MASTER THESIS

By Elifadhili Vincent Shaidi

Societal acceptance of alternative bio-energy sources and technology, Case of biomass briquettes acceptance in Dar es Salaam, Tanzania

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Supervisors; Dr. Frans Coenen

Prof. Joy Clancy

ABSTRACT

The world is in a transition process to renewable energy in response to climate change and global warming. Once among the factors hindering the transition is social acceptance to the alternative energy sources. Bioenergy is one among the renewable sources with high potential and is a major energy source in developing countries. Biomass is used in traditional cooking methods that have significant environment impacts like deforestation and health. In response to this, one among the promoted alternative is biomass briquettes in cooking. Though it is promoted in many countries, its adaptation has been slow as charcoal/firewood still occupies a large market share with a small percentage taken by briquettes. The aim of this study is to understand the challenge of social acceptance to sustainable bio-energy sources, particularly biomass briquettes as a cooking energy source instead of charcoal in developing countries' through analysis of Tanzania social acceptance to use of biomass briquettes as cooking fuel, with Dar es Salaam community as the case study. The methods used were literature review, interviews with briquettes suppliers and Dar es Salaam community survey. The analysis was done from three perspectives namely theory of social acceptance, theory of strategic niche management and theory of Bottom of the pyramid.

In this study 2 large producers, 10 small producer's and 369 respondents shared their perspective and views. The study found that the briquettes sector is being poorly addressed in the national policies although it is highlighted endorsed by some political leaders. There is a good to neutral acceptance from Dar es Salaam community, with a majority of them having heard/seen it but never used it. For those who have used it have positive feedback with regard to briquettes, which could justify the positive to neutral feedback from community members who heard about it. They perceived it to be useful, easy to use and has fitted well to community cooking. The major challenge hindering large community use to briquettes is un-accessibility of briquettes. This is caused by challenges in production and distribution from supplier side due to underdeveloped distribution channels, network, and support given to suppliers. Further factors which affect the acceptance to briquettes are economical (reduction of expenditure and affordability), awareness, environmental concerns, use in existing stove, and performance of briquettes mostly burning for a long time, annoyance from ash and storage.

This study recommends improvements of policies and incentives to be put in place for supporting small producers, consolidation of supplier's networks in order to enable learning, adaptation, and resources gathering. Besides it recommends the integration of briquettes to the existing charcoal distribution network so as to expand the network and improve distribution. Lastly is expanding of the briquettes value chain by producing other products such as bio char and briquettes with different properties for different uses.

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CHAPTER 01: INTRODUCTION

Climate change and global warming are a universal phenomenon threatening humanity existence. Among the contributing factors are emissions from the energy sector as a result of production activities, transmission, and consumption. Energy is a vital component in everyday life, as it is used in multiple purposes such as cooking, running equipments, heating and many more. Energy sources can be classified into two groups basing on their replenishment rate with respect to human time scale, namely renewable energy such as bioenergy and non-renewable such as fossil fuel. Due to the negative effects of non-renewables like climate change and global warming, the world is pushing towards the adaptation of more renewable energy sources. It is evident in the efforts such as the Paris Agreement, Tokyo Agreement, EU renewable energy directive, and many more initiatives worldwide. The transition towards renewable energy has been problematic as a result of multiple challenges that can be categorized into technical, economic, political, and social.

Bioenergy[1] is among the renewable energy sources that is the oldest and with great potential as shown in APPENDIX 7. Bio-energy is an important energy source as it currently contributes to roughly 9% of total world energy used, that is five times more than the contribution of solar and wind combined(IEA, 2019). The raw mateials for bioenergy are energycrops(eg starch based plants, wood, and oily plants, etc), biogenic residue(eg forest remains, grasses, agriculture remains, etc) and waste products(eg landscape material, sewage waste, animal manure, etc)(Jenssen, 2010). Bio-energy can be used for heating, electricity, and fuel production, in conjunction with the production of other bio-materials like bio-chemicals and biochar. Bio-energy can be categorized into biomass (charcoal, firewood, biomass briquettes and pellets) and biofuels (bio-ethanol, diesel, gas) (Sriram & Shahidehpour, n.d.).Bio-energy potential is unevenly distributed in the world nonetheless found in most locations in different forms and quantity (Berndes, G., Hoogwijk, M. and van den Broek, 2007). Sustainable utilization of bioenergy can greatly contribute to the attaining carbon free economy. Bioenergy has many advantages namely; emit little to no emissions, large diversified raw materials, well-established technology, and minimal loss during storage. Furthermore, it can be used as means of waste management, can be used to improve soil properties and co-generation of heat plus electricity. Despite its many advantages, it has disadvantages of competing for land and water with food production, sold at higher priced than conventional fuel and its unsustainable utilization leads to environmental degradation and pollution such as desertification and air pollution(Sriram & Shahidehpour, n.d.).

Bio-energy adaptation has been slow in both developed and developing countries due to a number of reasons that are technical and non-technical(Fagernäs et al., 2006). Among the non-technical challenge is social acceptance to bioenergy source/ technology/ product. Owing to its

[1] Bio-energy is the energy derived from the conversion of solid, liquid, or gaseous organic material/products derived from a biological process that can be reproduced on a renewable basis including feedstocks from animals, plants, manure, municipal waste, and many others.

potential and multiple benefits in a zero carbon economy, it is imperative to explore the challenges associated with social acceptance to bioenergy.

Social acceptance as highlighted by (Moffat, Lacey, Zhang, & Leipold, 2016) can be considered as a license from society to operate. This is supported by many authors like (Gehman, Lefsrud, & Fast, 2017)whom all conclude social acceptance is vital for a project or initiative success. Social acceptance is a context specific and time varying phenomenon that is affected by many contextual factors. Challenges arising in the implementation phase of feasible bioenergy projects due to lack of social acceptance may affect the success of the initiative(Jenssen, 2010). It is for this reason that it is important to consider the aspect of social acceptance to bioenergy.

The research focuses on social acceptance to bio-energy in developing countries context. More than 50% of the total bioenergy use in the world is used in developing countries for cooking and heating(IEA, 2019). Biomass (bio-energy) use has dominated over other sources such as LPG and electricity due to its availability, price, and culture preference, therefore, its continual use in the future is predicted in many scenarios(Berndes, G., Hoogwijk, M. and van den Broek, 2007). It is mostly used in unsustainable traditional form[2] that's associated with many harmful environmental, ecological, health and social effects. The most pronounced environmental and ecological effects are deforestation, desertification, and loss of biodiversity, for example in Africa deforestation for charcoal production covered an area of 29,760 km in 2009 (Gregory Sousa, 2017). Most of the produced charcoal is utilized in urban areas in comparison to rural areas. Apart from that, it has health effects worldwide where more than 2 million death annually are associated with indoor pollution from using traditional biomass and coal in cooking, with 99% of them in developing countries. In addition to that, it plays a significant role in other impactful social phenomena like gender imbalance(WHO & UNDP, 2009). Review report of (Felix & Gheewala, 2011) argues that the presence of biomass will continue to dominate in the energy mix, with an increase as the population and energy market grows. This necessities attention to sustainable use of biomass and shifting towards using environmentally friendly biomass source. It is from this perspective the shift to modern biomass[3] is encouraged over continual use of tradional biomass namely charcoal/firewood/animal waste.

Biomass briquettes are one among the forms of bio-energy that can be produced sustainably using different raw materials such as forest residues, agricultural residues, and municipal waste. Biomass briquettes are prepared by a process called briquetting which converts low bulk density biomass into high density and concentrated energy fuel. This offers the possibility of using loose bulk biomass along with long-distance transportation due to its concentrated form(Owen, Mwampamba, Owen, & Pigaht, 2013). In addition to that, it is environmentally friendly with fewer health effects in comparison to traditional fuels[4] and has good performance. Due to large

[2] Traditional biomass form include charcoal, firewood and animal excrete, meanwhile modern form include bio-fuels like bio-gas, bio-diesel, bio-ethanol, briquettes, and pellets.

[3] Modern biomass form include briquettes, pellets and bio-fuels like bio-gas, bio-diesel and bio-ethanol

[4] Biomass Briquettes have less particulate matter and emissions in comparison to traditional fuels(charcoal and firewood), which makes them less harmful to human health

availability of biomass in many areas, this offers a possible cheap sustainable energy source suitable for poor communities and developing countries(Owen et al., 2013).

The potential uses of briquettes are presented in Table 1 below:

Industry	Possible application
Domestic use	Cooking, water heating and space heating
Commercial and institutional catering	Cooking, water heating, grilling
Hospitality	Cooking, water heating, space heating (outdoor dining areas)
Industrial boilers	Generation of heat and steam
Food processing	Distilleries, bakeries, canteens, restaurants, drying
Textiles	Dyeing, bleaching
Crop processing	Tobacco curing, tea drying, oil milling,
Ceramic production	Brick kilns, tile making, pot firing, etc.
Gasification	Fuel for gasifiers to produce electricity
Charcoal production	Initiating pyrolysis to make charcoal production more efficient
Poultry	Incubation and heating of chicks

Table 1: Uses of briquettes

Even though it has many advantages and being produced in developing countries, biomass briquettes have not been embraced to a large extent in many developing countries for community cooking use. (Owen et al., 2013) analyzed the challenges of biomass briquettes in sub-Saharan countries namely Kenya, Uganda, Tanzania, and Rwanda and found that only a small volume of charcoal has been displaced and energy option for the limited group has been increased. For the purpose of comprehending this problem, an analysis of social acceptance towards the adaptation of biomass briquettes as an alternative environmentally friendly cooking energy source is vital.

To grasp the challenge of social acceptance, a desk study and case study approach were used with Tanzania (a developing country) as an empirical case study. Tanzania is among the countries that have the highest deforestation rate from charcoal production(Gregory Sousa, 2017). 80% of its national energy consumptions are more in domestic use for cooking and lighting, where biomass has the largest share as shown in APPENDIX 1 (Msuya, Masanja, & Temu, 2011). In accordance with the census of 2012, fuelwood and charcoal constituted as the major energy source with charcoal used mostly in urban areas and firewood in rural areas. Charcoal trade is mostly an informal sector that generates income for a large number of people. It contributes about 659$ USD million/year in the economy and employs several hundred thousand people (World Bank, 2010). The supply of charcoal mostly originates from rural areas or peri-urban areas near the city. Its production varies across the year depending on weather seasons like rainy and rural farming calendar like planting seasons. Resulting in price and quantity of available charcoal to vary across the year. From the supply side, the charcoal is mostly produced in inefficient earth kilns, then transported to cities by use of lorries, buses, and

motorcycle. In the city, it is distributed to either whole sellers and/or retailers and/or end user. The supply chain of charcoal has multiple stakeholders who play various roles along the chain(Ishengoma & Abdallah, 2016). The charcoal trade has taken a great toll on Tanzanian's ecosystem and nature. In Tanzania, 10,433 ha of forest is lost in a year for charcoal production, with expectations loss of almost 2.8 million ha of forest by 2030 for meeting charcoal demand. This loss of forest has other effects such as soil degradation, loss of biodiversity, degradation of water resources, acceleration of drought and many others(Msuya et al., 2011). It is for this reason they are promoting the usage of sustainable affordable environmental friendly briquettes. The Government efforts can be seen in initiatives like banning of charcoal use in big cities, restriction of illegal charcoal transportation and incentivizing of alternative energy sources. Though many efforts have been initiated, little progress have been made due to lack of capacity to implement them for a long time, wavering political will, and corruption among the implementers. Biomass briquettes are a niche market that is on development, it is mostly constituted of small producers and few large producers. Multiple projects and ventures have been initiated in Tanzania but have not been able to penetrate the regime to a great extent. Report of (Owen et al., 2013) discovered only a small percentage of charcoal has been replaced by briquettes and its supported by researcher observation of the on-going large quantities of charcoal being traded.

A special focus has been directed towards Dar es Salaam region which is the largest consumer of charcoal as it consumes 500,000 tonnes/year(World Bank, 2010). In addition to that, it has the highest population in comparison to other Tanzanian regions.

With regards to bioenergy, there isn't much research material available concerning the aspect of social acceptance. Existing literature, mostly look into the potential of bioenergy, its economic, and technical aspects and with few address it social acceptance. The few that cover social acceptance majority cover the acceptance to bioenergy facility and few cover acceptance to bioenergy product (technology). This research aims to contribute knowledge in the field of social acceptance to bioenergy products specifically in social acceptance to briquettes in developing countries for household use. Furthermore, it will assist policy makers by shading light on the existing situation in society hence assisting in making effective policy decision. As for briquette suppliers, concerned stakeholders, and concerned environmental activists will increase their understanding of market response to briquettes, facilitating streamlining, and improving their activities. The factors covered in literature with regards to social acceptance have been highlighted in Chapter 3, with contributing factors identified in the case study covered in Chapter 4 and 5.

The identified research gap of acceptance to bioenergy products specifically briquettes has been translated to the following research objective.

General Objective: To contribute towards an understanding of the challenge of social acceptance to sustainable bio-energy sources, particularly biomass briquettes as a cooking energy source instead of charcoal in developing countries'. Through analysis of Tanzania social acceptance to use of biomass briquettes as cooking fuel, with Dar es Salaam community as the case study.

The research objective has been translated to the following research question and sub questions:

Research question: What factors affect social acceptance towards the adaptation of alternative bio-energy sources specifically biomass briquettes?

Research Questions:

1) In theory, what are the social factors affecting market acceptance and community acceptance to alternative bio-energy sources specifically biomass briquettes use in cooking?

2) What are the barriers in the approaches taken by biomass briquettes suppliers in addressing household market needs particularly in Dar es Salaam?
    - What are their current production capacities and market approaches?
    - What are their marketing and service approach and challenges facing them?
    - Which benefits and challenges have their customers reported to face with regards to the products they provide?

3) What are the perceptions and views of the community members towards the use of biomass briquettes as an alternative source of charcoal particularly in Dar es Salaam?
    - What is their perception on user friendliness and ease of use of biomass briquettes?
    - What is their perception on the affordability, and performance of biomass briquettes in comparison to their desired cooking service?
    - Which benefits and disadvantage/risks are perceived/experienced by customers?
    - What are the associated feelings with regards to biomass briquettes use?

The research questions and sub questions will be answered through the use of two approaches namely: Theoretical analysis of social acceptance and the use of an empirical case.

1) Theoretical analysis of social acceptance towards bioenergy specifically biomass briquettes will be analyzed through review of secondary data namely literature and documents.
2) In the empirical case, the research will analyze the perceptions and views of community members and briquettes suppliers towards biomass briquettes, basing on criteria derived from analysis of literature on the theory of social acceptance, the theory of bottom of the

pyramid and strategic niche management. A confrontation of the findings from the literature review will enable the formulation of the assessment criteria.

3) The assessment of the perception and views of briquettes suppliers, households customers and non-customers towards biomass briquettes use in cooking basing on assessment criteria will yields results, whose confrontation will facilitate the understanding of social acceptance.
4) Different perspectives have been selected for various reasons, the literature on social acceptance will provide the classical view with regards to renewable energy acceptance based on the commonly accepted model of the triangle of social acceptance. Meanwhile, the theory of the bottom of the pyramid will shed light on the unique market and customer behavior at the bottom of the pyramid majority of them being users of charcoal. Strategic Niche Management Strategies will provide technique/guidelines which are followed in order to promote the growth of niche to the regime, through acceptance to the niche market in the regime.

CHAPTER 02: THEORETICAL BACKGROUND

Chapter two presents the theoretical background utilized in assessing and analyzing of the findings in order to answer the research questions and attain the intended objective. It begins with a general discussion of the theories used and their implication for the study. Followed by the discussion of individual theories and highlighting the selected criteria taken from the theories for use in the analysis.

The research approach consists of utilizing aspects from different theories for the purpose of getting perspectives from multiple directions and covering relevant factors. In accordance with the available resources and scope, not all aspects of the theories selected could be used, though such an approach would have given more comprehensive insights. The aspects used were selected depending on scope and relevance to the research objective. The aspects were operationalized and then translated to survey questions that were utilized in the case study.

Theories used are theory of triangle of social acceptance, strategic niche management using multi-level perspective and theory of bottom of the pyramid. The first viewpoint is from the theory of triangle of social acceptance to renewable energy innovation that highlights factors whose interaction affects the social acceptance to renewable energy. The second viewpoint is from the perspective of strategic niche management using a multi-level perspective that highlights factors for managing introduction of niche market products to get market acceptance in the regime (existing market) and its growth. Briquettes are a new niche product that's in transition process of penetrating the regime market dominated by charcoal and firewood. Strategic niche management will be used in assisting analysis of market acceptance basing on its techniques of transitioning new technology (niche market) into the regime. Lastly is the perspective of the theory of market at the bottom of the pyramid that provides understanding of market characteristics that encompass the majority of the population covered in the research project. As identified in the theory of bottom of the pyramid the characteristics and business operations at the bottom of the pyramid are different. This has resulted in conventional business approaches failing to tap on market at the bottom.

The analysis of the society and briquettes business operations basing on the three afore mentioned perspectives will yield an understanding of the existing interactions and its impact on social acceptance towards briquettes. This understanding will facilitate comprehension of the existing situation and increase the knowledge of social acceptance to bioenergy sources.

2.1 Theory of triangle of social acceptance to renewable energy innovation

According to the theory of triangle of social acceptance to renewable energy innovation, factors affecting social acceptance are divided into three dimensions namely socio-political acceptance, community acceptance, and market acceptance.

Figure 1: Triangle of social acceptance to renewable energy

Social-political dimension consists of factors on the processes of how actors (Organizations and individuals) interact with each other, make decisions, form partnership, resolve conflicts, engage the public and responsiveness to policies. At a general level, it also concerns acceptance by key stakeholders, policies concerned and policy actor's willingness to support the technology, and any institutional change required for its adaptation. The policy imposes a framework of institutionalization that promotes and enhances community and market acceptance. A good example is spatial planning systems to stimulate collaborative decision making or financial procurement systems(Wüstenhagen, Wolsink, & Bürer, 2007). This is through guiding on the interaction of the stakeholders, which can result in positive interactions that promote acceptance and growth of the technology or vice versa. The policies regarding briquettes will be assessed on how the framework they have established promote or hinder the acceptance of briquettes in the society.

Community acceptance refers to the acceptance by the local community and its stakeholders with regards to the use/operation of the energy source/technology. The level of acceptance is very much limited to the local context, multiple interests, and time dimension. Identified by (Wüstenhagen et al., 2007) there are three major factors influencing community acceptance. The first is the distribution of cost and benefits of a product which is referred to as distributional justice. The second one is procedural justice which concerns the degree stakeholders feels to have been involved/ participated in the process relating to bioenergy product. The last one is community trust towards technology, participants, procedures involved, project information, and

its implementers. The interaction of the three factors determines the way community members interact with the bioenergy product translating to community support/rejection. Simpson highlights that another contributing factor to community acceptance is the ability of social networks to promote interaction with the technology. It relates more to institutions and modes of organization in place to support or resist renewable energy than the technology itself(Simpson, 2017).

Market acceptance- refers to the willingness to support, adapt, and use of technology/innovation in the market whereby it considers the readiness of customers and investors to do transactions. In this aspect, the considered parties are consumers, investors, and intra-firms. Recognizing the level of awareness and their adaptation process in all parties is vital for developing competitive market-oriented products that are perceived to have usefulness and ease of use. In addition to understanding, consumer's requirements and expectations it enable's tailoring of the product to fit the user. It further acknowledges, in order to adopt the technology both the customers and investors have to be willing to financially endorse the technology and participation from the incumbent energy regime stakeholders so as to facilitate integration to the existing energy infrastructure(Simpson, 2017). Furthermore, acceptance by the market is affected by other factors outside the product performance and characteristics such as culture and experience of users and value associated within the context like identifying based on the rural landscape (Hofman, 2019). Besides consumers, the investors and intra-firms play a vital role in the development and progress of the products in the market and they can influence the process of financial systems, policy-making, and more others. However, for the purpose of this research, intra-firms relations will not be covered in accordance with the scope of the research. The above mentioned factors determine the adaptation process of consumers/customer, investors, and intra-firms which translate to acceptance of the product.

The overall interaction of the above mentioned aspects affects the perception and adaptation process which in turn determines the form and extent of social acceptance towards renewable energy.

2.2 Niche management strategies

The multi-level social-technical transition model is one among the framework proposed to explain the transition of renewable energy in the socio-technical aspect at different levels. The model points out that transition occurs across three tiered levels which are niche level, regime, and landscape. The lowest level is niche level that is made up of emerging technological novelties under development. It consists of early adopters and necessities protection of technology for its survival and growth towards a regime. Second is regime, it is the mainstream technology in place that is mostly used to meet the society functional needs. The regime is able to dominant by having an established socio-technical regime[5] which favors it and determines how it functions. The sociotechnical regime might involve the following rules which are:

[5] Socio-technical regime is a system of rules used and shared among various actors involved in meeting of societal functions

regulative rules(e.g. standards and laws), normative rules(e.g. roles of relation and values, etc.) and cognitive rules(e.g. believes and innovation agenda)(Langeveld, Meeusen, & Sanders, 2010). The last one is landscape level which are the overall arching social, economic, political, and environmental events and developments in the exogenous environment which can affect the regime such as recession, war, and global oil prices(Raven, 2006).

Strategic niche management theory is used to explain the transition process from niche towards the regime. Within the social function need of cooking fuels in developing countries, charcoal market dominance, and established socio-technical regimes qualify it to be among the regime bioenergy products. On the other hand biomass briquettes is a new product under development and being promoted as an alternative to charcoal. Making it a niche product propagated so as to penetrate the market dominated by charcoal. The strategic niche management theory offers insight on successful introduction of niche market into the regime in order to attain market acceptance for growth and integration. It focuses on fitting the technology to the social conditions in addressing the social need of the technology. It is imperative for the technology to fit the user in order to facilitate its adaptation and use, which will result in acceptance of technology enabling growth of niche market by gaining more support. For the fitting to society and transition to occur successfully three fundamental interrelated internal niche processes have been identified; (i) articulation and shaping of expectations (ii) networking and lastly (iii) are first and second loop learning. The articulation of expectations facilitates the existence of common understandings and expected performance among its stakeholders which acts as guide for future interaction in the network and contentment among stakeholders. Meanwhile networking facilitates the spread of technology, gaining of support and attraction of resources and other materials/knowledge required for niche development. The learning process leads to improvement of relationships between performance and price through adaptation and improvement enabling a better fit for addressing society needs. The learning process is focused on understanding changes that can be coupled with opportunities and utilized to overcome barriers outside the niche arena so as to improve the functionality of innovation. The interaction of the above mentioned factors results in the process of different kinds of regulatory, cognitive, and normative rules being formed. Alignment of the formed rules generates a system of socio-technical rules that directs further actions. The newly formed systems facilitate the fitting of technology in addressing societal needs which translates to social acceptance of the technology. The new system can take different forms namely; (i) replacing of the old system,(ii)new system running parallel with old regime,(iii) new system being integrated to old system,(iv) new system form its own regime and lastly (v) system fails to develop(Langeveld et al., 2010).

2.3 Bottom of the Pyramid (BOP)

This a socio-economic concept developed by CK Prahalad which describes the relationship between the population and economic status in a pyramid-like shape with the largest population at the bottom of the pyramid(economy) meanwhile the top of the pyramid has fewer people. Majority of people who live below the poverty line are located in developing countries(Subrahmanyan & Gomez-arias, 2003). With the poverty line coinciding with the top

limit of the bottom of the pyramid, it is evident that the majority of the population at the bottom of the pyramid are located in developing countries.

The bottom offers great potential but hindered by many challenges and the market has different characteristics in comparison to its counterparts. Due to this, the approach taken to address the market needs novelty for successful product/service acceptance by the market(Leow, Leong, & Mohd, 2015). The interaction and approach taken by the business in addressing and communicating with society/market will determine the response their products and company receives which will later translate to social acceptance. The theory of BOP describes the characteristics of the market which will facilitate the assessment of outcome of the interaction of briquettes business and customers/society. This outcome is the factor which affects the acceptance/denial of briquettes by society. The challenges and characteristics includes low disposable income, lack/weak infrastructure, criminal activities, and lack of awareness. The customers at BOP have shown to different characteristics such as to preferred personalized relations, motivated by products which address their other needs like compensatory-mechanism. Also building of social capital and family systems, mistrust large foreign cooperation, relevance and self-actualization. They also perceive value different for example personal relations over price, preference to abundance/crowed shops and a need to feel socially included (Barki & Parente, 2010; Subrahmanyan & Gomez-arias, 2003). Due to its nature, the traditional business approach has failed to work, necessity of novel approaches inorder to tap into this market. Among the strategies utilized is product addressing other needs such as employment, utilizing local personnel, packing in smaller quantities, different advertisement and many more(Christensen & Siemsen, 2014). Three components are needed for successful strategies in BOP, which are accessibility, availability, and affordability. In addition, he added more components which are awareness of products/company, offer relevance(self-image, social value/feeling and dignity), brand conscious as they purchase the label as a symbol of status, differentiation form extremely poor and integration with the community(Barki & Parente, 2010).

2.4 Desk Study Research

The interaction of bioenergy with society can be seen to originate in two dimensions. First is the interaction of society and bioenergy secondary energy carrier/technology like biogas, biofuels, and briquettes. Second is the interaction of society with bioenergy facility and its related processes and products which might include the facility operating within or outside the society areas, but never the less affect the society. The factors of social acceptance among the two interactions do differ to some extent. Specific factors that affect social acceptance of briquettes found in the literature are elaborated in the following section.

2.4.1 Factors influencing briquettes use

This section will present the finding of the literature review with regards to factors affecting the social acceptance of briquettes. These factors are as follows:

Firstly is the unwillingness of changing cooking practices towards adopting a new source of fuels which entails some modification in the handling and use in order to attain maximum

performance. The unwillingness is attributed to many factors such as culture, the belief that food taste better when cooked on charcoal, having more experience with charcoal/firewood and social commitments such as shop patronage.

Secondly is power relation in the household, whereby the final user (cook) of the fuel may not have power in deciding the fuel use. The most common final user are maids and housewives or children.

Thirdly is the preference in upgrading in the energy ladder by shifting to electricity or gas rather than to another form of biomass like briquettes. Since the transition process in most households is a gradual one, it has resulted in having a mixture of energy sources resulting in fuel stacking. There are multiple factors which could drive this such as social status, economic improvement and many more.

Fourthly is improving energy option is not of high priority in most household, due to being contentment with the existing situation. (Owen et al., 2013)

Next is the level of public awareness with regard to the briquette. The level of knowledge of the society with regard to briquette will play part in determining their perception and view which influence the overall social acceptance. Cases, where there is high public awareness, have shown to have more positive social acceptance than cases with low public awareness (Fagernäs et al., 2006; Owen et al., 2013)

Furthermore is the personal perception, culture, views, and morals with regard to the issue will affect the level of acceptance(Fagernäs et al., 2006).

Last but not least is the distribution of benefits gained from the use of briquettes and their importance to the user. The good characteristics of briquettes are a good performance, economic value, and physical properties (Alam, Islam, Hasan, & Siddique, 2011). Briquettes were preferred due to its good performance as a cooking fuel due to quick ignition, long burning time, low moisture, high burning efficiency, and easy storage. Their good economic value by being affordable, low operation cost and high performance like longer cooking time. Furthermore they have good physical properties such as compactness, having no smoke, transportable, being user-friendly and environment-friendly.

Lastly, some weakness was found with regards to briquette use which have contributed to their negative acceptance. These are its vulnerability to water hence user experiencing troublesome ignition and breaking apart when wet, this property is mostly seen in low quality briquettes. Troublesome ignition in damp conditions for example winter early morning, in addition to the challenge of requiring special stove and ash handling plus disposal(Alam et al., 2011).

2.5 Assessing Criteria

Resulting from literature review the following criteria were selected from the theories whose coupling together creates an overall assessment of the social/market response and perception, therefore, social acceptance of briquettes. The selected criteria are awareness, distribution of

cost, risk and benefits (value), perceived usefulness, perceive ease of use, willingness to endorse the technology, user satisfaction, fitting of innovation with community, accessibility, and affordability. These criteria were operationalized to form aspects used in the formulation of questions to be utilized in the empirical case study. The operationalization of the criteria to questions is presented in Table 2 below. Some of the operationalized aspects do fit into more than one criteria as can be seen in the analysis in chapter 5. As it is to be explained in the next chapter 03 section 3.5, the analysis of household was divided into two groups, the first group was of respondents with experience of using briquettes and second of respondents without experience. The operationalization of the criteria is presented in the table below in accordance with the analysis groups.

Criteria	**Operationalization of criteria**	Group One (have experience)	Group Two (Don't have experience)
User Satisfaction	Experience of use	×	
	Feedback of using experience		×
Willingness To Endorse The Technology	Recommendation	×	×
	Purchase	×	×
Perceived Usefulness	Quantity of heat	×	×
	Tolerance to smoke	×	×
	Tolerance to ash	×	×
	Ability to handle it	×	×
	Impact on Expenditure	×	×
Perceived Ease Of Use	Ability to Store	×	×
	Ability to control	×	×
	Ability to use	×	×
	Speed of lighting	×	×
	Feeling when using	×	
Fitting To Society	Use in existing stoves		×
	foods wouldn't prefer cooking by briquettes	×	
Accessibility	Access	×	×
Distribution Of Cost, Risk, and Benefits(Value)	Change of taste	×	×
	Benefits and loss	×	×
	Challenge Faced	×	×
	Reasons for not using		×
	Motivation for use	×	
Awareness	concerns before use	×	
	Information they have		×
Affordability	Affordability	×	×

Table 2: operationalization of criteria of assessment

Legend

×- Marks the point at which the assessment criteria were used

CHAPTER 03: METHODOLOGY

The following chapter presents the methodology taken to answer the research questions enabling attaining of research objective identified in Chapter 1. Its purpose is to provide the approach taken, reasons behind the selection of those approaches and development of the approach to fit the research objective and context specific factors. It begins by discussing the general approach of the research and then the specific approach is taken for each research question and the reasons behind them. It is followed by an explanation on the approach taken to analyse the collected data. The outcomes of the analysis produced results that add knowledge by increasing the understanding of bioenergy social acceptance specifically briquettes hence attaining of research objective.

3.1 Research Strategy

The research strategy comprised of desk research and single case study using research tools of survey and interviews, for generating both primary and secondary data. Desk research was employed in answering the first research question and the case study research was used in answering the second and third research question. Desk research has been chosen to answer the first question in order to address the question from a theoretical perspective through use of secondary data sources. On the other hand, the case study research has been selected due to having a single research unit (namely Dar es Salaam), which has two observational units namely community members and briquettes suppliers. Both primary data and secondary data were used so as to better address the research questions and attain appropriate depth and breadth. For primary data, open interviews and online surveys were employed.

For the first research question, a literature review has been selected, in order to get a general perspective of existing knowledge found in secondary materials. This method has been selected as it offers knowledge attained from multiple bioenergy projects and research. The strength of this method lies in the fact that it gives insight from various authors and articles which generates sufficient knowledge with regards to the topic. The drawback of this approach is the validity of the general results maybe in question due to the difference in contextual situations present during the writing/preparation of those secondary materials, as well as the data gathering methods used. This may lead to the identification of factors which would only be confined to a given context rather than in general context and some may also have been overlooked. In addition this approach cannot utilize specific factors that relate to specific type of bioenergy for example disadvantage of bio-diesel.

For the second research question, a mixture of interviews through phone and questionnaires was used to address the suppliers. Phone interview was given preference as first contact method due to its advantage of live direct contact, meanwhile, questionnaires were used when requested directly by the supplier or due to un-availability of the suppliers for a phone call. These two methods have been selected due to the accessibility of the small number of suppliers and based on the resource limitation of travelling to the respective dispersed supplier's location in Dar es salaam city or outside for some . Most of the suppliers are working in the informal sectors meaning few are registered, the total number of registered biomass briquettes suppliers is 5,

although there are multiple smaller suppliers who were reached through use of snow ball method/referrals hence the research covered as many of them as can be identified. The suppliers were derived from contact list provided by Tanzania Traditional Energy Development (Tatedo)[6], personal connection of researcher and using snowballing method with reference from the initially contacted suppliers who acted as informants. Therefore this approach identified the factors affecting the acceptance of briquettes from the information/ knowledge of the suppliers and their perspectives. Through this, the second research question was answered, in addition the factors from the perspective of suppliers were attained hence contributing to understanding the factors of bioenergy social acceptance.

Survey method was used in the third research question where questionnaires were distributed online by using a tool called Google forms. The approach was selected inorder to reach a huge number of respondents (community members) with limited resources available. The questionnaires consisted of descriptive questions so as to identify the factors and their corresponding intensity and frequency for attainment of reasonable depth and breadth of the empirical case. It consisted of mostly semi-closed, close end and few open end questions depending on the specific data to be attained from that respective question and in consideration of the respondents feeling during answering the questionnaires. The mixture of question type has been used inorder to capture the attention of respondent (General public members) without boring them with long questionnaires at the same time gaining maximum data required. This approach is limited in some extent in gaining the accurate intensity and context by which the factors has the most significance but none the less it can capture the approximate intensity help and identify (some if not all) the factors that are present.

3.2 Selection of respondents

The respondents were selected through the use of snow ball method, as the survey was highly spread in multiple social media groups and requested to be further spread in other groups by the respondents. Representation from other groups was tried to be attained through sharing in groups with different purposes like entertainment, religion, community, and encouraging spread in more other groups. Some respondents did so and showed proof of sharing in other groups. None the less there is high chance of occurrence of bias by having more people from a given social sphere and/or missing representation from some of the social spheres. As it was very hard to track the number of respondents from different social spheres, it proved to be a limitation in the research. From this the most of the population had a chance of replying and by sharing in social groups optimistically it was possible to address all social spheres in the community. The only criteria used was the respondent prior knowledge or awareness regarding biomass briquettes use and having lived in Dar es Salaam in period of 2015-2020. Both of these criteria were asked at the beginning of the survey hence served as a filtering parameter during analysis.

[6] Tatedo- is a sustainable energy service organization based in Dar es Salaam whose mission is to facilitate and empower stakeholders to overcome barriers so as to have more access to sustainable energy services. Their website is " http://www.tatedo.org/who-we-are/about-tatedo"

Dar es salaam has a population of 6,368,272 people in 2019 ("Dar Es Salaam Population 2019 (Demographics, Maps, Graphs)," n.d.). The number of respondents with respect to the aforementioned groups is unknown and there is no available data to indicate the possible number.

The sample size has been determined by use of Solvin formula with a margin of error of 5% and a confidence level of 95%.

$n = N / (1+N.e^2)$.
Whereas:
n = no. of samples
N = total population
e = error margin / margin of error

The total sample size was 384, with a response rate of 20%, the total number of surveys sent was over 1925 surveys.

This produced an output of the perspective from Dar es Salaam community members which is similar to the perspective from households. The first group provides knowledge, views, and experience they have from interaction with briquettes. On the other hand the second group provides their knowledge, view, and information they have heard/seen with regards to briquettes. In addition to that both groups expressed their support of or against briquettes. Through analysis of the obtained data, the factors, intensity, and their magnitude could be understood. This enabled the answering of third research question and the attainment of knowledge/information of factors affecting bioenergy social acceptance from the perspective of community members.

3.3 Definition of concepts

For the purpose of this research, the following concepts are defined as follows:

- Household- Is a group/unit of people often a family who eat from the same pot
- Community- is a group of people living in a defined area and considered as a unit due to their common interest, nationality, or social group
- Biomass briquettes suppliers are considered as the manufactures of biomass briquettes from any biomass for sale
- Biomass briquettes are taken as densified solid fuel irrespective of its size and shape, made from any biomass as its major component used for cooking food and it can either be carbonized and un-carbonized
- Community acceptance refers to the acceptance by a community and its stakeholders with regards to the use/operation of the energy source/technology.
- Market acceptance- refers to the support, adaptation, and use of technology/innovation in the market whereby it looks into the willingness of customers and investors willing to do transactions.
- Perceived value- refers to the value associated with the product in terms of its economical worth, associated risk and benefits

- Perceived usefulness- refers to the usefulness of biomass briquettes in performing the required tasks
- Ease of use- refers to convince in attaining and utilizing biomass briquettes
- Bio-energy is understood as the energy derived from living things or recently living things and the by-products associated with them such as manure and remains but excludes all fossil fuels such as coal and petroleum

3.4 Research Boundary

Generally, the research will analyze the social acceptance towards alternative bio-energy focusing more onto biomass briquettes as charcoal alternatives.

In the empirical case, the research will look into some aspects of market acceptance, socio-political acceptance and community acceptance towards alternative energy sources in Tanzania by considering Dar es Salaam as a case study.

It will cover policy overview and some aspects in the interaction of supplier to customer interaction as well as customer to product and customer to customer interaction as they have a vital role to play in the social acceptance in the case study.

The targeted group inside the community are household users due to their huge number hence assumed larger consumption of bio-energy. Other community users such as commercial usage won't be covered in the case study due to case study limitation of time and resources.

It will include all Dar es Salaam community members that are aware of the existence of briquettes

In market acceptance, the acceptance of shops, supermarkets, and the like business entities would not be analyzed in this research. Though they play a vital role however due to research constraints, they have to be omitted.

3.5 Data Interpretation/Analysis

The analysis of the output was carried out by the use of content analysis for the first research question. For the second research question, the data were analyzed by content analysis and narrative analysis through codifying with assistance of Excel Programme.

As for the third question, the data was edited first by data checking for removing errors such as incomplete answers, then they was codified. Data analysis for the community members was conducted in steps; To begin with, the data from the community were grouped based on the different possible interactions of briquettes with society members. Two major groups were formed and their respective sub-groups. The results of the groups have been presented in APPENDIX 2. Next was analysis of the sub-groups independently that was wrapped up with a sub-conclusion and sub-discussion of the respective group. The last step was the comparison of the finding between the two groups.

Basing on the interaction of society member with the briquettes, two major groups have been formed which are: those who have used briquettes and those who have never used it. The first

group “those who have used briquettes,” is constituted by the following subgroups: (i) those currently using it, (ii) Used in the past then stopped and plan to re-use it, and (iii) those used in the past then stopped and have no plan of re-using it. On the other hand, the second group consists of the subgroup of those whom (i) have never used it but have seen/heard and are interested to try it, (ii) have never used it but have seen/heard and are not interested to try it.

This classification enables identification of possible standpoint of the respondent with regard to briquettes and facilitates a better understanding of the motives behind his/her answer. This is not a final standpoint as one's perception changes over time and influenced by many factors. This analysis method is limited by the possibility of a respondent taking a false/unrepresentative group, causing misrepresentation. Though this confusion can be solved through critical analysis of consistency among respondents other answers, enabling determination of his/her standpoint. Although it has flaws, none the less enables gaining view of the current standpoint of the respondent for those who responded truthfully as per their view at the moment. For a better understanding of the perception, the respondent's response was analyzed and made sense in accordance to the group respondent had selected.

By combining the outputs of first, second and third research question, and analyzing them, the results and conclusion that were attained enabled the synthesis of knowledge that can contribute in the understanding of the general and specific factors that affect bioenergy social acceptance specifically briquettes inconsequently attaining the research objective.

3.6 Validation of Data

In the second research question for attaining greater validity of the data, the respective topics to be discussed were sent prior the interview, so as to give time for the supplier to prepare appropriate answers which accurately represent her/his situation and view. The drawback of this approach is the absence of physical interaction between researcher and interviewee. Second is the probability of supplier providing misleading information which can affect validity of data when not identified and rectified during data analysis. The misleading data can be identified due to its inconsistency and by use of statistics methods.

The research questionnaires for the third research question was first translated from English to Swahili (local language) then shared with colleagues and pilot tested with 20 selected respondents for ensuring It is easily comprehensible for everyone, with the same comprehension that is intended to be attained. It was then re-translated back to English to ensure the translation had the same intended meaning.

The validity of the response was ensured through checking for alternative explanations for derived findings, with close attention assigned to anomalies found in the explanations of the results. In addition to that through sharing of non-personal data and analysis results with colleague’s(moderator’s) specifically thesis supervisors and skilled friends for assessing the analysis validity and completeness.

This approach is threatened by the possibility of respondents filling the form more than once using different names which created duplication of data that was impossible to identify. Though its possibility is low but never the less it is there. Next is threat of incomplete responses, creating incomplete data set that was addressed by statistical methods in accordance with the available data. Lastly is, respondent providing misleading data leading to discarding of the data during analysis.

List of prepared questions for an interview with briquettes suppliers is in APPENDIX 5. The questions are mostly open ended questions, with few closed end questions. They covered the aspect of mapping current operations capacity, mapping percentage of targeted household customers in their market strategy, the perspective of suppliers with regards to household market and its respective challenges, identification of benefits and challenges experienced based on the feedback they received from their customers.

APPENDIX 6 is a prepared list of questions for community members. There are two groups of community members that have been identified basing on prior use of briquettes. The first group is those with experience of using briquettes and the second group, have never used briquettes, but know about them. The questions for both groups utilized the same criteria for assessment as identified in Table 2 in chapter 02.

CHAPTER 04: RESULTS AND DISCUSSION

This chapter contains the results from the finding and the discussion of the results. The results are from policy overview, community member surveys, and the interviews of the suppliers. The chapter will begins by providing the results of policy overview, followed by results of suppliers and its discussion, next is results of community members and its discussion and lastly an overall discussion utilizing the prior discussion. In the overall discussion, it builds on the prior discussions, utilizing the synergy between them. The format for presentation of results and its discussion for each group (community members and suppliers) have been highlighted in their respective sections.

4.1 Policy Overview

Tanzania national energy policy, development plans and national environmental policy all concur on the importance of the transition from charcoal use towards other alternative energy. With regards to briquettes, the energy policy, energy subsidy policy and environmental policy do not address it specifically. Furthermore, there isn't any policy that is directly addressing briquettes use and adaptation. In 2014 a two-year biomass energy strategy (BEST) was prepared with the aim of addressing key issues related to biomass use in the energy sector (*National Energy Policy*, 2015). The strategy identified the role of briquettes and addressed the main issue behind the adaptation of briquettes. The implementation of the strategy in adapting of briquettes in the national policies has been lacking. In the revised 2015 energy policy focuses more on the role of biomass in biofuel and LPG/natural gas use in domestic households (*National Energy Policy*, 2015).

The current political attention directed towards briquettes is from political leaders who are pushing forward the agenda of banning of charcoal use. The political support can be seen their public issued statements and actions such as hosting competition and organizing of events that promote briquettes (Namuhisa, n.d.). A governmental organ called Tanzania Traditional Energy Development (Tatedo) has been spearheading the development of briquettes and other renewable energies in Tanzania. With regards to other stakeholders like NGO and shops, they have positive to neutral response as can be seen few have opted to support of briquettes activities or to try selling of briquettes or support. Meanwhile, for the incumbent regime stakeholders namely the charcoal dealers, none has been seen to incorporate the selling of briquettes as no briquette supplier was cooperating with charcoal dealers in the selling of briquettes. For the other incumbent regime stakeholders, their position was not able to be deduced in this research.

Overall briquettes are not addressed in the national policies which show poor support for the alternative. This caused a lack of framework with regards to directing of briquettes related activities. Though it is supported by many political leaders most notable is the minister of environment and regional commissioner of Dar es Salaam.

4.2 Suppliers Results and Discussion

The findings from the suppliers had a high degree of similarity, henceforth presented, and discussed in this chapter together.

Suppliers can be divided into large producers and small producers depending on the amount produced. Large producers have a capacity of greater than 1000 kg/day and smaller producers

have a capacity of less than 1000 kg/day. They both make carbonized briquettes or pellets for household use, by using a mixture of raw materials. Most of the suppliers are individual businessmen and one was an NGO. Large producers serve mostly households, institutions, and businesses with more than half of their customer's portfolio being businesses and institution. On contrary, small producers, they serve mostly households and business. There are 3 large producers who were contacted and 2 large producers responded and for small producers out of 16 producers whom contacted 10 responded.

Apart from their difference in customer portfolio, they also differ in their delivery system. Small producers, operate by using a delivery system for customers who buy in bulk, and for smaller purchasing customers they have to go to their shops. In some cases, they outsource to distributors who operate from home or owning a shop were the customers go and purchase. Large producers, mostly outsource to distributing agents (sellers) who serve the household, and a delivery system for the business, institution, and bulk purchase from the household. The distribution agents could be independent entrepreneurs, shops, and supermarkets. These distribution method has two limiting factors that make tapping to the bottom of the pyramid market difficult. To begin with most customer purchase in smaller quantities at infrequent times in a day making delivery at a competitive price difficult. To further strengthen the challenge the majority of the customers don't live near a distribution shop which makes accessing briquettes to be a time and effort demanding endeavor. Coupled with few distributing agents per supplier/producer puts further strain on the distribution network resulting in un-accessibility and unreliability of supply of briquettes. On the other hand outsourcing to distributors has been challenging as it tends to increase its market price making it unattractive to a price-sensitive market nor could many of the supplier afford to open and operate multiple shops. Charcoal (regime product) has an established system that utilizes lots of informal small shops dispersed throughout the city facilitating gaining of additional advantage in attracting of customers. A more efficient way of distribution is required to reach to all customers throughout the city.

Some of the producers claimed to have stopped production for a while due to financial problems, space issue or technical (machinery) problems. This trend was mostly observed in smaller producers targeting household and business, which could further affect the consistency of their briquetting services.

Most of the advertisement is done through media, social media, mass gathering, demonstration and events, brochures and by use of agents. These methods have increased awareness among many people in Dar es Salaam, though the majority of them have seen/heard about it but have never actually used it. This corresponds to the community findings where 57% of respondents have seen/heard about it but haven't tried it.

In the existing regime charcoal is mostly sold per a certain locally agreeable volume, making dense energy-intensive briquettes to be seen expensive when measured per the same volume. This is the reason why respondents who hadn't used briquettes perceive them not being affordable when they do price to volume comparison of charcoal and briquettes. To cope with this the supplier are selling per weight (mass) of the product which is a new way for the market and highlighting the difference in expenditure incurred when using charcoal vs briquettes. The price range per kilograms is 500-900 Tshs/kg and most common packaging system among them

consist of 3 kg, 25 kg, and 50 kg, with each package size aimed to address different kinds of customer's needs.

All the suppliers perceive the market response to be positive and growing, though challenged by distribution, lack of awareness and familiarity. New customers are most concerned about the performance of the briquettes and its value, hence hindering their initial self-initiative. To overcome this, some supplier offers free or discounted products to promote new customers to try out their products, hence increasing their operation cost.

Customers reported to gain the benefits of good performance (lighting fast and burning for a longer time) in addition to a reduction of expenditure and utilization of ash as garden manure. The loss or disadvantage the customers reported to experience are un-reliability of supply, occasional smoke being produced, too much ash, and disintegration when touched. This corresponds to what was expressed by the community members with regards to the advantage and disadvantage experienced. To cope with these challenges, some suppliers offer instruction on how to use and handle them. Others leave the learning process and adaptation to customers who eventually through trial create the best methodology convenient for their use.

Furthermore, they have a pleasant cooking experience with no change in taste and can cook all foods by use of briquettes. Initially, a customer can have trouble cooking food that takes a short time and needs to control of flame, but after continual use, the customer is able to adapt and cook all the foods well. They prefer cooking foods that take a long time by use of charcoal rather than those taking a short time. This is somehow similar to the finding found in a community survey, though different since they identified beans and makande which takes a long time to cook. The exact reasons for the two food dissatisfaction is the difficult in damping down the heat output in during simmering stage.

None of the suppliers think the local culture and cuisine as among the hindrance factor to the adaptation of briquettes. Hindering factors identified are personal decisions, lack of awareness, bad past experience from using briquettes, believe that food tastes better when cooked on charcoal, and firewood/charcoal readily availability. They think the community has limited awareness about briquettes use, leading to the use of both briquettes and charcoal together or only charcoal. This can also attribute to the findings of food which the community members wouldn't prefer to cook using of briquettes instead cook using charcoal, thereby promoting the continuous use of charcoal within the society.

The major factors promoting briquette use are pressure from the government, the banning of charcoal use in the city, its affordability, and good performance.

4.3 Community Result and discussion

The collected survey data is analyzed and discussed in this section, and supplier's data in the previous section.

As identified in section 3.5 in chapter 03, the analysis was conducted basing on the identified groups. In nearly all cases the other responses showed congruence with their respective groups hence validating their presence in the group, though some few data raised a concern about their

validity hence were discarded or re-allocated in accordance to the other answer the respondent provided.

The total number of respondents in this research were 459, and among them 90 have been discarded due to various reason, leaving 369 responses for analysis. The analysis will continue basing on the respective groups and subgroups.

4.3.1 GROUP 1- Have experienced using briquettes

Respondents (society members) of this group all have experience using briquettes before the date of research hence their questions were tailored with this regard. The total percentage of respondents in this group was 23.4%, which is less than a quarter of the respondents. The small number of respondents in this group could have been contributed by:(i) few people have used it, (ii) few of them got the questionnaires and lastly (iii) few of them responded due to various reasons.

The third factor is the most probable that the user's neglected to respond to the survey as they lack interest in comparison to their counterparts who are interested in the product but have not used it before. The first factor is the second probable situation since the questionnaire was shared with briquette producers and sellers who were asked to share it among their client networks. This action could have resulted in a bias of data by having more user response, but this was not the case. To add to that, the questionnaire was shared on various social media sources which all people have access to, therefore by having few responses in this group its either they didn't respond as a personal choice or there are few users.

The result of this group is presented in APPENDIX 2. The results show that the responses are not evenly distributed among the criteria since it wasn't made compulsory responding to all the questions. From this, it was deduced that some of the criteria resonated more with the respondents by having more responses and in all the three subgroups. This occurrence gives a perception of them being important features or consideration in society. These characteristics are the amount of ash, reduction of expenditure, ability to control, ease of use, being happy and at peace while using. Further analysis was conducted under the subgroups.

4.3.1.1 Sub Group-01- Currently using it

This sub-group consists of respondents who identified themselves as currently using briquettes, which constitute 11.8% of the respondents.

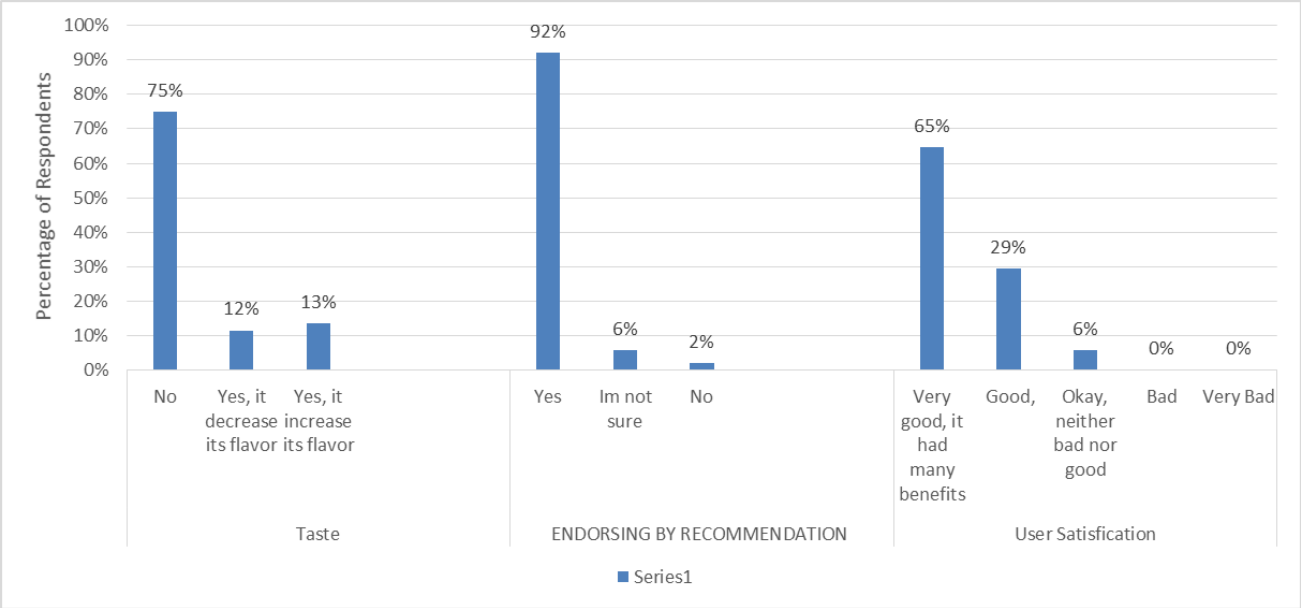


Figure 2: Taste, Endorsing and User satisfaction

As shown in Figure 2 above a large proportion have good experience with the use of briquettes while few find it neutral (neither bad nor good) which indicates a good satisfaction level. By being current users, it indicates they are willing to financially endorse the product. In addition to that, nearly all of them are ready to recommend it to their close friends and relative, with few of them not sure about the recommendation and very few that won't. Majority of the respondents (about 75%) didn't find any difference in food taste, with 13% experience increase in the taste of food and 12% decrease in the taste of food. Upon consultation with producers and literature review, it showed some few people also experience the change in taste whereby it was attributed to change in cooking temperature, personal bias, and emissions from the fuel. From this, It is evident they have a good rapport with the products which can be further confirmed from the answered given below. The few who were not sure of recommending it, expressed experience in decrease in the taste of food and difficulties in getting briquettes. These two observations could probably be the underlying cause for the uncertainty expressed.

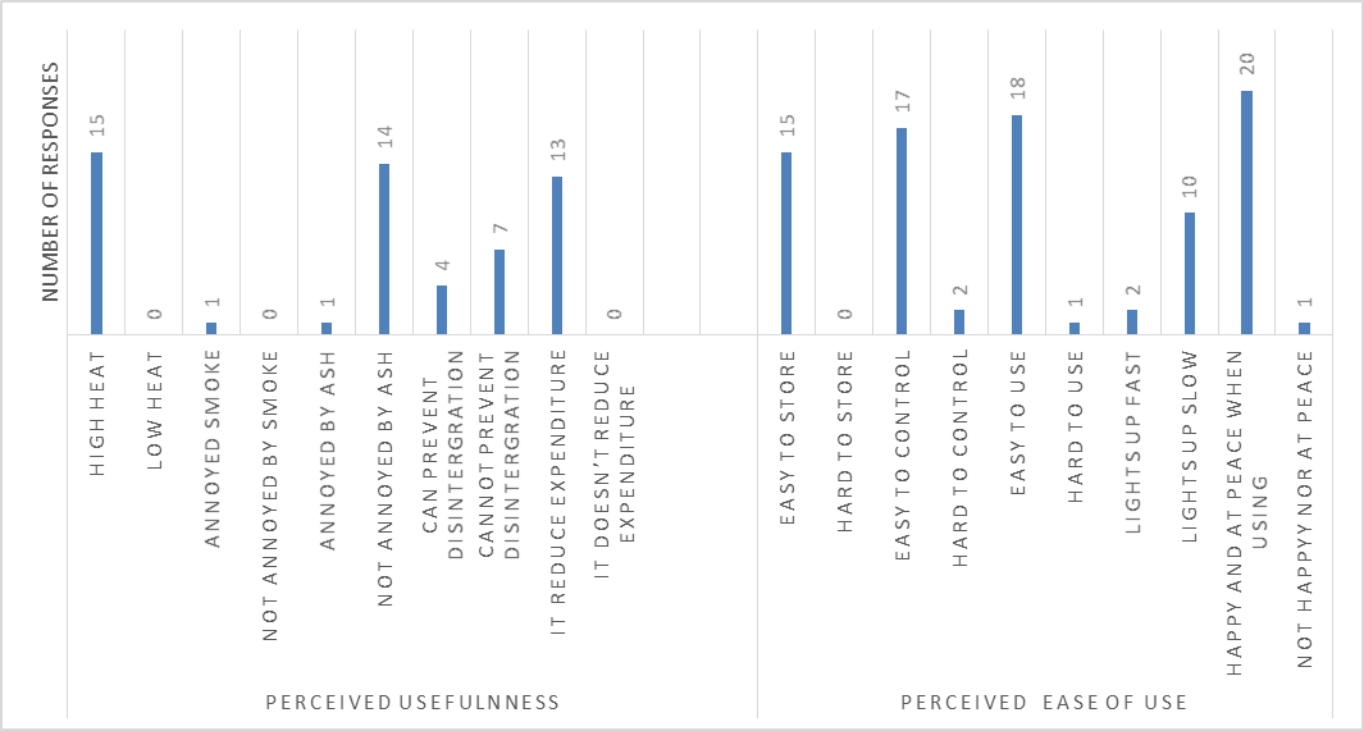


Figure 3: Perceived Usefulness and Ease of Use

Overall the respondents perceive briquettes to be useful and ease to use as shown in Figure 3 above. The perceived usefulness of briquettes according to its performance is as follows: has a high heat output, burns for a long time, reduce expenditure, not annoyed by its ash, and doesn't disintegrate. The characteristic of presence/absence of smoke, received very small/negligible attention for it to be considered. With respect to ease of use, respondents find it easy to store, control and cook with, plus are happy and at peace while using it. For majority they found it to take too long to light and some few people had trouble in controlling, preventing its disintegration, hard to use and not at peace when using it as shown in Figure 03.

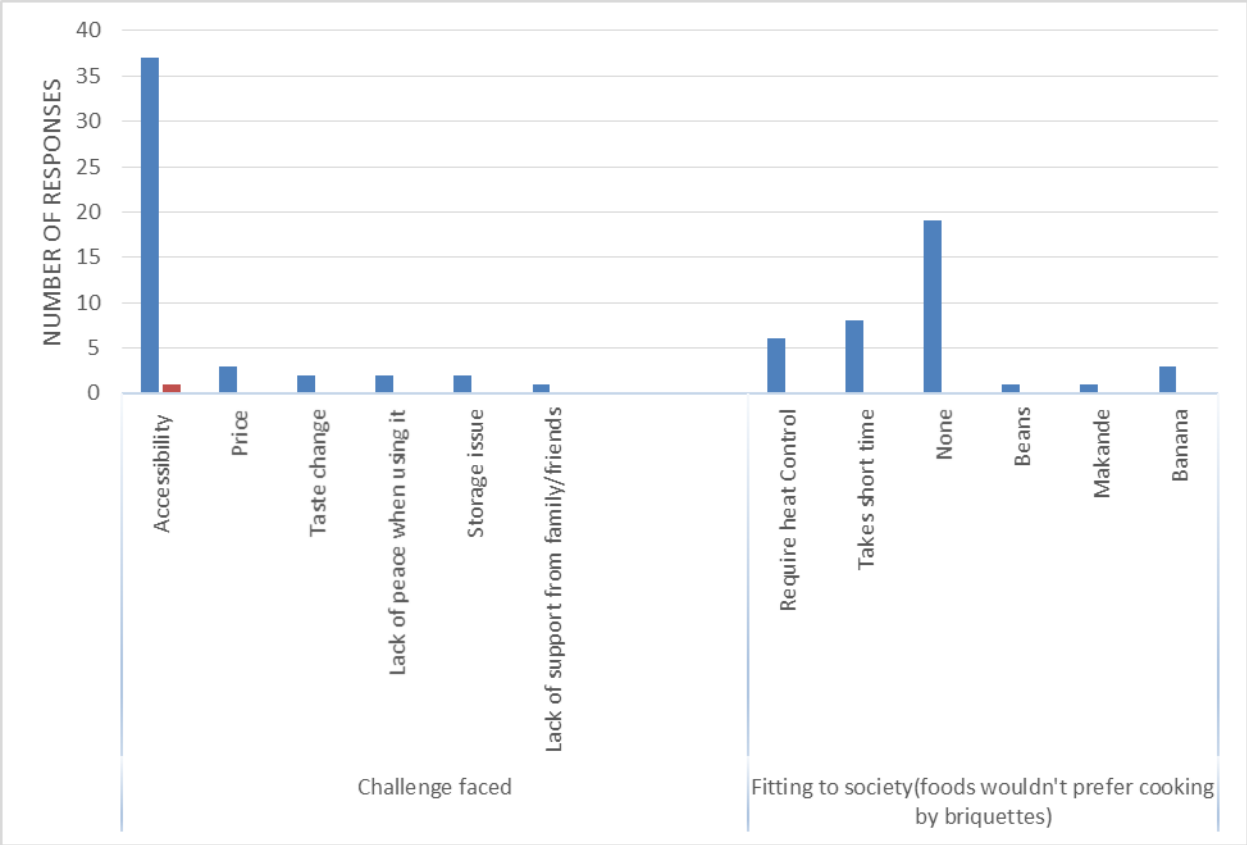


Figure 4: Challenges and fitting to community

From Figure 4 shows that the common disadvantage/challenge highlighted was difficulty in accessing briquettes. Other less common challenges/disadvantage identified by very few respondents were price, change of taste, lack of peace when using it, storage problem and lack of support from family/friends.

From Figure 4, briquettes has fitted to a large extent in addressing the cooking needs except for few food that are desired by the community. Majority of the respondents expressed not preferring cooking of foods which takes a short time to cook for example porridge, stiff porridge (ugali), spaghetti, and tea. Apart from those, they also don't prefer using briquettes when they cook beans, makande, banana and for foods that require cooking at low/medium heat like rice and pilau. Upon consultation with the producers and some homeowners, they hypothesized that the possible reasons for this are as follows: Firstly, the long burning time of the briquettes becomes a disadvantage when cooking food that takes a short time as the burning briquettes get wasted and take time to light up. Another possible reason was briquettes having high heat output, tends to cause these foods to burn at the bottom of the pan when not controlled properly, especially rice, eggs, and pilau. Lastly, for rice and pilau, it is required to control the heat at low/medium, then transferring some briquettes to the top of the pan (for even cooking both top and bottom). This can be inconvenient for briquettes that disintegrate to powder form hindering the transferring process and difficult for some in controlling of flame. In contrast to popular belief, suppliers knowledge, and researcher knowledge some respondents identified foods that are typically preferred to cook by use of briquettes. This is because, these food take a long time

to cook and require high heat output, therefore briquettes in such a scenario have the more pronounced effect of reduction of expenditure and cook slightly faster in comparison to charcoal. These foods are beans, makande, and banana. The respondents that mentioned these foods could have misinterpreted the question or there is something with those foods. To eliminate the possibility of misinterpretation the survey was shared again to 10 random people and at the end of the questionnaire, respondents were asked about their understanding of that specific question. All of them had the same understanding as to the intended meaning and looking at the number of respondents who identified these foods, it greatly reduce the possibility of misinterpretation. Upon further investigation it was understood the possible reason for beans, makande and banana was they require initially boiling followed by simmering that may be difficult to 'damp down' the heat output. According to Tanzanian culture, stiff porridge(ugali), rice, pilau, and beans are among the common staple food, this could justify the uncertainty in recommending it that is expressed by a few of them.

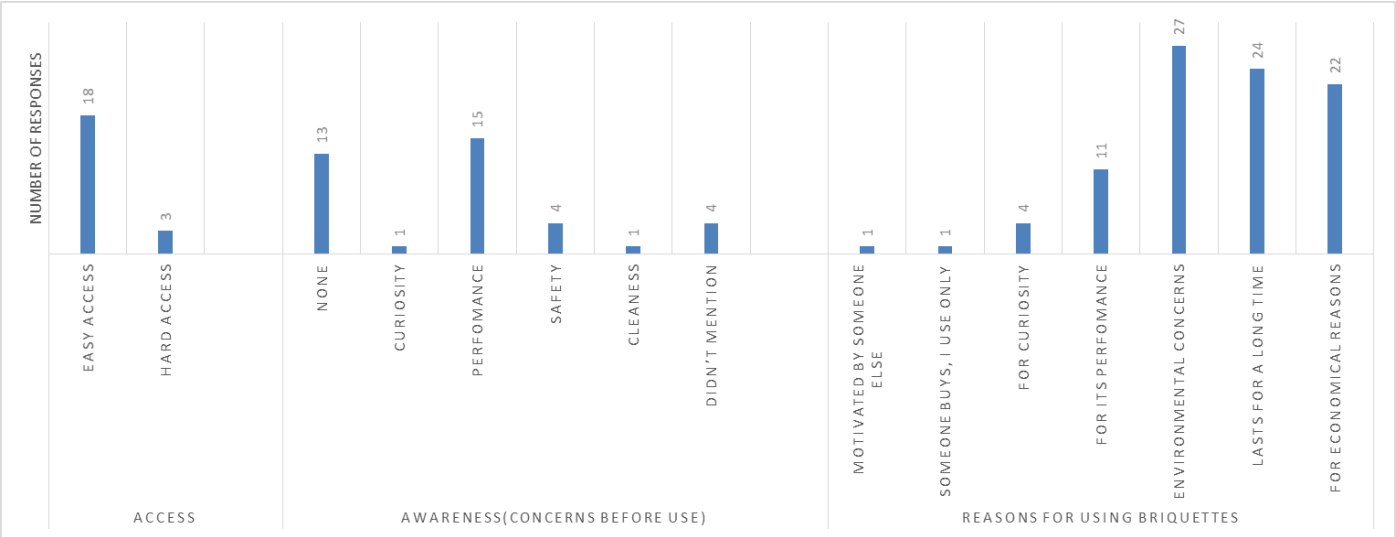


Figure 5: Access, Awareness, and Reasons for using briquettes

In this group, majority had identified to have access to briquettes although earlier on in Figure 4 they also highlighted accessibility to be a major challenge. As a current user they have access, and are aware of the accessibility challenge experienced by community members.
Majority of them didn't have any concerns before using briquettes or were concerned with its performance specifically ability to cook and longevity of burning). Other concerns expressed by few of them were safety (emission and explosion risk) and it produces too much ash as shown in Figure 5. These are normal concerns which don't have any false/misleading information indicating a positive level of awareness. Majority of the respondents have a medium to high influencing powers in their household with few having little influence.

The common motivation for using briquettes among them was economic reasons (reduction of expenditure and affordability), saving the environment from deforestation and its performance mostly burning for a long time. A small number of respondent were curious, convinced by someone and someone else buys it for them to use as shown in figure 5.

Overall this group has very good acceptance to briquette use as they have good experience with it, perceive it to be useful, easy to use, and has more benefits to cost. Furthermore, it fits well to their use, had good awareness, and are willing to endorse the further growth of briquettes niche though it is faced by major challenges like accessibility and other minor challenges.

4.3.1.1 Sub Group-02- Yes, Plan to re-use in The Future

This sub-group consists of respondents who had used briquettes then stopped and plan to re-use them again, which constitutes 8.1% of the respondents.

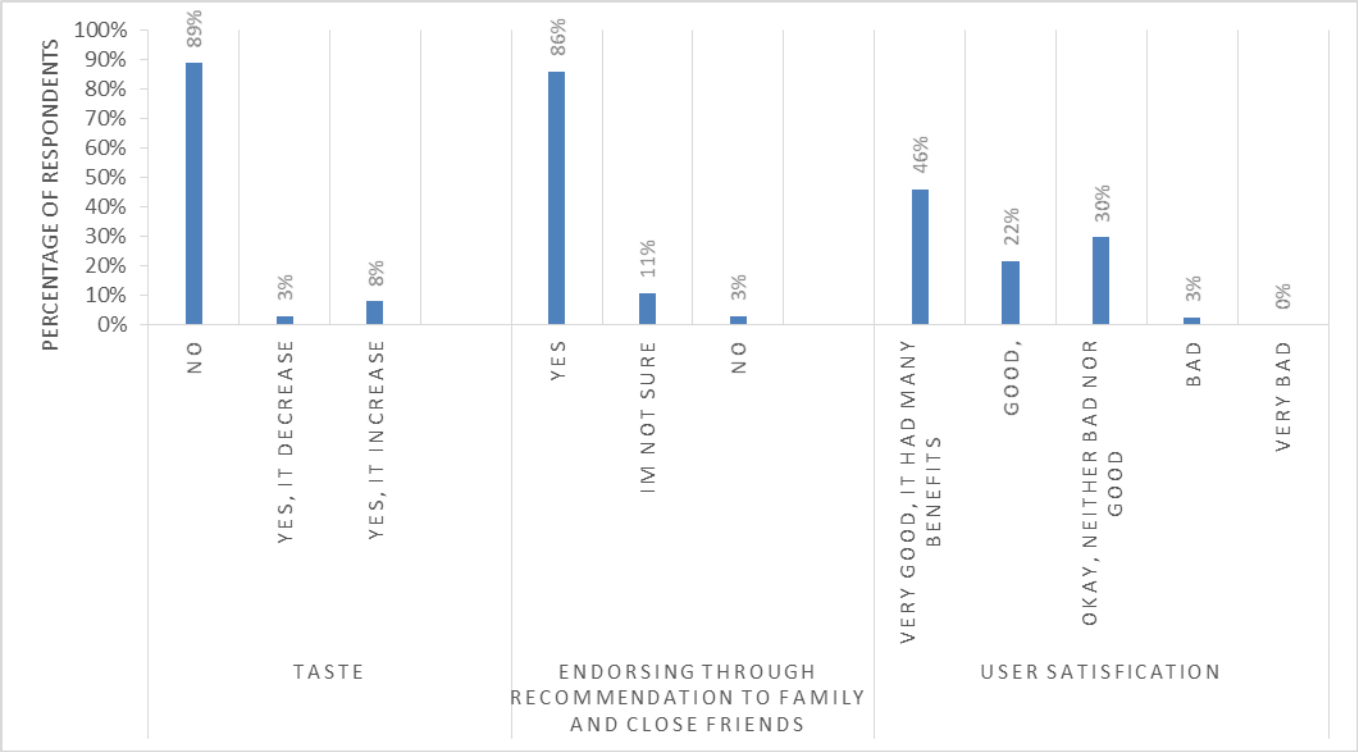


Figure 6: Taste, endorsing and user satisfaction

This group had more diverse responses in most of the questions in comparison to the first subgroup of the current user. Overall respondents in this group had a good experience, with a reasonable number that had neutral and very few had a bad experience. Respondents with bad experience had many challenges in using and accessing of briquettes hence justifying respondent's experience. The respondent is also among the people who are uncertain in recommending briquettes, motivated by environmental reasons and by choosing this sub-group indicates currently respondent is willing to re-try briquettes. Majority of the respondents are willing to endorse it by recommending it, and few that are unsure or won't. Majority of the respondents as in the first group didn't find any difference in taste, and few that did. The reasons for this observation are the same as one expressed in the first subgroup. This group has a reasonable rapport with regards to briquettes use as shown in Figure 6.

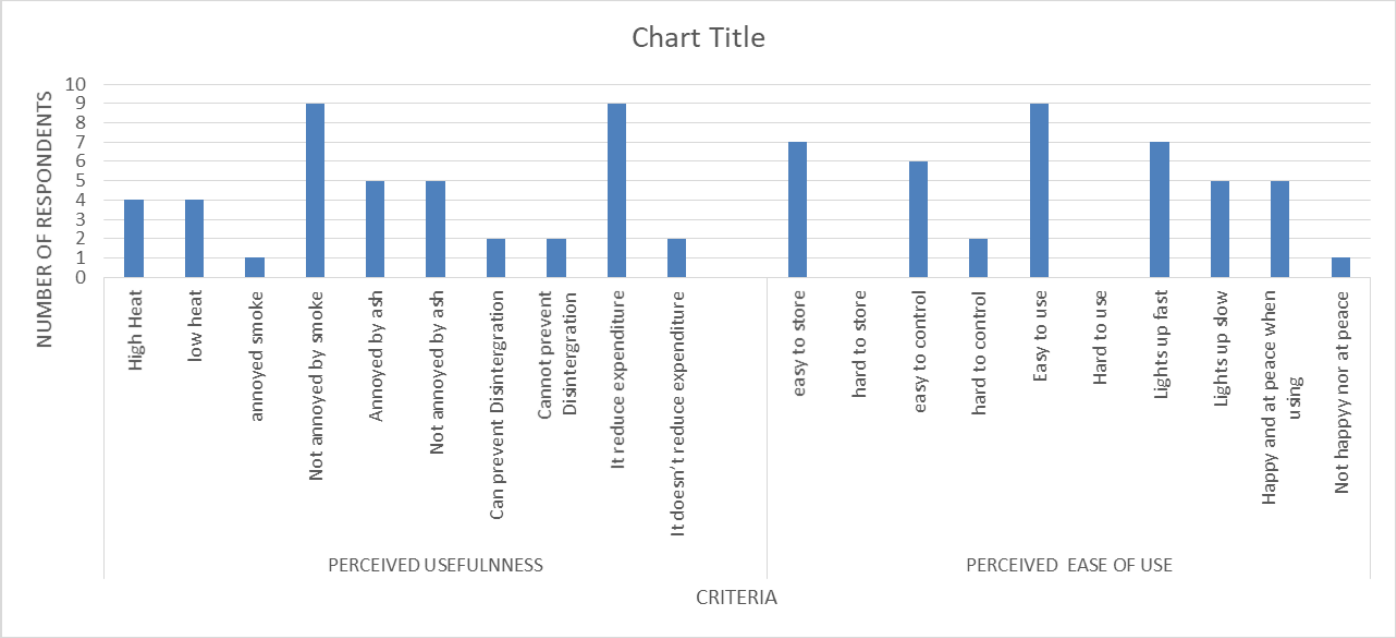


Figure 7: Perceived Usefulness and Ease of Use

The Group's perspective on ease of use and perceived usefulness was almost equally divided between the extremes of good and bad as shown in Figure 7. More respondents perceived it to be easy to use with an almost equal number finding it to have average usefulness. Perceived useful features identified by the majority were a reduction of expenditure and not being annoyed by smoke. It's burning temperature, ability to prevent its disintegration and perception of ash. An equal number of people found them to be useful and not useful. Meanwhile, for perception on ease of use, the majority identified it to be easy to store, control, use, lights up fast, plus are at peace and happy using briquettes. Even though, few experience challenges in controlling it, lighting up slowly and were not happy nor at peace using it as shown in Figure 7.

This demonstrates the difference in perspective among society members regarding to the same product. From interviews with suppliers, it was found out that currently there isn't a well functional established system for controlling quality. In the informal sector there are no quality control system hence some producers create un-checked quality control products. This leads to the market having low-quality products which don't have a good performance. The common observed low performance is having much ash than normal, production of smoke, high vulnerability to water and having low heat output.

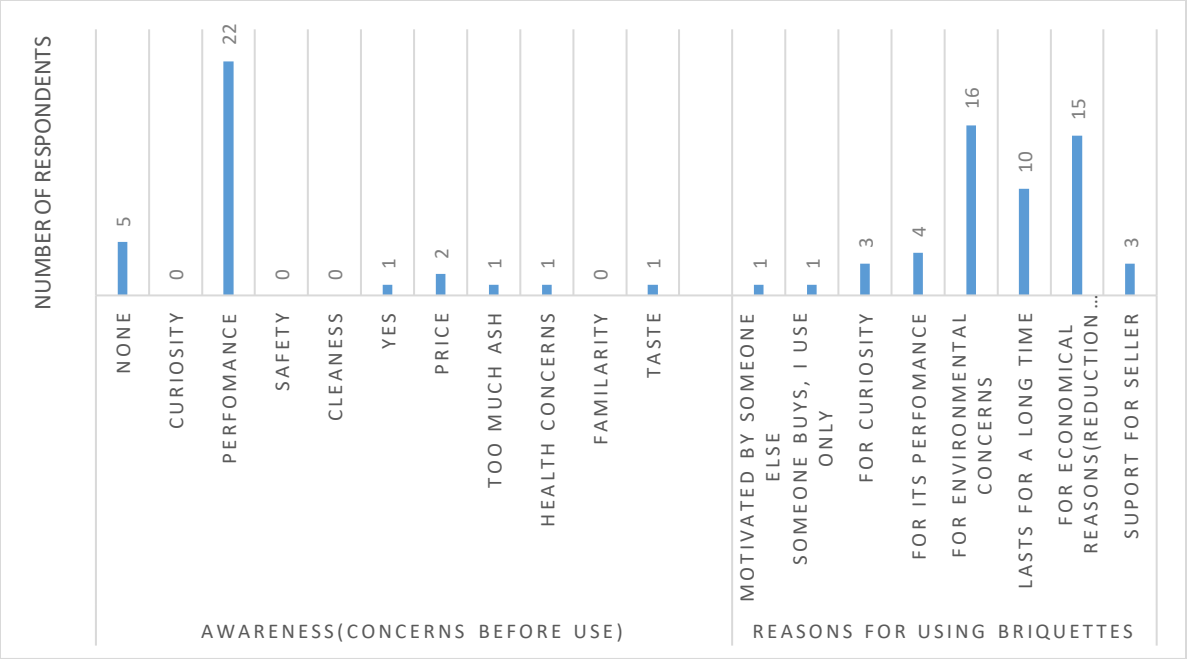


Figure 8: Awareness and Reasons for using briquettes

Before using briquettes the group had the same performance and health concerns as the first group, in addition to price and too much ash. These are normal concerns which don't have any false/misleading information indicating a positive level of awareness. The exact reason for the discontinued use of briquettes was not asked in this section which proved to be a limitation.

Similar to the first sub-group, common motivating factors for briquette use were economic reasons (reduction of expenditure and affordability), saving of the environment and burning for a long time. Other less common factors identified were its good performance, trying it out of curiosity, support of seller and someone else buys it for them.

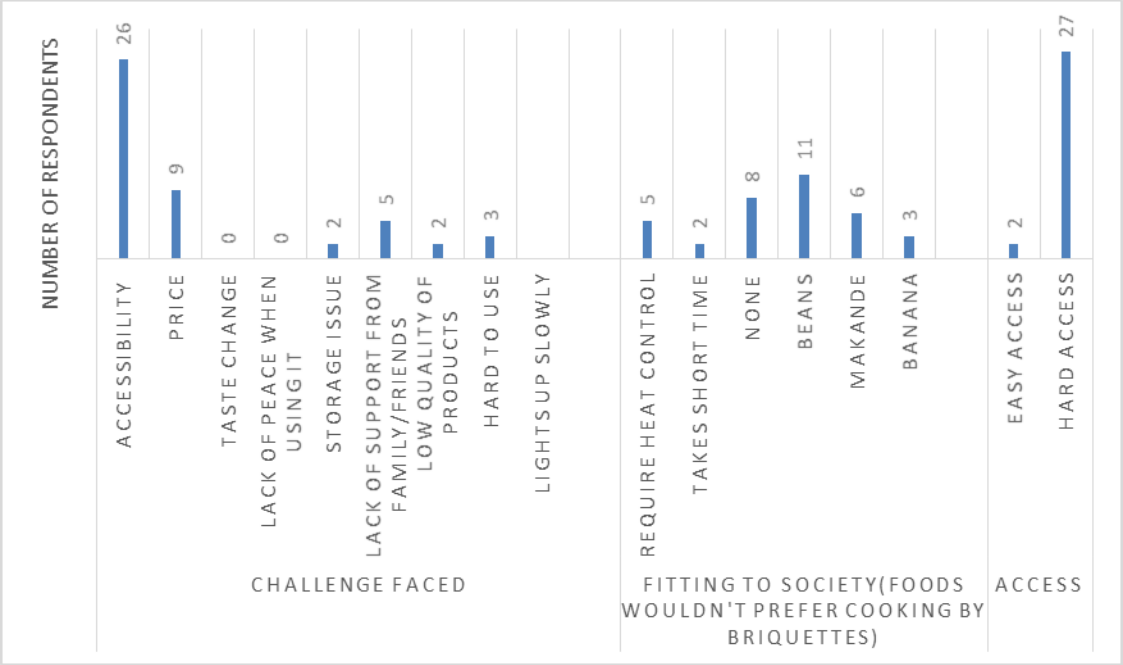


Figure 9: Challenges Faced and fitting to community use

The sub-group also identified the same kind of food, by which they wouldn't prefer to cook over briquettes as the first sub-group. Among the sub-groups this one had the highest number of people who identified beans, makande, and banana as foods they wouldn't prefer.
The most common challenges identified were reliable access to briquettes, price, storage, trouble cooking, lack of support from family members (they don't like it) and low quality of briquettes.

This sub-group has a good acceptance to briquettes which can be seen in their objective of re-using briquettes again and from their answers. They have more distributed perception on briquettes, none the less majority are willing to endorse/recommend their family/friends to use briquettes. This is due to their perception that briquettes have some usefulness and ease to use. Though they faced some challenges (cost) but have also gained reasonable benefits to offset it. Furthermore, they had positive awareness and product fitted well in their community except in few instances briquettes was not preferred.

4.3.1.1 Sub-Group 03-Yes, Don't plan to use in future

This group consists of respondents that have used briquettes, stopped and don't plan to re-use it again, which represents 3.5% of the respondents. The small number of respondents in this group, indicates that fewer people, are dis-interested in further using it in the future.

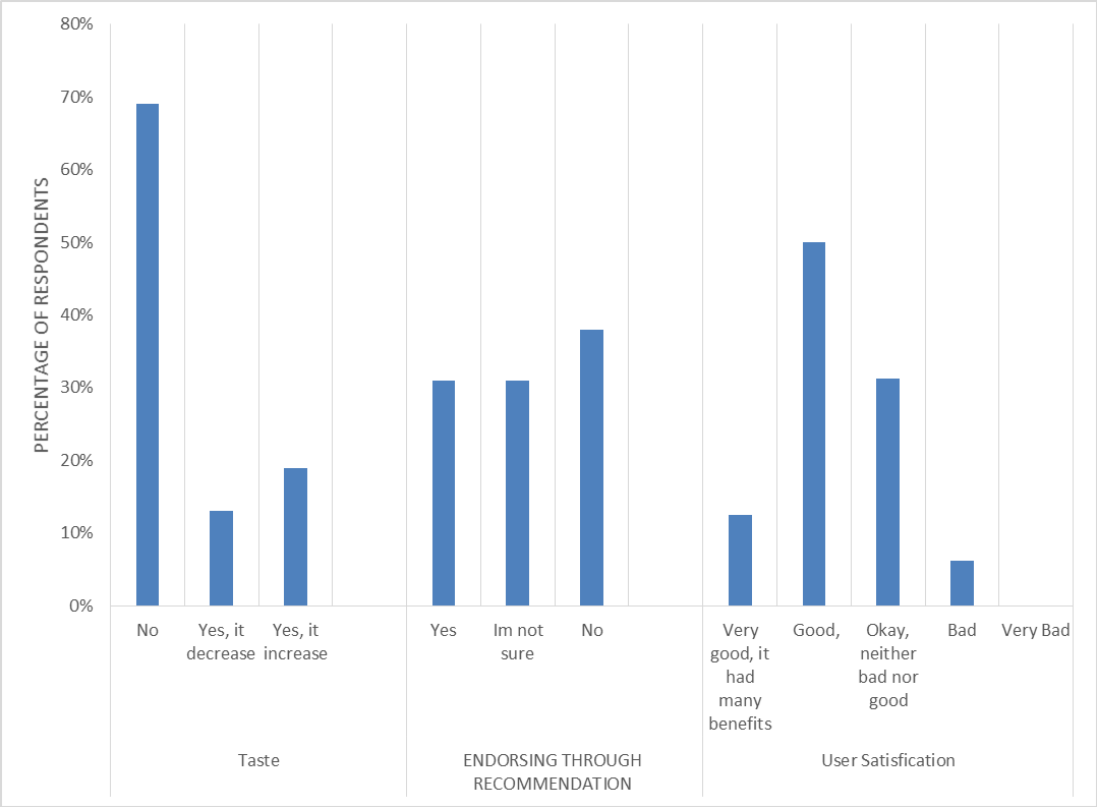


Figure 10: Taste, Endorsing and User Satisfaction

InFigure 10 the majority of the respondents perceive briquettes as good or neutral, with the exception of one who sees it as very bad. This one respondent had tremendous troubles using it and bad performance, which justifies all his/her answers. In addition to that one of the respondent identified briquettes as a good energy source but It is about to be replaced by gas and electricity which gives a good point to think about. About equal number of respondents are willing to recommend, not sure and won't recommend it.

Same as in prior sub- group's majority identified no difference in food taste, while few identified increase and decrease in food taste.

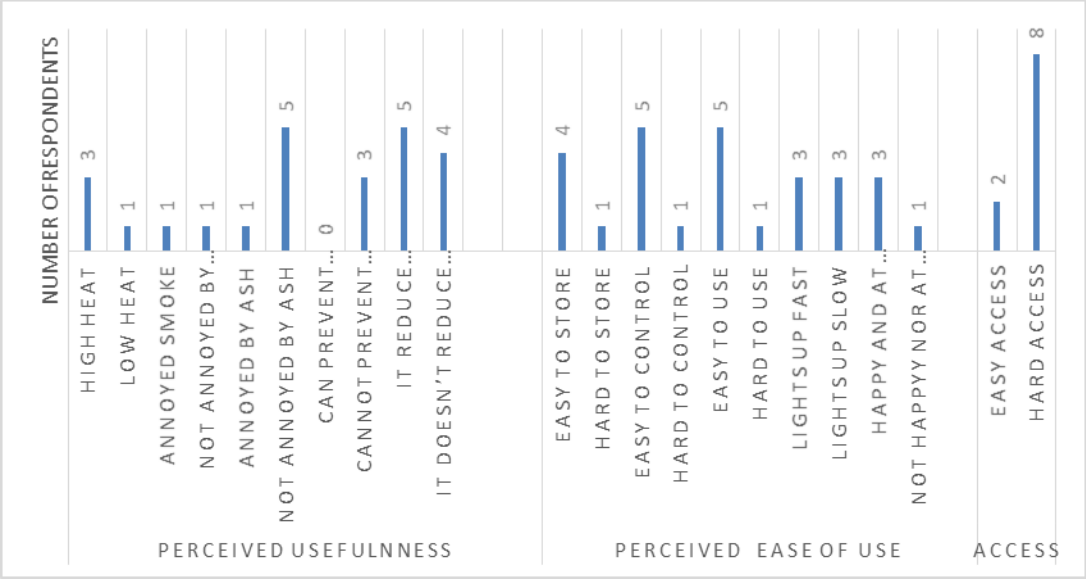


Figure 11: Perceived Usefulness and Ease of Use

Same as in the previous sub-group, its perspective on ease of use and perceived usefulness are divided. Some, they perceived it as easy to use and useful meanwhile others as hard to use and not useful. To start with, useful features identified are by the majority are; it has a high heat output and ash doesn't annoy them. An almost equal number of people identified it to reduce and not reduce expenditure, being annoyed/not annoyed by smoke, and they can't prevent the disintegration of briquettes to powder form. Few of them find it to have low heat output and annoyed by ash. In regards to ease of use the majority find it easy to store, control, and use. An equal number find it to light fast/slow, and are/are not happy and at peace using briquettes as shown in Figure 11. Though there is a small difference in benefits and challenges identified between this sub-group and the previous sub-group, they are almost the same. This consistency in the identified characters creates some validity for the factors.

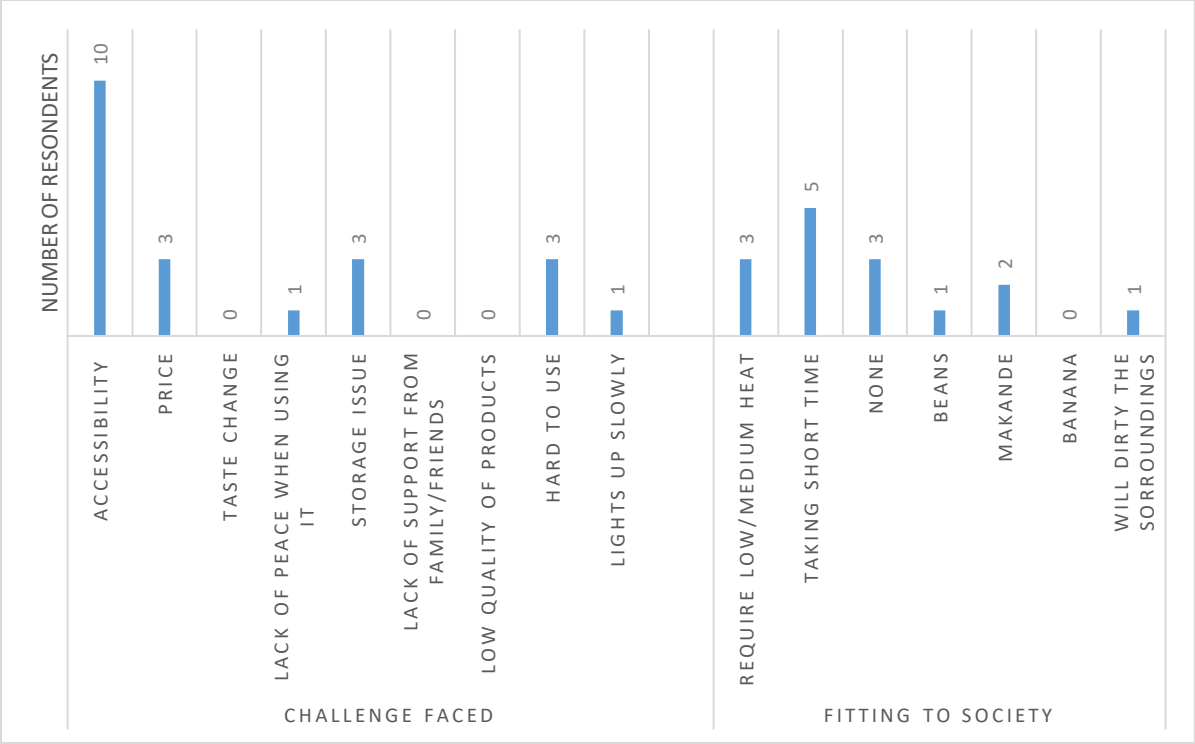


Figure 12: Challenge and fitting to society

This group as the previous groups, also identified the same kind of foods by which they wouldn't prefer cooking using briquettes hence validating this fact.

Same like in other sub-groups, the most common challenge is access to briquettes. Other challenges are price, storage issues, difficulty in using it, lack of peace using it and lighting slowly.

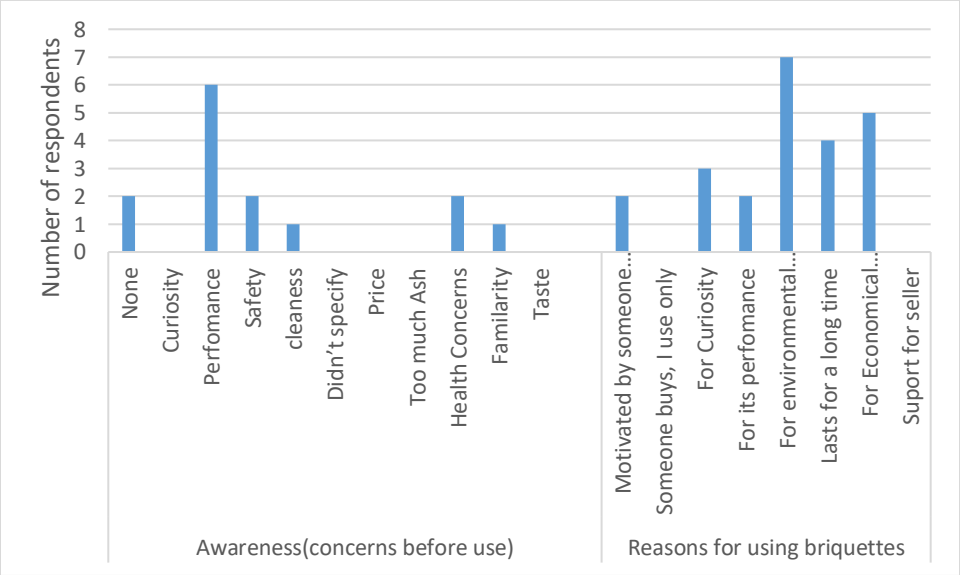


Figure 13: Awareness and Reasons for briquette use

Initially, the majority of the respondents had a concern about the safety, health, and performance of briquettes in the area of lighting, producing smoke, burning of house and food. Other concerns include its ability to cook well, lasting for a short time, lack of familiarity, dirtying of surroundings with ash and if it can save the environment. This shows that the absence of false information, indicating a positive awareness.

They are mainly motivated by economic reasons, saving the environment, trying it out of curiosity, performance reasons mostly burning for a long time and being motivated by another person.

Unique thing identified that could justify having good to neutral experience and such a significant number of respondents who won't recommend or unsure is related to performance and accessibility of briquettes. The most noteworthy underperformance is in area of reduction of expenditure and difficulty in use. As it will be shown in the comparison between groups, one among the factor that resonated with a majority of respondents across the different sub-groups and groups is the reduction of expenditure hence making it a vital assessment criterion. Furthermore, the expressed degree of difficulty in use and limited benefits could explain why they have good/neutral experience but wouldn't recommend it. The drawback is there wasn't a specific question asking on reasons for abandoning briquettes totally which could shed more light, rather than assuming.

Overall the acceptance of this subgroup is about neutral, as they appreciate the product, and they are equally divided among between those supporting/opposing/neutral. This neutrality is contributed by about equal distribution in usefulness, ease of use and distribution of cost and benefits. The sub-group show positive awareness and product fitted well in their community except in a limited situation is briquettes not preferred.

4.3.1.1 Sub-conclusion and sub-discussion for group 01

This group showed to have a large similarity in their response with a small difference in some aspects among the sub-groups. The first sub-group had a more positive experience in comparison to the second and third subgroup, though an overall majority of them have either a good or neutral experience with very few with a bad experience. This could be attributed to the challenge of quality control in the market that allows low-quality briquettes to enter the market. In addition to that, the presence of insufficient knowledge hinders full control and proper utilization of briquettes to achieve maximum results. Besides all these challenges, most of the respondents were willing to endorse it by recommending to close friends and families, except for few who were unsure and less whom won't. This shows a positive attitude towards briquettes despite its flaws in the socio-technical aspects. In all the groups, the majority hadn't experienced a change in taste, except for few. The possible reasons for this situation have been discussed in the first sub-group in Figure 2.

The major motivation for all the groups is the same; economic (reduction of expenditure and affordability), concern for the environment and performance (specifically long-burning time). These three could be taken as expected standards/expectations among briquette users, by which the products have to abide. Also, they can function as a selling point for the producers, in

addressing the market. Other minor motivations were its performance, motivation from others, and curiosity for trying it.

The first group perceived briquettes as more useful and easy to use in comparison to its counterparts. This could be explained by the fact that the niche market is learning and growing, the quality also improves, hence as current users, they have access to the latest quality products coupled with their experience of using it. Another possible reason is that they are all from certain producers who shared the questionnaire in their network as requested. It is possible the customers for producers with good quality responded and others didn't respond or share with their clients. This could also explain the reason of having few responses for the current user.

The major challenge identified is having reliable access to briquettes, and insufficient knowledge on controlling/operation of briquettes. Other less common challenges are storage issues, affordability, and lack of support from family members. In the case of fitting in the society, this group showed to agree on the type of food they wouldn't prefer to cook on briquettes, most of which are staple food in most Tanzanian household. They are few in number, they may have a significant impact on briquettes desirability.

The awareness in the community is positive in the sense that there aren't false ideologies or believes about briquettes. Before the use of briquettes, the group members (respondents) were worried about performance, affordability, and safety of use.

4.3.2 GROUP 02- Have never used it

The main characteristic in this group is not having experience in using briquettes but have heard or seen briquettes. The group is subdivided into two sub-groups which are "those interested in trying it" and the second group "those not interested in trying it." The respondents in this group answered the questions basing on the knowledge and information they have gained from briquette users/sellers, social media and community around them. Generally, this group can represent the available information and knowledge regarding briquettes that is accessible to the community. This information is among their guiding factor in assessing and judging the suitability of briquettes thereby signifying their perception and hence acceptance/denial of briquettes.

About 57.6% of the respondents are in this group, 23.4% in the first group (have experience using it), and 19% of respondents discarded. From these statistics, it can be deduced that the majority of the people have never used briquettes and are not using briquettes but rather other forms of energy like charcoal. It can't be deduced with certainty since there wasn't a question asking specifically the kind of energy they use which proved to be a shortcoming in this research. None the less, in one among the questions only 25% of the respondents in this group (Not having experience with briquettes) indicated the reason for not using briquettes was shifting away from biomass (charcoal/firewood/briquette) use. This raises the probability that the remaining 75% are probably using charcoal/firewood instead of briquettes and/or ignored the question per se. Secondly, this group demonstrated not having sufficient information, nearly in all the questions, more than 50% of the respondents responded to know nothing about the issue in-concern. Even though it is insufficient, there are trends which can be observed. One among

them is, there is more limited information about some performance-wise criteria of briquettes in comparison to other information such as its accessibility and economic value. In conclusion, it is evident there is information in the society regarding to briquettes, even though It is very much incomplete and a small percentage of the population have used it before this research was conducted.

Data analysis will be done in the subgroups as mentioned earlier on. The results for group two are separated into their respective subgroups seen in

APPENDIX *3* and APPENDIX 4. The analysis will mainly focus on using answers of the respondent who had information on the aspects in question and less on the "Don't Know" responses. The analysis will begin with the sub-group of those who are interested in trying it.

SUB-GROUP 01-N0, have heard/seen it, and would like to try it

This subgroup is made up of respondents who have an interest in trying using briquettes after hearing/seeing it. Majority of the respondent (53.2% out of 57.6%) are found in this group, indicating a positive interest in trying out briquettes. The results for this subgroup are found in

APPENDIX *3*. There are few criteria where respondents had more knowledge about them, in comparison with other criteria. These criteria were also characterized by having the sum of the other responses being equal to or more than 50% of the total response in that criteria. By people having more information on this, it raises their significance as important factors considered in the assessment by the community. The criteria are a reduction of expenditure, accessibility, and reliability of supply. Other criteria which had almost half the number are taste and usage in an existing stove. For the last three criteria which didn't receive much response are ash content, storage, and ability to control briquettes.

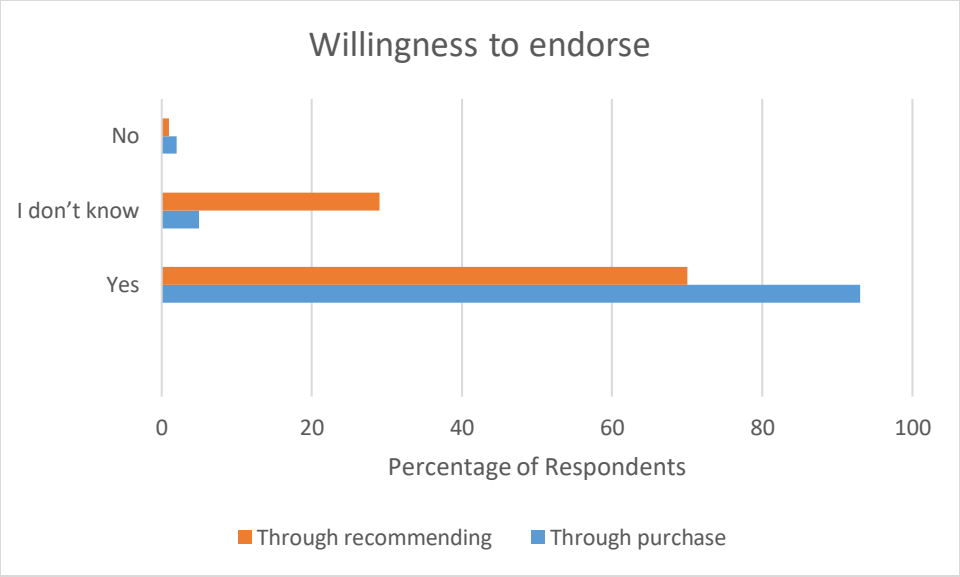


Figure 14: Endorsement

A good number of the respondents are ready to endorse the product by trying to purchase i and more than half are ready to recommend it with about a quarter that isn't sure. This demonstrates a good rapport of community with briquettes in accordance with what they have heard about/seen about it.

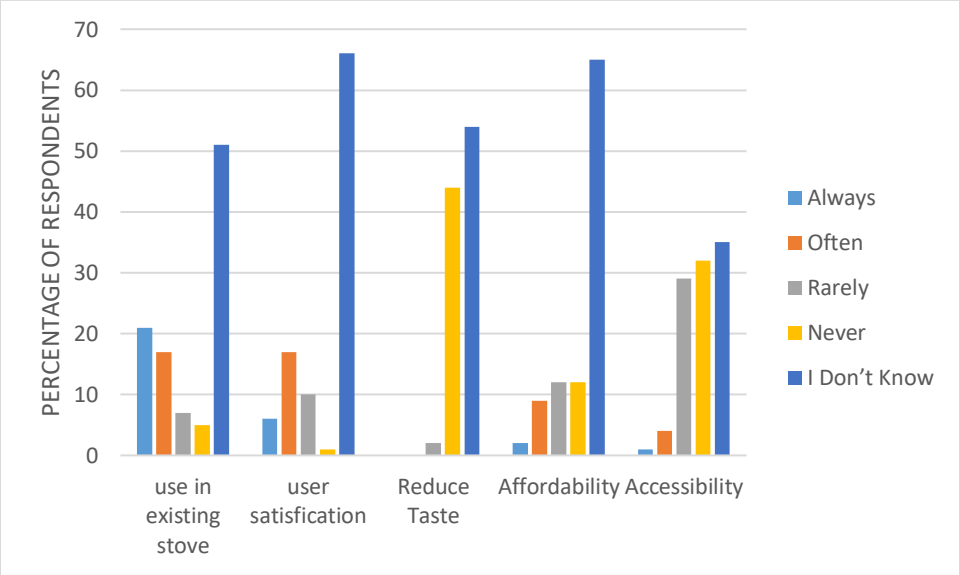


Figure 15: Use in existing stove, user satisfaction, taste, affordability, and accessibility

The findings of the research shows that briquettes are good and fitting to society. This is due to its ability to be used in existing stoves and positive feedback from existing user satisfaction as seen in Figure 15. Majority of people find it is possible to use briquettes in existing stoves with a small percentage finding it impossible. With regards to the satisfaction of existing briquette users, many respondents think it is often and rarely is the users satisfied, with very few people

think it never occurs and always occurs. It can be seen that satisfaction among briquettes users is intermittent between the two extremes. This is results from having multiple advantages and existence of un-satisfaction among them that is picked up by community members. These un-satisfaction/challenges/concerns and advantages are explored in details in the first group in section 4.3.1.1.

Nearly all of the respondents (44%) found no change in the taste of food, 2% think it rarely occurs and 54% don't know. This corresponds to the findings in other groups where a large percent didn't notice any difference, except for a few respondents that did.

Majority of the respondents perceive briquettes to be un-affordable and hard to access to. From the supplier's interview, it was deduced, briquettes reduce expenditure though it can be higher priced per volume in contrast to charcoal. This reduction trait can be attributed to property of high burning temperature and long-lasting enabling cooking more by use of less fuel. The price is affected by briquettes producers having lots of regulatory challenges like taxes and permits consequential having high operating cost, but firewood is freely available in nature, on other hand, for charcoal producers, they have little operation costs and don't pay any taxes enabling it to be very affordable. Secondly, due to the compact nature of briquettes, they have more energy per mass but less volume in contrast to charcoal.

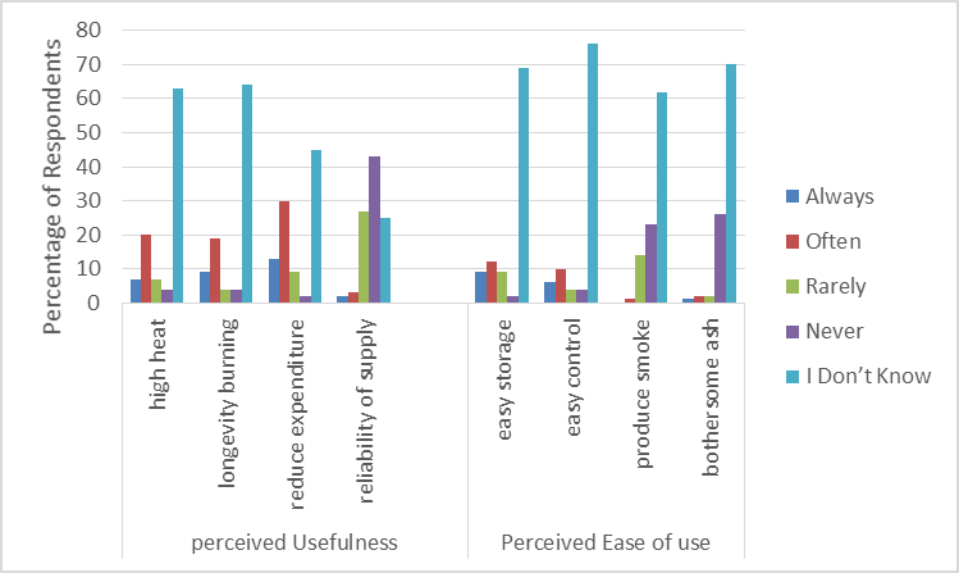


Figure 16: Perceived Usefulness and Ease of Use

Concerning the perspective of usefulness and ease of use, the results are favorable to briquettes, in terms of positive feedback as seen in Figure 16. Overall, majority of the respondents perceive that briquettes are often having a high heat output, last long and reduce expenditure, with un-reliable supply of briquettes. In case of ease of use, majority perceive that smoke in briquettes

isn't common[7], and are not bothered by the ash. Regarding controlling of flame and storage, it is almost evenly distributed between those who can manage/can't manage controlling and storing briquettes. Upon consultation with suppliers, it was found that briquettes are supposed to be stored in a dry area, because if they get wet they tend to disintegrate and produce much smoke when made with sub-standard quality. In comparison to charcoal which can get recovered if wet through drying, for briquettes isn't possible

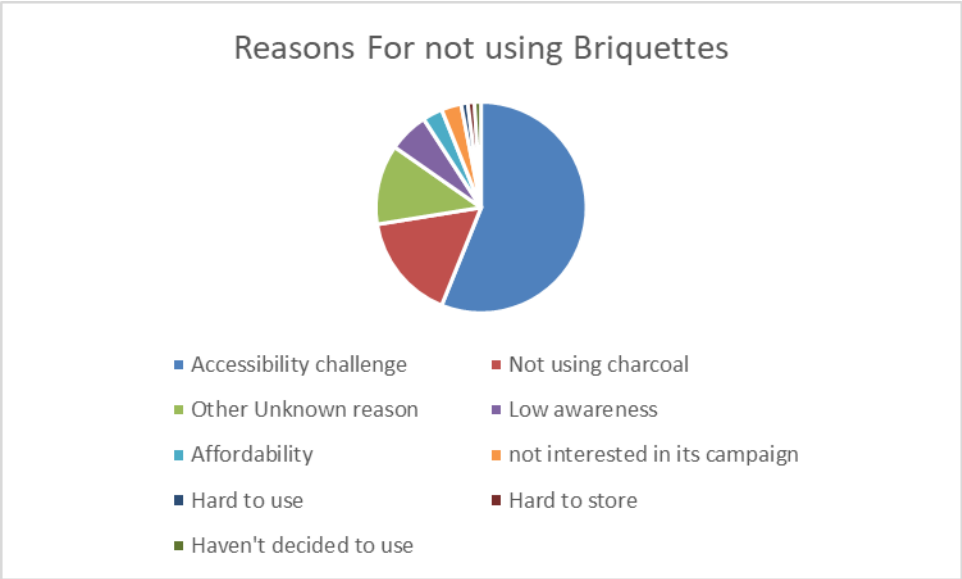


Figure 17: Reasons for not using briquettes

Common factors for not using briquette in this sub-group were mainly lack of access (55%) and shifting away from charcoal (16%). Other less common factors are storage problems, affordability, and difficulty in use, insufficient awareness/information, not motivated by on-going awareness campaigns and not seeing the need of trying it. The other unknown reasons accounted for 12% of the responses.

[7] The presence of smoke is not a common occurrence. When the briquettes do produce smoke the suppliers attribute this to the impurities which enter during the production process that is unnoticed by them

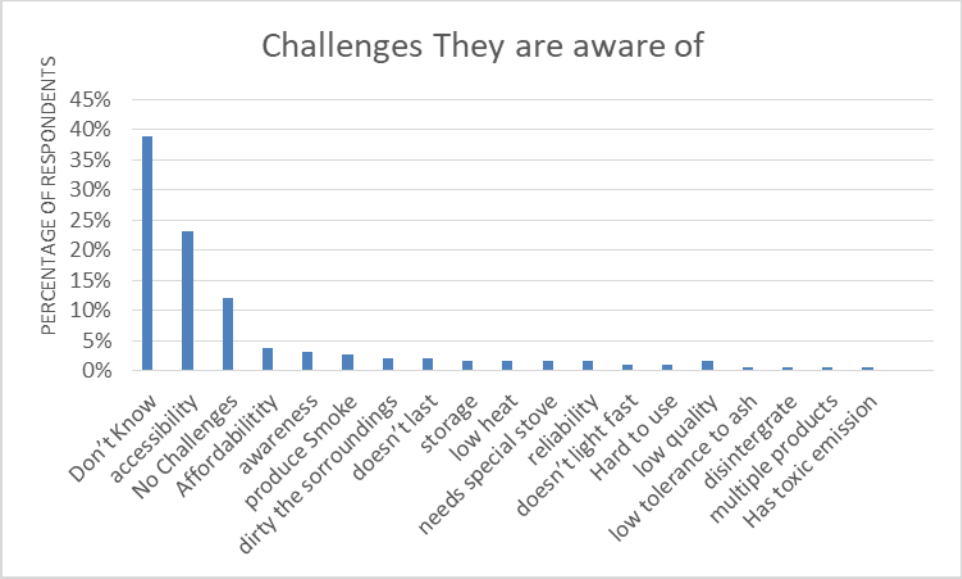


Figure 18: Challenges they are aware of with regards to briquettes

The challenges which they are aware of concerning briquettes are shown in Figure 18. The challenges are similar to those identified in group one thereby making them valid.

The analysis shows, that majority of the people are unaware of most of the issues regarding briquettes with less knowledge of performance. For those who are aware their knowledge is somehow spread between the extremes of good and bad.

Overall the acceptance of this subgroup is good, with majority ready to endorse the product, a good rapport in fitting to community use and favorable perception on usefulness and ease of use. The limiting factor for sub-group adaptation to briquette use is an accessibility challenge, shifting away from biomass and affordability though it reduces expenditure. Lastly, the level of awareness in the subgroup is significantly limited in some aspects.

4.3.2.1 Sub-Group 02: No, Haven't Seen It and Wouldn't Want To Try It

This group consists of respondents who have heard/seen briquettes and are not interested in trying it, which constitutes 4.6% of the total respondents. The results for this subgroup are found in APPENDIX 4.

About 40% of the respondents are not willing to endorse the product by trying it out (purchasing), 45% ready to purchase it, and 15% are unsure. 43% of them will recommend it to their friends and 38% are unsure, and 19% won't recommend it. The reasons for this observation of not being ready to purchase but ready to recommend or unsure can be derived from their reasons of not using briquettes and it less than average performance as seen below.

The major reasons for not using briquette was shifting away from biomass (charcoal/briquettes/firewood) to other forms of energy (52%) and accessibility problem (19%).

Other reasons were not seeing the importance of trying it (14%) and not being motivated by the on-going campaigns (14%). Half of the respondents in this group have shifted away from biomass use, a quarter has accessibility problems and the remaining quarter distributed to other factors as seen in Figure 19. The shift from biomass can explain the lack of interest in trying it out but willingness to recommend it to others. In comparison to the first sub-group, the major reason was accessibility which had half of the respondents but in this group it is the shift from biomass that has half of the respondents.

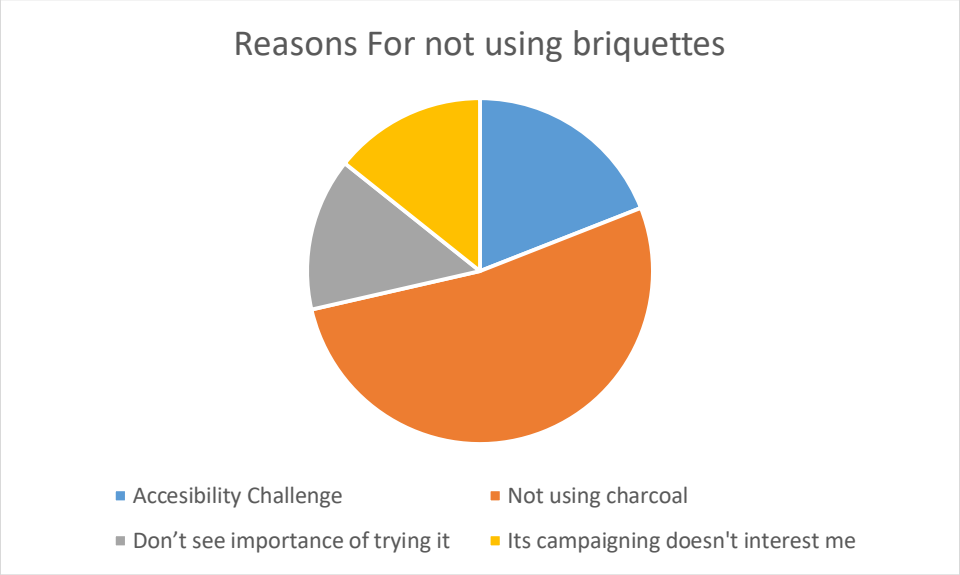


Figure 19: Reasons for not using briquettes

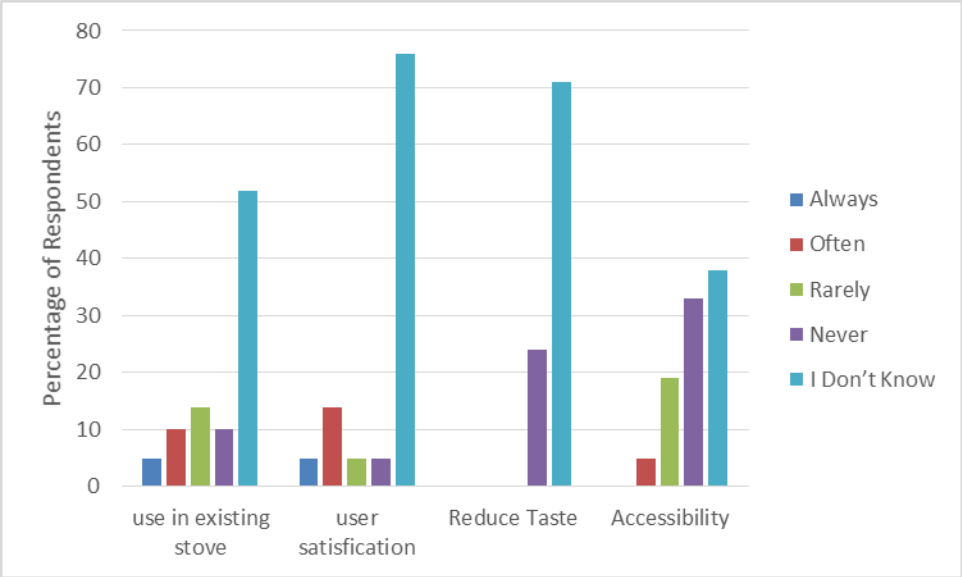


Figure 20: Use in existing stove, user satisfaction, taste, and accessibility

With regard to briquette use fitting into the community, the perception of use in existing stoves is almost equally distributed between those who perceive briquettes can never be used in existing stoves to those whom perceive it can always use in existing stove. Furthermore, regarding how they see the existing user level of satisfaction, a significant number identified often (10%) are the existing briquette user satisfied with briquettes, with some who find it rarely (5%) and never (5%) are they satisfied, with none that are always satisfied and 76% not knowing. This subgroup perceives satisfaction not to be that much spread among the existing briquette users. Generally fitting the community is equal to or less than neutral for this sub-group.Same as in other groups, a big percentage of the respondents do not observe a change in taste, with the exception of few.

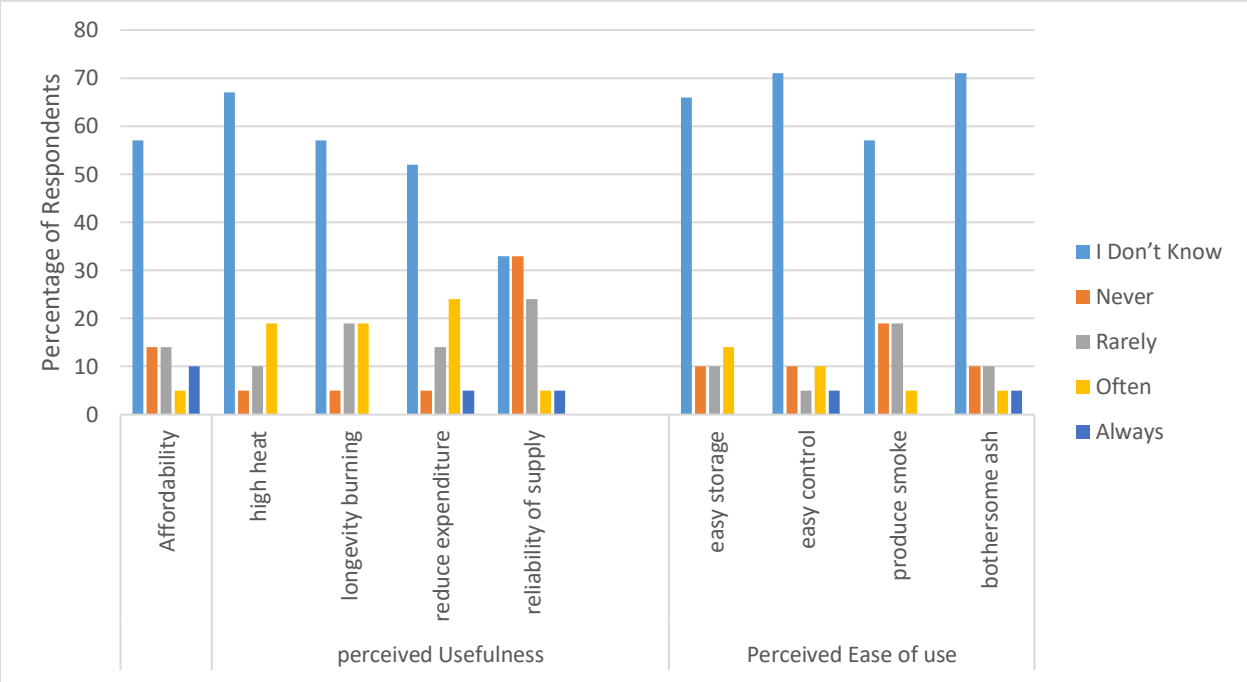


Figure 21: Perceived Usefulness and Ease of use

In this subgroup, they perceive usefulness and ease of use somehow different from the prior subgroup. In this case it is observed that most of them find it not to be of much use nor easy to use, though in some aspects the perception is distributed equally as seen in Figure 21. The majority find it rarely (19%) and often (19%) do the briquettes burn long with high heat output, with 0% finding it always and 5% finding it never does it burn long with high heat output. Besides that, they have about average reduction capability to reduce expenditure and the supply of briquettes is seen as unreliable by a substantial number of respondents. From this, it can be seen that briquettes are perceived as not burning long with a high heat output, an average reduction of expenditure and poor supply, which portrait it be not very useful to respondents of this group.

The perception of ease of use, on tolerance to ash and smoke from briquettes is high as findings show that a high percentage are never and rarely annoyed by them as seen in Figure 21. As for the ability to control the burning of briquettes, it is about equally distributed between those who don't have any control and those who have total control. More people perceive it is hard to store

briquettes than those who manage to store it. Overall, this group doesn't perceive it to be easy to use briquettes.

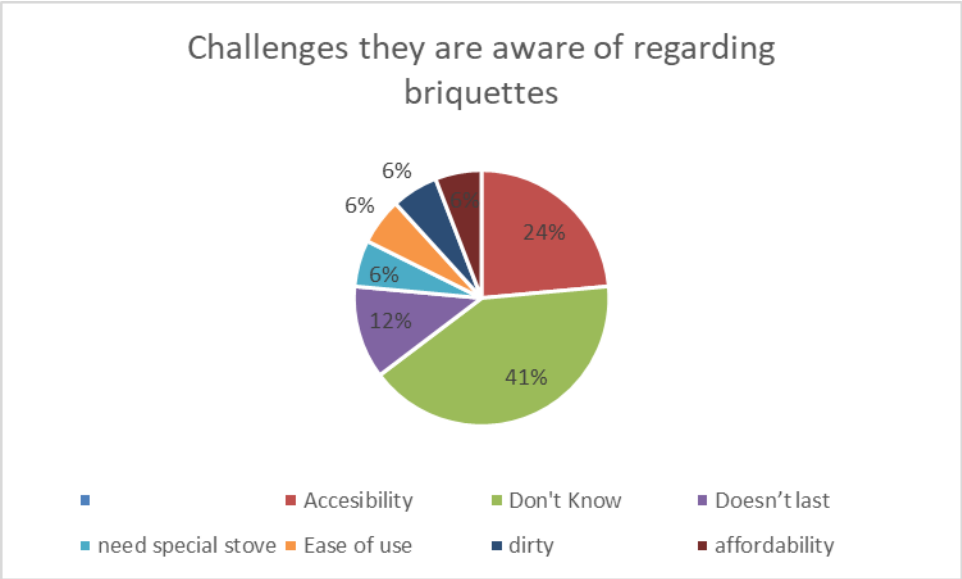


Figure 22: Challenges they are aware of regarding briquettes

Lastly, briquettes are seen to be commonly unaffordable and mostly un-accessible and can rarely lead to dirtying of the house surroundings with ash and soot and other challenges as highlighted in Figure 22 above.

Overall the acceptance of this subgroup is equal to or less than neutral towards briquettes. It is characterized by a neutral endorsement for use and a positive endorsement for recommending to family/friend. The distribution of cost, benefits, usefulness, and ease of use is seen to be neutral or less than neutral. Lastly, the product has on average mid-fitted between the extremes of the fitting that are unfit and fit.

4.3.2.1 Sub-Conclusion and Sub-Discussion for Group 02

The group showed to have insufficient information concerning briquettes, mostly notable related to performance. The available information shows that, they are willing to endorse it by recommending it and/or trying it out. A good number are not sure about endorsing it by trying it, and less on recommending it. The main reasons for this is explained by the fact that the respondents are transitioning away from charcoal used to other forms of energy and accessibility challenge. Few of them are not willing to endorse it through trying it out neither recommending it to friends and family.

This group perceives briquettes user to be rarely and/or often satisfied with briquettes use, and few of them perceive as always they are satisfied or never. The perception can be attributed to the challenges and benefits they have seen/heard from the briquette users which are analyzed in group 01 above.

The response in the group about ease of use, perceived usefulness, and affordability are spread between the extremes of easy to hard. Some criteria related to performance seen to be known by more people in comparison to others, namely reduction of expenditure, accessibility and use in existing stoves. The criteria which didn't receive much response are ash content and controlling of its burning. Taste and smoke, has almost similar response to the first group where the majority find it no change in taste and no smoke produced and few find there is change.

As for other criteria namely storage, hotness(heat output), longevity of burning, ash content and control of burning, nearly equal number of people perceive to be easy meanwhile the other half doesn't. The difference shows the existence of differences in experience regarding to briquettes uses in society as explored in group 01 where it was shown that some had a very good experience using briquettes and others not so good. There is a good ratio of benefits to cost/challenges incurred, which gives them an overall satisfaction of neutral to good.

Majority in this group view briquettes as being un-affordable even though it reduces expenditure. This observation is different from the first group which found it to be affordable. The reasons for this difference is highlighted in the upper section (Section 4.2: Supplier's Analysis).

It is generally agreeable in all sub-groups' reliability of supply to be a major challenge. With other challenges being need of a special stove, not enough awareness/knowledge, affordability and annoyance by ash content.

The main reasons for not using briquette were the transitioning away from briquettes and problems in access. Other minor reasons being not seeing the importance of trying it, storage problems and not motivated from the on-going campaigns.

4.3.2.2 Comparison and discussion of groups and sub-groups

Below is the comparison between the two groups and their subsequent subgroup in accordance with the criteria defined in chapter 3.

Table 3: Comparison of groups and subgroups

Legends

- Neutral- It is neither positive and negative/in between of positive and negative
- Equal to or less than- the value/trend is equal to the mentioned value or less than it to some extent but not a big enough deviation to enter to the next lower range
- Equal to or more than- the value/trend is equal to the mentioned value or more than it to some extent but not a big enough deviation to enter to the next upper stage

	Group 01				Group 02	
	Sub-group 01	Subgroup-02	Sub Group 03		Sub-group 01	Subgroup o2
Awareness	Good	Good	Good		limited in most aspects	limited in most aspects

Distribution of cost and benefits	More benefits over costs	Benefits are more than or equal to cost	Benefits are equal to or less than cost		Benefits are equal to or more than cost	Benefits are equal to or less than cost
Perceived usefulness	Very Good	Good	Neutral		Good	Equal to or less than neutral
Perceived ease of use	Very Good	Very Good	Neutral		Good	Equal to or less than neutral
Willingness to Endorse technology	Very Good	Good	neutral		Good	Equal to or more than neutral
User satisfaction	Very Good	Good	Good		Good	Equal to or less than neutral
Fitting to community	Good	Good	Good		very Good	Neutral
Accessibility	Good to neutral	Poor	Poor		Poor	Equal to or more than poor
Affordability	Good	Good	Good		Equal to or more than poor	Equal to or more than poor
Overall Acceptance	Very Good	Good	Neutral		Good	equal to or less than Neutral

Apart from the above-displayed differences and similarities in Table 3 above, there were many correspondences in their answers. The common features for both groups are a reduction of expenditure, challenge of accessibility and storage. The two groups differ concerning affordability, where group one perceives them to be affordable but group two doesn't though both groups agree they reduce expenditure. This difference in perception of affordability has been explained in the section below. Besides that they also differ in recognition of the amount of

ash as an important aspect, whereby group 1 resonates well with this group, meanwhile, group 2 don't resonate with this aspect. Some suppliers raised the issue of the amount as ash to be of concern among the population. It seems this is only important for those who have experienced using it and it is not annoying to them as highlighted in the results, and backed up by the fact that they don't discuss it with other people due to its irrelevance.

4.3.3 Overall Discussion

The findings from the literature review correspond to a large extent with the finding from the empirical case study. Though the literature review was limited due to having few articles that focus on the aspect of acceptance of briquettes specifically rather than on facilities and bioenergy in general. It was additionally limited by having a good number of the acceptance study focusing on the developed countries which is a different context to the research. None the less, valuable insights were able to be identified as highlighted in chapter 3. From the policy overview, it was deduced that there is a gap in its addressing briquettes niche market, with less attention being directed to it. This gap could have contributed to the slow on-take of briquettes, lack of proper market monitoring procedures and quality control. Furthermore for a niche to grow it needs to be protected, promoted and adapting to the contextual situation. The current protection and promotion being placed on briquettes can be seen to be unsatisfactory, justifying the struggles experienced by most suppliers in their production activities. A good similarity in the household findings was observed among the groups and sub-groups which validate the identified factors. It was observed respondents with experience using briquettes are favorable or neutral towards continual use of briquettes. On the other hand, for respondents who haven't used briquettes showed a neutral to favorable attitude towards it.

Briquettes have managed to fit community cooking needs, although it fails to address one crucial aspect. This aspect is, briquettes not being preferred in cooking certain foods that are staple foods in Tanzanian cuisine, namely food taking short time like stiff porridge (ugali), those requiring good control of heat like rice, beans, makande and bananas. To address this aspect some suppliers provide instructions to their clients to facilitate their adaptation, while others leave it to self-learning. This method seems to have worked to some extent since other respondents identified being able to cook all kinds of food by using briquettes. From researchers experience and findings of (Owen et al., 2013), both agree that product differentiation can assist in addressing the different cooking needs in the society. By having products that have different properties it will aid in addressing the different needs like fast high-temperature need, long low heat output needs, and other needs. This will enable addressing of all cooking requirements through briquettes alone and on the supplier side will create the opportunity of using more diverse raw materials[8]. It will also put more stress on the suppliers in meeting the different requirements but on the other hand, might open opportunities such as exporting and meeting other society heating needs. Therefore a critical in-depth assessment of this option is recommended.

[8] The raw material used have different properties such as calorific value and ash content, therefore by having different products, it will enable better use of the different properties of the raw materials which equate to more access to raw materials.

The community acceptance and market acceptance among the groups is favorable in terms of positive to neutral acceptance from society and lacking negative acceptance(oppositions). To have a more positive acceptance, the niche needs to address some of its internal factors.

In this niche, information and expectation have been well articulated resulting in common understanding in the society and absence of false misconception. By SNM theory this is a favorable phenomenon for its growth as it prevents the growth of dissatisfaction and creates a common goal. The major factor hindering market acceptance and niche growth is the un-accessibility of briquettes. This challenge is a common characteristic at the BOP due to lack of formal infrastructures in some aspects, compounded by challenges identified in the earlier sections. For addressing this challenge more actions are needed in networking and possibly re-addressing of the niche growth system/pattern.

From the above information, it is perceived there isn't enough unified action among the briquettes supplier in their networks for addressing the market. As identified in SNM theory, one among the success factor is networking among projects for unified action in addressing the market, raising awareness and many more. The unified network will also facilitate dissemination of knowledge among them on quality improvements, generation of capital, and even communicate with other stakeholders like government and NGO's. The effects will be increased when associated with second loop learning within the network rather than the on-going individual learning among the producers and other stakeholders.

The market is characterized in a similar degree to the proposed market in BOP theory. The common traits are poor accessibility due to lack of infrastructure, sensitivity of customers to affordability and low awareness. Most of the clients in the market are sensitive to the affordability of briquettes as it has been raised by the majority of respondents. Also, there is some awareness in the market though not to a high degree. (Leow et al., 2015) suggested the use of 4A's marketing strategy (Awareness, Acceptability, Affordability, and Accessibility) in addressing the market instead of 4P's strategy (Place, Price, Promotion, and Product). The attaining of high scores in all of the four criteria will enable the flourishing of the business in the market as done by many companies operating at BOP (Leow et al., 2015; Mårdh & Correia, 2013)

From the available information, the current growth of the niche looks to be grow in parallel with the regime with hopes of replacing it. This research recommends the alternative pathway of merging the niche to the regime for smooth growth. The growth will rise from using regime infrastructures of distribution at the same time redefining the rules gradually to fit briquettes. Currently the regime is shaken up by the on-going charcoal ban efforts, which translates to discomfort along its value chain from producer's distributors, and their customers. Taking advantage of this discomfort by bringing some of the key stakeholders from the regime will eventually cause its collapse. The key stakeholders are like its final distributors and retailers will bring along their network of customers offering profits from scale offsetting the increased expense from the recruiting process. Other key stakeholders are NGO's, local governments, regulators, renewable energy associations, and civil society to work together on unified actions for addressing the society and market. This will facilitate quality control, capital investment, the establishment of rules favoring the niche and many others.

CHAPTER 05: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The purpose of the study was to understand the challenge of social acceptance to sustainable bio-energy sources, particularly biomass briquettes as a cooking energy source instead of charcoal in developing countries. Responding to the first research question, from literature the factors affecting social acceptance to bioenergy products specifically briquettes are: unwillingness to change, power relation, preference in upgrading up the energy ladder, difference in priority, level of awareness, personal bias, drawbacks of briquettes, distribution of benefits and cost. The findings from the literature do correspond to a good extent to the finding of case study, even though was limited by the presence of few studies on social acceptance of briquettes in developing country context. Furthermore, not all of the findings from the literature review were applicable in the case study.

In the policy overview for the case study it was found out that there is little support from the policies although individual political leaders are supporting it. This influence the development and spread of briquettes in society in a negative way. In the empirical case, the results of survey and interviews coincide in many areas except in very few aspects where they differ. The similarity creates the validity for data within the community groups and with the supplier's responses. In the second research question, the suppliers were categorized based on production size into small suppliers and large supplier and use different raw materials for producing carbonized briquettes or pellets. They perceive the market to have a good response in regards to accepting briquette use. The most common methods for promoting briquettes in the market were through social media, mass gathering, and product demonstration. They have different packaging sizes and sell briquettes per kilogram instead of the common method used in the regime of selling per volume. Though they have a good response and are making progress, they are limited in distribution and production. This limitation comes in the form of challenge in the distribution of products via delivery and purchasing at the shops. It is further compounded in production by high operational costs and limitation in financial and technical capacity which in turn translate to challenge of accessing briquettes. The customers they are currently able to serve are happy with the performance of the briquettes in cooking, environmental, and economic aspects. The challenges they have experienced are the same as those described in community survey with exception to identifying specific foods which they wouldn't prefer cooking using briquettes.

In the third research question, the respondent's views differ from one group to another as highlighted in Table 3. The classification basing on possible interactions of the respondent to briquettes created valuable insights as shown in their respective sections in Chapter 05. The answers for the research question show that, overall they perceive it to be useful, easy to use and fits their use. Furthermore, it is beneficial with a limited drawback, affordable and they are willing to endorse it. Besides that, they have a good feeling using it from the experience they have and good performance in cooking most of their desired foods except for some. The major drawback identified was accessibility, limited awareness, and information on briquettes. Less common challenges were the unwillingness to change and performance challenge mostly storage.

To respond to the main research question and objective, overall the social acceptance to briquettes in Dar es Salaam is good and at worst neutral. The identified problem of the continued dominance of charcoal in the market isn't due to the poor community and market acceptance but rather due to un-accessibility of briquettes and transitioning away from biomass use. Majority of the people are willing and eager to try and use briquettes but are currently not able to make the transition. This is due to lack of reliable access, which results in continual prominence of charcoal in the market hence explaining the identified research problem. The factors which affect mostly the acceptance to briquettes are economical (reduction of expenditure and affordability), accessibility, environmental concerns, use in existing stove, and performance of briquettes mostly burning for a long time, annoyance from ash and storage.

5.2 Recommendation's

Basing on the findings from both the community and suppliers, this research would recommend further actions to be undertaken in these areas by the relevant stakeholders:

- Policy makers:

Creating a conducive environment for smaller producers, where they can operate and thrive. Attention should be paid to smaller producer's inorder to create a more decentralized production chain. The advantage of such a chain is better utilization of the dispersed biomass resources, creating economic opportunities in different localities where the production can act as stimuli enabling nuclei development of city/location. Furthermore it lowers production cost and monopoly in comparison to existence of large production site where raw materials are collected from different location, transported[9], processed, and then transported back to the community. The conducive environment can be created by improving dispersion of technical and business knowledge related to briquettes production, improving taxation system, streamlining attaining of necessary permits/certificates. By improving these aspects, it will lower production cost, improve quality of the productions, accessibility to quality machinery, and promote more compliance for the smaller producers. At the same time the Government of Tanzania and society will have better monitoring of the decentralized production, compliance to regulations, environmental benefits, growth of the economy, and reliable affordable quality briquettes.

- Briquettes suppliers:

Briquettes suppliers need to expand their distribution strategies by using established charcoal network and creating new channels. Charcoal as an existing regime has an established distribution network reaching most areas in the society, which is convenient to most people. The current regime turmoil of charcoal banning, creates an opportunity for utilizing the shaken up network. The passing of briquettes through this channel at the same time using as minimum

[9] As most biomass are bulky in size and weight before processing, this will create high transportation cost of raw materials.

number of middlemen as possible will enable a cost effective approach for improving accessibility as well as creating control through market mechanism (competition). Equally important is the use of other distribution channels like shops and local vendors which will enable better distribution and improve the economy.

Effort in raising awareness among the general public on the existence and use of briquettes is paramount. After establishing and solidifying the existing network, attention should be focused on raising awareness in society. There is urgent need to identify the proportion and characteristics of general public that is currently not adequately reached by current awareness campaigns. A well planned program on expanding public awareness campaigns to be prepared. The program to provide instructions of efficient use of briquettes on the packing inorder to reduce the challenge of difficult in cooking and simplify the learning process for consumers. This will facilitate initial user to have a smooth transition.

The expansion of briquettes value chain through the production of other valuable products from biomass or offering of other services tied up with it is essential. Different products can be produced from biomass such as bio-fuel, electricity, biochemical, bio-char, biogas, etc. A good example is in the combined heat and power production unit, through controlling of combustion temperature in the furnace both carbonization and generation of power will be possible resulting in the production of char for briquettes and electricity plus heat. Another option is expanding the briquettes niche in co-operating other sectors such as waste management in food markets, shops, and industries. Collecting of waste from institutions such as markets, lumber jack, and food processing sites as a waste management initiative will create an alternative income for producers which may lower their operational costs. This will also enable their growth and consolidation of the niche.

Creating of a unified network/association related to briquettes through uniting and officializing the existing social media groups related to briquettes. After formation of an official briquettes group/association, then can it be linked with the existing renewable energy associations (example REA) as among its stakeholders. The formed network should try to in cooperate different stakeholders such as supermarkets, research and education institutions, banks and many more. It will also be involved in the formulation of regulation and quality control.

Lastly is supplier should look into the possibility of product differentiation so as to meet all different societal needs in cooking by using briquettes and possibility the extension of briquettes to other community uses.

- For regulators

It is recommended that compulsory quality control measure and standards for production activities and products. The established compulsory measure and standards will take care of public safety and interests of having a quality products and environmental conservation. The regulations to ensure that the objectives of promoting briquettes is attained. As certification schemes are not that much common in that market, hence regulatory compliance is recommended as an early solution meanwhile certification schemes can be applied when the environment is conducive. The regulations are to covers business practices, production standards,

products quality, and environmental standards. Tanzania Bureau of standards and National Environment Management Council might be the guardian or custodian of these regulations which need to be friendly to both producers, users and the general public

5.3 Reflection on Thesis Research

The limitation encountered in this research are absence of some critical information which would have enriched the discussion. The missing information are gender role impacts on the results, reasons for certain observed phenomena like not using briquettes any more or economic condition of respondents. In place of such information reasonable hypothesis were formulated basing on existing data and consultation with suppliers. Secondly is the resource limitation which hindered the capability of data collection in community through interview's and funding some activities of research. Which in consequence hindered the attaining of in depth through interviews and other limitations highlighted in methodology Chapter 3. Furthermore is possible bias in respondent selection as a consequence utilizing online forms, which prevented people (possible respondents) who didn't have internet connection from responding. The use of snow ball method in data collection utilizing different social media groups, raises the probability of not addressing a particular social sphere hence presence of bias in respondents.

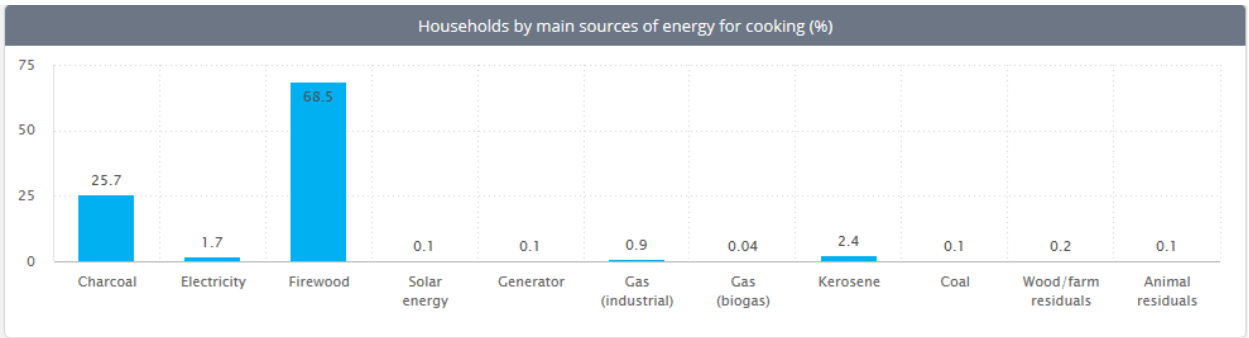
The strength of this thesis is in determining the acceptance of briquettes by using both primary and secondary data. In addition, it uses the perspective from community members and building on the knowledge from briquette suppliers that validates and gives more insights. Furthermore it analyzes community response by categorizing them based on their interaction with briquettes which enabled better understanding of the answers they provided and its interpretation.

To build upon this research, it is recommended that further research be undertaken/conducted on findings ways for increasing value in briquetting industry and building of knowledge which will enable the afore mentioned stakeholders to implement their recommendation. The value creation requires assimilation of existing bio-refinery knowledge and adjustments to fit the contextual features. For supporting the stakeholders, future research should address factors such as addressing best practices, best standards, and marketting.

The research has been able to contribute theoretical knowledge with regards to factors which affect the acceptance of bioenergy specifically briquettes. It has also given recommendations for future studies necessary to address social acceptance of bioenergy. The discovered factors which were found to be the limiting agents in the adaptation of briquettes in Dar es Salaam community could also be present in other communities. The research also proposed actions which could be taken by relevant stakeholders in the empirical call in addressing the factors. The research methodology used could be reciprocated in analysis of other developing countries to determine their acceptance. The research findings could be valid in other developing countries, for the research addressed common market characteristics in developing countries from theory of BOP. In addition it has selected multiple criteria's from other theories which gives different perspectives. Therefore the identified factors have a high possibility of validity in other developing countries though their given intensity might vary to the empirical case.

APPENDICES

APPENDIX 1: Figure of Household cooking energy use by type (sources-("Tanzania Census 2012 - Dashboard", 2019))



APPENDIX 2: Table of results for Group 01(Have experience using it

Criteria	**Operationalization of criteria**	**Sub-Group 01 (Current users)**		**Sub-Group 02(Yes, would use again)**		**Sub-Group 3(Yes, Wouldn't use again)**
Perceived Usefulness	High heat output	15		4		3
	low heat output	0		4		1
	annoyed smoke	1		1		1
	Not annoyed by smoke	0		9		1
	Annoyed by ash	1		5		1
	Not annoyed by ash	14		5		5
	Can prevent Disintegration	4		2		0
	Cannot prevent Disintegration	7		2		3
	It reduce expenditure	13		9		5
	It doesn't reduce expenditure	0		2		4
Taste	No	75%		89%		69%
	Yes, it decrease its flavor	12%		3%		13%
	Yes, it increase its flavor	13%		8%		19%
Perceived Ease Of Use	easy to store	15		7		4
	hard to store	0		0		1

	easy to control	17		6		5
	hard to control	2		2		1
	Easy to use	18		9		5
	Hard to use	1		0		1
	Lights up fast	2		7		3
	Lights up slow	10		5		3
	Happy and at peace when using	20		5		3
	Not happy nor at peace	1		1		1
Endorsing Through Recommendation To Family And Close Friends	Yes	92%		86%		31%
	Not sure	6%		11%		31%
	No	2%		3%		38%
User Satisfaction	Very good, it had many benefits	65%		46%		13%
	Good,	29%		22%		50%
	Okay, neither bad nor good	6%		30%		31%
	Bad	0%		3%		6%
	Very Bad	0%		0%		0%
Access	Easy Access	18		2		2
	Hard Access	3		27		8
Awareness(Concerns Before Use)	None	13		5		2
	Curiosity	1		0		
	Performance	15		22		6
	Safety	4		0		2
	cleanness	1		0		1
	yes	4		1		0
	Price	0		2		0
	Too much Ash	0		1		0
	Health Concerns	0		1		2
	Familiarity	0		0		1
	Taste	0		1		0

Reasons For Using Briquettes	Motivated by someone else	1		1		2
	Someone buys, I use only	1		1		
	For Curiosity	4		3		3
	For its performance	11		4		2
	For environmental concerns	27		16		7
	Lasts for a long time	24		10		4
	For Economic reasons(Reduction of expenditure and Affordability)	22		15		5
	Support for seller			3		
Challenge Faced	Accessibility	37		26		10
	Price	3		9		3
	Taste change	2		0		0
	Lack of peace when using it	2		0		1
	Storage issue	2		2		3
	Lack of support from family/friends	1		5		0
	low quality of products	0		2		0
	Hard to use	0		3		3
	lights up slowly					1
Fitting To Society(Foods Wouldn't Prefer Cooking By Briquettes)	Require low/medium heat	6		5		3
	Taking short time	8		2		5
	None	19		8		3
	Beans	1		11		1
	Makande	1		6		2
	Banana	3		3		0
	Will dirty the surrounding's	0		0		1

APPENDIX 3: Results of Sub Group 01 of Group 02 (Haven't used briquettes, only heard/seen them, and would like to try it)

	AFFORDABILITY	**PERCEIVED USEFULNESS**				**ACCESSIBILITY**
		high heat output	Burning for long	reduce expenditure	reliability of supply	
Always	2%	7%	9%	13%	2%	1%
Often	9%	20%	19%	30%	3%	4%
Rarely	12%	7%	4%	9%	27%	29%
Never	12%	4%	4%	2%	43%	32%
Don't Know	65%	63%	64%	45%	25%	35%

	PERCEIVED EASE OF USE				**FITTING TO SOCIETY**		**TASTE CHANGE**
	easy storage	easy control	produce smoke	bothersome ash	use in existing stove	user satisfaction	
Always	9%	6%	0%	1%	21%	6%	0%
Often	12%	10%	1	2%	17%	17%	0%
Rarely	9%	4%	14	2%	7%	10%	2%
Never	2%	4%	23	26%	5%	1%	44%
Don't Know	69%	76%	62	70%	51%	66%	54%

Reasons For not using	**Percentage**
Accessibility challenge	55.0%
Not using charcoal	16.0%
Other Unknown reason	12.0%
Low awareness	6.0%
Affordability	3.0%
Not interested in its campaign	3.0%
Hard to use	1.0%
Hard to store	1.0%
Haven't decided to use	1.0%

Challenges They are aware of	**Percentage**
Don't Know	39%
accessibility	23%

No Challenges	12%
price	4%
awareness	3%
Smoke	3%
dirty	2%
doesn't last	2%
cannt tolerate water	2%
low heat output	2%
needs special stove	2%
reliability	2%
doesn't light fast	1%
ease of use	1%
low quality	1%
ash	1%
disintegrate	1%
multiple products	1%
poisonous	1%
quality	1%

	ENDORSEMENT	
	Through purchase	Through recommending
Yes	93	70
I don't know	5	29
No	2	1

APPENDIX 4: Results of Subgroup 02 of Group 02(Doesn't Know briquettes, wouldn't want to try it

	AFFORDABILITY	**PERCEIVED USEFULNESS**			
		high heat output	Burning for long	Reduce expenditure	Reliability of supply
Always	10%	0%	0%	5%	5%
Often	5%	19%	19%	24%	5%
Rarely	14%	10%	19%	14%	24%
Never	14%	5%	5%	5%	33%
Don't Know	57%	67%	57%	52%	33%

	PERCEIVED EASE OF USE				FITTING TO SOCIETY		REDUCE TASTE	ACCESSIB
	easy storage	easy control	produce smoke	bothersome ash	use in existing stove	user satisfaction		
Always	0%	5%	0%	5%	14%	0%	5%	5%
Often	14%	10%	5%	5%	10%	14%	0%	5
Rarely	10%	5%	19%	10%	14%	5%	0%	19%
Never	10%	10%	19%	10%	10%	5%	24%	33%
Don't Know	66%	71%	57%	71%	52%	76%	71%	38%

Reasons For not using	**Percentage**
Accessibility Challenge	19%
Not using charcoal	52%
Don't see importance of trying it	14%
Its campaigning doesn't interest me	14%

Challenges They are aware of	**Percentage**
Accessibility	24%
Sifahamu	41%
Doesn't last	12%
Need's special stove	6%
Hard of use	6%
dirty	6%
affordability	6%

	Endorsement	
	Through purchase	Through recommending
YES	45%	43%
I DON'T KNOW	15%	38%
NO	40%	19%

APPENDIX 5: Supplier's Questionner

Below is a list of prepared questions for an interview with briquettes suppliers. They will cover the aspect of mapping current operations capacity, mapping percentage of targeted household customers in their market strategy, perspective of suppliers with regards to household market and its respective challenges, identification of benefits and challenges experienced basing on the feedback they received from their customers.

The respective questions are as follows:

Name:

Company name:

1. What are your current production and possible maximum capacity? -
   If there is a huge difference of more than half, will inquire as to reason of producing less than half their potential production capacity.
2. Which material do you use for production?
3. Which market segment are you serving?
4. What is the percentage of household's customers in your client's portfolio?
5. How does your product reach the household customers from your facility?
6. How do you advertise your products in addressing Household customers?
7. How do you view the response of household market?
8. What challenges have you faced with regards to the household market?
9. By estimation does your household market increase or decrease as time goes on, and by how many new household customers do you get or lose in a month?
10. What benefits have your customers report to gain through the use of briquettes?
11. What loss have your customers report to experience through the use of briquettes e.g. taste, finance, comfortability of use, storage, etc.?
12. What challenges have your customers report to experience during use and storage of briquettes?
13. What concerns are usually expressed by new clients with regards to briquettes?
14. How have your customers expressed their cooking experience(e.g. time taken, easiness, comfortability, expenditure, and many others) when using briquettes
15. How have your customers expressed the taste of the food when cooked using briquettes?
16. What expectations did your clients have initially that were not realistic?
17. How do you find the awareness of briquettes among the household market?
18. What do you think are the factors discouraging people from using briquettes
19. What do you think are the factors that promote people to use briquettes
20. How the Tanzanian culture, tradition, and cooking habits do interfere in the purchase and use of briquettes?
21. Which food or situation do your clients report to be inconvenient when using briquettes?
22. What does your client say with regards to their family and friends reaction upon knowing they use briquettes?

APPENDIX 6: Household's Questionner

Below is a prepared list of questions for the community. Their two groups of community members that have been identified basing on prior use of briquettes. The first group is those who know about briquettes but have never used them, and the second one those who have or are using

them. The questions for both groups will cover their perception and/or experience towards use of briquette, benefit and challenges they have, support of/or against briquettes and awareness on briquettes.

Name:

1) What city are you currently residing in?
2) Have you lived in Dar es Salaam in the period between 2014-2019- (Yes/ No)

3) Have you used briquettes before?
a) -Yes, I am currently using user
b) -Yes, I used previous and stopped but I am planning to use again
c) -Yes, I used previous and current have no plan to use it in the near future
d) -No, I have Never used it, but only heard or seen it and would like to try it
e) -No, I have never used it, but only heard and seen it but would not like to try it
f) No, never seen nor heard of them

For those who answered the first question "Yes…" will be directed to the following questions. Meanwhile for those who answered "No…" will be directed to start answering from question 13.

4) How would you express your experience in using briquettes
   a) Very good, it had many benefits
   b) Good,
   c) Okay, neither bad nor good
   d) Bad, it had troublesome some issues
   e) Very bad, it had many troublesome issues

5) Does cooking by use of briquettes change the taste of food?
   a) No
   b) Yes, it increases its flavor
   c) Yes, it decreases its flavor

6) Choose a sentence that corresponds to as close as possible to how you perceive briquettes
   a) It is easy to get briquettes
   b) It is hard to get briquettes
   c) It is easy to cook by use of briquettes
   d) It is hard to cook by use of briquettes
   e) It is easy to store briquettes
   f) It is hard to store briquettes
   g) It is easy to control the burning of briquettes
   h) It is hard to control the burning of briquettes
   i) The ash from briquettes annoy me

j) The ash from briquettes do not annoy me
k) It produces annoying smoke
l) It doesnot produce annoying smoke
m) The heat from briquettes is high enough for cooking
n) The heat from briquettes is low for cooking
o) It lights up slow
p) It lights up fast
q) I Don't know how to prevent it from breaking up/disintegrating
r) I know how to prevent it from breaking up/disintegrating
s) It reduces the cost of cooking fuel
t) Its doesnot reduce or the same cost as when using charcoal
u) I am at peace and comfortable using it
v) I am not at peace nor comfortable using it

7) Which type of food wouldn't you prefer to cook by use of briquettes?
8) Would you recommend to your close friend or relative to use briquettes(Yes/Not sure/No)
9) What reasons led your to use of briquettes
   a) It reduces expenditure
   b) Burns for a longer time
   c) To support someone I know(Shop patronage)
   d) To save the environment from deforestation for charcoal production
   e) To try it as I never tried it before
   f) love its performance in cooking
   g) Was convinced by someone(friend/family)
   h) Someone else buys it, I use it

10) Which challenges have you faced with regard to briquette use

   a) Getting access is a problem
   b) price is the issue
   c) It is hard to store it
   d) It is hard to use
   e) Friends and family don't support it
   f) I don't have peace using it

11) What worries or concerns did you have at the begin of using briquettes

12) How do you feel with regards to your ability to influence the choice of cooking energy in household use
   a) Small
   b) Medium

c) huge

Section 2

Basing on your knowledge and information you have with regards to briquettes, please respond to the following questions as per your view:

13) It is easy to get access to briquettes (never, few times, many times, always, don't know)
14) There is constant access to quality briquettes(never, some few time, many times, always, don't know)
15) It is easy to store briquettes(never, some few time, many times, always, don't know)
16) It is easy to handle/control the burning of briquettes while cooking(never, some few time, many times, always, don't know)
17) Briquettes users are satisfied/happy with it(never, some few time, many times, always, don't know)
18) Cooking by using briquettes reduces the taste of food(never, some few time, many times, always)
19) Briquettes produce smoke(never, some few time, many times, always, don't know)
20) Using briquettes reduce expenditure on cooking fuel(never, some few time, many times, always, don't know)
21) Briquettes burns with a high heat output (never, some few time, many times, always, don't know)
22) Briquettes burns for a long time (never, some few time, many times, always, don't know)
23) Amount of ash produced from briquettes is bothersome(never, some few time, many times, always, don't know)
24) Briquettes is an affordable energy source for everyday use(never, some few time, many times, always, don't know)
25) Briquettes can be used with existing stove (never, some few time, many times, always, don't know)
26) Are you willing to spend your money to purchase briquettes to try it(No/Yes/Maybe)
27) Would you suggest someone use briquettes?

a) Yes
b) No
c) Not sure

28) What made you not to use briquettes?

a) Getting access is hard
b) It is expensive
c) It is hard to use
d) It is hard to store
e) Its campaign is not attractive
f) I don't see the need of trying it
g) It would taint my social image
h) I don't use any form of charcoal

i) Other reasons

29) Which problems do you know about briquettes
30) How do you feel with regards to your ability to influence the choice of cooking energy in household use(small, medium, huge)

APPENDIX 7: Potential of Bioenergy

The current bioenergy use and potential

The availability of biomass for production of bioenergy has been measured in many studies. The results of the studies vary a lot depending on scope and assumption used in the analysis. Though all the studies concluded the bioenergy potential is large and showed by sustainable utilized. For global studies they have found the present potential to be in 100-270 EJ, meanwhile the 2050 potential to be 100-400 EJ. These studies have limited use due to insufficient attention to geographical distribution and cost of it(Fagernäs et al., 2006). They have a large variation of results due to the difference in calculation land availability and yield output in energy crop production

The upcoming potential will be affected by multiple factors such as demand for food, availability of degraded land, competing for land, recoverable residues, environmental requirements, research, and development, sustainable productivity of forest and energy crops, markets and incentives
In order to get realistic future potential, the supply of biomass has to be analyzed in terms of time, geographical yield capacity, and cost. This is an audacious task since biomass is derived from different sources which can be cultivated, collected from different areas like forest and dumpsites, recovered from wastelands and many more(Fagernäs et al., 2006).

By the end of 2015, about 51 EJ of energy consumed globally was derived from bioenergy which accounts for approximately 9% of the energy demand with more than half utilized in developing countries (IEA, 2019). Its usage is presented in the figure below:

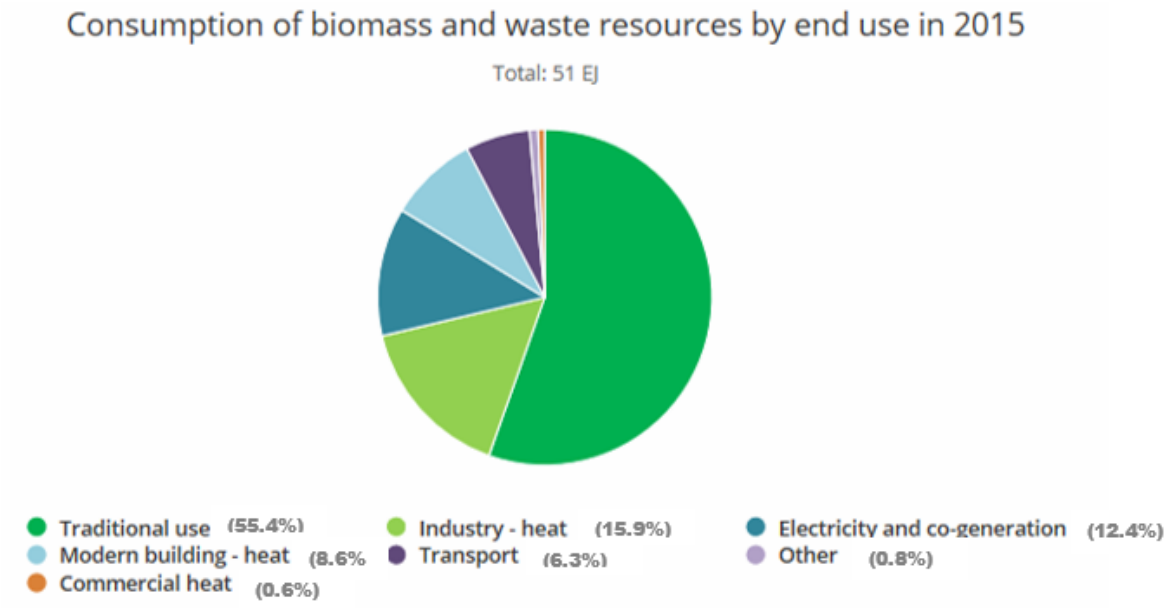


Figure 23: Consumption of bioenergy by end use in 2015(Source(IEA, 2019)*)*

Biomass is used by being transformed into secondary energy carriers namely heat, electricity, and fuel. These transformations are carried out through different processes as shown in the figure below:

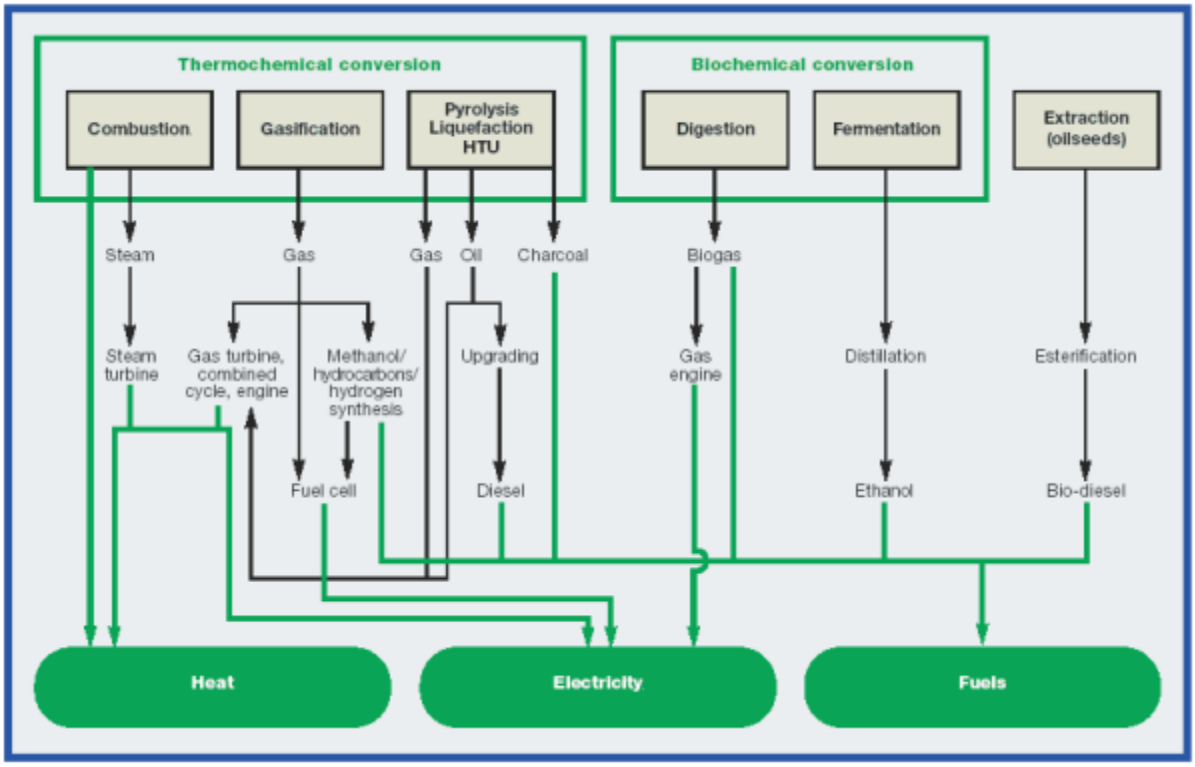


Figure 24: Conversion process of biomass

These transformations take place in a bioenergy facility. Bioenergy production facility size can be divided into different sizes or scale such as small, medium and large. The degree of social acceptance is assumed to be affected by the size of the facility, with smaller scale having more likelihood of positive social acceptance in comparison to larger ones.

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