Research Article

Mohammad Natsir*, Sri Mardiyati, Syafiuddin Syafiuddin

Determinants of rice consumer lexicographic preferences in South Sulawesi Province, Indonesia

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Abstract: Rice is a very strategic staple food and plays an important role in supporting sustainable food security. Understanding consumer preferences is essential for stakeholders in the rice supply chain, including producers, marketers, and policymakers. This study aims to analyze the factors that influence the hedonic price of rice and analyze the factors that determine the lexicographic preferences of rice consumers. Sampling is carried out using the cluster sampling method for urban and rural areas, with a total of 200 observations. Data analysis uses multiple linear regression and binomial logit regression. The results of this study indicate that the hedonic price of low-quality rice is influenced by cleanliness, durability, softness of rice, and urban areas. The hedonic price of medium quality rice is influenced by cleanliness, durability, packaging, whiteness level, and urban areas. The hedonic price of premium quality rice is influenced by aroma, brand, durability, packaging, whiteness level, and urban areas. The factors that determine the lexicographic preferences of premium quality rice consumers toward premium quality rice are aroma, brand, whiteness level, and urban areas. The determinants of consumer lexicographic preferences of premium quality rice compared to low-quality rice are price, brand, packaging, and urban area. The determinants of consumer lexicographic preferences of medium quality rice compared to low-quality rice are price, aroma, and rice grains. Consumer behavior continues to evolve based on sustainability principles, so hedonic pricing methods are emerging as an important tool to understand the market dynamics and help develop agricultural policies that support sustainable practices. Consumer awareness of sustainability can result in more appropriate policies that encourage sustainable practices in rice production and marketing, thus benefiting the environment and agricultural economy.

Keywords: consumer, hedonic price, lexicographic, preference, rice

1 Introduction

Rice is a very strategic staple food commodity in Indonesia and plays an important role in food security. Rice commodities are very important because they are difficult to substitute with other food commodities [1,2]. Rice consumers include various social classes, occupations, incomes, wealth, and other social variables, thus causing differences in consumer behavior [3]. Rice is an important contributor to global food security and is an important staple food for more than half of the world's population [4].

Indonesia is the fourth most populous country in the world. Based on the results of the 2020 Population Census published by the Central Statistics Agency, the population of Indonesia is 270.20 million people. The rapid increase in population each year is a major challenge, especially in terms of food security [5]. In Indonesia, rice consumption (per capita) in 2020, 2021, 2022, and 2023, respectively, was 94.02, 94.38, 93.51, and 93.79 kg [6].

In South Sulawesi Province, Indonesia, rice contributes the highest per capita consumption value. In 2021, rice consumption (per capita per month) reached 7.75 kg or equivalent to IDR 65240.00. The value of rice consumption in urban areas was lower than that in rural areas. Rice consumption (per capita per month) in rural areas was 8.16 kg or equivalent to IDR 69390.00, while in urban areas it was 7.26 kg or equivalent to IDR 60150.00 [6].

*** Corresponding author: Mohammad Natsir,** Master of Agribusiness Study Program, Postgraduate Program, Universitas Muhammadiyah Makassar, Jl. Sultan Alauddin No. 259, Makassar, 90221, Indonesia, e-mail: mohammad.natsir@unismuh.ac.id
Sri Mardiyati: Master of Agribusiness Study Program, Postgraduate Program, Universitas Muhammadiyah Makassar, Jl. Sultan Alauddin No. 259, Makassar, 90221, Indonesia
Syafiuddin Syafiuddin: Doctoral of Agribusiness Study Program, Postgraduate Program, Universitas Muhammadiyah Makassar, Jl. Sultan Alauddin No. 259, Makassar, 90221, Indonesia

The availability of rice with diverse features on the market will influence consumer purchasing decisions, since consumers will buy rice based on their preferences. Important values, namely the largest value indicating the most important rice attributes, were used to determine how consumers consider rice attributes [7]. Rice consumers have their own preferences in determining their choices, which can be influenced by various factors such as cultural environment and purchasing power [8]. Consumer attributes of rice include aroma, softness, whole grains, and purity. With regard to consumer behavior in traditional markets, rice attributes include grain shape, aroma, packaging, and price [9]. Consumer preferences for packaged rice products include attributes of softness, cleanliness, durability, price, and ease of obtaining [10].

Consumers play an important role in choosing rice, so producers must understand consumer preferences. Consumer considerations include packaging, aroma, taste, color, and brand perception, so that these conditions give rise to hedonic prices. Hedonic prices are implicit prices that occur due to certain characteristic elements inherent in the type of product. Consumers determine certain sequences based on the level of importance they believe. The sequence shows a person's lexicographic preference for the product [11].

The price of a product observed from a number of specific characteristics associated with each item is defined as a set of implicit prices or hedonic prices [12]. Meanwhile, according to the study of Freeman III [13], hedonic prices are implicit prices that occur due to certain characteristic elements inherent in a type of product. The general definition of hedonic prices is as follows: price is an indicator to quantify the differences in characteristics of a type of product. Implicitly explained by the studies of Freeman III [13] and Richard [14], hedonic prices from the demand side can be traced from consumer willingness to pay, which is generally abbreviated as WTP.

The hedonic pricing method is a useful approach to examine the relationship between the price and the quality of a product. This method is important for analyzing the relationship between price and product characteristics. From this analysis, the implicit price of a characteristic can be determined by reducing the regression function to the attributes of a product. In general, the price of an item depends on the characteristics inherent in the item [12]. Rosen shows that implicit prices can be interpreted as the additional value given by consumers for each additional unit of characteristics. Similarly, the studies of Rosen [12] and Lancaster [15] explain that the implicit price of a product characteristic is the minimum value that must be paid to the seller to obtain certain characteristics that maximize consumer utility.

Hedonic prices are derived from hedonic theory. The hedonic theory is part of microeconomic theory, which is usually presented when discussing the topic of lexicographic consumer choice. In some studies, it has been reported that lexicographic consumer choice means that consumer choice of a type of commodity is based on a certain set of characteristics, so that consumer choice here is formulated as a non-linear programing problem. Under certain conditions, some results deviate from the standard theory of consumption (including the Slutsky equation) and have an analogy with lexicographic choice [16]. The value of the hedonic price can be traced from the willingness of consumers to pay for certain characteristics of rice they want to consume [17].

Lexicographic preference is a preference that can be ordered, which represents a consumer group with respect to a vector value of the satisfaction function. Lexicographic consumer choice is a consumer choice of a type of commodity based on a certain set of characteristics [17]. A consumer will determine certain sequences based on the level of importance that the person believes. For example, in consuming milk, someone may put price at the top when deciding to buy milk, while for other people nutritional composition such as the presence or absence of additional vitamins and minerals in the milk may place the type of milk in a higher order than price. Motivations for consuming such as bone health or obtaining energy can also be a priority for consumers. The order or ranking shows a person's lexicographic preference for the product [11].

Marketing is based on the concept that consumers are the most important people for marketers. So, the marketing concept emphasizes consumers and identifies various requirements for fulfilling consumer satisfaction. In this concept, consumer satisfaction is the key to the welfare, growth, and ability of a business to survive. A consumer-oriented business will focus on what consumers want to buy, rather than what the company wants to make [15]. Therefore, in the end, consumers play an important role in choosing products that suit the preferences of each individual, so producers must be observant in reading and understanding consumer preferences and strive so that the products produced can meet consumer desires [11].

According to Lancaster's consumer theory, the utility of consuming a commodity is determined by its attributes [15]. Building on this concept, numerous research studies have used stated preference data to investigate consumers' attitudes and valuations of various food attributes. These characteristics are often categorized as intrinsic or extrinsic [18]. Extrinsic attributes cover food labels, product types, appearance, and aroma, while intrinsic attributes are linked to taste quality and nutritional value [19]. Rice can be

classified according to its quality attributes, which include intrinsic, extrinsic, search, experience, and trust attributes. Even among low-income households, there is increasing evidence, primarily from Asia and Africa, indicating consumers' awareness of rice quality attributes [20].

The hedonic pricing approach bases consumers' purchasing decisions on qualitative attributes that match their preferences, while the market pricing approach primarily reflects external economic realities without delving deeply into the qualitative determinants of consumer choices. Research in East Africa aligns with this notion, where consumer decisions were shown to reflect a mix of qualitative assessments (such as grain integrity) alongside price considerations [21]. The hedonic approach also allows for a more segmented understanding of consumer demographics and their quality preferences. Research by Herawati et al. found that different income levels significantly affect the demand for quality attributes across different socioeconomic groups [22]. In contrast, research using the market pricing approach often generalizes consumer behavior across a broader dataset, without this detailed demographic focus [23].

This study aims to analyze the factors that influence the hedonic price of rice (low, medium, and premium quality) and analyze the factors that determine the lexicographic preferences of rice consumers. This research is important for rice producers and traders to better understand consumer behavior in choosing rice based on various attributes, which are represented in the hedonic price function. This research is also important for policy makers, especially in the implementation of rice price policies, because rice is a staple food for the Indonesian population which greatly supports food security.

2 Methods

The basic method used in this study is the descriptive method. The descriptive method is a method for examining the status of a group of people, an object, a set of conditions, a system of thought, or a class of events in the present, which aims to create a description, picture, or painting systematically, factually, and accurately regarding the facts, characteristics, and relationships between phenomena being investigated [24]. The type of research method used is the survey method. According to the study of Sugiyono [25 the survey method is used to obtain data from certain natural (not artificial) places, but researchers carry out treatment in data collection, for example, by distributing questionnaires, tests, structured interviews, and so on.

The location of this study was determined purposively, namely in Makassar City (urban area) and Pangkep Regency (rural area), which are part of the South Sulawesi Province, Indonesia. The population in this study was all rice consumers who shopped at traditional markets and modern markets in the area. Sampling was carried out using the cluster sampling method for urban and rural areas, with 100 observations each, so that the total number was 200 observations.

The type of data collected in this study was primary data. Primary data were obtained by conducting a survey of the source directly, which in this case was rice consumers. Data collection techniques were carried out in two ways, namely observation techniques and interview techniques. Observation techniques are a way of collecting data by means of direct observation carefully and systematically, both participatory and non-participatory. Interview techniques are a way of collecting data by asking respondents directly, through direct interviews with rice consumers at the research location. The interview process was carried out using a data collection tool in the form of a list of questions (questionnaires).

To determine the level of consumer knowledge of the importance of rice quality and attributes, respondents were given the opportunity to answer a series of questions with the help of a questionnaire. To understand the quality of rice (low, medium, or premium), respondents were given 18 questions on a scale of 1–5 (strongly disagree to strongly agree). To find out about rice attributes, respondents were given 9 statements on a scale of 1–5 (very unimportant to very important). All of these statements have been tested for validity and reliability. Conventional demand analysis has generally been widely used, namely by including price variables, income, prices of related goods, and other socio-economic variables. The hedonic pricing method, especially for rice, is more important because it is able to provide a deeper understanding of consumer preferences for rice attributes. Conventional analysis focuses more on price and quantity, while hedonic pricing separates the value of rice based on its attributes such as quality, taste, and texture, thus providing more detailed information about the value perceived by consumers.

The data analysis techniques used were multiple linear regression analysis with the OLS method and multiple regression with binary logit. Both analysis techniques were used to analyze the hedonic price function and lexicographic preferences of rice consumers (Table 1).

WTP or consumer desire to pay is an operational visualization of hedonic prices. The way to measure WTP is by using a hypothetical market method asking several questions. The sequence of questions asked includes: (1) How much is the usual price of rice consumed? (2) Is the

Table 1: Description of attributes and levels for rice

Attribute	Description	Level
Aroma	Smell or fragrance of rice based on the sense of smell	1. Not very fragrant 2. Not fragrant 3. Neutral 4. Fragrant 5. Very fragrant
Cleanliness	The appearance of rice based on the sense of sight regarding the number of foreign objects other than rice, such as stones, and other objects that are not part of the rice, husks or grains of rice.	1. Very unclean 2. Not clean 3. Neutral 4. Clean 5. Very clean
Durability	Durability during storage is a series of consumer assumptions or impressions regarding the durability of rice products, which is indicated by the appearance of rice weevils which can damage the texture of rice grains from whole to incomplete and finally to flour.	1. Very short 2. Not long 3. Neutral 4. Long 5. Very long
Grains	The appearance of rice grains based on the sense of sight regarding the number of whole grains and/or broken grains.	1. Very many broken grains 2. Many broken grains 3. Neutral 4. Few broken grains 5. Very few broken grains
Softness	Stickiness is a series of consumer assumptions or impressions regarding the level of stickiness in rice.	1. Not very sticky 2. Not sticky 3. Neutral 4. Sticky 5. Very Sticky
Whiteness	The degree of whiteness is a series of consumer assumptions or impressions of the color of rice. Rice color is distinguished into dull and white categories.	1. Very dull 2. Dull 3. Neutral 4. White 5. Very white
Packaging	Rice packaging is a series of consumer assumptions or impressions regarding the color and image of the packaging and the packaging materials.	1. Very uninteresting 2. Not interesting 3. Neutral 4. Interesting 5. Very interesting
Brand	A brand is a name, term, sign, symbol or emblem, color, movement, or combination of other product attributes that are expected to provide identity and differentiation from competing products.	1. Very unimportant 2. Not important 3. Neutral 4. Important 5. Very important

price in accordance with the ability or desire to pay with the known properties of the rice? (3) If it does not match the previous question, the usual price paid is: (a) lower or (b) higher than the price you want to pay; 4) How much are you actually willing to pay for the rice? In this last question, the price offer is asked starting from the highest price (where consumers are willing to pay) in succession until a price agreement is reached with the consumer, either above or below the actual market price [26].

Informed consent: Informed consent has been obtained from all individuals included in this study. Responses were completely voluntary and respondents were assured that all answers and information would be used for research purposes only.

Ethical approval: This publication did not require ethical approval as it focuses on rice market activities and does not include any experiments involving human or animal subjects.

2.1 Analysis of the hedonic price function of rice

The hedonic price function shows the relationship between rice prices (low, medium, and premium quality) and rice attributes. The model used in the hedonic price analysis in this study is semilogarithmic inverse regression. Semilogarithmic inverse regression is a regression whose dependent variable is expressed in a logarithmic form [27]. This model is used with the aim of determining the relationship between changes in rice characteristics which are qualitative variables and the percentage change in price. The hedonic price function model for rice used in this study is as follows.

(1) Analysis of the hedonic price function of low quality rice:

$$\ln \mathrm{HBR} = \propto_0 + \propto_1 \ln \mathrm{RA} + \propto_2 \ln \mathrm{RC} + \propto_3 \ln \mathrm{RD} + \propto_4 \ln \mathrm{RG} + \propto_5 \ln \mathrm{SR} + \propto_6 \ln \mathrm{WR} + \propto_7 D1 + e_{\propto}.$$

(2) Analysis of the hedonic price function of medium quality rice:

$$\ln \mathrm{HMR} = \beta_0 + \beta_1 \ln \mathrm{RA} + \beta_2 \ln \mathrm{RB} + \beta_3 \ln \mathrm{RC} + \beta_4 \ln \mathrm{RD} + \beta_5 \ln \mathrm{RG} + \beta_6 \ln \mathrm{RP} + \beta_7 \ln \mathrm{SR} + \beta_8 \ln \mathrm{WR} + \beta_9 D1 + e_{\beta}.$$

(3) Analysis of the hedonic price function of premium quality rice:

$$\ln \mathrm{HPR} = \delta_0 + \delta_1 \ln \mathrm{RA} + \delta_2 \ln \mathrm{RB} + \delta_3 \ln \mathrm{RC} + \delta_4 \ln \mathrm{RD} + \delta_5 \ln \mathrm{RG} + \delta_6 \ln \mathrm{RP} + \delta_7 \ln \mathrm{SR} + \delta_8 \ln \mathrm{WR} + \delta_9 D1 + e_{\delta}.$$

The model was analyzed using the Ordinary Least Squares (OLS) method which was carried out in two stages, namely testing the classical assumptions and testing the model's suitability [27]. The classical assumption test carried out in this study was the multicollinearity and heteroscedasticity test because the data used in this study were cross-sample data. If the classical assumptions were met, then the analysis results used were the results of analysis with OLS. If the classical assumptions were not met, improvements were made and the results were used as a model of the hedonic price function of organic rice. The classical assumption test was intended to determine whether the regression coefficient is the best unbiased estimator (Best Linear Unbiased Estimator).

2.2 Lexicographic preference analysis of rice consumers

In this study, the analysis factors that influence consumer lexicographic preferences in consuming low, medium, and premium quality rice are categorized as follows:

(1) Factors influencing the lexicographic preferences of premium and medium quality rice consumers:

$$\ln\left(\frac{Pf_{\text{pm}}}{1 - Pf_{\text{pm}}}\right) = \theta_0 + \theta_1\text{PR} + \theta_2\text{RA} + \theta_3\text{RB} + \theta_4\text{RC} + \theta_5\text{RD} + \theta_6\text{RG} + \theta_7\text{RP} + \theta_8\text{SR} + \theta_9\text{WR} + \theta_{10}D_1 + e_\theta .$$

(2) Factors influencing the lexicographic preferences of premium and low quality rice consumers:

$$\ln\left(\frac{Pf_{\text{pb}}}{1 - Pf_{\text{pb}}}\right) = \varphi_0 + \varphi_1\text{PR} + \varphi_2\text{RA} + \varphi_3\text{RB} + \varphi_4\text{RC} + \varphi_5\text{RD} + \varphi_6\text{RG} + \varphi_7\text{RP} + \varphi_8\text{SR} + \varphi_9\text{WR} + \varphi_{10}D_1 + e_\varphi.$$

(3) Factors influencing the lexicographic preferences of medium and low quality rice consumers:

$$\ln\left(\frac{Pf_{\text{mb}}}{1 - Pf_{\text{mb}}}\right) = \gamma_0 + \gamma_1\text{PR} + \gamma_2\text{RA} + \gamma_3\text{RC} + \gamma_4\text{RD} + \gamma_5\text{RG} + \gamma_6\text{SR} + \gamma_7\text{WR} + \gamma_8D_1 + e_\gamma.$$

Here, $\propto_0, \beta_0, \delta_0, \theta_0, \varphi_0$, and γ_0 are the intercepts of each regression function, $\propto_1 - \propto_7, \beta_1 - \beta_9, \delta_1 - \delta_9, \theta_1 - \theta_{10}$, $\varphi_1 - \varphi_{10}$, and $\gamma_1 - \gamma_8$ are regression coefficients (parameters), e is the error term, $Pf_{\text{pm}} = 1$ for consumers who chose premium quality rice and $Pf_{\text{pm}} = 0$ for consumers who chose medium quality rice; $Pf_{\text{pb}} = 1$ for consumers who chose premium quality rice and $Pf_{\text{pb}} = 0$ for consumers who chose low quality rice; $Pf_{\text{mb}} = 1$ for consumers who chose medium quality rice and $Pf_{\text{mb}} = 0$ for consumers who chose regular rice; HBR refers to the hedonic price of low quality rice (IDR/kg); HMR indicates hedonic price of medium quality rice (IDR/kg); HPR indicates hedonic price of premium quality rice (IDR/kg). Scoring is applied to variables that include the following: RB = packaged rice brands; PR = rice price; RP = rice packaging; RA = rice aroma; RG = rice grains; RC = rice cleanliness; SR = softness of rice; WR = whiteness of rice; RD = rice durability; D1 = dummy area: 1 = urban and 0 = rural.

3 Results and discussion

3.1 Respondent characteristics

Rice consumers in rural and urban areas have several different characteristics. Rice comes from rural areas, which will then be distributed to various urban areas. This situation will certainly affect the behavior of rice consumers in rural areas because they have high accessibility.

Rice is a staple food for people of South Sulawesi Province, both in rural and urban areas. In rural areas, the average age of rice consumers who were respondents was 46.64 years, slightly older than respondents in urban areas who had an average age of 45.3 years. The lowest level of formal education attained by respondents in rural areas was elementary school, and the highest was a Master's degree, while the dominant level (44%) was high school. The lowest level of formal education for respondents in urban areas was 30% high school, and the highest was a doctorate, while the dominant level (40%) was a Bachelor's degree. This difference can occur because urban areas have higher facilities and infrastructure and environmental support for educational progress.

The main occupation of the respondents was mostly entrepreneurship both in rural areas (49%) and urban areas (46%), with the number of dependents in both areas averaging three people. The household income of respondents in rural areas averaged IDR 4460500.00 per month, while in urban areas it tend to be higher, reaching an average of IDR 7038000.00 per month. This can happen because the population in urban areas is denser, and economic activity is more dynamic, so it has a higher carrying capacity in increasing the household income (Table 2).

Table 2: Characteristics of rice consumer respondents

Characteristics	Rural Average	Urban Average
Age (years)	46.64	45.30
Level of formal education (%)		
Elementary school (SD)	26.00	—
Junior high school (SMP)	8.00	—
Senior high school (SMA)	44.00	30.00
Diploma (D3)	7.00	8.00
Bachelor's degree (S1)	14.00	40.00
Master's degree (S2)	1.00	14.00
Doctorate (S3)	—	8.00
Main occupation (%)		
State civil apparatus (ASN)	12.00	35.00
Private employee	10.00	17.00
Entrepreneur	49.00	46.00
Farmer/Fisherman	11.00	—
Laborer	14.00	1.00
Retired ASN	4.00	1.00
Number of family dependents (persons)	3.06	2.96
Household income (IDR/month)	4460500.00	7038000.00
Amount of rice consumed (kg/month)	27.61	19.49
Quality of rice consumed (%):		
Low quality rice	44.00	20.00
Medium quality rice	39.00	27.00
Premium quality rice	17.00	53.00

Source: Primary data analysis, 2024.

Rice consumption in rural areas averaged 27.61 kg per household per month, higher than in urban areas which only reached 19.49 kg per household per month. This difference can occur because urban areas have easier access to support food diversification (availability of various food sources distributed from rural areas). The quality of rice consumed by people in rural areas was more dominantly low quality rice (40%), while in urban areas the most dominant rice consumption (53%) was premium quality rice. This can happen because most people in rural areas have easier access to fresher rice commodities from local rice milling production, so premium packaged rice is not an option. On the other hand, premium quality rice has a higher price level, so the purchasing power of people in rural areas is lower. Consumer knowledge of rice quality was deemed perfect because of the ease of access of information through product packaging labels, hereditary habits from families and local communities, or directly from information from rice producers or traders.

In rural areas, consumers tend to have more homogeneous consumption patterns, while in urban areas, there is greater diversity in food preferences, influenced by education, income, and lifestyle [28,29]. Migration from rural to urban areas often changes dietary behavior, with urban consumers starting to consume more energy-dense and animal-based foods, reducing their reliance on rice as a staple food [30]. In addition, as income increases in urban areas, the proportion of expenditure on rice tends to decrease, as consumers have greater access to a variety of other food options [28].

3.2 Hedonic price function analysis on lexicographic preferences

3.2.1 Hedonic price function of low quality rice

The hedonic pricing model effectively captures the complexity of consumer preferences in the rice market, depicting how various quality attributes affect pricing. Findings from various studies underscore the importance of quality in driving consumer demand and the economic viability of rice production.

Acceptance, selection, and consumption of food is a complex process impacted by a variety of characteristics, both intrinsic (color, scent, taste, and texture) and extrinsic to the product [31]. Many lower-to-middle-class people achieve their daily calorie requirements at stalls or grocery stores and then buy rice at the same location because it is more convenient [23]. Low quality rice in the South Sulawesi Province is widely available in traditional markets and stalls near residential areas, so accessibility is easier and prices are more affordable (Tables 3–5).

The hedonic price of low quality rice is simultaneously influenced by aroma, cleanliness, durability, grains, degree of whiteness, and rice fluffiness, as well as location dummy, which is 46.05%, while the rest is influenced by other factors not examined in this study. Rice cleanliness significantly has a positive effect on the hedonic price of low quality rice, meaning that if the level of cleanliness of low quality rice

Table 3: Factors influencing the hedonic price of low quality rice

Variable	Coefficient	Standard error	Prob.
Rice aroma	−0.008856	0.009442	0.3495
Rice cleanliness	0.067930***	0.013889	0.0000
Rice durability	0.020805**	0.009995	0.0387
Rice grains	−0.005787	0.011152	0.6044
Rice softness	0.049420***	0.011219	0.0000
Rice whiteness	0.010957	0.011241	0.3309
Location (1: urban; 0: rural)	0.032346***	0.005279	0.0000
Constant	9.123299***	0.023573	0.0000
R^2	0.460474		
F-statistic	23.409720***		

***Significant at α = 1%; **significant at α = 5%; *significant at α = 10%.

Table 4: Factors influencing the hedonic price of medium quality rice

Variable	Coefficient	Standard error	Prob.
Rice aroma	0.001196	0.005068	0.8137
Rice brand	−0.002537	0.004535	0.5764
Rice cleanliness	0.022692***	0.007326	0.0022
Rice durability	−0.017306***	0.005464	0.0018
Rice grains	−0.005225	0.005888	0.3760
Rice packaging	0.016149***	0.004769	0.0009
Rice softness	0.007084	0.006030	0.2415
Rice whiteness	0.013181**	0.005913	0.0270
Location (1: urban; 0: rural)	−0.008893***	0.002809	0.0018
Constant	9.357544***	0.012476	0.0000
R^2	0.186225		
F-statistic	4.831071***		

***Significant at α = 1%; **significant at α = 5%; *significant at α = 10%.

increases by 1%, the hedonic price of low quality rice will increase by 0.0679%.

The durability of rice in storage has a positive effect on the hedonic price of low quality rice, meaning that if the level of durability of low quality rice increases by 1%, the hedonic price of low quality rice will increase by 0.0208%. The level of rice fluffiness has a positive effect on the hedonic price of low quality rice, meaning that if the level of rice fluffiness increases by 1%, the hedonic price of low quality rice will increase by 0.0494%. The urban area dummy has a positive effect on the hedonic price of low quality rice, meaning that in urban areas the increase in the hedonic price of low quality rice will reach 0.03235% compared to rural areas.

Table 5: Factors influencing the hedonic price of premium quality rice

Variable	Coefficient	Standard error	Prob.
Rice aroma	0.007759*	0.004672	0.0984
Rice brand	−0.010752**	0.004180	0.0109
Rice cleanliness	−0.005801	0.006753	0.3914
Rice durability	−0.017480***	0.005037	0.0006
Rice grains	−0.003420	0.005427	0.5293
Rice packaging	−0.015167***	0.004396	0.0007
Rice softness	0.004025	0.005558	0.4698
Rice whiteness	0.015942***	0.005450	0.0039
Location (1: urban; 0: rural)	−0.022326***	0.002589	0.0000
Constant	9.519467***	0.011500	0.0000
R^2	0.492819		
F-statistic	20.513300***		

***Significant at α = 1%; **significant at α = 5%; *significant at α = 10%.

The relationship between rice quality and price is further supported by research conducted in various regions. For example, Peterson-Wilhelm et al. examined consumer preferences in Nigeria and found that homogeneous long slender kernels are preferred, with consumers showing indifference to chalkiness [32]. This specificity in consumer preferences underscores the need for producers to focus on quality attributes that align with market demands.

Additionally, the study by Kawamura et al. in Laos emphasized the significance of visual characteristics in determining rice prices, suggesting that grading systems based on physical quality can enhance the market efficiency [33]. This aligns with the broader understanding that consumer perceptions of quality, influenced by visual and sensory attributes, are critical in shaping market dynamics.

3.2.2 Hedonic price function of medium quality rice

One of the primary attributes that consumers consider when selecting rice is its appearance, particularly color and texture. Research indicates that Asian consumers exhibit a strong preference for white rice due to its visual appeal and perceived quality [34]. The texture of rice, including its chewiness and stickiness, also plays a significant role in consumer acceptance. Studies have shown that consumers often prefer rice varieties that are less sticky and have a desirable mouthfeel, which enhance the overall eating experience [35]. This preference for texture is influenced by cultural practices surrounding rice consumption in different regions [36].

The results of this study indicate that the hedonic price of medium quality rice is simultaneously influenced by aroma, brand, cleanliness, durability, grains, packaging, rice fluffiness, and whiteness, as well as location dummy, which is 18.62%, while the rest is influenced by other factors not studied. Rice aroma, rice brand, rice grains, and rice fluffiness do not have a significant effect on the hedonic price of medium quality rice. According to the findings of the study by Antriyandarti et al. [23], rice brands have little influence on rice purchasing decisions since many individuals ignore them and instead look for rice based on their requirements and quality.

Rice cleanliness significantly has a positive effect on the hedonic price of medium quality rice, meaning that if the rice cleanliness level increases by 1%, the hedonic price of medium quality rice will increase by 0.0227%. Rice durability has a negative effect on the hedonic price of medium quality rice, meaning that if the rice durability level increases by 1%, the hedonic price of medium quality rice will decrease by 0.0173%.

Rice packaging has a positive effect on the hedonic price of medium quality rice, meaning that if the packaging

quality level increases by 1%, the hedonic price of medium quality rice will increase by 0.016149%. The degree of whiteness of rice has a positive effect on the hedonic price of medium quality rice, meaning that if the degree of whiteness of rice increases by 1%, the hedonic price of medium quality rice will increase by 0.013181%. The urban area dummy has a negative effect on the hedonic price of medium quality rice, meaning that in urban areas the hedonic price of medium quality rice will decrease by 0.013181% compared to rural areas.

3.2.3 Hedonic price function of premium quality rice

WTP for specific rice attributes is an important aspect of consumer behavior. Various studies have shown that consumers are often willing to pay more for rice that meets their quality standards, such as a low percentage of broken grain or improved nutrient content [37,38]. This WTP reflects the intrinsic value that consumers place on certain rice characteristics, which producers can leverage to increase market competitiveness.

The hedonic price of premium quality rice is simultaneously influenced by aroma, brand, cleanliness, durability, grains, packaging, rice softness, and whiteness, as well as a location dummy, which is 49.28%, while the rest is influenced by other factors that were not studied. In line with this, research of Twine et al. [39] reveals that consumers are willing to pay higher prices for head rice, slender grains, peak viscosity, parboiled rice, and rice marketed in urban marketplaces. According to the research of Twine et al. [21 Ugandan consumers are willing to pay a premium price for rice that contains a high proportion of undamaged grains, but they overlook chalkiness.

The aroma of rice has a significant positive effect on the hedonic price of premium quality rice, meaning that if the aroma level of rice increases by 1%, the hedonic price of premium quality rice will increase by 0.007759%. The brand of rice has a significant negative effect on the hedonic price of premium quality rice, meaning that if the brand of rice increases by 1%, the hedonic price of premium quality rice will decrease by 0.010752%.

The durability of rice has a negative effect on the hedonic price of premium quality rice, meaning that if the durability level of rice increases by 1%, the hedonic price of premium quality rice will decrease by 0.01748%. Rice packaging has a positive effect on the hedonic price of premium quality rice, meaning that if the quality level of packaging increases by 1%, the hedonic price of premium quality rice will increase by 0.015167%. The degree of whiteness of rice has a positive effect on the hedonic price of premium quality rice, meaning that if the degree of whiteness of rice increases by 1%, the hedonic price of premium quality rice will increase by 0.015942%. The urban area dummy has a negative effect on the hedonic price of premium quality rice, meaning that in urban areas the hedonic price of premium quality rice will decrease by 0.022326% compared to rural areas.

Research has shown that various quality attributes significantly influence consumers' WTP. The application of hedonic pricing methods to analyze consumer preferences in Benin revealed that attributes such as grain length, color, and the presence of broken grains play a significant role in determining market prices. Their findings indicate that consumers are willing to pay a premium price for rice that meets certain quality standards, highlighting the importance of quality in the rice market [40].

3.3 Factors influencing the lexicographic preference of rice consumers

3.3.1 Consumer preferences for premium quality rice and medium quality rice

Factors influencing preference are the intrinsic and extrinsic quality of rice. The importance of quality attributes such as cleanliness, grain size, and taste in influencing consumer preferences for local and imported rice [41]. In Southeast Asia, premium quality is defined by nutritional advantages, softness, and perfume, whereas in South Asia it is defined by grain appearance (uniformity, whiteness, and slenderness), satiation, and aroma [42].

Consumer preferences for premium and medium quality rice are simultaneously influenced by price, aroma, brand, cleanliness, durability, grains, packaging, softness, degree of whiteness, and location dummy, with a significant influence of 20.76%. The logit regression equation model for this consumer preference is fit and feasible with the results of the Hosmer–Lemeshow tests (H–L statistic) of 0.8678 (p-value > 0.05). Consumer preferences for premium and medium quality rice are significantly influenced by rice aroma, rice brand, degree of whiteness of rice, and area dummy (urban and rural).

Rice aroma has a positive effect on consumer preferences, meaning that if the rice aroma score increases by one unit, then the consumer's chance of choosing premium

Table 6: Factors that determine consumer preferences for premium and medium quality rice choices

Variable	Coefficient	Prob.	Odds ratio
Rice price	−0.129634	0.5721	0.8784
Rice aroma	0.442208*	0.0647	1.5561
Rice brand	0.580788**	0.0156	1.7874
Rice cleanliness	−0.425498	0.1629	0.6534
Rice durability	0.340815	0.1655	1.4061
Rice grains	0.273123	0.3368	1.3141
Rice packaging	−0.272936	0.2570	0.7611
Rice softness	0.283672	0.2722	1.3280
Rice whiteness	−0.555475*	0.0540	0.5738
Location (1: urban; 0: rural)	1.628664***	0.0006	5.0971
McFadden *R*-squared	0.207643		
LR-statistic	38.821910***		
H–L statistic	0.867800		

***Significant at α = 1%; **significant at α = 5%; *significant at α = 10%.

quality rice is 1.5561 higher than choosing medium quality rice. The higher the consumer's assessment of the rice aroma, the higher the consumer's chance of choosing premium quality rice. Rice brand has a positive effect on consumer preferences, meaning that if the rice brand score increases by one unit, then the consumer's chance of choosing premium quality rice is 1.7874 higher than choosing medium quality rice (Table 6). The higher the consumer's assessment of the rice brand, the higher the consumer's chance of choosing premium quality rice.

The degree of whiteness of rice has a negative effect on consumer preferences; this shows that if the whiteness of rice increases by one unit, the consumer's chance of choosing premium quality rice is 0.5738 lower than choosing medium quality rice. The higher the consumer's assessment of the degree of whiteness of rice, the lower the consumer's chance of choosing premium quality rice. The location dummy variable has a positive effect on consumer preferences for rice, and rice consumers in urban areas have a 5.0971 higher chance of choosing premium quality rice than in rural areas. This indicates that urban rice consumers are very likely to choose premium quality rice, while rural rice consumers tend to choose medium quality rice.

According to the study of Bidarti and Husin [43], urban consumers still stick to premium quality rice consumption because they already have sufficient awareness and knowledge about the ins and outs of rice. According to the research of Walisinghe and Gunaratne [44], the kind, color, and purity of rice were the most significant of the four qualities, whereas price was not. Part worth assessments revealed that purity is the most significant factor in choosing a type of rice.

3.3.2 Consumer preferences for premium and low quality rice

In various regions, rice consumers exhibit distinct preferences that are influenced by both sensory attributes and socio-economic factors. For instance, studies indicate that consumers in Southeast Asia prioritize attributes such as taste, aroma, and texture, with a notable preference for white rice due to its visual appeal and cooking qualities [34,45,46]. In contrast, consumers in regions like Africa show a growing interest in local rice varieties, driven by factors such as availability, taste, and the absence of foreign materials [47–49]. This suggests that while the lexicographic model emphasizes certain attributes, the context of the consumer's environment and socio-economic status plays a crucial role in shaping these preferences.

Consumer preferences for premium quality rice and low quality rice are simultaneously influenced by price, aroma, brand, cleanliness, durability, grains, packaging, softness, whiteness, and location dummy, with a significant influence of 29.52%. The logit regression equation model for consumer preferences for premium and regular quality rice is fit and feasible with the results of the H–L statistic of 0.2195 (p-value > 0.05). Consumer preferences for premium quality rice and low quality rice are partially and significantly influenced by price, brand, packaging, and area dummy (urban and rural).

Rice prices have a negative effect on consumer preferences for premium quality rice and low quality rice; this shows that if the price of rice increases by one unit, the consumer's chance of not choosing premium quality rice is 0.5310 higher than choosing low quality rice. Rice brands have a positive effect on consumer preferences; this means that if the rice brand score increases by one unit, the consumer's chance of choosing premium quality rice is 2.5719 higher than the preference for low quality rice. The higher the consumer's branding of the rice brand, the higher the consumer's chance of choosing premium quality rice (Table 7).

Rice packaging has a negative effect on consumer preferences for premium and regular quality rice, meaning that if the rice packaging score increases by one unit, the consumer's chance of choosing premium quality rice is 0.5708 lower than the preference for low quality rice. The higher the consumer's assessment of rice packaging, the lower the consumer's chance of choosing premium quality rice. This indicates that consumers of regular quality rice are not affected by the existence of increasingly attractive rice packaging. The location dummy variable has a positive effect on consumer preferences for premium and regular quality rice, and rice consumers in urban areas have a 6.9495 higher chance of choosing premium quality rice

Table 7: Factors that determine consumer preferences for premium and low quality rice choices

Variable	Coefficient	Prob.	Odds ratio
Rice price	−0.632903**	0.0217	0.5310
Rice aroma	0.030784	0.9233	1.0313
Rice brand	0.944663***	0.0004	2.5719
Rice cleanliness	−0.444627	0.1888	0.6411
Rice durability	0.300979	0.3127	1.3512
Rice grains	0.358908	0.2262	1.4318
Rice packaging	−0.560758**	0.0330	0.5708
Rice softness	0.300719	0.3187	1.3508
Rice whiteness	−0.045181	0.8872	0.9558
Location (1: urban; 0: rural)	1.938669***	0.0001	6.9495
McFadden *R*-squared	0.295212		
LR-statistic	54.374840***		
H–L statistic	0.219500		

***Significant at α = 1%; **significant at α = 5%; *significant at α = 10%.

Table 8: Factors that determine consumer preferences for medium and low quality rice choices

Variable	Coefficient	Prob.	Odds ratio
Rice price	−0.662021***	0.0058	0.5158
Rice aroma	−0.368537*	0.0972	0.6917
Rice cleanliness	−0.037667	0.8950	0.9630
Rice durability	−0.142699	0.4919	0.8670
Rice grains	0.523787**	0.0415	1.6884
Rice softness	−0.021402	0.9289	0.9788
Rice whiteness	0.326003	0.1670	1.3854
Location (1: urban; 0: rural)	0.351668	0.3931	1.4214
McFadden *R*-squared	0.093328		
LR-statistic	16.816500**		
H–L statistic	0.371800		

***Significant at α = 1%; **significant at α = 5%; *significant at α = 10%.

than those in rural areas. This indicates that urban rice consumers have a very strong tendency to choose premium quality rice, while rural rice consumers tend to choose regular quality rice.

Consumer attitudes regarding bulk rice and packaged rice are assessed, and some qualities, such as expiration clarity (in both bulk and packaged rice), convenience of getting (in bulk rice), and content, are found to be positive. Positive qualities identify the important aspects influencing consumers' attitude and preferences while making purchasing decisions [50].

3.3.3 Consumer preferences for medium and low quality rice

The results of this study indicate that consumer preferences for medium quality rice and low quality rice are simultaneously influenced by price, aroma, cleanliness, durability, grains, softness, whiteness, and location dummy, with a significant influence of 9.33%. The logit regression equation model for consumer preferences for medium and low quality rice is fit and feasible with a H–L statistic value of 0.3718. Consumer preferences for medium and low quality rice are partially and significantly influenced by price, aroma, and rice grains.

Research has shown that attributes such as grain length, stickiness, and the presence of broken grains significantly influence consumer choices [38,51]. For example, in Indonesia, consumers demonstrated a preference for long-grain rice that is less sticky, aligning with their culinary practices [43,52]. Similarly, in Ghana, the perceived quality of rice, including its appearance and cooking characteristics, heavily influences consumer preferences, often leading to a preference for imported rice over local varieties [49,53] (Table 8).

Rice price has a negative effect on consumer preference; this means that if the price of rice increases by one unit, the consumer's chance of choosing medium quality rice is 0.5158 lower than the choice of low quality rice. Rice aroma has a negative effect on consumer preference, meaning that if the rice aroma increases by one unit, the consumer's chance of choosing medium quality rice is 0.6917 lower than the preference for low quality rice. The higher the consumer's assessment of the aroma of rice, the lower the consumer's chance of choosing medium quality rice. This indicates that low quality rice consumers are not affected by the strengthening of the aroma of rice. Rice grains have a positive effect on consumer preference; the higher the level of intactness of the rice grains, the more likely consumers are to choose medium quality rice, about 1.6884 higher than choosing low quality rice.

According to the research of Shiratori et al. [54], Malagasy people have various distinguishing qualities, such as a preference for indigenous, unscented rice, whereas many Africans prefer aromatic imported rice. Consumers' top three considerations for selecting local rice were attractive grains, quality packaging, and the absence of foreign materials in rice. There were indications of an increase in demand for high-quality local rice [47].

The lexicographic preference model can be further understood through the perspective of WTP for specific rice attributes. Consumers are often willing to pay more for rice that meets their desired quality standards, such as a low percentage of broken grain or improved nutrient content [55–57]. This WTP reflects the underlying value that consumers place on specific rice attributes, which

Table 9: Robustness check for hedonic price determinants of low quality rice

Variable	Original model	Model 1	Model 2	Model 3
Rice aroma	−0.008856	−0.011759	0.007133	−0.004859
Rice cleanliness	0.067930***	0.064705***	0.037892*	0.079107***
Rice durability	0.020805**	0.018902*	−0.043846***	0.047048***
Rice grains	−0.005787	−0.004053	−0.019844	0.005411
Rice softness	0.049420***	0.044910***	0.008821	0.065477***
Rice whiteness	0.010957	0.012228	0.058741***	0.003104
Rice brand		0.020445**		
Location (1: urban; 0: rural)	0.032346***	0.030671***		
Constant	9.123299***	9.116172***	9.280960***	9.045517***
R^2	0.460474	0.476511	0.226714	0.485164
F-statistic	23.409720***	21.73246***	4.544338***	14.60668***
Number of observations	200	200	100	100

***Significant at α = 1%; **significant at α = 5%; *significant at α = 10%.

producers can leverage to improve market competitiveness. Consumer lexicographic preferences for rice are shaped by complex interactions between sensory attributes, socioeconomic factors, and WTP. Understanding these preferences is important for stakeholders in the rice supply chain, as it can inform breeding programs, marketing strategies, and policy decisions aimed at improving rice quality and consumer satisfaction.

3.4 Robustness checks

Robustness checks are a way for researchers to examine the behavior of certain core regression coefficient estimates when the regression specification is modified by adding or removing regressors. If the coefficients are reasonable and robust, they can be interpreted as evidence of structural validity [58]. In this study, robustness check was conducted to test the sensitivity and consistency of the research results using the main model. Robustness checks that have been conducted for the hedonic price determinants of low, medium, and premium quality rice are explained in Tables 9–11.

Robustness check for hedonic price determinants of low-quality rice was conducted by modifying model 1, model 2, and model 3. Model 1 is a modification of the regression model that adds the rice brand variable, while model 2 and model 3 separate urban and rural areas by reducing the number of observations. The results of robustness check of the three models indicate that the regression model for hedonic price determinants of low-quality rice is proven to be robust. The results still show significant variables, such as rice cleanliness, rice softness, rice whiteness, and location

Table 10: Robustness check for hedonic price determinants of medium quality rice

Variable	Original model	Model 1	Model 2	Model 3
Rice aroma	0.001196	0.003970	0.002305	0.006209
Rice brand	−0.002537		−0.017604**	0.012776***
Rice cleanliness	0.022692***	0.022739***	0.010012	0.029776***
Rice durability	−0.017306***	−0.012387**	−0.036287***	−0.008904*
Rice grains	−0.005225	−0.003512	−0.012683	−0.002663
Rice packaging	0.016149***		0.025509***	0.003751
Rice softness	0.007084	0.009778	0.015938	−0.003632
Rice whiteness	0.013181**	0.014011**	0.038976***	0.001814
Location (1: urban; 0: rural)	−0.008893***	−0.008013**		
Constant	9.357544***	9.356728***	9.361693***	9.354194***
R^2	0.186225	0.137072	0.295794	0.325997
F-statistic	4.831071***	4.356895***	4.777936***	5.501768***
Number of observations	200	200	100	100

***Significant at α = 1%; **significant at α = 5%; *significant at α = 10%.

Table 11: Robustness check for hedonic price determinants of premium quality rice

Variable	Original model	Model 1	Model 2	Model 3
Rice aroma	0.007759*	0.006529	−0.003630*	0.009221
Rice brand	−0.010752**		−0.006990***	−0.008305
Rice cleanliness	−0.005801	−0.007455	−0.006064*	−0.002057
Rice durability	−0.017480***	−0.017993***	0.004544*	−0.027892***
Rice grains	−0.003420	−0.002366	−0.000739	−0.002898
Rice packaging	−0.015167***	−0.016695***	0.005872***	−0.031860***
Rice softness	0.004025	0.001961	0.001293	0.014043
Rice whiteness	0.015942***	0.016674***	−0.000059	0.015449*
Location (1: urban; 0: rural)	−0.022326***	−0.023105***		
Constant	9.519467***	9.515726***	9.471978***	9.529102***
R^2	0.492819	0.475155	0.333881	0.372088
F-statistic	20.513300***	21.614620***	5.701519***	6.740589***
Number of observations	200	200	100	100

***Significant at α = 1%; **significant at α = 5%; *significant at α = 10%.

(urban and rural) with a direction consistent with the original model (Table 9). Different regression models do not change the main results of the study, and the *F* test (over all test) is proven to be all significant, indicating that the estimation results are proven to be robust.

The hedonic price determinants of medium quality rice were robustness checked by modifying model 1, model 2, and model 3. Model 1 is a modification of the regression model by reducing the variables of rice brand and rice packaging, while models 2 and 3 separate urban and rural areas by reducing the number of observations. These results indicate that the regression model for the hedonic price determinants of medium quality rice is proven to be robust because it still shows significant variables, such as rice cleanliness, rice packaging, rice whiteness, and location (urban and rural) with a direction consistent with the original model (Table 10). The different regression models did not change the main results of the study, and the *F* test (over all test) was proven to be significant, indicating that the estimation results were proven to be strong.

The hedonic price determinants of premium quality rice were robustness checked by changing them into model 1, model 2, and model 3. Model 1 is a modification of the regression model by reducing the rice brand variable, while models 2 and 3 separate urban and rural areas by reducing the number of observations. These results indicate that the regression model for the hedonic price determinants of premium quality rice is proven to be robust because it still shows significant variables, such as rice durability, rice packaging, rice whiteness, and location (urban and rural) that are consistent with the original model (Table 11).

In model 1, model 2, and model 3, the main results of the study did not change, and the *F* test (over all test) also proved significant, which indicate that the estimation results of the hedonic price determinants of premium quality rice are proven to be robust. Model 2, which focuses on urban areas for premium quality rice consumers, shows significant estimation results in the opposite direction, namely rice durability and rice packaging. This indicates that for urban rice consumers, the higher/better the level of rice durability and packaging, the higher the price of premium quality rice. The results of the study [39] showed that consumers are willing to pay premium prices for head rice, slender grains, peak viscosity, parboiled rice, and rice sold in urban markets.

The application of lexicographically ordered models can raise issues around transitive relations. Many studies have shown that individuals frequently violate transitive preferences, suggesting that people may not consistently rank their preferences in a way that aligns with the structure assumed by lexicographic models [59,60]. These transitivity violations reveal a fundamental weakness in the lexicographic assumption, as they suggest that strict hierarchies may fail to capture the dynamic nature of human preferences and decision-making pathways.

4 Conclusions

The hedonic price of bulk quality rice is significantly influenced by cleanliness, durability, rice fluffiness, and location dummy (rural and urban). The higher the level of rice cleanliness, rice durability, rice fluffiness, and urban location, the higher the influence on the increase in the hedonic price of low quality rice. The hedonic price of medium quality rice is significantly influenced by

cleanliness, durability, packaging, degree of whiteness, and location dummy. The higher the level of rice cleanliness, rice packaging, and rice whiteness, the higher the influence on the increase in the hedonic price of medium quality rice. Rice durability has the opposite effect on the hedonic price of medium quality rice, namely the higher the durability of rice in storage, the lower the hedonic price of medium quality rice. The hedonic price of medium quality rice in urban areas will tend to decrease compared to rural areas. The hedonic price of premium quality rice is significantly influenced by aroma, brand, durability, packaging, degree of whiteness, and location dummy. The higher the level of rice aroma and rice whiteness, along with urban locations, the higher the influence on the increase in the hedonic price of premium quality rice. Brand, durability, and rice packaging have opposite effects on the hedonic price of premium quality rice, namely the higher the influence of these variables, the lower the hedonic price of premium quality rice.

Factors that significantly influence consumer lexicographic preferences for premium and medium quality rice are aroma, brand, degree of whiteness of rice, and location dummy. The better the aroma and brand of rice, the more the consumers tend to choose premium quality rice than medium quality rice. The higher degree of whiteness of rice will decrease consumer interest in choosing premium quality rice, and urban location also influences consumers to choose premium quality rice.

Factors that significantly influence consumer lexicographic preferences for premium quality rice and low quality rice are price, brand, packaging, and location dummy. The stronger the brand of packaged rice and being located in urban areas, the more the consumers tend to choose premium quality rice over low quality rice. The higher the price of rice and the better the rice packaging will actually reduce consumer interest in choosing premium quality rice over low quality rice.

Factors that significantly influence consumer lexicographic preferences for medium quality rice and low quality rice are price, aroma, and rice grains. The higher the level of intactness of the rice grains, the more consumers tend to choose medium quality rice over low quality rice. The higher the price of rice and the higher its aroma will reduce consumer interest in choosing medium quality rice over low quality rice.

Strategic policy implications related to rice consumer lexicographic preferences that can be followed up through effective approaches are through specific interventions such as targeted input subsidies and public awareness campaigns on sustainability. With the advancement in information technology and social media, governments and non-governmental organizations can increase public awareness of product quality, especially regarding sustainability and environmentally friendly agricultural practices.

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