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Research Article

Customer perception and market potential of wood pellets biofuel in Swabi, Pakistan

Ali Raza[1] | Majid Hussain*[1] | Syed Moazzam Nizami[1] | Quratul Ain Afzal[1] | Muhammad Tayyab Khan[2]

1. Department of Forestry and Wildlife Management, The University of Haripur, Pakistan.
2. Department of Land, Environment, Agriculture and Forestry, University of Padova, Legnaro, Italy.

*Corresponding Author Email: majid_forester@yahoo.com

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Abstract:
This paper comprehensively investigates wood pellets customer's perception and the market potential in district Swabi, Khyber Pakhtunkhwa, Pakistan. The study in district Swabi combines surveys and interviews to gather quantitative and qualitative data through in-depth interviews with industry experts, policymakers, and relevant stakeholders to gain deeper insights into market dynamics, regulatory frameworks, and potential barriers to adoption. The analysis of the collected data involves both descriptive and inferential statistics. The quantitative results provide a comprehensive overview of customer perceptions, identifying patterns and correlations between various factors. The qualitative findings contribute to a nuanced understanding of market dynamics, highlighting key opportunities and challenges associated with wood pellet adoption in Swabi. Findings show awareness of wood pellets in Swabi, yet knowledge gaps and misconceptions hinder widespread adoption. Factors such as pricing, availability, and lack of infrastructure emerge as key barriers. The study also reveals promising market potential, especially considering the region's abundant biomass resources and growing interest in sustainable energy solutions. This paper proposes recommendations and strategies to enhance customer awareness, promote the benefits of wood pellets, and address the identified barriers.

Keywords: Wood pellets, Wood pellets adoption, Biofuel, Biomass resources, Market potential, Customer perception, Customer awareness, Market dynamics, Energy solutions.

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1. Introduction

Wood pellets, as a renewable energy source, have gained significant attention as an alternative to traditional fossil fuels due to their environmental benefits and cost-effectiveness. Understanding customer perceptions and assessing the market potential are crucial for developing effective strategies to promote the adoption of wood pellets and to support sustainable energy practices. The research begins by reviewing existing literature on wood pellets, renewable energy, and customer perception studies. Various theoretical frameworks and models are examined to develop a conceptual understanding of the factors influencing customer perceptions and market potential. Furthermore, the significance of district Swabi as a geographic region is explored, considering its natural resources, socio-economic characteristics, and energy demands. The surveys assess customers' awareness, attitudes, and preferences regarding wood pellets, focusing on factors such as environmental concerns, cost, availability, and ease of use.

The recommendations include educational campaigns, financial incentives, and collaborations with local stakeholders to develop wood pellet production, distribution, and utilization infrastructure. In conclusion, this paper contributes to the existing literature by shedding light on customer perception and market potential of wood pellets in district Swabi. The findings serve as a valuable resource for policymakers, energy providers, and entrepreneurs interested in promoting sustainable energy practices in the region. The study underscores the importance of understanding customer perceptions and addressing market challenges to facilitate the successful integration of wood pellets into the energy landscape of district Swabi and beyond. The first official pallet was patented in 1932 by Bill House and George Raymond. However, the use of pallets only started to grow in the 1940s, as they became valuable tools to ease the demand for increased material handling speed during the Second World War (Rashedi *et al*., 2022). Since World War II, the use of pallets has expanded into other industrial applications outside of the military. Today, wooden pallets are used by 93% of material handling companies (Hassan *et al*., 2023).

Pelletization is the process of compacting biomass to make it easier to handle, keep clean, and increase the amount of energy contained in a given volume. In comparison to conventional wood biomass, the compact size is especially advantageous for storage and transportation. The by-products of primary wood processing facilities are typically used to create wood pellets, a densified form of biomass. Wood pellets have less than 10% moisture content and a bulk density of about 650 kg/m^3. Wood pellets are recognized as a standardized worldwide commodity and have a consistent cylindrical shape. Similar to other popular commodities like coal, wood chips, and grain, wood pellets require a similar infrastructure for processing, storing, and transportation. Compared to other kinds of biomass, these characteristics make wood pellets simpler to handle, store, and use (Rashedi *et al*., 2022; Gurria et. al., 2022).

Common materials for pallet production are wood, corrugated paperboard, metal, and plastic (Millwood Inc.). Wood pallets can be produced from a variety of species, including hardwood and softwood species, such as pine or oak. This lumber must be, at a minimum, economy grade or better. Paper pallets are manufactured from corrugated, paperboard or honeycomb. Biomass is the non-fossilized and biodegradable organic material originating from plants, animals and micro-organisms. This definition includes products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilized and biodegradable

organic fractions of industrial and municipal wastes. The biomass wastes in Portugal have a great capacity to contribute to energy production and are partially exploited for this purpose. In the context of pellets production, the biomass sources come from the forestry, wood processing industry and agricultural wastes (Monteiro *et al.*, 2013).

The wood pellet manufacturing process begins with collecting feedstock and finishes with distributing pellets to clients. The feedstock is typically a byproduct of the wood-processing industry, such as sawdust, shavings, chips, and even barks. The quality of wood pellets is highly dependent on the feedstock. A typical pellet plant contains the following unit operations: drying to remove moisture, grinding to reduce size, densification for pelletization, cooling, bagging, and storage. Trucks, railcars, and ocean vessels are commonly used to convey finished goods to domestic and foreign clients (Rashedi *et al*., 2022; Borgianni et al., 2011).

Wood-fuelled systems are frequently utilized for domestic heating all throughout the world, and wood pellets have recently replaced the firewood traditionally used for residential heating. Pellet stoves, which have a better combustion efficiency than traditional heating systems (wood stoves and fireplaces), are used to burn wood pellets. Furthermore, assuming an energy basis, wood pellets have a higher energy density and hence require less storage space than firewood (Hassan *et al.*, 2023). The use of woody biomass for energy purposes has been increasing in recent decades, highlighting the importance of woody resources in sustainable economies (Rashedi *et al.,* 2022). Wood pellets are a clean renewable fuel, mostly produced from highly compressed sawdust, planer shavings and bark. This fuel has been considered as one of the substitutes for fossil fuels like coal and oil for heating and cogeneration.

The biomass wastes in Portugal have a great capacity to contribute to energy production and are partially exploited for this purpose. In the context of pellet production, the biomass sources come from forestry, the wood processing industry, and agricultural wastes (Monteiro *et al*., 2013). Pellets have two major obstacles to overcome in Portugal. First, at the production level, the limitation of biomass resources for pellet production in Portugal, as shown, can increase difficulties for new pellet plants. Second, at the market penetration level, the main marketing problem for pellets has been to convince small-scale customers that wood pellets are a good alternative fuel. Large-scale plants will have to compete with biomass power plants for raw materials. For small-scale units in particular, it is very important to take care of the specific framework conditions of the producer because the risk of non-economic pellet production is substantially higher than for large-scale systems.

For economic reasons, Hassan *et al*. (2023) did not recommend the use of dryers in small-scale pellet production plants. Various studies for pellet production cost distribution have been made showing that the specific pellet production costs are dominated by the consumption costs (raw material, heat, and electricity costs), followed by the operating costs (personnel costs) and the costs based on capital. Raw materials have the biggest influence (nearly 40%) on the cost of the production of pellets. Directly influenced by raw materials, when wet, the need for a drying step may have a share of nearly 30% of the total cost of production. The possibility of reducing the pellet production costs could be increased plant capacities and the combination of the biomass power plants implemented in Portugal with pellet production plants to reduce the drying costs. Power plants are generally heat exceeding, so it is a good solution to use this heat for drying. Another reason is that the 15 new biomass power plants will most likely dominate the market of forest residues, which are the main source for pellet production. The combination

of biomass power plants with pellet production plants is already a reality in Austria and Sweden (Monteiro *et al.*, 2013; Fiedler, 2004).

The wood pellet market is booming in Europe (Sikkema *et al.*, 2011). The EU 2020 policy targets for renewable energy sources and greenhouse gas emissions reduction and the worsening situation of strong energy dependence on oil (Hassan *et al.*, 2023) are among the main drivers. Nowadays, wood pellets are one of the largest internationally traded solid biomass commodities used specifically for energy purposes. In terms of traded volume – about 4 million tonnes – they can be compared to biodiesel or bioethanol (Rashedi *et al.*, 2022). In Portugal, significant pellet production capacities have been installed since 2005. Several major production plants were commissioned in 2008, increasing the total capacity to around 400,000 tonnes. Besides some smaller producers, mainly large-scale plants are in operation. Currently, more than 90% of the produced pellets are exported, mainly to Northern Europe. The domestic pellet consumption in Portugal is very limited. The annual consumption in 2008 is estimated at 10,000 tonnes (Monteiro *et al.*, 2013).

Pellet production is a combination of sequential steps, including preprocessing, drying, grinding, pelletizing, cooling, screening and bagging. A detailed review is provided elsewhere in the literature (Hassan *et al*., 2023). Therefore, only a brief description is made herein. Fig. 2 shows schematically a pellets production line. Grinding depends on the state of the raw material used. High-dimension wood residues may be compacted into smaller ones. Alternatively, they can be applied to biomass power plants. Milling is also sometimes made to homogenize the raw material. Drying is of high importance for the final product since raw material with a water content higher than 15% is difficult to pelletize. The extent to which material needs to be dried before pelletizing makes a big difference to the energy required in the manufacture of wood pellets. It is worth ensuring that any steam used in the process is recycled and trying to ensure that the drying process is itself powered using a renewable source of energy such as wood, which the manufacturer may well have close at hand. Drying is usually carried out in heat exchangers that use hot water or steam. The choice depends on the level of investment. For example, the choice of a heat exchanger using superheated steam requires a more robust initial investment, but the potential for heat recovery is higher, reducing operating costs. Another possibility may be the integration of a pellets production plant within an industry with excess heat. Drying usually is not necessary if the raw material comes from the furniture industry, where the moisture content is low.

On the opposite, sawdust from sawmills has a high moisture content. After drying, a hammer mill equipped with a 3.2–6.4 mm screen size reduces the dried biomass to a particle size suitable for pelletizing. The pelletizing process is mainly based on the use of a matrix-shaped drum in which the raw material is extruded under pressure through holes. Adding organic matter or steam is sometimes needed to facilitate the extrusion process. This phase of the process represents the major portion of electricity consumption in the manufacture of pellets and the main source of maintenance costs (up to 15% of investment per year). Cooling may not be strictly necessary and always represents a small cost. The pellets are cooled immediately after pelletizing to adjust the additive binding and stabilize the pellet. Wood industry residues by sub-sector in Portugal. As opposed to Portugal, the wood pellets market is booming in Europe. This work foresaw possible reasons for this market behaviour according to the key indicators of biomass availability, costs and legal framework. Two major constraints are found in the Portuguese pellets market: the first is the lack of internal consumption, which is the

market based on exportations. The second one is the shortage of raw materials, mainly due to the competition with biomass power plants. (Monteiro *et al*., 2012).

Pellets rely on a renewable energy source (solid biomass) and constitute a flexible way to use wood residues (mostly sawdust) and reduce the greenhouse emissions that other energy sources produce. The continuous rise of electricity and fossil fuel prices, and the depletion of fossil fuels, are strong incentives for the demand for pellets as heating fuel for both domestic and, increasingly, industrial applications. Domestic use of pellets must comply with very high standards regarding pellet quality with a strong emphasis on the ash content/formation (below 1 %), and the ease of use is paramount to the consumer. On the other hand, large-scale industrial applications do not require such strict standards (≤3 %), according to EN 14961-2. In addition, the increasing demand for such fuels (due to the cost-effectiveness and policies promoting the use of renewable sources) has raised interest in using other forms of raw materials for pellet production (Ferreira *et al.*, 2014).

Energy security, global warming, and utilization of local resources are the driving factors for using biomass as an alternative energy source. The production of energy from renewable sources has acquired special importance in the energy policy of the European Union because of the worsening situation of strong energy dependence on oil (Rashedi *et al.*, 2022). A major contribution to this is expected to come from biomass as a renewable and CO_2-neutral energy source (Monteiro *et al.*, 2013). In recent years, pellets have become an important fuel to produce heat and power around the world. These are considered an option for competitive fuels since their higher fuel density translates into reduced transport and storage costs compared to other biomass forms, and this advantage can be used in areas where the cost of efficient delivery is a challenge due to storage and transportation over long distances. Additionally, they have lower moisture content than unprocessed biomass, higher heating value, uniformity, clean burning, and reduced formation of ash. Another advantage is that they are easier to transport, store and handle and can be obtained from different raw materials. Therefore, it is adaptable to different locations. These advantages have increased the commerce of high-quality pellets (Hassan *et al.*, 2023).

1.1. Importance of the study

- Contribution to the renewable energy sector: Wood pellets are considered a renewable energy source and play a vital role in reducing reliance on fossil fuels. By assessing the customer perception and market potential of wood pellets in district Swabi, this study can provide insights into the feasibility and viability of using wood pellets as an alternative energy source, thereby contributing to the renewable energy sector.
- Environmental sustainability: Wood pellets are known for their low carbon emissions and environmentally friendly nature. Investigating the customer perception and market potential of wood pellets can shed light on the potential for reducing carbon footprints and promoting sustainable practices in district Swabi. The findings of this study can encourage the adoption of wood pellets as an eco-friendly energy source, leading to a greener and more sustainable future.
- Economic benefits: Understanding the market potential of wood pellets can have significant economic implications. The study can provide insights into the demand and preferences of customers in district Swabi, which can aid businesses, investors, and policymakers in making informed decisions. This information can help identify potential

investment opportunities, foster the growth of wood pellet production and distribution enterprises, and create employment opportunities, thereby contributing to the local economy.

- Consumer behaviour and preferences: Assessing customer perception of wood pellets is crucial for understanding consumer behaviour and preferences in district Swabi. It can help identify the factors that influence customers' acceptance and adoption of wood pellets as an energy source. By examining consumer attitudes, concerns, and motivations, this study can contribute valuable insights for businesses and policymakers to develop effective marketing strategies and tailor their offerings to meet customer needs and expectations.
- Policy development and implementation: The findings of this study can serve as a basis for formulating policies and regulations related to the production, distribution, and usage of wood pellets in district Swabi. Policymakers can leverage the insights gained to design incentives, subsidies, or other mechanisms that encourage the adoption of wood pellets, thereby fostering a supportive regulatory environment. Additionally, the study can highlight any barriers or challenges faced by consumers, enabling policymakers to address them effectively.
- Future research and expansion: Researching the customer perception and market potential of wood pellets in district Swabi can pave the way for future studies and expansion of the renewable energy sector. The findings can serve as a foundation for further investigations into related areas, such as the impact of wood pellet usage on energy security, rural development, or the integration of wood pellet production into the existing biomass supply chain. This research can contribute to a comprehensive understanding of the broader implications of wood pellet adoption in district Swabi and beyond.

1.2. Objectives of the study

- What is the market potential of wood pellet biofuel in district Swabi, KP, Pakistan?
- What is the customer perception of wood pellets biofuel in the study area?
- To devise a commercialization roadmap framework development for wood pellets biofuel in the study area.

2. Review of literature

In Portugal, the pellet market in Portugal is an emerging sector in which the leading producers of wood pellets aim to persuade small-scale buyers that wood pellets are a good choice as a fuel since the energy they produce is cost-effective in the long run (Nunes *et al.*, 2014). Data on production, production capacity, and consumption in Portugal were gathered for this project. Consumption is low because the majority of sales are exported. The various points of pellet production in Portugal have been identified, and a price analysis has been conducted. The database Bioraise was used to supplement the information obtained from prospecting and inquiries to collect data on the plant's production capacity and market referrals. Although the pellet industry in Portugal is still in its early stages, the potential for growth is significant because the internal consumption is modest in comparison to the level of exports to other countries where the pellet industry is thriving. The pellet sector is an essential alternative in the Portuguese energy market because of its low cost as compared to other fuels (Nunes *et al.*, 2014).

According to García-Maroto *et al.* (2014), pelletizing technology is gaining popularity as a technique for enhancing solid biomass energy recovery. The widespread use of wood pellets as a biofuel has the potential to replace fossil fuels in heat and power production. This study looks into the understanding of wood pellets among many agents in the pellet supply industry, the major variables influencing the deployment of this energy source, and the potential need for novel formats and packaging. This study looks into the understanding of wood pellets among many agents in the pellet supply industry, the major variables influencing the deployment of this energy source, and the potential need for novel formats and packaging. Such data can help the industry establish plans to commercialize this biofuel better. A qualitative survey of managers (producers and distributors) is carried out, as well as a quantitative study of the biomass sector, namely the wood pellet market. The main findings are summarized. To begin, pellets are largely utilized for heating family homes and other structures due to their comfort, cleanliness, ease of use, and stability. Second, industry participants agree that the 15 kilogram pack is the best option due to its ease of use, transportation, and storage. Finally, the data indicate that direct delivery to residential customers will be the most common in this market. This, however, demands increased distribution through a number of points of sale. The study contributes to the literature by providing in-depth knowledge about the logistics and future market potential of wood biomass.

Hassan *et al.* (2023) explored the social, economic, and environmental aspects of using woody biomass for energy in this research. The study conducted a questionnaire to establish which energy utilization methods were favoured in Japan, as well as to collect statistics on the cost, labour, and energy production associated with each energy utilization method. According to the survey results, direct burning and combusting wood pellets were the favoured methods for energy recovery. Following that, the researchers used input-output analysis to compare several aspects of the two recommended energy utilization methodologies. The variables were evaluated in relation to energy generation from unutilized woody biomass in Japan, which totals 8.58 million tons per year. The key considerations were the social and economic consequences of job creation, as well as the decrease of CO_2 emissions. As a result, while direct burning reduces CO_2 emissions by 13.7 million tons, there are limited effects on increased productivity and job generation. Furthermore, we discovered that burning wood pellets was favourable due to an increase in production (981 million USD) and the establishment of employment prospects (24,700 jobs).

Rashedi *et al.* (2022) stated that wood pellets have become a major fuel in the generation of heat and power, and pellet markets are expanding rapidly. The pellet markets, raw materials, and supply structures for Sweden and Finland are examined in this article, which is based on a database on the present location and production capacity of pellet companies, supplemented with existing reports and literature. In Sweden, 94 pellet plants/producers were found, generating 1.4 million tons of pellets, while domestic consumption was 1.7 million tons, with around 400,000 tons of pellets imported to meet demand in 2007. In Finland, 24 pellet plants/producers were discovered, and production was approximately 330,000 t in 2007, with domestic consumption being 117,000 t. In Finland, the pellet business has long been export-orientated, although domestic consumption has been increasing mostly in the small-scale consumer sector, with an estimated 15,000 households having pellet heating systems in 2008. The growing number of pellet consumers will necessitate a dependable transportation network and high-quality bulk pellet delivery equipment in the future. Provision of new raw materials and assurance of pellet quality across the whole production, delivery, and handling chain will

be critical in increasing the usage of pellets and maintaining their ability to compete with alternative fuels.

Monteiro *et al.* (2013) stated that the production of pellets represents the possibility of using different biomass residues in a standardized fuel. In this article, the economic feasibility of pellet production is analysed in the Portuguese scenario according to the key indicators of biomass availability, costs, and legal framework. The potential of biomass residues in Portugal is significant, mainly from forestry. However, several limitations to its utilization for pellet production may arise since they are already put to other uses, such as biomass power plants. The combination of biomass power plants with pellet production plants seems to be the best option for pellet production in the actual Portuguese scenario. The main constraints for the pellets market have been convincing small-scale customers that pellets are a good alternative fuel, mainly due to the investment needed and the strong competition in fuel price with natural gas. These market problems need incentives at a political level, bringing the value-added tax for the same level of natural gas.

Uasuf and Becker (2011) said that developing cleaner and renewable energy sources is needed to reduce dependency and global warming. Wood pellets are a clean, renewable fuel and have been considered as one of the substitutes for fossil fuels. In Argentina, large quantities of sawmill residues are still unused, and wood pellet production could be seen as both an environmental solution and an extra economic benefit. This study aimed to determine the wood pellets production costs and energy consumption under different framework conditions in northeast Argentina. The specific costs of wood pellets for the different scenarios showed relatively lower costs compared to the ones reported in other studies, ranging from 35 to 47 €/Mg pellets. Raw material costs represented the main cost factor in the calculation of the total pellets production costs. A lower specific production cost was observed when 50% of the raw material input was wood shavings. The specific electricity consumption per metric ton of pellet was lower in scenarios with higher production rate. Lower heat energy consumption was observed in scenarios that have a mixed raw material input. The most promising framework condition for Northeast Argentina, in terms of cost effectiveness and energy consumption, could be acquired with production rates of 6 Mg/h with sawdust and wood shavings as raw materials. However, a simultaneous increment of the electricity by 50% and raw material price by 100% may increase the specific costs by up to 50%.

3. Material and methods

3.1. Study area

District Swabi was given the status of district in July 1988. Previously, it was part of district Peshawar district and then a sub-division of district Mardan. It consists of Four Tehsils, namely Swabi, Lahore, Topi and Razar. Swabi has 56 Wards/Union Councils, which have been subdivided further into 160 Neighbourhood/Village Councils. As per census 2017 it has a population of 1.6 million with a growth rate of 2.00 % (Rounded). Total Area of the district is 1543 square kilometres. The district may be divided into two parts, the northern hilly areas and the southern plain area. The major parts of these hills are in Gadoon area in the north-east. These are the continuation of the Mahaban hills. The other important hills are situated in north-western corner of the district. These are locally called as the Narranji hills. The height of these

hills varies between 750 to 1400 meters above sea level. There are also a few other small, isolated hills, the most important of which is located south of Swabi town.

Numerous streams and many smaller ravines intersect the plain area of the district. The important stream is the Narranji Khowar, which flows from Narranji hills in a southwestern direction, joining the Kalapani stream in the district Mardan. Another important stream is Badri Khowar, which flows from the south close to Swabi town and joins the river Indus near the village of Hund. The Indus River flows along the southern boundary of the district. It is bounded on the north by district Buner, on the east by district Haripur, on the South by district Attock of the Punjab Province and on the west by districts Nowshera and Mardan. Swabi is at a distance of 132 kilometres from Islamabad towards the west and 100 kilometres from the Provincial Headquarters Peshawar towards the east.

3.2. Physical features and topography

The arable soil of the Swabi district in Khyber Pakhtunkhwa has developed either from River alluvium or loess plains. The texture of river alluvium ranges from sandy loam to loamy sand, loam approaching clay loam. The soil of loess plains ranges in texture from silt loam to silty clay loam or silty clay. The soil is irrigated for general cropping with canals supplemented by well–irrigation. Some parts where irrigation is not feasible are used for dry farming of wheat, gram and groundnuts.

3.3. Geology

The district Swabi exhibits the following rock units, Salkhala Formation, Manki Formation, Sobra Formation, Tanawal Formation, Ambar Formation, Misri Banda Formation, Panjpir Formation, Granite and Sills/Dykes.

3.4. Climate condition

The district has an extreme climate. The summer season is extremely hot. A steep rise in temperature is observed from May to June, and even in July, August and September, temperatures are quite high. During May and June dust storms are frequent at night. The temperature reaches its maximum in the month of June. Due to intensive cultivation and irrigation, the tract is humid, and the heat is oppressive. A rapid fall in temperature is recorded from October onwards. The coldest month is January. Towards the end of the cold weather, there are occasional thunderstorms and hailstorms. The maximum rainfall is received in July and August, during which the weather becomes hot and humid. The relative humidity is quite high throughout the year, while maximum humidity is recorded in December.

4. Methodology

The primary and secondary data were used for the market potential and customer perception of wood pellets in the study area. After the production of wood pellets on a large scale at the production site. Pellets were bagged in different sizes, i.e. 15, 20, 25 kg, etc., and the pellet bags were marked with a specific logo on them and taken to different industries and households for selling purposes. For this, first of all, we launched our product (wood pellets) at the district level and demonstrated in the launching ceremony the advantages of wood pellets and the

burning procedure of wood pellets in stoves to compel the customer to purchase the wood pellets. After selling wood pellets, a questionnaire was also distributed to the customer to know their perception of wood pellets.

5. Results and discussions

5.1. Market potential

This research aimed to investigate the market potential of wood pellets in the Swabi region. The consumer perception and purchasing behaviour towards wood pellets is analysed. In Table-1, it is evident that a majority of the population, 76%, expresses a liking for wood pellets, while 24% of the respondents have a negative sentiment towards them. This indicates a promising market opportunity as a significant portion of the population already holds a favourable view of wood pellets.

Table-1: Questionnaire survey based on customer perception in the district Swabi

Do you like the wood pellets?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Dislike	24	24.0	24.0	24.0
	Like	76	76.0	76.0	100.0
	Total	100	100.0	100.0	

Figure 1: Pie chart illustrating the predilection of individuals towards wood pellets

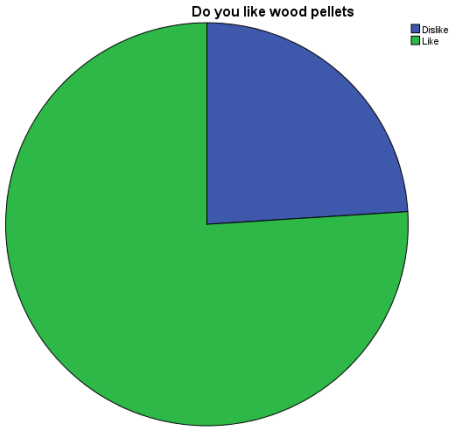


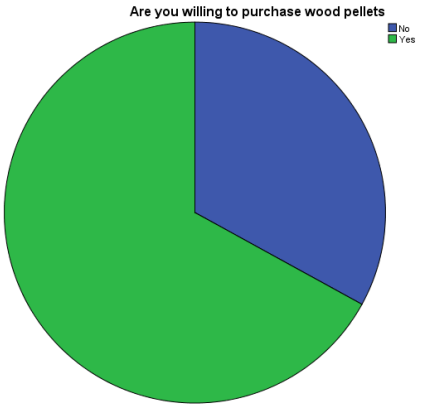
Table-2 reveals that 66% of the surveyed individuals are willing to purchase wood pellets, while the remaining 33% express a reluctance to do so. This finding suggests a considerable potential market for wood pellets in Swabi, as most respondents are open to the idea of purchasing them. By understanding the factors influencing the preferences and purchase decisions of consumers, businesses can strategize and tailor their marketing efforts to tap into this market potential effectively.

Table-2: Questionnaire survey based on the market potential of wood pellets in district Swabi

Are you willing to purchase wood pellets?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	33	33.0	33.0	33.0
	Yes	67	67.0	67.0	100.0
	Total	100	100.0	100.0	

Further analysis and research are required to identify the key drivers and barriers influencing the purchasing decisions of individuals who dislike wood pellets. Additionally, understanding the specific reasons behind the willingness of the 66% who are inclined to purchase wood pellets can provide valuable insights for businesses to develop targeted marketing campaigns and highlight the benefits of wood pellets to attract more customers.

Figure 2: Pie chart illustrating the willingness of individuals to purchase wood pellets



This research aimed to investigate the customer perception of wood pellets in Swabi, focusing on the awareness and knowledge level among the local population. Table-3 reveals that among the respondents surveyed, 39% of individuals indicated knowledge about wood pellets, while the remaining 61% were unfamiliar with this renewable energy source. This finding highlights the need to examine the factors influencing the local community's awareness and understanding of wood pellets. By analysing customers' perceptions, attitudes, and preferences towards wood pellets, this study aims to contribute to developing and promoting sustainable energy sources in Swabi, ultimately fostering a greener and more environmentally conscious community.

Table-3: Questionnaire survey based on the customer perception in the district Swabi

What is the extent of customer perception towards the adoption of wood pellets in district Swabi?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	61	61.0	61.0	61.0
	Yes	39	39.0	39.0	100.0
	Total	100	100.0	100	

Figure 3: Bar chart illustrating individuals' knowledge about wood pellets

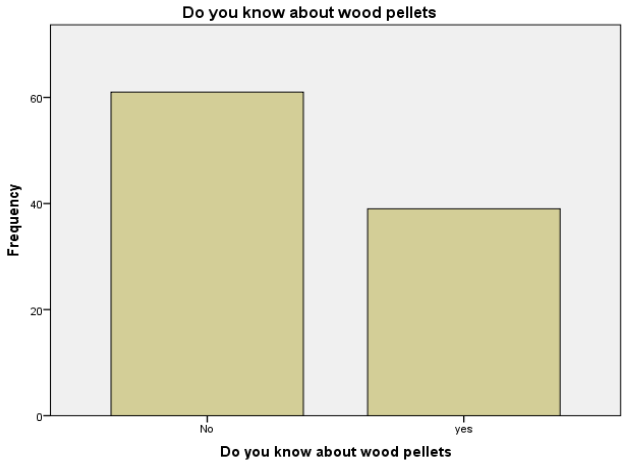
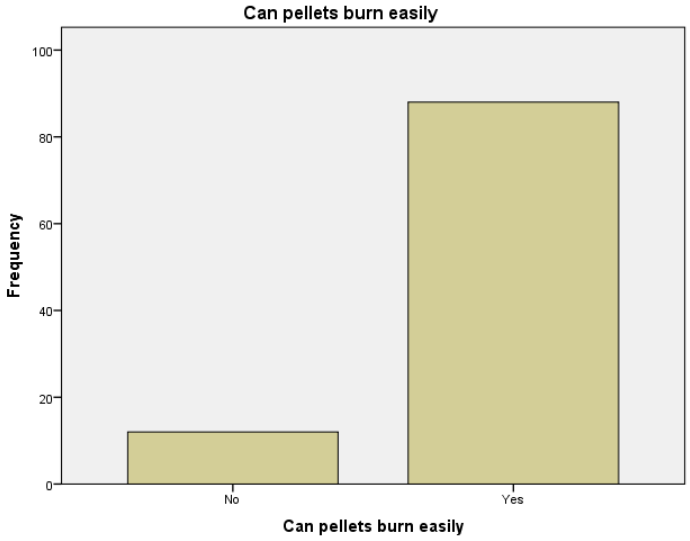


Table-4 presents the results of the survey conducted to understand the customer perception of wood pellets in Swabi. Among the participants, 88% of the respondents stated that wood pellets burn easily, while the remaining 12% expressed a contrary opinion. These findings indicate a strong belief among the majority of customers that wood pellets are efficient and effective as a fuel source. Further analysis and research in this field are needed to explore the reasons behind such perceptions and their potential impact on the market demand for the wood pellets in Swabi.

Table-4: Customer perception about burning of wood pallets

Can pellets burn easily?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	12	12.0	12.0	12.0
	Yes	88	88.0	88.0	100.0
	Total	100	100.0	100.0	

Figure 4: A pictorial depiction portraying individuals' perspectives on ignitability of wood pellets



The research aimed to investigate the customer perception of wood pellets in Swabi. One of the aspects explored was the heating durability of wood pellets as perceived by customers. Table-5 presents the results obtained from the survey, wherein 89% of the respondents expressed that wood pellets are heating durable, while 11% disagreed. The findings indicate a significant majority of customers in Swabi perceive wood pellets as reliable and long-lasting heat sources. These results can be valuable for wood pellet manufacturers and suppliers in understanding customer preferences and enhancing product offerings to meet the demands of the local market.

Table-5: Customer perception about heating durability of wood pellets

Is heating durability of pellets was good?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	11	11.0	11.0	11.0
	Yes	89	89.0	89.0	100.0
	Total	100	100.0	100.0	

Figure 5: Bar chart illustrating individuals' perceptions on efficacy of wood pellets' heating value

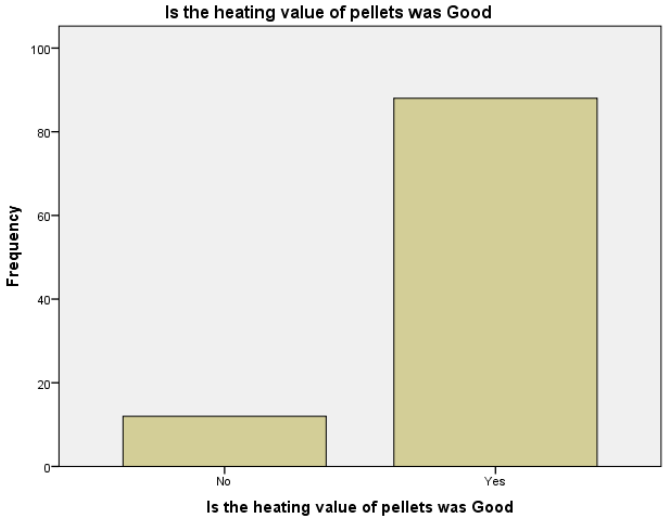
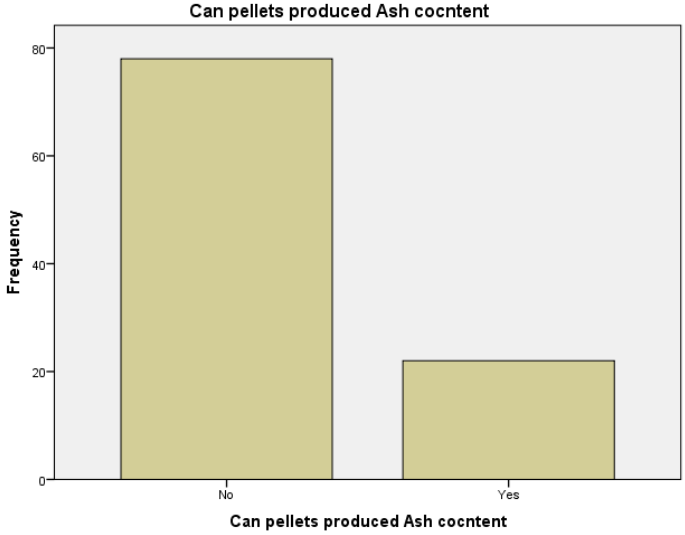


Table-6 presents the results of a survey conducted in Swabi to explore customer perception regarding the ash content produced by wood pellets. The survey aimed to understand whether customers perceive wood pellets to produce less or more ash content. Among the respondents, 78% reported that wood pellets produce less ash content, while 22% indicated that wood pellets produce more ash content to some extent. These findings provide valuable insights into the customer perception of wood pellets in terms of ash content and can be used to inform marketing strategies, product development, and consumer education initiatives in the wood pellet industry in Swabi.

Table-6: Customer perception of pallets ash content

Can pellets produced ash content?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	78	78.0	78.0	78.0
	Yes	22	22.0	22.0	100.0
	Total	100	100.0	100.0	

Figure 6: Bar chart elucidating individuals' viewpoints on the ash production of pellets

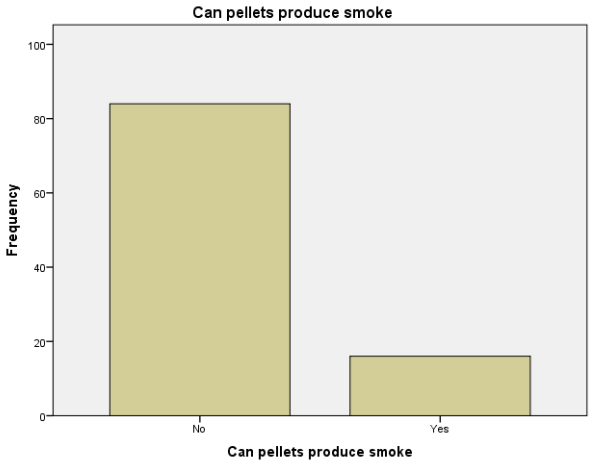


This research aimed to investigate the customer perception of wood pellets in Swabi, particularly focusing on the amount of smoke produced. Table-7 presents the results of the survey conducted, where 84% of the participants stated that wood pellets produce less smoke, while 16% expressed that it produces more smoke to some extent. These findings highlight a positive perception among the majority of customers regarding the smoke emission of wood pellets. The high percentage of respondents acknowledging that wood pellets generate less smoke suggests that they are perceived as a cleaner and more environmentally friendly alternative to traditional fuel sources. Further analysis and evaluation of customer opinions and experiences with wood pellets can provide valuable insights for policymakers in enhancing the adoption and acceptance of this sustainable energy option in Swabi.

Table-7: Customer perception about pallets producing any smoke

Can pellets produce smoke?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	84	84.0	84.0	84.0
	Yes	16	16.0	16.0	100.0
	Total	100	100.0	100.0	

Figure 7: Bar chart portraying individuals' perspectives on whether pellets emit smoke or not



The research aimed to investigate the customer perception of wood pellets in Swabi, specifically focusing on their perceived health effects. Table-8 presents the results of the survey conducted among a sample population. Among the respondents, 83% of the participants reported that they believed wood pellets do not produce any health issues. On the other hand, 17% of the participants expressed a concern that wood pellets may produce some health issues. These findings provide valuable insights into the prevailing customer perception regarding the potential health effects associated with the use of wood pellets in Swabi. Further analysis and research can be conducted to explore the factors influencing these perceptions and their implications for the wood pellet industry in the region.

Table-8: Customer perception of wood pallets producing any health issues

Can pellets produce health issues					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	83	83.0	83.0	83.0
	Yes	17	17.0	17.0	100.0
	Total	100	100.0	100.0	

Figure 8: Bar chart delineating perspectives of individuals on whether pellets produce health issues

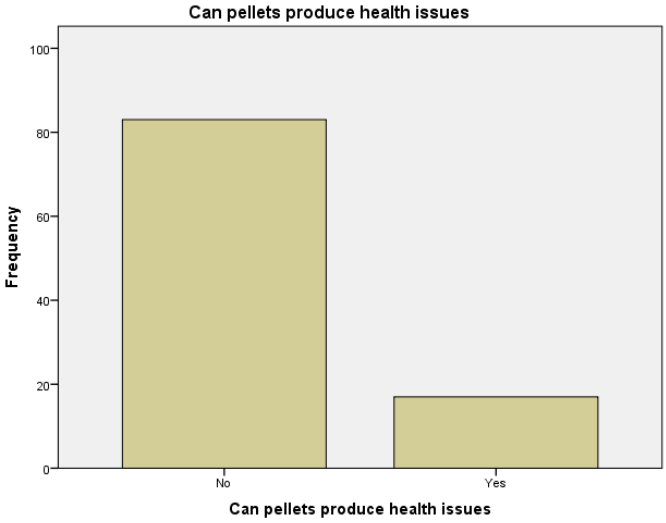
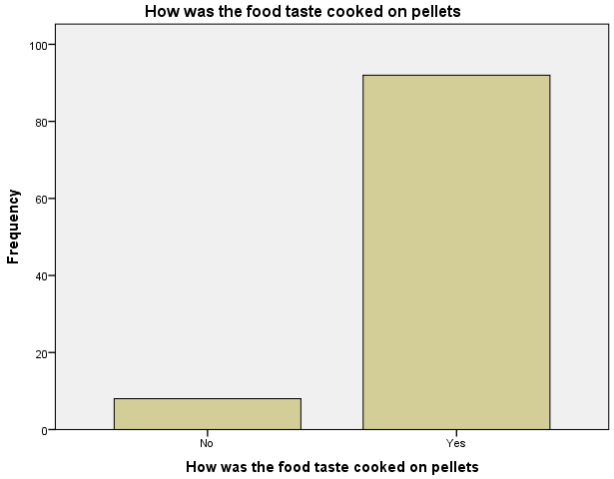


Table-9 presents the findings regarding the customer perception of wood pellets in Swabi, specifically focusing on the taste of food cooked using wood pellets. The table indicates that 92% of the respondents reported that the food cooked on wood pellets tasted good, while 8% expressed a different opinion. These findings suggest a predominantly positive customer perception regarding the taste of food cooked with wood pellets in Swabi. The data highlights the potential satisfaction among customers who have experienced food prepared using this cooking method. Further analysis and exploration of additional factors related to wood pellets, such as convenience, environmental impact, and cost-effectiveness, could provide a comprehensive understanding of customer perceptions in this context.

Table-9: Customer perception of food taste cooked on wood pallets

How was the food taste cooked on pellets?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	8	8.0	8.0	8.0
	Yes	92	92.0	92.0	100.0
	Total	100	100.0	100.0	

Figure 9: Bar chart delineating individuals' perceptions regarding food taste cooked on pellets



6. Conclusion

It has been concluded from the research study that through an in-depth analysis of customer perception and market potential of wood pellets in district Swabi, several key findings and insights have emerged. These studies collectively shed light on customers' perceptions regarding wood pellets as an alternative fuel source and the overall market potential in the mentioned district. The research highlights that customer perception of wood pellets in district Swabi is generally positive. Wood pellets are viewed as a viable and sustainable energy option, particularly in the context of rising energy costs and environmental concerns. Customers recognize the benefits of wood pellets, such as their renewable nature, low emissions, and potential for cost savings, which have significantly influenced their perception and willingness to adopt this alternative fuel source.

The study demonstrates that the market potential of wood pellets in the district of Swabi is promising. The demand for wood pellets is growing steadily, driven by increasing awareness of environmental sustainability, energy independence, and the availability of wood waste resources in the region. Market analyses reveal a rising trend in the adoption of wood pellets, particularly among residential users, commercial entities, and small-scale industries. This presents a lucrative opportunity for businesses involved in producing, distributing, and marketing wood pellets. The research emphasizes the importance of addressing customer concerns and barriers to market penetration. Factors such as initial investment costs, lack of awareness about the benefits of wood pellets, and limited availability of pellet stoves and boilers have been identified as key obstacles to widespread adoption. Overcoming these challenges will require concerted efforts from stakeholders, including government bodies, industry players, and local communities, to facilitate education and awareness programs, incentivize investment, and improve the accessibility of wood pellet technologies.

To maximize the market potential of wood pellets in district Swabi, it is crucial to develop a comprehensive strategy that encompasses both supply-side and demand-side measures. This entails fostering partnerships between wood pellet manufacturers, suppliers, and distributors to ensure a reliable and sustainable supply chain. Additionally, targeted marketing campaigns tailored to different customer segments should be employed to raise awareness, emphasize the benefits, and address customer concerns effectively. In conclusion, the research on customer perception and market potential of wood pellets in district Swabi indicates a positive outlook for adopting and growing wood pellets as an alternative fuel source. Customer perception is favourable, driven by the recognition of the environmental and economic benefits of wood pellets. The market potential is substantial, with increasing demand and available resources. However, concerted efforts are needed to overcome barriers and ensure a successful transition towards a wood pellet-based energy system. By addressing these challenges and implementing a well-rounded strategy, the wood pellet industry in district Swabi can thrive, contributing to sustainable energy practices and regional economic development.

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Declaration of conflict of interest

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