The majority of respondents (65.6%) obtain pellets from local markets or vendors outside the refugee camp who come to sell their products at the main market, indicating a strong reliance on external commercial supply chains for pellet fuel. This dependence on local market channels exposes users to potential risks such as price fluctuations, stock shortages, and inconsistent availability, all of which can significantly impact stove usage and adoption. Ensuring stable and affordable access through these market channels is therefore critical to maintaining consistent pellet supply.

Meanwhile, approximately 34.4 percent of users purchase pellets from sellers within the camp. This internal supply infrastructure offers greater convenience and potentially reduces travel and waiting times for residents. However, in-camp pellet distribution may be limited in scale and reliability, suggesting opportunities to strengthen this supply channel to improve accessibility and potentially lower costs for camp residents.

Weekly expenditures on pellets among users range widely, from as little as 500 MWK to as much as 20,000 MWK, with an average spend of approximately 5,400 MWK. Notably, about half of the population reported that their pellet expenditure is lower than what they previously spent on charcoal. This cost advantage is a critical incentive for pellet stove adoption and sustained use. The People who mostly use charcoal spend more than those who use Zipo Stove with their expenditure ranging from 500 to around 20000 Tanzanian shillings. Majority of them spend between 15000-20000 shillings weekly which is higher than those using pellets. This is between 10,375.82-13,834.42 Malawi kwacha at the current rate.

The following figure illustrates weekly distribution of expenditure for non-users.



Similar findings regarding fuel costs have been reported in other studies. For example, Bailis et al. (2015) emphasized that lower fuel costs are a key driver of improved cookstove adoption (Bailis, Drigo, Ghilardi, & Masera, 2015), while price volatility and inconsistent fuel availability remain significant barriers. In addition, Chitawo et al. (2024) found that affordability and reliable access to fuel pellets are crucial determinants of clean cooking technology uptake, reinforcing the importance of stable, cost-effective supply chains to support transition away from traditional fuels.

Case Studies:

Innovative Business Models for Pellet-Fed Gasifier Cookstoves: Lessons from Malawi and Rwanda

A pilot study on pellet-fed gasifier cookstoves in Lilongwe Urban revealed that households valued pellet fuel savings, installment payment options, and maintenance support. However, inconsistent fuel quality and access impeded broader adoption (Zulu, Kamoto, Djenontin, & Jumbe, 2024).

A private-sector enterprise in Rwanda (Inyenyeri Model) combined local pellet production with a lease-based cookstove model, featuring home delivery, in-home repairs, and consumer-friendly financing. By 2017, production increased 400% to 800,000 kg/year, demonstrating the feasibility of scalable fuel provision systems (Jagger & Das, 2018).

These cases illustrate the effectiveness of **integrated supply systems** that combine local production, vendor coordination, service provision, and flexible financing, critical components that can inform the sustainability and scale-up of the ZIPO stove initiative.

4.8. Drivers of ZIPO Stove Utilization

Qualitative data from focus group discussions (FGDs) and key informant interviews (KIs) revealed several key reasons why respondents use the ZIPO stove on a daily basis. The primary motivations include its lower operating cost, with users noting that cooking with the ZIPO stove and pellets is less expensive than traditional fuels such as charcoal. Additionally, respondents highlighted the stove's faster cooking time, which helps save valuable time in daily food preparation. Ease of use was also emphasized, with many users describing the stove as simple and convenient to operate. Finally, the affordability of pellets as a fuel source compared to charcoal further reinforces the stove's economic appeal.

Together, these factors illustrate that the ZIPO stove is valued mainly for its economic and practical benefits. Users consistently reported that when the stove is functional and adequately fueled, it effectively meets their daily cooking needs. This qualitative feedback underscores that fuel efficiency and usability are critical drivers of adoption and sustained use among beneficiaries.

4.9. Barriers to ZIPO Stove Utilization

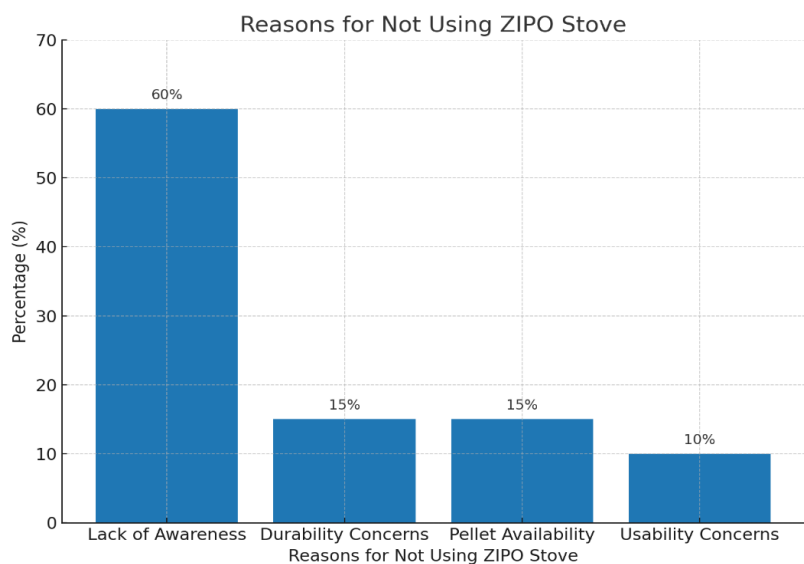
Qualitative data collected from 214 respondents highlighted several key reasons for not using the ZIPO stove. These reasons were categorized and quantified based on their frequency of mention during discussions and interviews, as summarized in **Table 4.2**.

Table 4.2: Key Reasons for Not Using the ZIPO Stove

Reason Category		Description	Approximate Frequency
1. Pellets Availability Issues		Scarcity or unavailability of pellets in the market or camp, lack of convenient selling points	>70
2. Smoke Production		Excessive smoke generated by the pellets or stove	25–30
3. Stove/Fan Malfunction or Damage		Fan failure, stove damage, weak fan or dynamo	20–35
4. Pellet Quality and Cost Concerns		Poor pellet quality, high pellet prices, charcoal easier to access	<15
5. Slow Cooking Speed		Stove cooks food too slowly, especially problematic for larger families	10–15
6. Complexity or Lack of Training		Difficulties in stove operation, adding pellets, or relighting the fire	<10
7. Other Issues		Problems related to lighting, limited stove size, or stove design flaws	<10

The data indicate that the most commonly cited barrier to stove use is the limited availability of pellets, which undermines consistent stove operation. Smoke production and mechanical issues such as fan malfunctions also significantly hinder usage. Concerns about pellet quality and cost, as well as slow cooking performance especially when cooking things such as beans or using bigger pots, were less frequently reported but remain relevant challenges. Additionally, a minority of users experienced operational difficulties due to inadequate training or design limitations. The Malawi Integrated Energy Plan (IEP) emphasizes the importance of addressing fuel supply chains, enhancing stove durability, and providing user support to achieve sustained adoption and satisfaction with improved cookstoves (Government of Malawi, 2022). These findings reinforce the need to strengthen these three areas to enhance long-term uptake and effectiveness of the ZIPO stove.

As shown in Figure 4.7, 60% of non-users reported a lack of information about the ZIPO cookstove as the main barrier to adoption. Other factors cited included concerns about durability (15%), limited pellet availability (15%), and other usability issues (10%). When asked whether they would purchase the ZIPO stove if pellets were available and affordable, only a quarter of respondents said they would, while 75% indicated that they ‘might’ consider purchasing it. Further probing revealed that 70% of non-users cited the high cost of purchase the ZIPO cookstove as a major concern and suggested that a price reduction could increase their likelihood of adoption.



4.10. User Satisfaction of ZIPO Stove among users

The satisfaction data reveal distinct patterns in user perceptions of various stove attributes, highlighting both strengths and critical areas for improvement.

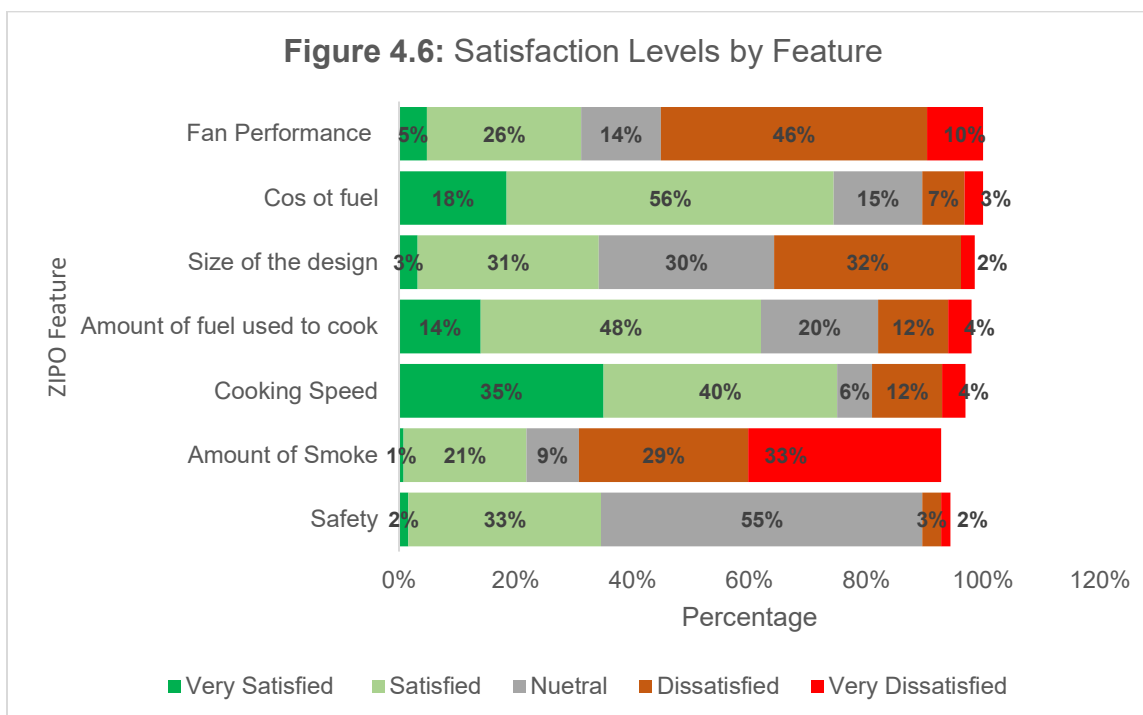
Cooking Speed stands out as a generally positive feature, with a combined 75 percent of respondents expressing satisfaction or higher. This suggests that the stove meets user expectations for timely cooking, a key factor influencing adoption and continued use. However, the presence of a notable minority (18%) expressing dissatisfaction signals that improvements in speed consistency or user interface might enhance overall acceptance.

Conversely, **smoke emission** represents a significant challenge. With over two-thirds of users expressing dissatisfaction, the stove’s smoke output undermines its perceived health and comfort benefits. This high level of dissatisfaction suggests that smoke reduction should be prioritized in future stove designs or interventions, as it directly impacts indoor air quality and user well-being. Further investigation revealed that excessive smoke results primarily from a design flaw: the ash outlet holes are too small and tend to clog quickly after the initial use of fuel pellets, impeding proper airflow and combustion efficiency.

The **safety** feature elicited a predominantly neutral response (55%), indicating either limited user awareness of safety benefits or potential shortcomings in communicating and ensuring perceived safety. Nevertheless, a reasonable 38% satisfaction level shows promise, but the low dissatisfaction percentage suggests room for clearer messaging or design improvements to enhance confidence in safety.

Fuel efficiency was relatively well-regarded, with 62 percent of respondents satisfied or very satisfied. This positive perception aligns with economic and environmental motivations for adopting improved cookstoves. However, the combined 16 percent expressing dissatisfaction points to variability in fuel consumption or differences in fuel types used by households, warranting further investigation into usage patterns.

Responses to **stove design size** were mixed, reflecting diverse household needs and preferences. The nearly equal split between satisfied (34%) and dissatisfied (34%) respondents, alongside a substantial neutral segment (30%), indicates that stove dimensions may not be universally appropriate. Customization or offering multiple size options could better address this heterogeneity.



The **cost of fuel** feature emerged as one of the more favorable aspects, with over 74 percent of users satisfied or very satisfied. This likely reflects the stove's contribution to reducing ongoing fuel expenses, a critical factor in long-term adoption decisions.

Lastly, **fan performance** was a significant source of dissatisfaction, with over half of respondents (55.2%) expressing negative views. Given the fan's role in combustion efficiency and smoke reduction, this feedback underscores the need for technical refinement or user training to optimize fan operation and reliability.

These findings suggest that while the stove performs well in speed, fuel cost, and efficiency, serious improvements are needed in smoke control, battery availability and fan functionality to enhance user health and satisfaction. Addressing design size variability and better communicating safety features could further improve user experience. Prioritizing these areas in product development and user education will likely increase adoption rates and sustained use, contributing to better health and environmental outcomes.

4.11. Willingness to Purchase Another ZIPO Stove and User Recommendation

Among ZIPO user respondents who no longer own a ZIPO stove, 46 percent expressed an intention to purchase another stove, while 54 percent indicated they would not. Among those

unwilling to repurchase, 70 percent cited concerns related to the stove's durability, frequent fan malfunctions, limited availability of pellets, and excessive smoke production as the primary deterrents. This significant proportion of users unwilling to reinvest reflects broader dissatisfaction with the stove's quality and reliability, which poses a considerable risk to the long-term sustainability of the program if these issues remain unaddressed.

The study found that about 61.6 percent of respondents would recommend the ZIPO stove to others, reflecting general satisfaction among users. Many praised the stove's fast cooking speed, with one user noting,

"It cooks quickly, saving me a lot of time. The flame is more concentrated than with a charcoal burner, so I can prepare meals much faster. Plus, it costs less than charcoal, which helps me save money," Female participant, FGD.

Ease of use and simplicity were also commonly appreciated, often linked to the stove's low fuel consumption. Several users remarked that the stove requires fewer pellets compared to traditional charcoal, which contributed to its appeal. Positive expressions such as "nice," "good quality," and "I love it" appeared regularly, underscoring an overall favorable impression.

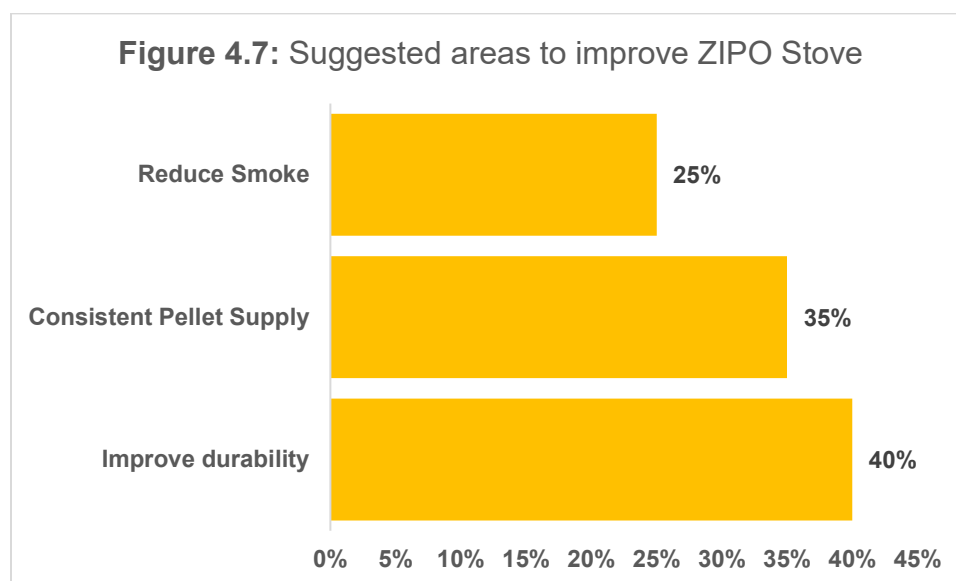
Similar findings have been reported in other studies conducted in Malawi and comparable settings. For example, research by (Kankam, Mensah, & Owusu, 2019) identified stove durability and inconsistent fuel supply as key barriers to sustained adoption of improved cookstoves. Likewise, another study emphasized that user satisfaction with stove performance and fuel availability strongly influences repurchase intentions, continued use and recommendation to other users (Nyirenda, Banda, & Mwale, 2017). These parallels highlight the critical need for programs to prioritize product quality improvements and reliable fuel supply chains to enhance user retention and program impact.

Among the 16% of respondents who would not recommend the stove, several key issues emerged. Quality concerns were prominent, with over 30% citing poor workmanship, frequent breakdowns, and unsatisfactory design, indicating that while the stove's concept is generally well received, its durability and execution fall short for many users. Complaints about excessive smoke, whether from the stove itself or the pellets, were common, suggesting problems related to manufacturing, design flaws, or fuel quality that negatively impact both user comfort and health. Maintenance challenges also featured prominently, with difficulties related to batteries, fans, and costly spare parts creating barriers to sustained use and potentially limiting long-term adoption. Lastly, some users reported usability and performance difficulties, describing the stove as hard to operate or inefficient. These mixed experiences may reflect inconsistencies in training or quality control, highlighting areas for targeted improvement.

4.12. Areas to Improve the ZIPO Stove

The ZIPO Stove demonstrates strengths in cooking speed, fuel cost efficiency, and fuel consumption; however, several critical areas require attention to enhance overall user satisfaction and health. Users provided valuable and constructive feedback pinpointing several critical areas for improvement that are essential to enhancing satisfaction and promoting sustained use of the ZIPO Stove. Approximately 40 percent of respondents emphasized the need to improve stove durability, highlighting concerns over the product's lifespan under regular use. Most of the

respondents mentioned that the stove broke down within the first few months after purchase. Ensuring a consistent supply of pellets was identified by 35 percent of users as a vital factor affecting their cooking experience and continued stove use. Additionally, 25 percent of respondents specifically called for reductions in smoke emissions, underscoring health and comfort as key priorities.



These user-identified challenges align closely with the quantitative findings. Smoke emission remains the most pressing issue, with over two-thirds of users expressing dissatisfaction. This is largely due to a design flaw where the ash outlet holes are too small and clog rapidly, restricting airflow and increasing smoke production. Fan performance also emerged as a significant concern, with many users dissatisfied, suggesting that technical refinement and improved user guidance are needed to optimize stove operation.

Feedback on stove design size was mixed, reflecting diverse household needs and signaling the potential benefit of offering adjustable or multiple size options. Safety perceptions were predominantly neutral, indicating room for enhanced safety features and clearer communication to build user confidence.

These findings are consistent with studies conducted in Malawi and similar contexts. For instance, Nyirenda et al. (2017) identified durability and inconsistent fuel supply as major barriers to sustained cookstove use, while smoke reduction significantly influenced user satisfaction. Kankam et al. (2019) similarly emphasized stove reliability, steady fuel availability, and smoke-related health concerns as key determinants of adoption. More broadly, Lewis and Pattanayak's (2012) systematic review highlighted that product reliability and continuous fuel access are among the top factors affecting clean cookstove uptake globally, with smoke reduction consistently valued by users.

Collectively, these insights demonstrate that addressing both technical design issues—such as smoke control, fan performance, and durability—and supply chain challenges—like reliable pellet

availability—will be crucial to maximizing the impact, user satisfaction, and sustainability of the ZIPO Stove intervention.

4.13. Impact of the ZIPO Stove on Gender Roles and Household Workload

A significant majority of respondents (87.38%) reported no perceived change in gender roles or workload following the introduction of the ZIPO stove, while only 12.62% noted some shift. Among the 213 respondents who elaborated on their experiences, approximately 60 percent indicated limited or no use of the stove, often due to technical issues like breakdowns or lack of pellet availability. This limited usage hindered their ability to observe or experience any meaningful impact on household roles. Additionally, around 60 percent emphasized that cooking responsibilities remain culturally defined, with women predominantly tasked with this role regardless of the stove technology employed.

These findings align with similar studies in comparable contexts. For example, a study in rural Malawi found that the adoption of improved cookstoves rarely altered traditional gender dynamics, as cooking remains culturally assigned to women (Smith, et al., 2014). Likewise, other studies highlighted that while improved cookstoves can reduce physical workload, they do not necessarily shift household gender roles without broader social interventions (Johnson & Bryden, 2018) (Simone & Van Heerden, 2015). Overall, these results underscore that technology adoption alone is insufficient to transform entrenched cultural norms around gender and labor division.

5.0. RECOMMENDATIONS

5.1. Product Design, Durability and Performance

Recommendation 1: Smoke emission remains a major challenge, with over two-thirds of users expressing dissatisfaction. Investigation revealed that excessive smoke results primarily from a design flaw: the ash outlet holes are too small and tend to clog quickly after the initial use of fuel pellets, impeding proper airflow and combustion efficiency. Introduction of smaller size of pellets to match the size of the holes present in the stoves can be one the solutions. Another cause for smoke highlighted was that the material used to make the pellets might also be the reason why it produces lots of smoke. Redesign the ZIPO stove to improve smoke reduction by enlarging air outlet holes, explore other raw materials that can be used to produce pellets that emit less smoke and strengthening fan and battery components.

Recommendation 2: Many users reported frequent mechanical failures, particularly broken fans and batteries, leading to a 62% non-ownership rate due to broken stoves. These breakdowns directly undermine sustained use and user confidence. Improve stove durability by using higher-quality materials and implementing rigorous quality assurance before distribution.

Recommendation 3: Establish a robust warranty and repair scheme, including local repair hubs within the camp staffed by trained technicians. Facilitate stove replacement programs to minimize downtime and maintain user trust.

5.2. Pellet Supply Chain and Affordability

Recommendation 4: Pellet availability and cost were significant barriers to consistent stove use, with users facing frequent shortages and high prices due to limited supply channels and reliance on external vendors. Diversify pellet supply channels by supporting both external market vendors and formalizing in-camp sellers to ensure resilience. Promote community-based pellet production by training local entrepreneurs and cooperatives and providing small-scale pelletizing equipment. Implement pricing policies, subsidies, and loyalty schemes to keep pellet costs below charcoal prices.

Recommendation 5: Enhance pellet distribution tracking to prevent delivery failures and introduce flexible financing options, such as targeted subsidies and pay-as-you-go models, to improve affordability.

5.3. User Training, Behavior Change Communication (BCC), and Community Engagement

Recommendation 6: To address the lack of information among non-users, implement targeted awareness campaigns highlighting the benefits and proper use of the ZIPO cookstove. Develop comprehensive, culturally appropriate training materials in local languages (Swahili, French, Kinyarwanda, Chichewa), including hands-on demonstrations. Conduct regular refresher sessions and roll out multilingual behavior change communication (BCC) campaigns using radio, community theaters, and peer educators. Engage community influencers and satisfied users as advocates to promote proper use and sustained adoption. In Dzaleka camp, the community radio station YETU can be leveraged to promote the cookstoves, further increasing awareness and

reaching more non-users. Make sure the User manual is translated into the main languages spoken in the camp.

Recommendation 7: Lack of accessible, timely repair services and spare parts contributes to stove abandonment due to unresolved technical malfunctions. Train local technicians within the refugee camp to provide maintenance and repairs, creating jobs and ensuring prompt support. Develop community-run stove replacement programs and establish accessible support channels such as hotlines and repair centers.

5.4. Gender and Social Inclusion

Recommendation 8: Cultural norms continue to place the responsibility for cooking primarily on women, and the introduction of the stove has not significantly shifted these gender roles. However, while women are the main users and managers of cooking technologies, men often hold decision-making power over major household purchases, including whether to acquire a stove. Therefore, empowering women alone is not enough, engaging men as informed and supportive partners is also critical to improving adoption and sustained use. Outreach and training should be tailored to equip women as confident stove users and decision-makers, while also facilitating inclusive community dialogues that actively involve men, emphasizing the health, economic, and environmental benefits of clean cooking for the entire household.

Recommendation 9: Adopt gender-transformative approaches that promote shared household responsibility and ensure materials and communications are linguistically inclusive and culturally respectful.

5.5. Market Development and Entrepreneurship

Recommendation 10: Some users revert to traditional cooking methods due to stove limitations with certain meals, and local market infrastructure for stoves and pellets remains underdeveloped. Conduct ethnographic assessments to align stove design and guidance with local cooking practices.

Recommendation 11: Collaborate with local entrepreneurs to strengthen marketing, distribution, and repair services. Support sustainable business models that incentivize vendors and technicians and invest in local infrastructure such as storage and demonstration sites.

Recommendation 12: Collaborating with UNHCR, WHH and DCCU on long-term coordination. Support DCCU to establish a center dedicated to storing or selling point for stoves and pellets.

6.0. CONCLUSION

The ZIPO stove initiative represents a significant step towards promoting clean, efficient cooking solutions within refugee camp settings. However, this assessment highlights several challenges that must be addressed to maximize impact and sustainability. Key issues such as excessive smoke emissions from design flaws, frequent mechanical breakdowns, unreliable pellet supply, and limited after-sales support have hindered sustained use and user satisfaction. Among non-users, low awareness about the ZIPO stove, high perceived cost, and limited access to pellets were major barriers, with only a quarter indicating they would purchase the stove if pellets were affordable and available. These findings underscore the importance of targeted outreach and communication strategies.

Cultural norms and gender dynamics also influence adoption patterns, highlighting the need for gender-sensitive approaches that empower women while engaging men as supportive partners. Addressing these challenges through stove redesign, strengthening local pellet production and supply chains, enhancing user training, and establishing community-based repair and maintenance programs will be essential. Leveraging community platforms, such as the Dzaleka camp radio station YETU, and engaging satisfied users as advocates can further improve awareness and sustained adoption among non-users.

By aligning technical improvements with social inclusion, economic accessibility, and behavior change strategies, the ZIPO stove program can achieve higher adoption rates, improved health outcomes, and long-term environmental benefits. This integrated approach will enhance the quality of life for refugee households and provide valuable lessons for clean cooking interventions in similar contexts globally.

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